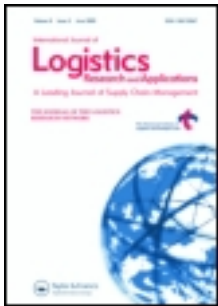


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Wei-Hsi Hung^a, Chieh-Pin Lin^b, Yi-Ming Tai^c, Chin-Fu Ho^{de} & Jau-Jeng Jou^f

^a Department of Information Management, National Chung Cheng University, Chia-Yi, Taiwan

^b Department of Information Management, National Chung Cheng University, Chia-Yi, Taiwan

^c Department of Information Management, National Pingtung Institute of Commerce, Pingtung, Taiwan

^d Department of Information Management, National Sun Yat-Sen University, Kaohsiung, Taiwan

^e Program of Chain Stores Management, Takming University of Science and Technology, Taipei, Taiwan

^f Department of Industrial Technology, Ministry of Economic Affairs, Taiwan

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Exploring the impact of Web-based e-procurement on performance: organisational, interorganisational, and systems perspectives

Wei-Hsi Hung^a, Chieh-Pin Lin^b, Yi-Ming Tai^{c*}, Chin-Fu Ho^{d,e} and Jau-Jeng Jou^f

^a*Department of Information Management, National Chung Cheng University, Chia-Yi, Taiwan;*

^b*Department of Information Management, National Chung Cheng University, Chia-Yi, Taiwan;*

^c*Department of Information Management, National Pingtung Institute of Commerce, Pingtung, Taiwan;*

^d*Department of Information Management, National Sun Yat-Sen University, Kaohsiung, Taiwan;* ^e*Program of Chain Stores Management, Takming University of Science and Technology, Taipei, Taiwan;* ^f*Department of Industrial Technology, Ministry of Economic Affairs, Taiwan*

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This study investigates how the advantages derived from implementing a Web-based e-procurement system in a supply chain can influence a firm's organisational performance. We propose a model that includes the contextual factors from organisational, interorganisational, and systems perspectives involved in the processes of Web-enabled direct procurement. To test the model, we conducted a survey in 105 manufacturing firms in Taiwan and used partial least-squares regression for data analysis. The results revealed that electronic purchasing activities improve organisational-level efficiency as well as the interorganisational dimension. In addition, an enhanced partnership has a positive impact on the performance of both suppliers and buyers. Finally, system initiation and system breadth both have a positive impact on buyers' organisational performance.

Keywords: Web-based e-procurement; direct procurement; system initiation; system breadth; organisational performance

1. Introduction

Despite the electronic data interchange (EDI) having been the most common technology for performing electronic procurement (e-procurement) in the past, its defects in increasing transaction specificity, switching costs and uncertainty, and a lack in partnering flexibility had lowered the intentions of companies to adopt the system (Lee and Lim 2005; Handfield and Nichols 2008). By acknowledging the trend of implementing Web-based tools, most conventional procurement solutions have evolved into Web-based e-procurement under specific protocols in the creation of electronic transactions (Subramaniam and Shaw 2004; Tai, Ho, and Wu 2010; Tai 2011). The objectives of Web-enabled applications for business-to-business (B2B) procurement are to reduce purchasing process costs, increase purchasing alternatives, transform the purchasing process from an operational to a strategic activity, and generate opportunities for improving market coordination

*Corresponding author. Email: ymtai@npic.edu.tw

by lessening asset specificity and increasing the number of partners (Croom 2005; Saeed, Malhortra, and Grover 2005).

The benefits resulting from the implementation of Web-based e-procurement can be either operational or strategic (Grey, Olavson, and Shi 2005; Grover and Saeed 2007). Web-based e-procurement generates operational benefits by reengineering the internal processes of an organisation and the procurement process among purchasing partners, and generates strategic benefits by strengthening the buyer–supplier trading relationship. Unlike strategic benefits, operational advantages are caused by flexible configurations in the relationships between purchasing partners for addressing changes in the business environment (Ordanini and Rubera 2008; Chopra and Meindl 2010). By using Web-based e-procurement, firms and their suppliers at all levels can integrate their supply chains across the extended enterprise to remove inefficiencies and respond effectively at a lower-cost level. Earlier generations of the e-procurement system, such as the EDI, were used to establish only linear links between one buyer and one supplier, whereas a Web-based system can be used to create a vast network in the supply chain (Wagner and Essig 2006; Tai, Ho, and Wu 2010; Tai 2011). The benefits resulting from the implementation of Web-based e-procurement warrant both research and practice. Investigating the impacts of the implementation of Web-based e-procurement provides substantial value for organisations in the current Internet-based economy.

To maximise the benefits of Web-based e-procurement, it is critical to understand how contextual factors create the values in its development and implementation. Despite numerous previous studies having determined the importance of Web-based e-procurement in firms' organisational performance, empirical research on testing the system has been relatively limited. This study draws on concepts from the literature on interorganisational systems (IOSs), supply chain management (SCM), and strategic management to develop a model explaining how Web-based e-procurement affects organisational performance from organisational, interorganisational, and systems perspectives.

2. Literature review

2.1. E-procurement

2.1.1. B2B e-procurement model

E-procurement is an information technology (IT)-based business model that facilitates the necessary processes conducted between business parties in a procurement transaction (Smart 2010; Tai, Ho, and Wu 2010; Tai 2011). In its broadest sense, enterprise-level procurement can be classified into indirect procurement (operating inputs) and direct procurement (manufacturing inputs) (Subramaniam and Shaw 2004; Chopra and Meindl 2010). Indirect procurement involves goods and services that are not a part of the finished product but support managerial activities of the business, such as purchasing computers, office equipment, and maintenance, repair, and operating goods. Conversely, direct procurement entails the purchase of raw materials and components used in the manufacturing process of a finished product.

The procurement method denotes the approach used by businesses to purchase goods and services to spread the risk of outside purchasing, which includes systematic or spot sourcing (Gulati and Sych 2007; Chopra and Meindl 2010). Systematic sourcing is the purchase of goods through negotiated contracts with qualified suppliers. In this type, buyers and sellers often develop close relationships because this type of purchasing involves long-term contracts, a high procurement frequency, and specialised logistics and fulfilment mechanisms. In contrast, spot sourcing concerns the fulfilment of an immediate need at the lowest possible cost. Buyers and sellers

rarely develop a close relationship in this type because it involves non-strategic purchasing, inconsequential buyer–seller relationships, and a low procurement frequency.

2.1.2. *Web-based support for procurement*

Web-based solutions have recently emerged for supply chain participants to conduct B2B procurement transactions (Ordanini and Rubera 2008; Tai, Ho, and Wu 2010; Tai 2011). Web-based solutions comprise a set of interrelated technologies that enable an e-procurement system to be built and integrated, regardless of the programming language used or the platform on which they run (Chopra and Meindl 2010). Regarding platform independence, the Web-based e-procurement system allows organisations to easily form integrated relationships with business partners who may be operating different internal systems.

The application of a Web-based e-procurement system for conducting B2B procurement transactions appears to resolve the drawbacks of the EDI (Tai, Ho, and Wu 2010; Tai 2011). Previous studies have argued that by using the Web-based e-procurement system, buyers' enterprises can enhance their abilities in sourcing, order processing, monitoring and control, and coordination (Subramaniam and Shaw 2004; Tai, Ho, and Wu 2010; Tai 2011). In brief, the advantages of a Web-based e-procurement system over the EDI include a more economical communication approach, reduced costs for searching and negotiations, and real-time information on external market conditions and procurement transactions, as well as the convenience of easily integrating various procurement-related systems (Wagner and Essig 2006; Son and Benbasat 2007).

2.2. *The impact of implementing a Web-based e-procurement system*

The Web-based e-procurement system is designed to streamline the purchasing processes conducted among various trading partners and manage their interrelationships. The implementation of a Web-based e-procurement system leads to varying degrees of both operational and strategic impacts (Gosain, Malhotra, and El Sawy 2004; Grover and Saeed 2007; Tai, Ho, and Wu 2010; Tai 2011).

2.2.1. *Operational impacts*

The benefits of technology-based support for procurement activities can be divided into two broad categories: (a) organisational and (b) interorganisational (Tai, Ho, and Wu 2010). At the organisational level, the implementation of a Web-based e-procurement system enables firms to automate their procurement process and reengineer their internal processes, thereby enhancing organisational performance.

Previous studies on the implementation of an e-procurement system have suggested that the benefits of implementing e-procurement can be tangible and intangible (Davila, Gupta, and Palmer 2003; Chopra and Meindl 2010). For tangible benefits, implementation can enable firms to increase their profits by improving their payment process, reducing sourcing and transaction costs, eliminating transaction and administrative errors, shortening the order fulfilment and time-to-market cycles, lowering inventory levels, and reducing the price of goods. Regarding intangible benefits, implementation enables firms to reduce the administrative time in monitoring and controlling the procurement process, enhance budgetary control, and improve the integration of business processes among departments in a company.

Previous studies have suggested that companies may exchange substantial planning and operational data daily, such as information on annual contracts, progress reports, data for real-time delivery, and invoices (Gosain, Malhotra, and El Sawy 2004; Gunasekaran and Ngai 2008).

Partnership-type relationships require extensive information processing to facilitate mutual adaptations and process synchronisation. Thus, process efficiency is a major objective in IOS implementation based on close coordination between buyers and suppliers.

2.2.2. *Strategic impacts*

The increasing trend of purchasing from outside parties is driving organisations to increase coordination between buyer and supplier firms. The information sharing mechanism improves coordination between the processes of each trading partner and enables the flow of materials and reduces inventory costs (Moberg et al. 2002; Panayiotou, Gayialis, and Tatiopoulos 2004; Chan and Chan 2009). Information sharing is defined as the extent to which critical and proprietary information is communicated between trading partners. To achieve effective information sharing among trading partners, an appropriate environment is required, where participating firms are willing to provide information necessary for effective coordination. Previous studies have suggested that increasing the use of an IOS such as a Web-based e-procurement system augments the breadth and nature of information flow between trading partners, leading to a more effective information sharing environment (Gosain, Malhotra, and El Sawy 2004; Grover and Saeed 2007).

The use of a Web-enabled IT platform constructed for establishing interorganisational coordination can enable strategic and operational information sharing. After achieving cohesion in all functions between trading parties, the visibility of information required to make decisions can stimulate mutual adjustments between them (Tai, Ho, and Wu 2010; Tai 2011). Previous studies have argued that mutual adjustments are the primary mechanism for coordinating interorganisational activities, particularly those that require trading parties to complete their tasks collaboratively (Sobek, Liker, and Ward 1998; Hung et al. 2011). A high degree of mutual adjustment indicates coordinated activities because they are conducted through interactions between trading firms (Hung et al. 2011). To maintain effective mutual adjustment, a continuous exchange of information among purchasing firms is necessary (Fredriksson 2006; Zimmerman and Sparrow 2007). The implementation of a Web-based e-procurement system can enable firms to construct a more effective information sharing environment and facilitate mutual adjustments between themselves and their suppliers (Tai, Ho, and Wu 2010).

2.2.3. *Supplier externality*

Buyer-centric e-procurement is a type of private e-market (Son and Benbasat 2007) that involves two types of players (i.e. a single buyer firm and numerous supplier firms), and exhibits one-way network externality, where the value of the e-market for the buyer is dependent on the number of supplier firms available (Dai and Kauffman 2002). The capability of buyer-centric e-procurement is based on the diversity of suppliers. The buyer tends to hold higher expectations when more suppliers are linked to its Web-based e-procurement system. As the number of supply alternatives rises, the buyer enjoys increased premiums and bargaining power. Previous studies have referred to this phenomenon as supplier externality, in which the buyer benefits from free premiums caused by an increased number of supply alternatives (Sudhi 2005; Zhu et al. 2006). This situation implies that the increased number of suppliers participating in a procurement system initiated by the buyer is likely to enhance the buyer's organisational performance.

When suppliers consider adopting an e-procurement system provided by a buyer, the costs and advantages of the project typically determine the adoption decision. Only with such considerations can the e-procurement system possibly generate a relative advantage prompting suppliers to deliberate on its adoption. Determining whether the adoption of an e-procurement system can be

advantageous requires weighing the benefits versus the costs of implementation. The investment costs of an e-procurement system include system implementation, staff training, and business process reengineering. The following are the common advantages of investing in an e-procurement system: reducing the possibility of errors, saving manpower in receiving orders, shortening the order fulfilment lead time, and improving the efficiency of inventory management (Grover and Saeed 2007; Gunasekaran and Ngai 2008).

2.3. Key facts from the literature review

Web-based e-procurement is an IT-based environment in which firms can effectively conduct transactions online and coordinate with their trading partners (Craighead et al. 2006). Procurement is a complex task in which execution strategy can be categorised into two dimensions: the procurement category and the method. The B2B e-market model in this study refers to a buyer-centric e-procurement model, in which the procurement category belongs to direct material, and the procurement method is systematic sourcing. Buyer-centric e-procurement is a type of private e-market. Web-based e-procurement often follows the private e-market model in the purchase of direct material. In such a purchase, particularly for strategic components, firms typically employ the e-procurement platform to share sensitive information with their suppliers, to improve process efficiency (Tai 2011).

Previous studies have observed that few companies are willing to risk their sensitive procurement process and information by using a public e-market (Handfield and Nichols 2008; Chopra and Meindl 2010). A Web-based e-procurement system provides the infrastructure necessary to assist firms in conducting purchasing activities. Implementing a Web-based e-procurement system to support interorganisational coordination can exert various effects on inter-firm governance structures (Tai, Ho, and Wu 2010). A Web-based e-procurement system can also reduce firms' order fulfilment cycle, lower inventory levels, lessen the administrative costs of procurement, and enhance the order fulfilment performance of suppliers. Past studies have shown that Web-based e-procurement systems serve as coordination mechanisms that result in operational and strategic benefits (Grey, Olavson, and Shi 2005; Grover and Saeed 2007; Tai, Ho, and Wu 2010). Such systems are being increasingly adopted because of the growing needs of an automated procurement process, integrated organisational, internal processes, and more effective management of purchasing information.

3. Research model

Web-enabled direct procurement enhances the effectiveness of the operational processes of trading partners as well as their efficiency in interorganisational coordination. Implementing a Web-based e-procurement system enables firms to create an efficient information sharing environment, and enhances current cooperative relationships with business partners. Prior studies (Tai, Ho, and Wu 2010; Tai 2011) on Web-based e-procurement have explored the system's impact on firm performance from organisational, interorganisational, and process perspectives. However, they did not adopt a synthetic and broader view that also includes a systems perspective. To fill this gap, this study proposes a research model (Figure 1).

Table 1 presents a summary of the conceptual definition of the constructs. This study assumes that firms expect to achieve five performance measures by implementing a Web-based procurement system: reduced transaction costs, shorter transaction time, enhanced partnerships, enhanced supplier performance, and increased organisational performance. The interactions between supply chain participants resulting in these performance outcomes can be categorised at the organisational

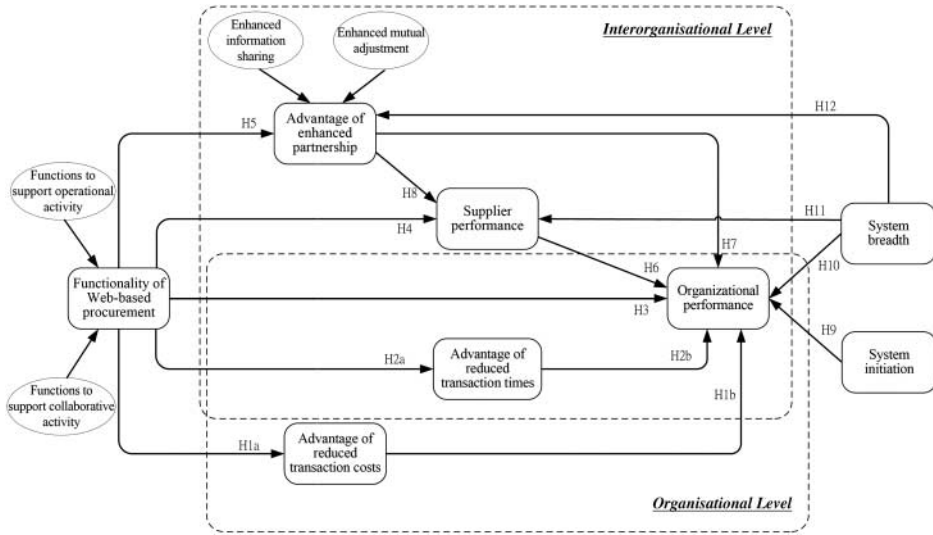


Figure 1. Research model.

Note: The construct of functionality of Web-based procurement and advantage of enhanced partnership are set as the formative second-order construct.

and interorganisational levels. Previous studies have argued that establishing electronic connections with numerous suppliers might allow firms to expand their sourcing leverage and grant them the ability to negotiate better contracts (Saeed, Malhortra, and Grover 2005). We added system breadth – which measures the ability of a Web-based e-procurement system to interact with multiple suppliers – to the model as an exogenous variable to strengthen our argument. For the same reason, we added another exogenous variable, system initiation, which measures the number of online relationships initiated by firms. In the following subsections, we elaborate on the model's variables and the rationale behind our hypotheses.

3.1. Organisational-level impact

Automation and the acceleration in data handling, storage, and transmission activities can enhance data accuracy and reduce the number of errors (Subramaniam and Shaw 2004; Gunasekaran et al. 2009). Thus, when measuring the direct impact of implementing procurement automation, the critical advantages are in the reduced transaction times and costs.

The effective management of relationships with suppliers can help firms create an operational environment where firms and suppliers conduct coordinated interactions. Such an operating environment can have a positive impact on the performance of both transaction parties (Shin, Collier, and Wilson 2000). Previous studies have identified the importance of e-procurement in facilitating collaborative relationships through improved information flow, leading to an environment that is conducive to supply chain operations (Presutti 2003; Wagner and Essig 2006).

Prior studies have also suggested that, because buyers take the lead in procurement, their performance can be evaluated according to four aspects: business processes, purchasing costs, product quality, and organisation (Essig and Arnold 2001; Subramaniam and Shaw 2004). The performance of business processes is assessed primarily according to the quality of the purchasing process, whereas purchasing cost performance is related to, for example, effective time management, the error rate, the product lead time, and costs for manpower. Regarding product quality, because the buyer has stronger purchasing power, it can choose from numerous vendors and is

Table 1. Conceptual definition of the constructs.

Construct	Definition
Functionality of Web-based procurement:	The extent to which the functions of an established Web-based e-procurement can be applied to assist in procurement activities
Functions to support operational activity:	The extent to which Web-based e-procurement can function to support operational activities in the procurement process
Functions to support collaborative activity:	The extent to which Web-based e-procurement can function to support collaborative activities in the procurement process
Advantage of reduced transaction costs:	The extent to which firms have reduced costs for conducting procurement operations
Advantage of reduced transaction times:	The extent to which firms have shortened the time for conducting procurement operations
Advantage of enhanced partnership:	The extent to which the partnerships between firms and their suppliers has been improved
Enhanced information sharing:	The extent to which information sharing between firms and their suppliers has been improved
Enhanced mutual adjustment:	The extent to which firms and their suppliers are willing to adjust their own activities in accordance with their negotiated and convergent expectations to obtain mutual benefits
Supplier performance:	The extent of an improvement in the performance of a firm's suppliers because of the deployment of a buyer-side e-procurement system
Organisational performance:	The extent of improvement in the performance of the buyer's organisation because of an enhanced procurement process
System initiation:	The number of electronic connections initiated by firms divided by the total number of electronic connections that the firms have established
System breadth:	The number of suppliers with who firms had existing electronic connections divided by the total number of suppliers who engaged in routine interactions with the firms

likely to choose a vendor offering high-quality products. Adopting Web-based e-procurement can enhance buyer performance. Based on this discussion, we propose the following hypotheses:

Hypothesis 1a (H1a): The functionality of Web-based procurement contributes to a reduction in transaction costs.

Hypothesis 1b (H1b): Reduced transaction costs positively influence a buyer's organisational performance.

Hypothesis 2a (H2a): The functionality of Web-based procurement contributes to reduced transaction times.

Hypothesis 2b (H2b): Reduced transaction times positively influence a buyer's organisational performance.

Hypothesis 3 (H3): The functionality of Web-based procurement positively influences a buyer's organisational performance.

Shin, Collier, and Wilson (2000) demonstrated that the cost, quality, and delivery attainment of products are critical indicators for assessing a vendor's performance. Purchasing cost is a primary factor in determining profits, and establishing a sound cooperative relationship is an effective approach to reducing purchasing costs. Product quality has been commonly considered a critical supply chain issue (Manoochehri 1984; Gunasekaran et al. 2009). Regarding product delivery, Shin, Collier, and Wilson (2000) stated that the product lead time is a major indicator in the assessment of delivery attainment. The advantage of timely deliveries is a shorter lead time, resulting in the reduction of inventory and a faster inventory turnover (Huang, Lau, and Mak 2003; Tai, Ho, and Wu 2010). Because IT can influence the supplier's performance, we assess its impact regarding service cost, product delivery attainment, and its ability to meet customer requirements. Accordingly, we propose the following hypothesis:

Hypothesis 4 (H4): The functionality of Web-based procurement positively influences a supplier's performance.

3.2. *Interorganisational-level impact*

The partnership between a buyer and suppliers is a key foundation for e-procurement systems (Croom 2005; Gunasekaran et al. 2009). A critical procurement goal is to build partnerships with strategic suppliers as well as their technological capability (Gelinas and Jacob 1996; Mukhopadhyay and Kekre 2002). Therefore, a procurement strategy should deliver a 'make or buy' decision to meet a company's needs in core competence and strategic capability.

Even when companies can produce outsourcing materials, they may still rely on a supplier's capacity to minimise costs (Gulati and Sych 2007; Chopra and Meindl 2010). In certain situations, companies require a supplier's critical knowledge to be able to provide crucial components in a product. For example, before introducing a prototype, Toyota invites its suppliers to product-design meetings. The suppliers design the components and also help with the concept of development of a new vehicle. First-tier suppliers are regarded as long-term partners who invest in developing various parts and present every alternative to Toyota before the company makes a decision on the final option for its concept vehicle (Womack and Jones 1990).

Partnership-type relationships require extensive information processing to facilitate mutual adaptation and process synchronisation (Gosain, Malhotra, and El Sawy 2004; Gunasekaran and Ngai 2008; Hung et al. 2011). Information sharing among chain members provides a competitive advantage by increasing customer value and reducing costs in the supply chain. Supply chain members who provide timely higher-quality products are able to set higher prices and increase their sales.

Because of the uncertain correlation between forecasts and actual needs, suppliers are forced to prepare a substantial inventory if outstanding information sharing practices between companies are nonexistent, and excessively large inventories are a waste of resources. Therefore, an effective information sharing practice between B2B partners can improve the efficiency of the entire supply chain (Gosain, Malhotra, and El Sawy 2004; Handfield and Nichols 2008).

Previous studies have suggested that companies establishing an IOS can use the Internet to transmit information in real time to their suppliers and help companies coordinate with them (Ordanini and Rubera 2008; Tai, Ho, and Wu 2010; Tai 2011). Suppliers can also control their inventory more efficiently and maintain it at a minimum. Therefore, a Web-based e-procurement system can improve a company's ability to share information with suppliers and to do so in a timelier manner, thereby maintaining close and mutually beneficial relationships. Accordingly, we propose the following hypothesis:

Hypothesis 5 (H5): The functionality of Web-based procurement contributes to an enhanced partnership.

The integrated business processes of manufacturers and suppliers are known to be a critical factor in managing supply chains (Handfield and Nichols 2008; Chopra and Meindl 2010). Just-in-time (JIT) purchasing is an extreme case that epitomises interorganisational process integration and long-term relationships in a lean manufacturing environment. The potential advantages of JIT purchasing include the reduction of inventory, delivery lead time and supplier costs, and improvements in scheduling flexibility and quality (Gelinas and Jacob 1996). If both trading parties are connected through a Web-based IOS, an IOS that facilitates comprehensive information flow through a system-to-system connection can reduce inventory costs and provide the advantages of vertical integration (i.e. greater control, coordination, and lower costs). Hence, supplier performance can contribute positively to buyer performance when using an e-procurement system in a supply chain environment (Tai, Ho, and Wu 2010). Accordingly, we propose the following hypothesis:

Hypothesis 6 (H6): A supplier's performance positively influences a buyer's organisational performance.

Partnerships evolve over time through repeated financial transactions or through recurrent joint problem-solving experiences (Gosain, Malhotra, and El Sawy 2004; Croom 2005). Previous studies have argued that the structure and quality of social ties between firms shape the financial decision-making process of both parties, such as the exchange of sensitive information and joint activity (Fredriksson 2006; Handfield and Nichols 2008; Chopra and Meindl 2010). The depth of the partnership is determined according to the degree of integration in business processes across trading partners, which is also discerned based on the range of information shared and the degree of mutual adjustment (Tai, Ho, and Wu 2010; Hung et al. 2011; Tai 2011). An effective practice of information sharing and mutual adjustment improves coordination, thereby enabling material flow to reduce inventory costs and improving the organisational performance of firms and their suppliers. Accordingly, we propose the following hypotheses:

Hypothesis 7 (H7): An enhanced partnership positively influences a buyer's organisational performance.

Hypothesis 8 (H8): An enhanced partnership positively influences a supplier's performance.

3.3. *E-procurement system initiation and system breadth*

The implementation of a Web-based procurement system allows a firm to adjust its functionalities and features to generate an advantage. Thus, initiators have leverage in dictating communication protocols, message standards, product coding, and information-handling procedures through the procurement systems. Consequently, initiators may be able to structure the procurement system to increase their advantage by better serving their needs, thereby improving their organisational performance (Masseti and Zmud 1996; Saeed, Malhortra, and Grover 2005). We thus propose the following hypothesis:

Hypothesis 9 (H9): The extent of system initiation positively influences a buyer's organisational performance.

The concept of system breadth for a Web-based procurement system is the extent to which the procurement system can be used to establish connections with multiple suppliers. This concept is similar to those in previous studies, such as EDI breadth (Masseti and Zmud 1996) and IOS breadth (Saeed, Malhortra, and Grover 2005; Zhu et al. 2006). System breadth is a critical and strategic consideration for buyer firms because buyers can expand the search scope and enhance the efficiency of their partner relationship by establishing electronic connections with their suppliers. According to supplier externality, increasing the availability and number of participating suppliers enables buyers to increase their competitive sourcing opportunities with their suppliers. Accordingly, we propose the following hypotheses:

Hypothesis 10 (H10): The extent of system breadth positively influences a buyer's organisational performance.

Hypothesis 11 (H11): The extent of system breadth positively influences a supplier's performance.

Hypothesis 12 (H12): The extent of system breadth contributes to an enhanced partnership.

4. Research methodology

4.1. *Measurement development*

We adopted the survey method to examine the proposed research model. We collected from manufacturing firms (i.e. buyer organisations) empirical data for measuring the organisational-level and interorganisational-level variables and the dyadic relationships established between manufacturing firms and their suppliers. We employed a two-step procedure to create items for the constructs developed in this study and confirmed their content validity.

First, we recruited a focus group to discuss and choose the items proposed in relevant studies. The focus group comprised two professors with several years of research experience in IOSs and SCM and six postgraduates who studied in the same fields under supervision for at least one year. We subsequently devised items relevant to the constructs of the proposed research model. Second, we gathered a content validity panel as proposed by Lawshe (1975) to reconsider the items generated in the second step for determining the applicability and semantics of each item. This panel was composed of two professors from the management field and six managers from manufacturing firms. Based on the results of this process, we modified the items to devise the instruments required for the full-scale study in the following stage (Table 2).

4.2. Data collection and analysis

We drew respondents from a random sample of senior procurement executives from the list of the Fortune 1000 Manufacturers in Taiwan. Our decision in selecting respondents for testing the hypotheses was based on their position within their organisation and on their knowledge of the use of Web-based e-procurement systems to manage their direct procurements and coordinate with their suppliers. We mailed the questionnaire to 181 senior procurement executives, and 105 valid questionnaires were returned, yielding a valid response rate of 58.01%.

We applied partial least-squares (PLS) regression to analyse the model, which can be used to assess the impact on organisational performance generated by implementing a Web-based e-procurement system. PLS employs a component-based approach that is generally recommended for predictive research models emphasising theory development (Jöreskog and Wold 1982). We chose the PLS method of structural equation modelling combined with SmartPLS 2.0 (M3) software (Ringle, Wende, and Will 2005) to test the research model for the following reasons: (a) previous relevant theories are scant, and few empirical studies have been conducted to explore the impact on organisational performance of buyer firms implementing Web-based e-procurement systems and (b) we received relatively few responses.

5. Results and discussions

5.1. The results of property assessment in the measurement model

Before testing the proposed structural model, we evaluated the properties of eight first-order latent constructs through confirmatory factor analysis by using a measurement model in which the first-order latent constructs were specified as correlated variables with no causal paths. We then assessed the measurement model to examine the individual reliability, internal consistency reliability, and convergent and discriminant validity of the items (Jöreskog and Wold 1982).

For this study, we assessed the individual reliability of the items by examining their loadings to their respective constructs. Items should be unidimensional in their representation of first-order latent constructs, and should thus be correlated with each other. The item loadings were above 0.707, indicating that the constructs obtained more than half of the variance. Table 3 shows the factor structure and the corresponding values for their loadings (ranging from 0.743 to 0.840).

We assessed the internal consistency reliability of the first-order latent constructs by confirming their Cronbach's alpha values and the composite reliability (CR) values. A score of 0.70 or above is an acceptable value of internal consistency for exploratory research (Jöreskog and Wold 1982). Table 4 shows Cronbach's alpha (ranging from 0.767 to 0.863) and CR values of the constructs (ranging from 0.815 to 0.907). They were all above the recommended level of 0.70, indicating adequate internal consistency.

Table 2. Item constructs.

Construct	Item	References
Functions to support operational activity	<ul style="list-style-type: none"> • Finding a suitable product more quickly • Finding a suitable product more easily • Inquiring on the progress of product purchasing has become more convenient • Acquiring new product information in a timelier manner 	Ageshin (2001), Subramaniam and Shaw (2004), and Craighead et al. (2006)
Functions to support collaborative activity	<ul style="list-style-type: none"> • Monitoring orders more effectively • Monitoring the logistics process more effectively • The orders our company fulfil for suppliers have gained accuracy • Communication between our company and suppliers has become more stable 	
Reduced transaction costs	<ul style="list-style-type: none"> • The cost of conducting the procurement process has diminished • The monitoring cost of product quality has decreased 	Yen and Ng (2003), Subramaniam and Shaw (2004), and Craighead et al. (2006)
Reduced transaction times	<ul style="list-style-type: none"> • The purchasing time has shortened • Orders are received faster • The response time for the order has shortened 	
Enhanced information sharing	<ul style="list-style-type: none"> • Our company and our strategic partner exchange more inventory information • Our company and our strategic partner exchange more demand-forecasting information • Our company and our strategic partner exchange more information on product specifications 	Huang, Lau, and Mak (2003), Saeed, Malhortra, and Grover (2005), Fredriksson (2006), Wagner and Essig (2006), and Hung et al. (2011)
Enhanced mutual adjustment	<ul style="list-style-type: none"> • We and our suppliers are willing to adjust our business processes to meet each other's requirements • We and our suppliers are willing to invest specialised assets to meet each other's requirements 	
Supplier performance	<ul style="list-style-type: none"> • The delivery time is more precise • Our supplier's service cost has decreased • Our supplier's workforce cost has diminished • The products provided by our supplier met our requirements more precisely 	Mukhopadhyay and Kekre (2002), Presutti (2003), and Tai, Ho, and Wu (2010)
Organisational performance	<ul style="list-style-type: none"> • Total procurement costs have decreased • Product quality has increased • The production lead time has shortened • Deliver reliability has risen • Flexibility has increased in managing demand uncertainties 	Olig and Spears (2001), Subramaniam and Shaw (2004), Saeed, Malhortra, and Grover (2005), Tai, Ho, and Wu (2010), and Tai (2011)
System initiation	<ul style="list-style-type: none"> • The number of electronic connections initiated by firms 	Massetti and Zmud (1996) and Saeed, Malhortra, and Grover (2005)

(Continued)

Table 2. Continued

Construct	Item	References
System breadth	<ul style="list-style-type: none"> • The total number of electronic connections that the firms have established • The number of direct material suppliers with whom a firm has electronic connections • The number of direct material suppliers with whom a firm routinely interacts 	

Table 3. Factors structure and loadings ($N = 105$).

	FOA	FCA	EIS	EMA	RTC	RTT	SP	OP
FOA 1	0.831							
FOA 2	0.813							
FOA 3	0.829							
FOA 4	0.837							
FCA 1		0.801						
FCA 2		0.833						
FCA 3		0.819						
FCA 4		0.840						
EIS 1			0.755					
EIS 2			0.743					
EIS 3			0.781					
EMA 1				0.807				
EMA 2				0.799				
RTC 1					0.771			
RTC 2					0.803			
RTT 1						0.778		
RTT 2						0.761		
RTT 2						0.759		
SP 1							0.791	
SP 2							0.811	
SP 3							0.753	
SP 4							0.802	
OP 1								0.808
OP 2								0.792
OP 3								0.811
OP 4								0.799
OP 5								0.800

Note: FOA, Functions to support operational activity; FCA, Functions to support collaborative activity; EIS, enhanced information sharing; EMA, enhanced mutual adjustment; RTC, reduced transaction costs; RTT, reduced transaction times; SP, supplier performance; OP, organisational performance.

Table 4. Internal consistency reliability of first-order constructs.

Construct	CR	Cronbach's alpha
FOA	0.907	0.861
FCA	0.901	0.855
EIS	0.815	0.767
EMA	0.829	0.789
RTC	0.855	0.796
RTT	0.851	0.803
SP	0.893	0.824
OP	0.899	0.863

Table 5. Inter-correlation among first-order constructs.

Construct	AVE	1	2	3	4	5	6	7	8
1. FOA	0.711	0.843							
2. FCA	0.706	0.593	0.840						
3. EIS	0.629	0.441	0.443	0.793					
4. EMA	0.715	0.442	0.447	0.551	0.846				
5. RTC	0.637	0.437	0.439	0.213	0.225	0.798			
6. RTT	0.692	0.449	0.453	0.219	0.214	0.579	0.831		
7. SP	0.725	0.221	0.227	0.421	0.417	0.137	0.113	0.851	
8. OP	0.658	0.172	0.179	0.237	0.235	0.251	0.225	0.299	0.811

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

Table 6. Paths between first-order constructs and second-order construct.

Second-order construct	First-order construct	Path coefficient
Functionality of Web-based Procurement	Functions to support operational activity	0.479*
	Functions to support collaborative activity	0.604**
Advantage of enhanced partnership	Enhanced information sharing	0.663**
	Enhanced mutual adjustment	0.358*

* $P < 0.05$.

** $P < 0.01$.

Table 5 shows the average variance extracted (AVE) and the square root of the AVE, as well as the correlations between the constructs. The percentage of variance of a construct is obtained from its AVE. Convergent validity is demonstrated as the AVE values for all constructs that are higher than the suggested threshold value of 0.50 (ranging from 0.629 to 0.725). A construct is considered distinct if the square root of its AVE is greater than that of its correlations with other latent constructs (Jöreskog and Wold 1982). Comparing the square root of the AVE with the correlations among the constructs indicates that each construct is more closely related to its own measures than to those of the other constructs, thereby showing an acceptable level of discriminant validity.

5.2. The testing results of the structural model

We tested the structural model to assess the impact on organisational performance of implementing a Web-based e-procurement system. Figure 2 displays a graph of the PLS results, which shows the standardised path coefficients among the constructs; they were determined using the bootstrap resampling method and the R^2 values of the five aspects of performance derived from implementing Web-based e-procurement. The statistical significance of the weights can be used to determine the relative importance of the indicators in forming a latent construct. We observed that all the specified paths between the second- and first-order constructs in the research model had significant path coefficients (Table 6).

One indicator of the predictive power of path models is the explained variance or R^2 values. The R^2 values are interpreted in the same manner as those obtained from multiple regression analysis. They indicate the amount of variance in a construct that is explained by the path model. The results shown in Figure 2 provide strong support for H1–H10 (but not H11 and H12).

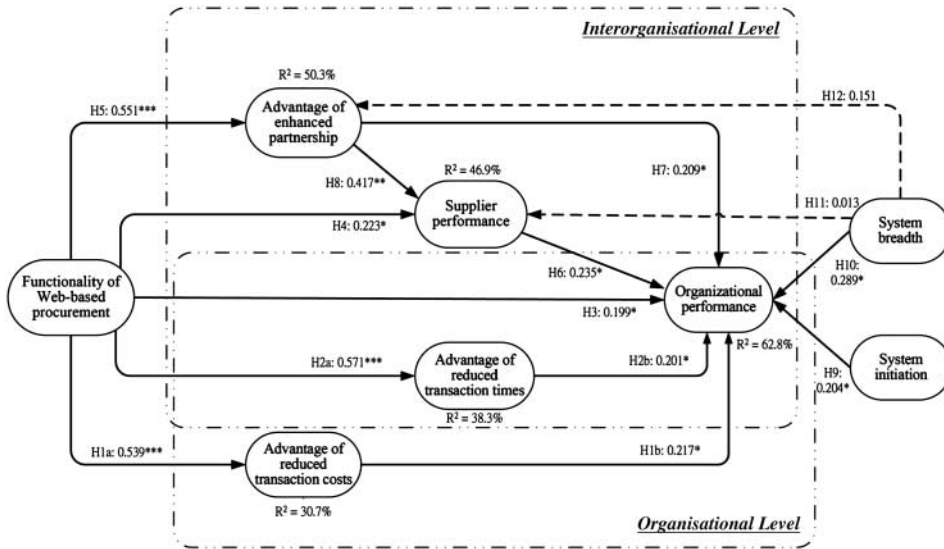


Figure 2. Results of path analysis.
 Note: Path coefficients, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

5.3. Discussion of results

Previous studies have indicated that short- and long-term financial values should be the prime motivating factors for B2B e-commerce implementation (Essig and Arnold 2001; Wagner and Essig 2006). In addition to contributing to an increase in process efficiency, another critical measure is whether the implementation of this technology strengthens relationships between firms and their suppliers, and results in firms rewarding suppliers who have also adopted this technology. Our findings show that a relationship might be equally critical in the pursuit of process efficiency in B2B direct procurements. Our results also support the existence of supplier externality as a benefit for the buyer. Nevertheless, B2B e-commerce systems may not succeed if they do not achieve economies of scale (Handfield and Nichols 2008; Chopra and Meindl 2010); if Web-based e-procurement is considered an efficient solution to firms, the supplier base in the platform must be sufficiently large to reduce transaction and collaboration costs substantially.

6. Conclusion

This study examined how Web-based e-procurement affects firms' organisational performance from organisational, interorganisational, and systems perspectives. The results show that the implementation of Web-based e-procurement can generate operational and strategic impacts on an organisation. Among the operational effects, we observed reductions in transaction times and costs and an enhancement in both buyer and supplier performance to be stronger. The strategic effect most impacted by adopting Web-based e-procurement is the enhanced partnership. These factors should be considered when assessing the advantages of implementing an e-procurement platform. From the interorganisational perspective, we can conclude that organisational performance, supplier performance, and partnership can be enhanced through the development of appropriate functionalities of Web-based e-procurement and the smooth execution of an implementation project.

This study has limitations that must be considered when interpreting the results and the derived conclusions. First, the use of senior procurement executives from Taiwan-based companies as the chief informants in our survey could be a limitation. Because purchasing behaviour is often tied to the culture and the industrial structure of society, generalising our results to other countries may lead to limitations. For example, the process efficiencies and partnerships might differ according to the characteristics of the purchasing behaviour in a particular nation. However, the constructs derived in this study may still serve as a basis for the assessment of effective Web-based e-procurement.

Second, we targeted manufacturing firms as the sample for investigating the impact on performance resulting from the implementation of Web-based e-procurement. Overall, the perceptions of manufacturing firms regarding this impact are grounded in industry-specific assumptions. Our focus on only manufacturing firms may have restricted the generalisability of our findings to other industries. Consequently, an adjustment may be required if the performance impact model is to be applied to non-manufacturing industries (e.g. the retail industry).

For future research, we offer the following suggestions. This study focused only on the buyer-centric e-procurement model, and considered only the measures associated with direct procurement. However, most e-procurement models that companies adopt for purchasing activities consist of more than one type. Companies may adopt multiple e-procurement models because a diverse set of products and services may need to be purchased from outside, thereby requiring different procurement methods. Further development of associated measures for different business models on e-procurement may be required (e.g. an e-auction and a non-private e-marketplace).

Numerous other interorganisational factors, such as trust, commitment, power, and dependence, have been shown to influence the breadth of information sharing and collaboration between purchasing parties (Li and Lin 2006; Chopra and Meindl 2010). This might explain the non-significant relationship between system breadth and enhanced partnership (H12). Future studies could adopt these factors to extend the current performance impact model, to increase its explanatory power.

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