

## Chapter

# **The Effects of Process Characteristics on the Value of B2B E-Procurement**

Michael J. Shaw and Chandrasekar Subramaniam

*Department of Business Administration, University of Illinois at Urbana-Champaign*

**Abstract:** In the previous chapter, we address the issue of value of B2B e-procurement by proposing a valuation framework. Of the three levels of factors identified, the process-related factors are closest to the locus of Web impact and most fundamental in determining the value. In this chapter, we focus on the effect of process characteristics on the value by the dual approach of empirical study and analytical modeling. We use an empirical study to highlight value differences caused by process types. We then develop a more comprehensive economic model to capture theoretically the effects of process types, as well as demand volume and process complexity. The integration of theoretical and empirical approaches provides a strong foundation to develop and evaluate useful adoption strategies for B2B e-procurement.

**Key words:** Value of B2B e-procurement, Measurement of value, Process types

## **1. INTRODUCTION**

In the previous chapter, we introduced a valuation framework to determine the value of an e-procurement system and proposed how process characteristics, organization of business units and the extended enterprise affect the value. In this chapter, we use the framework to focus on the role of process characteristics in determining the value of B2B e-commerce, through a dual approach of empirical study and analytical modeling. Process

related factors are closest to the locus of Web-impact and differences in process characteristics have a profound impact on the value realized from e-procurement. Our study and analysis validates part of our framework relating to the process characteristics, such as type and complexity. However, it also brings out the interesting interaction effects of type and complexity. This chapter is organized as follows. We review the major issues relating to the value of e-procurement and the effect of process characteristics on the value. We then present our findings from an empirical study. Following this, we develop an economic model to analytically evaluate e-procurement value and to gain insights into how, in addition to procurement type, other process factors may affect value. We conclude by pointing out the implications for e-procurement design and implementation based on the insights gained about the process effects.

## **2. VALUE OF WEB-BASED B2B PROCUREMENT SYSTEM**

We have seen in the previous chapter that a Web-based procurement system provides benefits by reducing the human efforts involved in search, coordination and processing of transactions. In addition, the greater visibility of enterprise-wide data enables managers to negotiate better terms and conditions while contracting with suppliers. One way to derive the value of the system is to quantify the impacts of the Web on the critical performance measures of B2B processes. The impacts are dependent on the level of inefficiencies in the current processes and the extent to which they can be reduced by using the Web. For example, a current process that involves many fragmented steps, multiple points of manual input and delays can benefit dramatically by the use of Web. On the other hand, a process that is currently efficient will benefit only to the extent of reduction in the use of manual labor, and the resultant value may be modest. The impacts are also dependent on the ability of the organization to use the Web to increase its bargaining power with its suppliers and derive benefits in the form of better terms and conditions, one of which is lower total price for procuring and consuming the products.

Given this conceptualization of the value of a B2B system and the effect of within firm level factors on the value, organizations need a practical methodology to measure this value and understand its implications for their adoption strategies. Knowing the conditions that affect the value helps organization identify the business units or processes that can show maximum

positive impact, and can be taken up for initial implementation. Thus, the major research questions are:

1. How to measure the economic value of e-procurement?
2. How do process characteristics affect the value?
3. What implications do the process characteristics and their influence on value have for implementation strategies of e-procurement solutions?

### **3. A REVIEW OF THE EVALUATION METHODOLOGY**

The evaluation methodology is based on the integration of an analytical model with empirical field study. We first develop a valuation framework, based on the principle that the capabilities of e-procurement solutions are used to support and enhance B2B tasks, which have impact on a set of intermediate variables. These intermediate variables lead to improvement in the B2B performance variables. The value is determined by measuring the improvements achieved in the performance variables by the use of e-procurement solution. Using empirical data from a large organization, we look at the effect of process characteristics on the value of e-procurement. We then use an analytical model to capture the theoretical relationship between the value and the factors that affect the value. The analytical model provides us with more insights into the independent effect of process characteristics and also on the combined effect of other factors on the value of e-procurement.

#### **3.1 Evaluation framework**

Based on the capabilities of the e-procurement system discussed in section 2, there are two critical B2B measures that are affected – the transaction costs of procurement and the price paid for the items procured. Our evaluation methodology is based on the quantification, both theoretically and empirically, of the changes in these two measures. In order to capture the opportunity costs, we introduce the lock-in costs of choosing a particular e-procurement solution. Thus, the economic value of e-procurement is the sum of the *price benefits, transaction cost benefits and technology lock-in costs* (Subramaniam and Shaw, 2001).

Even though the use of Web benefits all B2B transactions, the fact is that not all transaction processes are similar in terms of their search requirements, processing time and efforts and errors. We can expect the characteristics of the B2B process to greatly influence the realization of the benefits and hence the *first level of evaluation is B2B process*. The extent of decentralization in the current procurement system differs in different business units. As the major driver of the price benefits is the increase in centralization, the value will depend on the level of change in centralization achieved in each business unit. Hence, the *next level of evaluation is organization of the business unit within a firm*. The scope of B2B operations goes beyond the buying enterprise and extends to the “extended enterprise”<sup>1</sup>, to include all suppliers and other business partners. However, all business partners do not have the same characteristics to adopt e-procurement. We expect that the value of a Web-based system for each participant is different and thus, the *third level of evaluation is the extended-enterprise / supply chain*. The overall value framework is shown in figure 1.

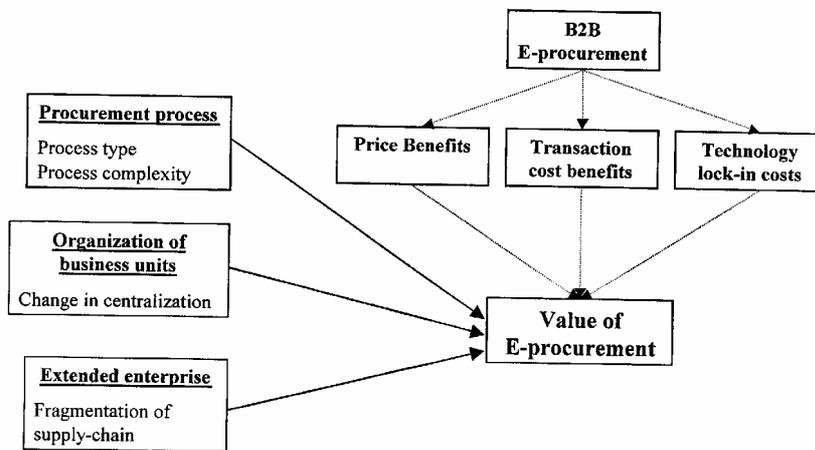


Figure 1. Valuation framework for the value of e-procurement

<sup>1</sup> The term “extended enterprise” refers to an expanded scope of studying the impact of Web-based information systems beyond the traditional organizational boundaries. In our study, we use it to refer to the B2B processes and issues from the perspective of a buying organization. “Extended enterprise” includes the internal user, the procurement department, and business units of the enterprise, along with its immediate suppliers and suppliers of these suppliers, up to the last tier of supplier whose inputs are used by the buyer enterprise.

We use this evaluation framework to first study the e-procurement efforts of a large organization, focusing on the process level characteristics that cause differences in the value. We then develop a more complete analytical model to study the effect of the factors on the value from a more theoretical perspective.

### **3.2 Empirical study**

Our empirical research site is a large manufacturer of heavy equipment located in the mid-west. The electronic commerce initiative was started with a study of the costs and benefits of a Web-based electronic catalog enabled procurement system for purchasing indirect materials. Indirect purchases account for nearly \$2-3 billion annually and hence the organization saw potential for significant cost reduction. The research team interviewed the users, purchasing analysts, purchasing managers at the individual business units and at the corporate office, and information system team in charge of developing the system. The time and cost savings by using a Web-based system for specific procurement related tasks were obtained through an internal study of users in the buyer's organization.

### **3.3 Analytical approach**

The economic value of e-procurement solution for a given "product category", expressed in terms of the various critical factors, has been discussed earlier (Subramaniam and Shaw, 2001) and forms the basis for our economic analysis. In this model, we derive the three components based on the critical factors that drive the costs and benefits and how the Web impacts those factors, in turn affecting the value.

**Price benefits:** The price benefits are derived as a result of better demand management capability of e-procurement systems. Web-based systems provide a centralized and more accurate visibility of the enterprise-wide procurement of products and services. This helps to consolidate the demand at the enterprise-level and negotiate lower prices with suppliers. Using a demand function, the price benefits are calculated as the difference between a lowest negotiated contract price and average market price for a product (or product category).

**Transaction cost benefits:** The transaction costs benefits represent savings in search, negotiation and contracting, and coordination costs.

Search costs relate to the efforts of the user in locating the appropriate product and supplier. Negotiation and contracting costs represent the costs of bidding, evaluating and selecting the supplier and writing the contract with the selected supplier. Coordination costs are incurred to process the purchase requests, follow-up on the orders placed and coordinate other related processes, such as agency approvals and logistical arrangements.

**Technology lock-in costs:** This is more a cost, rather than a benefit. By implementing a particular type of system, the enterprise essentially “locks” itself into a technology solution and incurs switching costs to move its transaction to a different procurement model. Thus, these costs reduce the extent of the benefits realized from the use of a specific Web-based procurement system. However, lock-in also protects the buyer enterprise from costs due to uncertainty in the supply market.

The economic value ( $V_i$ ) for a product category  $i$ , based on the three components, can be formally derived and is given as (McGuire and Staelin, 1983; Subramaniam and Shaw, 2001; Trivedi, 1998):

$$V_i = \frac{(A_i - q_i)\beta\delta q_i}{1 - \theta(1 - \rho)} + kf\rho((1 - \theta) + (1 + q_i)(n + \beta(1 - n))) - r(\rho(1 - \theta) - f)q_i$$

where,  $A_i$  = demand when price and product substitution are zero

$q_i$  = the demand for product category  $i$

$\beta$  = increase in degree of centralization

$\delta$  = rate of price decrease with increase in centralization

$\theta$  = product substitution factor

$\rho$  = process complexity

$f$  = degree of fragmentation in the product supply chain

$k$  = constant reflecting unit cost of search, negotiation and coordination efforts

$r$  = constant reflecting unit technology lock-in cost

$n$  = number of business units

The factors  $\beta, \delta, \theta, \rho$  and  $f$  are between 0 and 1.

With this formulation of economic value, we are interested in how it responds to the variations in the characteristics of process, business unit and supply chain. However, at the business unit level and supply chain level of analysis, the effect on value is an aggregation of the effects on the processes of the business unit or the supply chain. Hence, understanding the process

characteristics and their effect on the value is a critical step and is the focus of this chapter.

#### **4. THE E-PROCUREMENT PROCESS CHARACTERISTICS**

An important suggestion in IT value literature is to use transaction level variables to more precisely understand the impact of technology. The differences in transaction costs are caused by differences in the attributes of transactions, and analysis of these costs is facilitated by making the transaction as unit of analysis (Williamson, 1996). But in our analysis, we are interested in the aggregated behavior of similar transactions and hence look at the underlying processes that support the transactions. Also, researchers have suggested that value analysis, in order to overcome the confounding effects of macro level studies, should always consider the process context in which the system is being deployed (Barua, et.al., 1995; Davern and Kauffman, 1989).

Transaction cost economics identifies asset specificity, transaction frequency and supply uncertainty as the principal dimensions on which we can study the differences in transaction costs of procurement (Williamson, 1996). In the context of our study of e-procurement value, the process types provide us with a way to combine asset specificity, transaction frequency and supply uncertainty with other important dimensions, such as demand variations, to differentiate among transactions. 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. The different types of procurement systems and business rules that organizations have currently in place have implications for the realization of the value of e-procurement.

In the procurement of non-production goods, unlike in production goods, organizations deal with a large number of different products and user preferences. It is extremely costly to establish a separate purchasing process for each product procured and consumed in the organization. To address this, organizations use the procurement processing needs, such as search, approvals, processing, monitoring and coordination, as a basis to group purchases into process categories. Each process category can then be set-up to have business rules, such as approval requirements, dollar limits, suppliers, etc., that would be similar for all transactions in this category. For

example, the procurement processing needs of printing paper, files and paper clips are mostly similar and hence, can be grouped together into a category called office supplies. Within each category, we expect the procurement costs of each transaction to be similar, and across categories, we expect the procurement costs to be different. When an e-procurement solution is implemented, we assume that the procurement costs of using the Web is so low, that it can be considered equal for all Web-based transactions. Thus, what differentiate the benefits are the procurement costs that existed before the implementation of e-procurement, which depend on the characteristics of the process in each category. Accordingly, we 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.

**Structured procurement:** On the one end, there are procurement processes that are highly automated in terms of the 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 with time, organizations can reduce the transaction costs by negotiating a long-term contract with a supplier and designing an automated procurement process for reordering the items. We call this type of procurement as “*structured*” procurement. Examples of such procurement include *tooling items, welding wires, and custom replacement parts*.

**Unstructured procurement:** On the other end, there are some products that are not suitable for any level of automated procedures. Often organizations allow the end-users to take advantage of best deals available at the time of ordering and there is very little benefit of tying such procurement to product-specific purchasing steps with a particular supplier. These procurements tend to have very broad procurement rules giving plenty of freedom to the users to choose suppliers. We call this type of procurement as “*unstructured*”. Examples of this category of procurement include office equipment and furniture.

We present the product and process characteristics of structured and unstructured procurements in table 1. It is important to note that these two types represent two ends of the “process type continuum”, and there are other types with varying levels of automation potential. In order to highlight

the effect of the process type on the value of e-procurement, however, we will focus on the structured and unstructured process types only.

*Table 1. Characteristics of structured and unstructured procurements*

	<b>Structured Procurement</b>	<b>Unstructured Procurement</b>
Product characteristics	<ol style="list-style-type: none"> <li>1. Regular demand with low demand uncertainty</li> <li>2. High demand volume</li> <li>3. Specifications do not change with each order</li> <li>4. High business risk of supply uncertainty</li> </ol>	<ol style="list-style-type: none"> <li>1. Sporadic demand with high demand uncertainty</li> <li>2. Low demand volume</li> <li>3. Involves greater product variety and options</li> <li>4. Low risk of supply uncertainty</li> </ol>
Process characteristics	<ol style="list-style-type: none"> <li>1. High level of automation</li> <li>2. Consists mostly of re-orders</li> <li>3. Product selection, supplier selection and order details are decided at set-up and coded into the procedures</li> <li>4. No approvals needed for individual transactions</li> </ol>	<ol style="list-style-type: none"> <li>1. Orders manually initiated by the end-user</li> <li>2. Consists mostly of one-time orders</li> <li>3. Product selection, supplier selection and order details are decided for each transaction</li> <li>4. Approvals are required for most transactions, based on dollar volume and requesting employee's status in the organizational hierarchy</li> </ol>
Examples	<ol style="list-style-type: none"> <li>1. Tooling items</li> <li>2. Welding supplies</li> <li>3. Custom replacement parts</li> </ol>	<ol style="list-style-type: none"> <li>1. Office furniture</li> <li>2. Office equipment</li> </ol>

## 5. EFFECTS OF E-PROCUREMENT PROCESS CHARACTERISTICS ON VALUE

Structured and unstructured procurements each has different search, processing, coordination and control needs. These differences lead organizations to develop very different process flows for the two types of procurement. As we have seen in section 5, for structured procurement, the orders are created automatically or with very little human intervention for each transaction. On the other hand, for unstructured procurement, each transaction requires human intervention in the form of product search, requisition, approvals, supplier matching, and order creation. The two types of process flows are shown in figure 2.

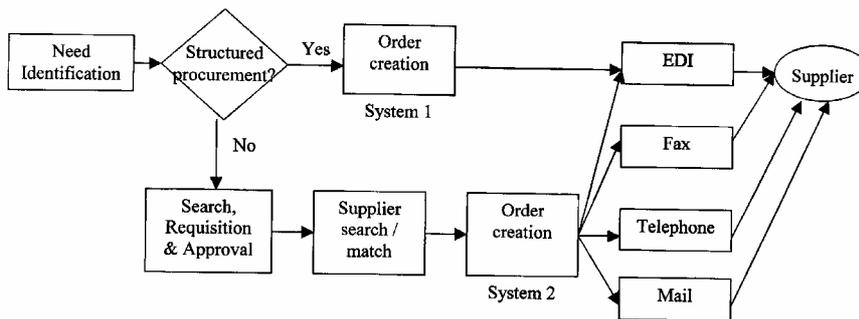


Figure 2. Flow of different procurement types in the old system

In the non-Web environment, structured procurement (*for example, the reorder of tooling items*) is initiated automatically based on re-order point or re-order period. The order details, such as product specifications, order quantity and shipment, are pre-specified and used by system 1 to create the purchase order. System 1 represents a fully automated order generation program that is integrated with the other systems of the enterprise, such as ERP or Inventory Management. As the suppliers are involved in long-term relationships, all of them have EDI connectivity and hence the orders are transmitted through EDI.

On the other hand, unstructured procurement (*for example, the ordering of office furniture*) is initiated by an end-user who searches for the right item and places a requisition for the product. Unstructured procurement involves need for higher levels of human intervention in the form of supplier identification, product selection, approvals, and order generation. In most

cases the approved requisition is sent in the form of a paper document to trained data entry operators who feed it into system 2. Many times, order creation in system 2 involves human intervention in deciding issues, such as product specifications, supplier, and the grouping of the individual requisitions into purchase orders for the different suppliers. As the suppliers involved do not all have EDI capabilities, the orders are transmitted using other communication means, such as phone, fax or ordinary mail.

Table 2 presents the organizational response, legacy information systems and e-procurement system needs for the two types of procurement.

Table 2. Effects of procurement types on organization and information systems

	<b>Structured procurement</b>	<b>Unstructured procurement</b>
Organizational response	Development of systematic, automated procedures Electronic ordering Link with supplier through dedicated systems, such as EDI Development of long-term relationships with supplier	Development of more decentralized procedures Manual, paper-based ordering All suppliers may not have EDI, hence need to use other communication means, such as fax, phone, or mail Use of distributors or aggregators, who can provide economies of scale from multiple suppliers
Legacy information systems	Highly centralized information systems Minimum user intervention required More emphasis on integration with enterprise systems and less emphasis on user interface Primary use of information systems is for monitoring and reviewing purchases	Decentralized systems for purchases Data for each transaction to be input by data entry operators Emphasis on providing training to data entry operators Decentralized systems provide poor decision support
E-procurement system needs	Replace expensive EDI communication with	Use of Web to centralize and integrate the

Structured procurement	Unstructured procurement
less costly Web communication	different procurement systems
Web-based support for search and negotiation before finalizing the contract	Web-based support for all phases of procurement for each transaction
Real-time information about external market conditions to compare the existing purchase contracts	Real-time information about the internal procurement transactions to monitor and control procurement costs

**Effect on value of e-procurement:** The structured ordering procedures result in very little time spent by the user and procurement staff in the current process for search, input and processing activities at the level of each transaction. The streamlined and repetitive nature of the orders reduces the scope for errors in input and processing. The use of Web is mainly to replace the 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 increases the incidence of errors, and staff time is spent more in error resolution. When we Web-enable such unstructured procurement, we save on the staff resources used for search, input, processing and error resolution. Thus, we expect the use of Web for unstructured processes to result in higher value than its use for more structured processes.

## 5.1 Empirical study

In this study, we grouped all procurement transactions into the two types, depending on the two types of systems through which the orders flowed. We found that the structured transactions, accounted for 55% of total volume of procurement and unstructured, accounted for 45% of total volume. The savings in processing, errors, and inventory are plotted for each of the two types of procurement. The results are shown in figure 3. *The total cost savings from using Web for unstructured procurement is significantly higher than for structured procurement*, which is in line with our expectations.

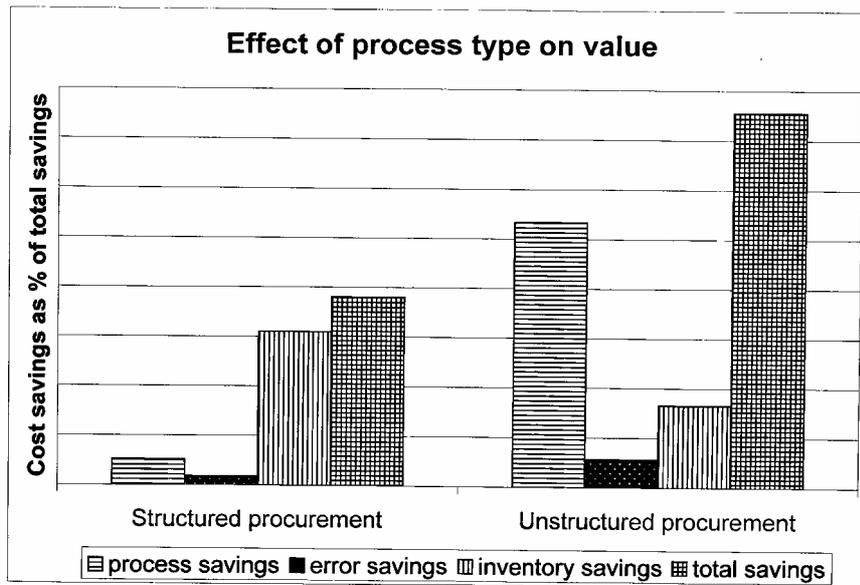


Figure 3. Effect of process type on value - Empirical results

**Finding 1a:** The value from e-procurement is greater when used for unstructured procurement than for structured procurement

**Finding 1b:** For unstructured procurement, the value is mostly from transaction cost savings, while for structured procurement, the value is mostly from inventory savings.

Though the empirical data supports our expectations about structured and unstructured procurement, there are other factors, such as demand volume and process complexity, that are not captured in this study. We use our economic model to evaluate the value in terms of these additional process factors.

## 5.2 Analytical results from the economic model

The economic model, described in section 3.3, was used to analyze the effects of process type on e-procurement value. In our economic analysis, we assume the product substitution factor to represent the structuredness of the process. As products with low substitution reflect more customization,

buyers develop closer relationship with supplier to procure these items. Thus, more customized products tend to be procured through more structured process, with more specific procedures for re-ordering and replenishment. On the other hand, products with high substitution mean that they can be sourced from multiple suppliers without the need to set up a specific and structured procurement process. Figure 4 shows the value for varying levels of demand considered for procurements with varying levels of structuredness. At all demand levels, the value from unstructured procurement is greater than from structured procurement. But, for unstructured procurement, the value is highest for moderate demand and decreases as demand level becomes high.

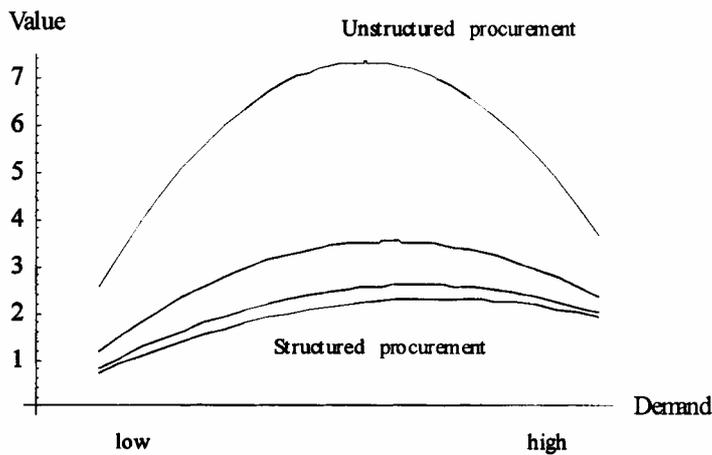


Figure 4. Effect of process type on value - Analytical results

**Finding 2a:** The value from e-procurement is greater for unstructured procurement than for structured procurement

**Finding 2b:** The value from e-procurement for unstructured procurement is highest for moderate demand levels and decreases as demand increases

In many organizations, irrespective of the type of process used for procurement, certain products require more complex steps. For example, the procurement of *hazardous chemicals* requires additional approvals and certifications by internal safety regulators as well as government agencies. E-procurement systems can be used to reduce the coordination costs of such complex procurement and thus may be of more value to more complex procurement. Thus, we expect the complexity of the process to have an

interaction effect with the procurement type. The effect of simultaneously varying procurement type and complexity is shown in figure 5.

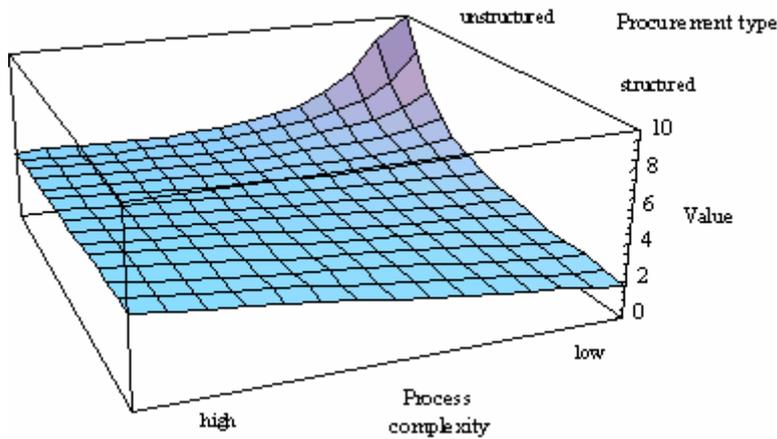


Figure 5. Effect of process type and complexity on value - Analytical results

At lower levels of complexity, the value is significantly greater for unstructured procurement than for structured procurement. This difference disappears for moderately complex items. One reason could be the offsetting of the Web benefits by the decrease in potential price benefits and increase in opportunity costs. At high complexity, though, the trend is reversed, with structured procurement resulting in slightly higher value than unstructured procurement.

**Finding 3a:** At low levels of process complexity, the value from e-procurement is higher for unstructured procurement than for structured procurement

**Finding 3b:** When the process complexity is high, the value of e-procurement does not vary significantly with the procurement type

## 6. IMPLICATIONS OF THE VALUE ANALYSIS FOR ORGANIZATIONS

From our analysis, it is clear that the use of Web is beneficial for unstructured procurement, such as unplanned purchases. But the benefits realized are highest only when the demand levels are moderate. One of the

major costs involving unstructured procurement is time spent by procurement analysts in resolving the transaction errors. This cost is reflected in the transaction costs and the use of Web for unstructured procurement reduces the errors significantly. Our analysis results support the conjecture that unstructured procurement benefits more from the Web. But, these benefits are offset at higher levels of demand, because of the higher technology lock-in costs. For procurement involving very high or very low demand levels, there is a need to evaluate the potential benefits of other B2B models, such as electronic markets.

For a strategy involving business unit level implementation, we should understand the B2B process characteristics of the business unit to decide the implementation process. From our analysis, it is clear that for unstructured procurement, moderate demand levels yield higher benefits than very low or very high demand levels. An implication of our analysis is that both smaller business units and very large business units having a dominance of unstructured procurement may not see significant levels of benefits. It is the moderately sized business units that will have the greatest beneficial impact of the Web.

It is reasonable to expect that large business units, particularly in manufacturing industries, have a predominance of structured processes, such as planned procurement. For these units, the strategies should be those discussed for structured procurement. But, most smaller business units may have a dominance of unstructured procurement, due to their low procurement volume. Also, several of them may be located at remote sites from the central organization. Because of the nature of the Web, it is tempting to provide Web-based procurement connectivity to these units. But, the organization has to realize that the level of benefits will be low, and in many cases may be lower than the expected returns from a Web-based system. Further light can be shed on this issue by examining how the overall benefits are impacted by the participation of remote business units and the importance of this participation.

If a business unit has a dominance of unstructured procurement, but most of them are highly complex, Web-enabling these transactions will yield lower level of benefits than if they were less complex. The organization can reduce the complexity of the process, for example by implementing better standards, and gain higher benefits. Alternately, it can proceed to convert the process into structured procurement, where the benefits are higher for higher complexity. Such measures may involve use of IT for establishing

document and information flow to meet the increased processing needs of complex processes.

## **7. CONCLUSION**

This study is part of an ongoing research to develop a theoretically sound and empirically validated valuation methodology for B2B e-Commerce systems. In this phase, the data related to the B2B transactions and limited cost implications in one organization. Further survey will complete the collection of data to cover the business unit and the “extended enterprise” factors, and the other effectiveness measures, i.e. quality, user satisfaction and system responsiveness. The expanded research will help us understand the impact beyond the transactions. In particular, coordination benefits of a Web-enabled B2B supply chain is expected to be significant and cannot be ignored by organizations.

Global scope and enhanced supply chain coordination capability beyond immediate business partners illustrate the big leap that Web-based IOS makes over traditional IOS. Using the Web, organizations and its several levels of suppliers can integrate their supply chain across the “extended enterprise” in order to remove the inefficiencies and to be able to respond effectively to demand changes. While previous generations of IOS were linear links between organizations, Web-based IOS are truly networked business systems. The economic contribution of each participant in this network, benefits realized by each participant, optimal incentives for increased participation and the type of “network externalities” created are very interesting issues for research and practice. Also, 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 chain and reaping economic benefits, there is a need to fully understand how this value is created and realized. Once we know how the value is created, it is 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 B2B adoption strategies to ensure that the migration to e-procurement results in maximum benefits to the “extended enterprise”. We have provided a start to this effort by developing a framework for understanding the value of Web-based procurement and the factors that affect the value. We were able to

establish the effects of process related factors, such as type and complexity, in determining the value of Web-based procurement to an enterprise, and the implications for implementation strategies. Future work on this research will combine this economic perspective with behavioural perspectives of user adoption and validate our framework both theoretically and empirically.

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