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The performance impact of implementing Web-based e-procurement systems

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As Web-based e-procurement has become an important business avenue for the improvement of inter-organisational process efficiency, its implementation for purchasing direct materials nevertheless implies establishing collaboration mechanism among supply chain participants based on the adopted Internet based infrastructure. However, the value of Web-based procurement to the supply chain participants remains an arduous task for researchers. This study proposes a Web-based e-procurement impact model based on supply chain orientation, which includes both operational and strategic impacts. Specifically, the strategic dimension is about partner relationship, and the operational efficiency dimension includes supplier performance, buyer performance, process integration, and process automation. To prove the proposed model's contribution, a questionnaire survey was conducted on 137 firms in Taiwan who have all participated in e-procurement related projects. The results verify that the electronic execution of purchasing activities improves both the operational efficiency dimension and the strategic dimension. Furthermore, partnership has a positive impact on supplier performance and buyer performance.

Keywords: Web-based e-procurement; performance impact; supply chain collaboration

1. Introduction

The benefits of procurement have been verified by many leading companies worldwide, and procurement is a significant tactic in most companies' e-business strategies. Ghazaly (2005) predicts that an enterprise engaging in electronic procurement could cut procurement costs by as much as 8 to 15%. More and more companies are conscious of the need to introduce Internet-based technologies in their order process, due to the benefits of saving transaction cost, increasing competitive sourcing opportunities, and enhancing inter-organisational coordination (Yen and Ng 2003, Agi *et al*. 2005, Craighead *et al*. 2006). According to the 2006 e-Business W@tch survey, more than half of the interviewed enterprises said that they intend to place orders through a Web-based procurement system (e-Business W@tch 2006).

In the era of pre-Internet IT, electronic data interchange (EDI) was the most common method applied for conducting the purchasing processes of direct material. While EDI was

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the most common method of electronic procurement (e-procurement) in the past, the cost of implementing and maintaining EDI is high and only large-sized companies can afford it as the system platform of EDI is proprietary and closed (Gebauer and Buxmann 2000). With the increasing availability of lower-cost public network infrastructures and the development of Web-based tools, most traditional e-procurement evolved into Web-based e-procurement. The emergence of Web-based e-procurement is not only expected to reduce the cost of the purchasing process but is also to alter the activities of purchasing, transforming the purchasing process from an operational into a strategic activity (Subramaniam and Shaw 2004, Saeed *et al*. 2005, Lawson *et al*. 2009).

Business-to-business (B2B) e-commerce is rapidly transforming how organisations structure and coordinate their business relationships. Thus evaluating investments on Web-based B2B systems becomes critical. Much of the attention on the value of Web-based procurement systems has focused on indirect materials for a single company through case studies (Ageshin 2001, Olig and Spears 2001, Subramaniam and Shaw 2002). Realisation of the value of the system is conditional upon characteristics of the procurement process, interaction among business units within the organisation, and supplier participation (Subramaniam and Shaw 2004). A broader perspective of procurement including direct materials should put greater emphasis on the connectivity enabled by the Web encourages collaboration at the supply chain level (Marston and Baisch 2001).

Research on the impact and value of inter-organisational information systems (IOS), 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 organisations (Srinivasan *et al*. 1994, Mukhopadhyay *et al*. 1997). Most evidence of Web benefits derived from procurement in supply chains is either anecdotal or case-based studies (Yen and Ng 2003), and there are very few systematic studies in this area that try to understand the impacts comprehensively from both organisational and inter-organisational perspectives.

This study draws on the concepts from the interrelated streams of literature on information systems (IS), supply chain management (SCM), and strategic management (SM) to develop the key constructs and relationships associated with how Web-based e-procurement affect organisational performance. Specifically, from both organisational and inter-organisational perspectives, this study proposes to develop a performance impact model of Web-based e-procurement for direct purchases, encompassing both the operational and strategic impacts. Thus, the research question of this study can be stated as:

> *How do the operational and strategic impacts resulting from the implementation of Web-based e-procurement system influence the organisational performance?*

2. Literature review

2.1 *Web-based e-procurement and major research streams*

Procurement supports a delivery relationship between buyers and sellers (Subramaniam and Shaw 2004, Saeed *et al*. 2005). Being a broader scope than 'purchasing,' procurement involves strategic activities such as sourcing, negotiating with suppliers, and coordination with product development. Procurement is more than putting purchasing decisions online,

its functions also include linking suppliers and buyers into the purchasing network and rethinking of inter-organisational processes driven by transactions.

Manufacturing firms are increasingly seeking cost and other competitive advantages by tightly coupling and managing their relationship with suppliers. However, procurement for direct material would involve more collaboration with suppliers than the case for indirect material. Procurement usually covers two types of purchases – direct and indirect (Subramaniam and Shaw, 2002; Chaffey, 2004). 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 a Web-based procurement system can strengthen search ability, facilitate faster and more accurate data transmission, provide quicker and more plentiful information, and achieve relatively low communications and coordination cost. Web-based procurement has covered procurement automation for internal organisational processes, and supplier collaboration for inter-organisational processes. The former addresses automated, paperless internal process from end user item selection, to creation and routing of purchase request and approval to purchase order creation, and receiving. The latter is about connectivity with suppliers for electronic catalogues, transaction management and on-going relationship management.

Web-based e-procurement is one form of IOS and the aim of the system implementation is to streamline purchasing processes and enhance competitive advantage. Based on the premise of focusing on investigating what the benefits of e-procurement system can be, this study classifies previous studies related to investigating the impacts of e-procurement system implementation into two streams – SCM and IS.

2.2 *SCM perspective*

An important theme that emerges from this work is that for effective management of the supply chain, a firm needs to choose appropriate relationships with suppliers and structure management processes such that they fit the nature of those relationships (Ho *et al*. 2002, Chen and Paulraj 2004). For example, in the case of competitive spot bidding, a firm needs to put in place processes that will enable it to scan the market thoroughly and shop around for the best possible price. In contrast, long-term cooperative relationships require coordination mechanisms that can facilitate extensive information sharing to optimise the efficiency of the linkages (Strader *et al*. 1998, Simchi-Levi *et al*. 2003).

For effective management of buyer–supplier relationships, firms need to maintain a portfolio of relationships that may have different characteristics and objectives, and structure supply chain processes to fit the nature of those relationships. Supply chain management theory views IOS as a facilitator of coordination between supply chain partners (Tan 2001, Akyuz and Rehan 2009). Process efficiency is the likely objective in IOS implementation that entails close coordination between buyers and suppliers. Edwards *et al*. (2001) argue that in order to gain efficiencies, companies need to exchange large amounts of planning and operational data, ranging from information on annual contracts and periodic progress reporting to real-time delivery and invoicing data (Subramaniam and Shaw 2002, Chiang and Feng 2007). In particular, partnership-type

relationships require extensive information processing to facilitate mutual adaptations and process synchronisation (Johnston and Vitale 1988, Chan and Chan 2009).

2.3 *IS perspective*

Web-based procurement system is one form of IOS. The body of research that evaluates IOS performance is large and diverse. It can be summarised into two groups. The former examined the impacts at lower operational levels in an enterprise, e.g. the impact on order processing. The latter examined strategic implications of inter-organisational systems, including how IOS improves the business or manufacturing processes between firms in the supply chain. This dichotomy follows the traditional line of operational versus strategic uses of IT (Simchi-Levi *et al*. 2003, Son and Benbasat 2007). The former emphasised process automation such as order-entry procedures or payroll processing within a firm. The latter addressed strategic goals like increasing customer satisfaction, providing an edge over competitors, opening new sales channels, or increasing brand awareness.

Research in integration in electronic exchange environments has distinguished between interface integration and internal integration (Truman 2000). Interface integration means integration between IOS and enterprise systems, and can extend value chains activities for transactions, information sharing, and cooperation with other companies (Chiang and Feng 2007, Chandra *et al*. 2007). Internal integration denotes integration between internal systems. The typical example is Web-based procurement system integrated with back-office applications so companies can have integrated business processes within the organisation. There has been some discussion on collaboration risks that address the lock-in from highly partner-specific IT infrastructure investments (Croom 2005, Gulati and Sytch 2007). In EDI implementations, it has been found that increased transaction specificity, switching costs, and uncertainty may create the possibility of opportunistic behaviour and reduce partnering options (Mukhopadhyay *et al*. 1997). Industry-wide standards (e.g. RosettaNet) and software for adaptation can be used to reduce lock-in costs (Katz and Shapiro 1994, Craighead *et al*. 2006). Past research indicated that companies employ multiple trading mechanisms to realise substantial benefits in their procurement strategies.

2.4 *SM perspective*

Researchers contend that purchasing is the key intermediary between members of the supply chain, and should serve as an integral (including administrative and strategic) in the management of the supply chain (Novack and Simco 1991, Leender *et al*. 1994). Strategic management theory clearly addresses a distinction between a strategic purchasing function and a clerical purchasing function. At the clerical level, purchasing decisions are routine in nature. Strategic purchasing has a proactive, long-term focus (Spekman 1988, Talluri *et al*. 2007, Lawson *et al*. 2009). Strategic procurement actions can be divided into three levels:

(1) Performance related strategies focus on managing purchasing resources, controlling expenses and serving users' needs within an organisation.
(2) Procurement system related strategies build information links between the organisation and its more immediate external environment, and the strategic issues focus on supplier selection, contract duration and value analysis.

(3) Competitive procurement strategies focus on the buyer's intrinsic bargaining power that allows buyers to leverage purchasing and improve the company's competitive advantage.

Building on this hierarchical guideline, various typologies and suggested practices have been developed over time to categorise procurement strategies. A major theme emerging from such studies is that traditional approaches focusing on managing purchasing activities are not likely to yield the needed results. To be a world-class competitor, a company must build on the expertise and commitment of its supplier (e.g. Macbeth and Ferguson 1994, Jain *et al*. 2009).

2.5 *Synthesis of literature*

Both SCM and IS streams reviewed above reveals that the existing research in the area of studying the impact of implementing e-procurement system focuses on improvement in the operational level. Previous research in SCM field primarily focuses on investigating issues regarding the effects of e-procurement system on improving coordination among supply chain participants. The SCM literature provides insight into the impact of e-procurement system on enhancing planning processes (e.g. production planning, delivery planning and inventory planning) and mitigating supply chain uncertainties. Previous research in IS field primarily focuses on investigating issues related to the nature and types of e-procurement system and the characteristics of the e-procurement system in influencing governance structure. The IS literature provides insight into the impact of e-procurement system on improving transparency in procurement process and reducing transaction cost. Comparing the research in SCM field and IS field engaging in studying the effects of e-procurement system on organisational performance, the research in SM field focuses on investigating issues related to competitive procurement strategies with less touch on the impacts of e-procurement system. The SM literature provides insight into the impact of strategic partnership on improving a company's competitive advantage.

Based on the concepts of SCM, IS and SM, this study suggests that the Web-based e-procurement system serves as a coordination mechanism leading to operational and strategic benefits. Driven by the support of an automated procurement process, integrated organisational internal processes and managed purchasing information, the Web-based e-procurement system enables firms to shorten their order fulfilment cycle time, lower the inventory levels, reduce the administrative cost of procurement, and enhance the order fulfilment performance of suppliers (Subramaniam and Shaw 2002, Son and Benbasat 2007). Implementing a Web-based e-procurement system for direct procurement not only makes the operational processes of trading partners more effective, but it also makes inter-organisational coordination among trading partners more efficient. Implementing a Web-based e-procurement system enables firms to construct a better information sharing environment and enhance the existence of a cooperative relationships among trading partners (Simchi-Levi *et al*. 2003, Saeed *et al*. 2005).

Web-based e-procurement enhances inter-organisational coordination and improves relationships among business partners. The research on the benefits of implementing a Web-based e-procurement system can be summarised by the framework in Figure 1 which classifies its value and identifies its determining factors.

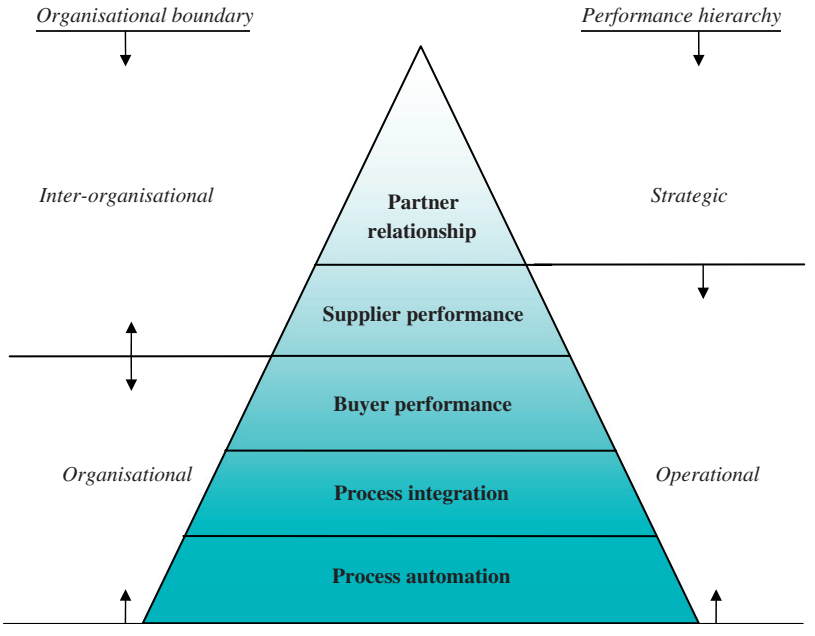

Figure 1. Summary of the impact of e-procurement based on organisational boundary and performance hierarchy.

3. Research model

3.1 *Formulation of research model*

Figure 1 shows that the performance impact of implementing a Web-based e-procurement system can be generated at the organisational and inter-organisational level, and can be either an operational or a strategic benefit. Based on previous studies reviewed in Section 2, this study argues that the operational benefits of a buyer organisation are generated by Web-based e-procurement through automating the procurement process, re-engineering the internal processes of the organisation and sharing of information in the transaction context. The strategic benefits of a buyer organisation are generated through Web-based e-procurement by strengthening the buyer–supplier trading relationship. Based on this perspective, this study proposes the research model as shown in Figure 2. Table 1 summarises the operational definitions of constructs and sub-constructs.

As illustrated in Figure 2, this study assumes that firms through implementing Web-based procurement systems target five performance outcomes:

(1) buyer immediate measure,
(2) buyer integrated process,
(3) buyer organisational performance,
(4) supplier performance, and
(5) partner relationship.

The interactions among supply chain participants that result in these performance outcomes can be grouped into organisational level and inter-organisational level. Subsequent subsections will elaborate the rationale of related hypotheses.

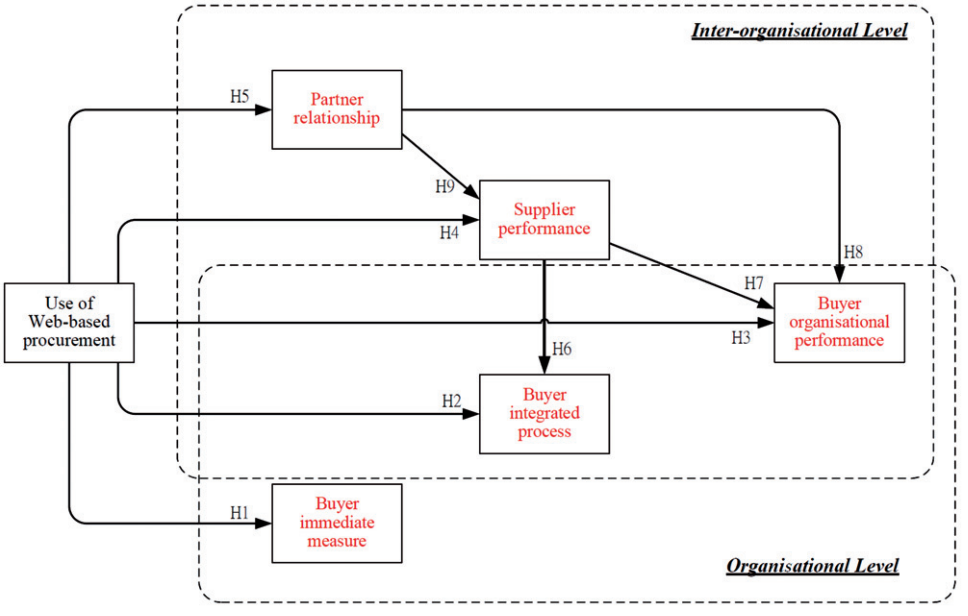

Figure 2. Research model.

3.2 *Impact on performance*

In measuring the direct impact by implementing procurement automation, one of the most important benefits is lower transaction cost. In addition, automation and acceleration of data handling, storage, and transmission activities can enhance data accuracy and reduce the number of errors (Sriram *et al*. 2000, Craighead *et al*. 2006, Akyuz and Rehan 2009). This leads to the following hypothesis:

H_1: Use of Web-based procurement positively influences buyer immediate measure.

Although the impact on integrated process occurs mainly at the operational level, it addresses the impact of e-procurement when procurement function is integrated with back-office applications. Value impacts like lower inventory cost, better user satisfaction, and more process transparency will emerge when such integration occurs. The difference between impacts on immediate measure and integrated process represents a transition for evaluating the buying firms from using procurement systems to employing more sophisticated enterprise systems. The integration of internal systems helps leverage the synergy among the systems.

H_2: Use of Web-based procurement positively influences buyer integrated process.

Web-based e-procurement system plays a fundamental role in B2B purchasing by streamlining the buying process and providing the information needed to make more effective purchasing decisions (Osmonbekov *et al*. 2002, Presutti 2003, Talluri *et al*. 2007). Previous studies allude to the fact that many companies have found benefits from implementation of an e-procurement system. The adoption of an e-procurement system in the B2B purchasing transaction allows buyer firms to reduce transaction costs, improve internal procurement process efficiency, and increase collaboration with suppliers

Table 1. Operational definitions of constructs.

Construct*	Definition
Use of Web-based procurement (WP):	
The extent to which the functions of the implemented Web-based e-procurement system can be applied to assist in purchasing activities.	
Process operation (WPO)	The extent to which Web-based e-procurement can function to support operational activities in the procurement process.
Collaborative operation (WCO)	The extent to which Web-based e-procurement can function to support collaborative activities in the procurement process.
Buyer immediate measure (BIM):	
The extent to which the firm has improved the efficiency of purchasing processes.	
Transaction cycle time (BTCT)	The extent to which the firm has reduced the time and cost of conducting procurement operations.
Error rate (BE)	The extent to which the firm has decreased the procurement error.
Partner relationship (PR):	
The extent to which the firm has increased collaborative activities with suppliers.	
Information sharing (PIS)	The extent to which information sharing between the firm and its suppliers has enhanced.
Technology dependence (PTD)	The extent to which production technology collaboration between the firm and its suppliers has enhanced.
Supplier performance (SP):	
The extent to which the firm's suppliers have better performance due to the deployment of buyer-side e-procurement system.	
Buyer integrated process (BIP):	
The extent to which the firm has improved the performance due to the integration of purchasing process and other business processes.	
Buyer organisational performance (BOP):	
The extent to which the performance of the whole organisation has improved due to the improvement made on the procurement process.	

*Both constructs and their sub-constructs are defined in this table. The italicised definitions are associated with constructs.

(Chaffey 2004, Barbieri and Zanoni 2005). Previous studies suggested that implementing an e-procurement system could make buyer firms' procurement process more efficient and effective through automating procurement process, reengineering the internal processes and enhancing inter-organisational coordination (Davila *et al*. 2003, Presutti 2003). Implementing an e-procurement system not only could make the operational processes of the buyer firm more effective, but also could make the order fulfilment process of the supplier organisation more efficient. The order fulfilment performance can be improved if the supplier can recognise the order, so that the order demand patterns are more transparent to the supplier (Lin and Shaw 1998, Chopra and Meindl 2000). Therefore, this study proposes the following hypotheses:

H_3: Use of Web-based procurement positively influences buyer organisational performance.

H_4: Use of Web-based procurement positively influences supplier performance.

3.3 *Impact on partnership*

The business partnership has been defined as an ongoing relationship between two firms involving a commitment over an extended time period. The partnership is evolved over time through repeated economic action or through repeated face-to-face joint problem-solving experiences. Previous study argues that the structure and quality of social ties between firms shape economic action of both parties, such as exchange of sensitive information and joint action undertaken by both parties collaboratively (Uzzi 1997, Jain *et al*. 2009).

Previous studies argued that, with the ubiquitous adoption of the Internet, companies establishing ERP and e-commerce systems can use the Internet to transmit information in real-time to vendors and customers, helping companies to coordinate or cooperate with their vendors and customers (Kim and Narasimhan 2002, Wagner and Essig 2006). At the same time, information systems allow the two-way sharing of information between companies and their vendors and customers (Akemi and Philp 2000, Chan and Chan 2009). For instance, the sharing of information with both buyers and sellers can facilitate more effective market forecasts, allowing effective control of inventory and ensuring that inventory is kept at the lowest level, and even enabling zero inventories in some cases.

H_5: Use of Web-based procurement positively influences partner relationship.

Integrated business processes between manufacturers and suppliers have been cited as a critical factor in managing supply chains. Just in time (JIT) purchasing is the extreme case that epitomises inter-organisational process integration and long-term relationship in a lean manufacturing environment. Potential benefits of JIT purchasing include reduction of inventory, delivery lead-time and supplier cost, and improvement of scheduling flexibility and quality (Gelinas and Jacob 1996, Huang *et al*. 2003). If both buyers and suppliers are connected by Web-based systems, IOS that facilitate comprehensive information flows through a system-to-system linkage can reduce inventory costs and provide the benefits of vertical integration (more control, coordination, and lower costs). Hence, in a supply chain operating environment enabled by e-procurement systems, supplier performance can contribute positively to buyer integrated process. Furthermore, an improved supplier's performance improves the buyer's performance.

H_6: Supplier performance positively influences buyer integrated process.

H_7: Supplier performance positively influences buyer organisational performance.

In light of information sharing, Agi *et al.* (2005) suggest that in EDI operating environments the greater the information sharing between a central car manufacturer and vehicle parts manufacturers (VPM), the better their operating performance. For instance, the central car manufacturer shares market forecast information with VPM, leading to reduction of inventory levels for these suppliers. Hence, the sharing of information can bring the benefit of cost reduction. In addition, in light of technology dependence, Lee and Lim (2005) suggest that high technology dependence can increase the efficiency of transactions and decrease transaction process cost between partners. Furthermore, a high level of dependence facilitated component delivery between the central car manufacturer and VPM. As discussed above, this study proposes the following hypotheses:

H_8: Partner relationship positively influences buyer organisational performance.

H_9: Partner relationship positively influences supplier performance.

4. Research methodology

4.1 *Measurement development*

A two-step procedure was employed to create items for the first-order constructs developed in this study, and establish its content face validity. First, this study used a focus group to discuss the items proposed in relevant literatures. The focus group was assembled and included two professors who have researched IS, SCM and SM fields for several years and six postgraduates who have studied the same fields under guidance for at least one year. Then, this study generates items that reflect the first-order constructs. Second, this study brought together a content validity panel, proposed by Lawshe (1975), to reconsider the items generated in second step for determining the applicability and semantics of each items. A content validity panel was assembled, including two professors from management schools at universities and six managers from manufacturing firms. Based on these tests, the items were modified to create the instruments for the full-scale study (Table 2).

4.2 *Data collection*

To promote electronic business, the government in Taiwan has subsidised many leading domestic companies' plans for electronically integrating their supply chains, such as e-business projects for IT industry (Project A and B, sponsored by the Department of Industrial Technology (DOIT) and the Ministry of Economic Affairs (MOEA)) and manufacturing industries (e-business Projects for Manufacturing Sectors, sponsored by the Industrial Development Bureau (IDB)). Using procurement as an important thrust, these series of projects aimed to promote the development of domestic industrial information technology and applications, and to improve the competitiveness of domestic industries.

The data were collected from manufacturing firms which have participated in the aforementioned projects, and the domestic Fortune 1000 manufacturers that have appeared in the e-procurement literature. Part of the sampling frame is the directory of buyer organisations compiled by IDB and DOIT, which consisted of firms that have

Table 2. Items of constructs.

Construct	Item	Reference
Process operation	• Finding the suitable product has become quicker. • Finding the suitable product has become easier. • Inquiring the product purchasing progress has become more convenient. • Acquiring the new product information has become timelier.	Srinivasan *et al.* 1994, Ageshin 2001, Subramaniam and Shaw 2002, Craighead *et al.* 2006
Collaborative operation	• Monitoring the order has become more effective. • Monitoring the logistic process has become more effective. • The order that the supplier received from our company has become more accurate. • The communication between our company and supplier has become more smooth.	
Transaction cycle time	• The purchasing time has become shorter. • Receiving the order has become faster. • Response time of the order has become shorter. • Monitoring cost of the product quality has become lower.	Sriram *et al.* 2000, Yen and Ng 2003, Subramaniam and Shaw 2004, Craighead *et al.* 2006
Error rate	• The error rate of the order has become lower. • The error rate of the order information transmitting among inner-enterprise has become lower.	
Information sharing	• Our company and strategic partner exchange more inventory information. • Our company and strategic partner exchange more demand forecasting information. • Our company and strategic partner exchange more product specification information.	Johnston and Vitale 1988, Edwards *et al.* 2001, Huang *et al.* 2003, Saeed *et al.* 2005, Wagner and Essig 2006
Technology dependence	• Our company executes more collaborative manufacturing with strategic partner. • Our company executes more collaborative product development with strategic partner.	
Supplier performance	• Delivery time has become more precise. • The service cost of our supplier has become lower. • The work-force cost of our supplier has become lower. • The product provided by our supplier has fitted our requirement more precisely.	Srinivasan *et al.* 1994, Mukhopadhyay *et al.* 1997, Presutti 2003
Buyer integrated process	• Inventory cost has become lower. • The purchasing process has become more transparent. • Our company has become more satisfying for the transaction with suppliers.	Truman 2000, Kim and Narasimhan 2002, Simchi-Levi *et al.* 2003
Buyer organisational performance	• Total procurement costs have become lower. • Product quality has become higher. • Production lead time has become shorter. • Deliver reliability has become higher. • Dealing with demand uncertainty has become more flexible.	Olig and Spears 2001, Subramaniam and Shaw 2002, Saeed *et al.* 2005

qualified by MOEA for corporate IT readiness. The rest of the sampling frame is the Fortune 1000 list provided by the *Commonwealth Magazine*. The unit of analysis in the survey is the purchasing department of the buyer organisation.

The questionnaire was mailed to 250 senior managers of domestic companies, including 17 companies that participated in Projects A and B, 52 companies that participated in e-Business Projects for Manufacturing Sectors, and 181 companies sampled from the domestic Fortune 1000 manufacturers list provided by the *Commonwealth Magazine*. Finally, 137 valid questionnaires were returned, yielding a 54.8% valid response rate.

5. Analysis results

This study chooses partial least squares (PLS) for analysing the model of procurement effects on supply chain participants. PLS is generally recommended for predictive research models where the emphasis is on theory development (Jöreskog and Wold 1982, Lohmöller 1989, Chin *et al*. 2003). Given that there have been little prior theory and very few empirical studies in exploring procurement effects on supply chain participants, the focus of this study is on theory development.

With PLS, analysing the model of procurement effects on supply chain participants involves two steps: first by the assessment of measurement properties, and then by the test of the structural model.

5.1 *Results of assessing measurement properties*

In this section, this study focused on measurement properties of constructs. This study assessed convergent and discriminant validity by factor analysing items grouped under the first-order constructs. Table 3 shows the factor structure and loadings. The items loadings are above 0.707, showing that more than half of the variance is captured by the constructs.

The internal consistency of first-order constructs was assessed by using Cronbach's alpha and computing the composite reliability (CR). A score of 0.70 or above is an acceptable value of internal consistency for exploratory research (Compeau *et al*. 1999, Gefen *et al*. 2003). The Cronbach's alpha ranged from 0.771 to 0.868 (as shown in Table 3) and CRs ranged from 0.826 to 0.912 (as shown in Table 4), all of them were above the 0.7 acceptable thresholds.

Another suggested criterion for discriminant validity is that the variance shared by a construct with its indicators should be greater than the variance shared with other constructs in the model. The percent of variance captured by a construct is given by its average variance extracted (AVE). A construct is considered to be distinct from other constructs if the square root of the AVE for it is greater than its correlations with other latent constructs (Barclay *et al*. 1995, Gefen *et al*. 2003). Table 4 shows the square root of the AVE for each construct greater than the correlation between that construct and other constructs.

5.2 *Results of testing the structural model*

A test of the structural model is used to assess the structure of the impact of using a Web-based procurement system and the influence of using a Web-based procurement

Table 3. Factors structure and loadings ($N = 137$).

	WPO	WCO	PIS	PTD	BTCT	BE	BIP	SP	BOP
WPO1	**0.839**	0.435	0.324	0.276	0.279	0.309	0.247	0.231	0.262
WPO2	**0.817**	0.411	0.297	0.283	0.293	0.311	0.241	0.223	0.271
WPO3	**0.821**	0.423	0.301	0.297	0.285	0.294	0.254	0.228	0.269
WPO4	**0.843**	0.408	0.313	0.274	0.291	0.317	0.236	0.213	0.254
WCO1	0.431	**0.806**	0.289	0.271	0.276	0.289	0.228	0.204	0.239
WCO2	0.419	**0.841**	0.306	0.257	0.284	0.296	0.222	0.209	0.243
WCO3	0.404	**0.826**	0.311	0.263	0.261	0.302	0.231	0.221	0.247
WCO4	0.417	**0.854**	0.294	0.438	0.249	0.191	0.226	0.217	0.251
PIS1	0.293	0.296	**0.763**	0.404	0.141	0.131	0.139	0.274	0.262
PIS2	0.308	0.291	**0.748**	0.411	0.126	0.149	0.147	0.298	0.278
PIS3	0.315	0.289	**0.795**	0.397	0.173	0.168	0.171	0.253	0.239
PTD1	0.271	0.274	0.409	**0.819**	0.152	0.171	0.138	0.237	0.225
PTD2	0.262	0.283	0.402	**0.811**	0.147	0.145	0.115	0.281	0.231
BTCT1	0.279	0.241	0.138	0.137	**0.757**	0.412	0.129	0.169	0.114
BTCT2	0.264	0.272	0.181	0.125	**0.794**	0.421	0.142	0.181	0.155
BTCT3	0.281	0.259	0.163	0.161	**0.779**	0.393	0.147	0.174	0.173
BTCT4	0.295	0.226	0.149	0.153	**0.753**	0.407	0.124	0.138	0.168
BE1	0.313	0.281	0.147	0.173	0.404	**0.843**	0.145	0.164	0.127
BE2	0.309	0.294	0.161	0.159	0.419	**0.851**	0.191	0.159	0.143
BIP1	0.271	0.253	0.173	0.148	0.117	0.162	**0.806**	0.171	0.159
BIP2	0.264	0.269	0.141	0.137	0.134	0.129	**0.782**	0.159	0.131
BIP3	0.247	0.251	0.139	0.154	0.179	0.143	**0.829**	0.183	0.143
SP1	0.253	0.249	0.304	0.269	0.127	0.193	0.174	**0.786**	0.194
SP2	0.247	0.234	0.291	0.287	0.149	0.131	0.151	**0.814**	0.162
SP3	0.228	0.232	0.297	0.301	0.114	0.147	0.183	**0.732**	0.147
SP4	0.239	0.227	0.316	0.274	0.131	0.164	0.169	**0.795**	0.131
BOP1	0.291	0.278	0.273	0.231	0.143	0.141	0.161	0.179	**0.791**
BOP2	0.289	0.293	0.259	0.226	0.135	0.135	0.153	0.134	**0.758**
BOP3	0.296	0.301	0.265	0.251	0.132	0.154	0.141	0.142	**0.822**
BOP4	0.293	0.284	0.271	0.239	0.161	0.116	0.137	0.158	**0.772**
BOP5	0.305	0.289	0.276	0.233	0.146	0.143	0.139	0.191	**0.789**
Cronbach alpha	**0.868**	**0.862**	**0.771**	**0.795**	**0.813**	**0.807**	**0.836**	**0.819**	**0.851**

Table 4. Inter-correlation among first-order constructs.

Construct	Composite reliability (CR)	1	2	3	4	5	6	7	8	9
1. WPO	0.912	**0.849**								
2. WCO	0.909	0.602	**0.845**							
3. PIS	0.826	0.472	0.465	**0.785**						
4. PTD	0.838	0.453	0.487	0.569	**0.850**					
5. BTCT	0.869	0.429	0.424	0.216	0.231	**0.789**				
6. BE	0.862	0.465	0.437	0.225	0.207	0.592	**0.870**			
7. SP	0.881	0.401	0.413	0.476	0.424	0.238	0.256	**0.844**		
8. BIP	0.892	0.416	0.441	0.292	0.273	0.264	0.213	0.339	**0.820**	
9. BOP	0.898	0.438	0.422	0.417	0.402	0.237	0.256	0.343	0.218	**0.799**

Note: Diagonal elements (bold) are the square roots of AVE by latent constructs from their indicators. Average variance extracted (AVE): $Li^2/(Li^2 + Var(Ei))$. Composite reliability (CR): $(\Sigma Li)^2/((\Sigma Li)^2 + \Sigma Var(Ei))$. Li = factor loading, Var(Ei) = error variance.

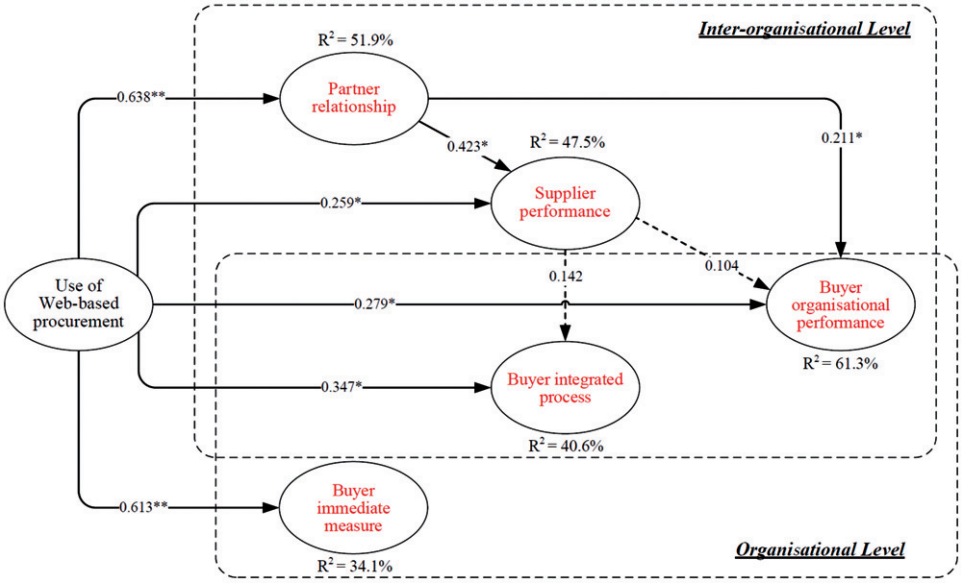

Figure 3. Results of path analysis.
Note: path coefficients, $*p < 0.05$, $**p < 0.01$.

Table 5. Paths between first-order constructs and second-order construct.

Latent construct (second-order construct)	Sub-construct (first-order construct)	Path coefficient
Use of Web-based procurement	Collaborative operation	0.483*
	Process operation	0.611**
Buyer immediate measure	Transaction cycle time	0.462*
	Error cost	0.617**
Partner relationship	Information sharing	0.669**
	Technology dependence	0.349*

Note: Path coefficient, $*p < 0.05$, $**p < 0.01$.

system on the performance of buyer and supplier. Results of the analysis for the structural model are presented in Figure 3. The statistical significance of weights can be used to determine the relative importance of indicators (first-order constructs) in forming a latent construct (second-order construct). This study found that all specified paths between first-order constructs and second-order construct in the research model had significant path coefficients (as shown in Table 5).

One indicator of the predictive power of path models is to examine the explained variance or R^2 values (Barclay *et al.* 1995, Chin *et al.* 2003). R^2 values are interpreted in the same manner as those obtained from multiple regression analysis. R^2 values indicate the amount of variance in the construct that is explained by the path model. As shown in Figure 3, 34.1% of the variance in buyer immediate measure was explained by use of Web-based procurement; 40.6% of the variance in buyer integrated process was

explained by use of Web-based procurement and impact on supplier performance; 61.3% of the variance in buyer organisational performance was explained by use of Web-based procurement, supplier performance and partner relationship; 51.9% of the variance in partner relationship was explained by use of Web-based procurement; and 47.5% of the variance in supplier performance was explained by use of Web-based procurement and partner relationship. Moreover, the results shown in Figure 3 provide strong evidence for hypotheses 1 to 9 except H_6 and H_7.

6. Conclusion

The primary contribution of this research is that the operational and strategic impact of Web-based e-procurement on organisational performance was specified. The results from the empirical study provide substantial support for the research model in Figure 2. Our framework proposes several important considerations for the effects of implementing a Web-based e-procurement system in purchasing processes. In particular, this study contributes to the analysis of the strategic value of Web-based e-procurement for improving partner relationship. While previous literature has paid particular attention to investigate operational value of e-procurement system, this research shows that in Web-enabled B2B commerce, strategic value can also be generated by an e-procurement system.

Hypotheses of this study are largely supported and suggest that by implementing a Web-based e-procurement a company cannot only reduce the transaction cost and inventory cost and improve production plan, but can also alter the activities of purchasing, transforming the procurement activity from an operational into a strategic function. To answer the research questions raised in the introduction, we summarise the key results from the empirical study below.

The results confirm that buyer firms implementing a Web-based e-procurement system for conducting purchasing activities can reduce transaction cycle time and error rate (as verified in H_1) and facilitate to integrate processes of purchase, inventory and supplier delivery (as verified in H_2). This study also provides evidence that implementing Web-based e-procurement system not only can improve buyer organisational performance (as verified in H_3) but can also improve supplier performance (as verified in H_4). Results of this study also indicate a significant finding that Web-base e-procurement can lead to better partnership between buyers and suppliers. By adopting a strategic-oriented Web-based procurement solution, buyers can enhance their partnerships with suppliers with respect to information sharing and technology dependence (as verified in H_5). Moreover, as verified in H_8 and H_9, partner relationship contributes to both supplier performance and buyer performance, indicating that good partnership paves the way for sounding SCM operating environment. The non-acceptance of H_6 and H_7 indicates that the supplier's operational performance does not have a significant positive impact on both buyer integrated process and buyer organisational performance. Improvement on these two accounts would require internal integration and business process redesign on the part of the buyer organisation.

Initially started as an automation device, procurement eventually leads to the provision of value-added services such as sharing information and technology support. In a manufacturing firm, purchasing is closely linked to engineering design and the order fulfilment process because of the need for customised components and for responding to customer orders. Thus, the coordination benefits of Web-enable procurement activities

are expected to be significant and cannot be ignored by organisations. Future research can explore how collaborative behaviour in procurement may be affected in a value-trusted network.

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