E-procurement and supply chain performance

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Abstract
Purpose – The aim of this study is to discuss the relationship between e-procurement and supply chain performance.
Design/methodology/approach – Both interviews with practicing managers and an empirical study were conducted in the current study. Interviews with four practicing managers were conducted to gather the practical insights of the theoretical framework. Empirical data were collected from 108 Taiwanese enterprises.
Findings – The paper found that partner relationships, information sharing, and supply chain integration can represent the processes through which e-procurement contributes to supply chain performance. Supply chain integration has the highest standardized total effect on supply chain performance.
Research limitations/implications – Future studies could more systematically analyze the relationships among e-procurement, supply chain integration and supply chain performance. Cross-level analysis is also worthy of investigation when considering the influence of technology-usage characteristics.
Practical implications – Compared to partner relationships and information sharing, supply chain integration has more influences on supply chain performance. Therefore, this study suggests that a joint-learning practice can be implemented for properly managing supply chains (e.g. know-how collaboration, mutual competency creation).
Originality/value – This paper contributes to the literature by proposing and testing the influences of partner relationships, information sharing, and supply chain integration. This allows a strategic viewpoint when implementing e-procurement systems intended to improve supply chain performance.

Keywords E-procurement, Supply chain performance, Partner relationships, Information sharing, Supply chain integration, Interviews, Survey, Supply chain management, Taiwan

Paper type Research paper

Introduction

An e-procurement system is an information technology-based purchase system which is at the input end of the supply chain (Presutti, 2003). It has been commonly accepted that information infrastructures such as e-procurement systems become increasingly connected and embedded with other infrastructures to initiate the growth of enterprises (Vaast and Walsham, 2009). In line with this notion, the usage of information technology in e-procurement systems is considered to be an innovation strategy action (Mishra and Agarwal, 2010).

In recent years, e-procurement has been advocated as a new strategic view of supply chain management (Nelson *et al.*, 2002). The innovation of implementing e-procurement systems can create value for enterprises through utilizing IT-enabled resources on supply chain management (Dong *et al.*, 2009). Previous studies have focused on the benefits of e-procurement on supply chain performance (e.g. Dell, 1999; Presutti, 2003; Timme and Timme, 2001, Turban *et al.*, 2000). However, the process through which e-procurement contributes to supply chain performance is still an unknown issue. For academics, e-procurement is an emerging phenomenon in the business world, and it needs to be systematically analyzed. For supply chain managers, e-procurement creates a need to understand the impact of information technology on the achievement of competency on a practical level (Dong *et al.*, 2009; Jonsson and Gunnarsson, 2005; Presutti, 2003).

In the current study, we consider partner relationships, information sharing, and supply chain integration as the processes through which e-procurement contributes to supply chain performance. This argument is based on previous studies that have indicated that relational exchange, information rich and joint-learning are basic strategies applied through technological functions in organizations (Walters, 2008). In line with this notion, we suggest that partner relationships, information sharing and supply chain integration represent the reasons for the relationship between e-procurement and supply chain performance. The rationale underlying this agreement is consistent with practical implementations. For instance, Wal-Mart's inventory and supply chain management system benefits not only itself but also its partners. Mattel's inventory system improves its relationship with channel members and enhances

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manufacturing efficiency as well (Johnson, 2002). Thus, the current study contributes to literature by proposing and empirically testing a theoretical model that can both reflect the technological nature of e-procurement and also can capture basic strategies applied through technological functions.

The remainder of this study is structured as follows: In the next section, we present a literature review and the theoretical framework of e-procurement and supply chain performance. Following our literature review, we conducted interviews with practitioners to gather practical insights and to initially understand the appropriateness of our research framework. After the interviews, an empirical study was conducted to statistically test the theoretical framework. Finally, after demonstrating the results, we present the conclusions and implications in the last section of this article.

Research framework and hypothesis development

Supply chain performance, E-procurement and research framework

Supply chain performance refers to the evaluation of supply chain management, and includes both tangible (e.g. cost) and intangible (e.g. capacity utilization) factors (Croom and Johnson, 2003; Eng, 2004; Presutti, 2003; Tan *et al.*, 2002). E-procurement is an electronic procurement system. The wider application context of e-procurement system is e-business. E-business refers to the implementation of business activities business activities through digital technologies over the internet (or extranet) (Amit and Zott, 2001). Among the several applications of e-business, e-procurement is considered as our research focus for two reasons:

1 E-procurement system can improve the effectiveness of operation processes and the transparency of the supply chain (Puschmann and Alt, 2005). Therefore, it could be implied that an e-procurement system is more pivotal than other e-business applications when studying supply chain performance.
2 In the current economic environment, a value creation perspective is important for improving supply chain performance (Wiengarten *et al.*, 2010). It can be expected that the functional characteristics of e-procurement systems can enable companies to improve the efficiency of value creation processes in the supply chain.

In the current study, we view e-procurement as an electronic procurement system that has four functions: e-design, e-sourcing, e-negotiation, and e-evaluation (Croom, 2000; Kim and Shunk, 2004; Presutti, 2003; Sain *et al.*, 2004; Tatsis *et al.*, 2006). E-design refers to the setting of purchasing requirements on an electronic procurement system; e-sourcing refers to the process wherein an enterprise selects its suppliers through an electronic procurement system; e-negotiation refers to the contract agreement conducted through technology; e-evaluation refers to the stage where extensive information about suppliers is collected for further evaluations and transactions. From this point of view, e-procurement can provide a strategic function for supply chain management and can contribute to supply chain performance (Dell, 1999; Nelson *et al.*, 2002; Presutti, 2003; Timme and Timme, 2001; Turban *et al.*, 2000).

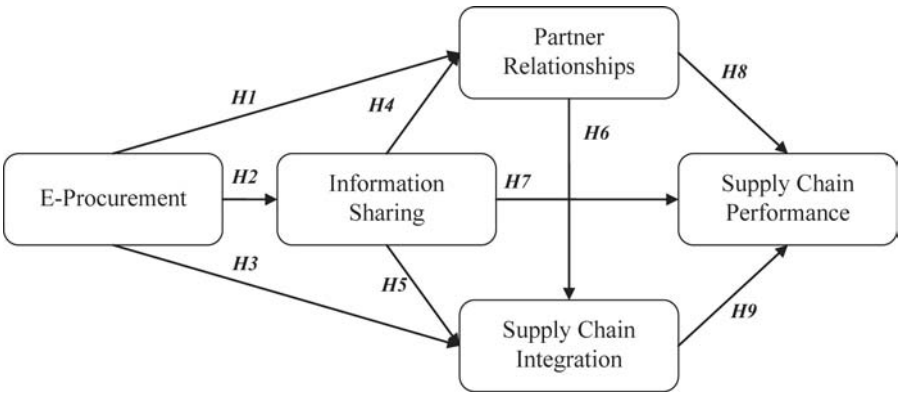
However, the process through which e-procurement contributes to supply chain performance is still an unknown issue. Figure 1 presents our theoretical framework, which can explain the relationships among such processes. Partner relationships, information sharing and supply chain integration are proposed as the processes that connect e-procurement systems with supply chain performance. The rationales are explained as follows: Since e-procurement is an electronic (technology-based) system (Presutti, 2003), the consequences of e-procurement can be inferred from the technological applications associated with supply chain management. Previous studies have indicated that relational exchange strategy, information rich strategy and joint-learning strategy can be the basic strategies applied through technological functions in supply chains (Walters, 2008). As a result, it is reasonable to expect that relational exchange, information enrichment and joint-learning are three basic strategies when enterprises can implement in e-procurement systems with an expectation of their having an impact on supply chain performance.

In line with this notion, we suggest that the characteristics of relational exchange, information enrichment and joint-learning strategies can be reflected in the domains of partner relationships, information sharing and supply chain integration, respectively. In particular, relational exchange strategy stresses the focus of committed ongoing relationship between enterprises (Walters, 2008). The focus of information enrichment strategy is on information flows, such as acquisition, distribution, and exploitation (Walters, 2008). Joint-learning strategy focuses on know-how collaboration and mutual competency creation (Walters, 2008). The term partner relationships refers to mutually committed relationships between enterprises and their partners (e.g. suppliers, the same tier manufactures and channel members) in the supply chain (Ellram and Krause, 1994; Li *et al.*, 2005; Liker and Choi, 2004; Panayides and So, 2005; Skjøtt-Larsen *et al.*, 2003). Information sharing refers to good-quality information flow between an enterprise and its partners (e.g. suppliers, the same tier manufactures and channel members) in the supply chain (Lee *et al.*, 1997; Monczka *et al.*, 1998; Tan *et al.*, 2002). Supply chain integration is defined as the coordination and activity integration of supply chain processes between an enterprise and its partners (e.g. suppliers, the same tier manufactures and channel members) in the supply chain (Lee and Whang, 2001; Morash and Clinton, 1997; Tan, 2001, Tan *et al.*, 2002; Virolainen, 1998; Zhang *et al.*, 2006) It is necessary to note that the domain of the supply chain integration in this study focuses on the functional aspect, which is the integration of functional activities in the supply chain (Dornier *et al.*, 1998). As a result, partner relationships, information sharing and supply chain integration are incorporated into the theoretical framework since they reflect the potential applications of e-procurement. The specific rationales of the research hypotheses are presented as follows:

Hypothesis development

E-procurement and partner relationships. The relationship between e-procurement and partner relationships is expected to be positively related. E-procurement could serve as a platform to facilitate the problem solving process between an enterprise and its partners (i.e. suppliers, the same tier manufactures and channel members) in the supply chain

Figure 1 Research framework



(Cagliano *et al.*, 2003). Through this facilitation, the relationship (e.g. mutual trust) between an enterprise and it partners could further be enhanced (Johnson and Klassen, 2005). This would be expected to improve such partner relationships. Thus, *H1* is proposed:

H1. E-procurement is positively related to the partner relationships between an enterprise and its partners.

E-procurement and information sharing. E-procurement is expected to be positively related to information sharing that occurs between an enterprise and its partners (i.e. suppliers, the same tier manufactures and channel members). First, an e-procurement system provides an internet-based infrastructure that enables an enterprise to communicate with its suppliers more effortlessly (Eng, 2004). Second, through the use of internet-based technology, information flows among organizations can be facilitated and hence the quality can further be maintained (Cagliano *et al.*, 2003; Johnson and Klassen, 2005). Thus, information sharing can be treated as a consequent element led by an e-procurement system. As a result, *H2* is presented:

H2. E-procurement is positively related to information sharing between an enterprise and its partners.

E-procurement and supply chain integration. We propose that e-procurement is positively related to supply chain integration based on the following reasons: E-procurement systems can provide opportunities for an enterprise to be coordinated with its partners (Sain *et al.*, 2004). For example, previous studies have found that collaborative planning can be enhanced by information technology (Cagliano *et al.*, 2003; Croom and Johnson, 2003; Skjøtt-Larsen *et al.*, 2003). Hence, this implies the extent to which the cooperation between an enterprise and its partners can potentially be enhanced through e-procurement. As a result, it could be expected that supply chain integration might be advanced by an e-procurement system, and, consequently, *H3* is proposed:

H3. E-procurement is positively related to the supply chain integration between an enterprise and its partners.

Apart from the influence of e-procurement, potential relationships among partner relationships, information sharing and supply chain integration might also exist. First, we propose that partner relationships will be influenced by information sharing. Second, supply chain integration is expected to be influenced by information sharing. Third, we expect that supply chain integration is also influenced by partner relationships.

Information sharing and partner relationships. Information sharing refers to good-quality information flows between an enterprise and its partners (Li *et al.*, 2005; Tan *et al.*, 2002). Through good-quality information flow, mutual trust between enterprises can be established. In addition, information sharing activities have been found to be facilitators leading to improvement in relationships among enterprises (Bakos, 1991; Ellram, 1995; Liker and Choi, 2004). As a result, *H4* is presented:

H4. Information sharing is positively related to the partner relationships between an enterprise and its partners.

Information sharing and supply chain integration. A positive relationship is expected between information sharing and supply chain integration: Supply chain integration refers to the integration of supply chain processes (Lee and Whang, 2001; Tan, 2001, Zhang *et al.*, 2006); and one of the basic criteria for it is the information availability among the parties under consideration (Morash and Clinton, 1997). Thus, it can be further expected that the processes of information sharing could advance supply chain integration (Cagliano *et al.*, 2003; Morash and Clinton, 1997); therefore we expect that:

H5. Information sharing is positively related to supply chain integration between an enterprise and its partners.

Partner relationships and supply chain integration. In the theoretical framework, partner relationships are also expected to be positively related to supply chain integration. Our rationales are as follows. First, tightly linked relationships among enterprises are a necessary criterion of business activity integration (Lee and Whang, 2001). Further, past literature has indicated that the higher the level of relationships among enterprises, the greater is the extent of business cooperation (Patterson *et al.*, 2003; Skjøtt-Larsen *et al.*, 2003). Thus, the sixth hypothesis is proposed:

H6. Partner relationships are positively related to supply chain integration between an enterprise and its partners.

Information sharing and supply chain performance. Information sharing between an enterprise and its partners is expected to positively influence supply chain performance. In particular,

information sharing among enterprises could not only advance the control ability of supply chain management, but also could reduce transaction costs between enterprises and their partners (Eng, 2004). Furthermore, the flexibility of product specifications could be enhanced by a technology-based information sharing platform (Evans and Wruster, 2001). This implies that information sharing could provide an opportunity for enterprises to manage their supply chains more effectively (Barratt and Rosdahl, 2002; Tan *et al.*, 2002). Therefore, *H7* is presented:

H7. Information sharing between an enterprise and its partners is positively related to supply chain performance.

Partner relationships and supply chain performance. The influence of partner relationships on supply chain performance is expected to be positive. Relying on ongoing and mutually beneficial partner relationships, an enterprise can launch a successful product/service faster than its competitors (Liker and Choi, 2004). Enterprises that incorporate strategic collaboration partners in their product design process could potentially further reduce the time and cost of developing and introducing new products (Eng, 2004). Therefore, *H8* is proposed:

H8. Partner relationships between an enterprise and its partners are positively related to supply chain performance.

Supply chain integration and supply chain performance. In addition to information sharing and partner relationships, supply chain performance could also be improved by supply chain integration. Process automation is one of the key drivers for increasing process efficiency (Croom, 2000). It could be expected that product quality and customer service performance would be enhanced by supply chain integration activities (Tan *et al.*, 2002). As a result, we suggest that the higher the extent of supply chain integration, the higher the supply chain performance. Therefore, *H9* is expected:

H9. Supply chain integration between an enterprise and its partners is positively related to the supply chain performance.

Methodology

We conducted interviews with practicing managers prior to the empirical study. The purposes of interviews are two-fold: to gather insights into each research construct from the practice; and to understand the appropriateness of the theoretical framework.

The background information and rationales for the case companies and interviewees are presented as follows: we selected three case companies which rely on supply chain management to achieve competitive advantage. The industry categories for the three companies are "Hard disk drive and telecommunication industry," "Steel industry," and "Biochemistry industry", respectively. Each industry represents a high extent to which a comprehensive supply chain exists. Since these three companies are all at the top in their corresponding industries, it further implies that these three companies are highly relying on supply chain management to achieve competitive advantage. Appendix 1 (see Table AI) presents their background information. For the purposes of confidentiality, the three companies are presented anonymously as A, B, and C, respectively. Four employees from the three companies participated in interviews, two from company A and one each from companies B and C, and all of them are in charge of the procurement departments of their companies. Appendix 2 (see Table AII) lists their background information. Miss Ling is the deputy manager of the inventory control department in company A. She is in charge of all procurement projects, including sourcing, partner relationships, and contract negotiating. Mr Lee works in the material science and mechanical department. He is in charge of developing the sources of new corporate partners and working with the corporate inventory control department, material science department and mechanical department in company A. Mr Tai has a complete knowledge background of the e-procurement systems in company B. He works in the purchasing department and has previously been in charge of the information system department. Mr Liu is a senior project manager of the purchasing division in company C. He works with an information team to build the e-procurement system in company C.

Results of the case study

Practical insights

The first purpose of a case study is to gather practical insights for each research construct. We conducted open-ended questions in interviews with practicing managers. Appendices 3 and 4 (see Tables AIII and AIV) present these questions and the results of interviews from the three companies, respectively. In general, supply chain performance is recognized as an important factor for improving competitive advantage. Managers tend to evaluate supply chain performance from both tangible (e.g. cost) and intangible perspectives (e.g. time). E-procurement is treated as a comprehensive system applied to each purchase process. Case companies acknowledge that e-procurement has an influence on supply chain performance. Furthermore, the functions of e-procurement are "e-sales," "e-purchases," and "e-transportation" in company B.

The issues of partner relationships shared by case companies are "bonding," "reciprocity," "empathy" and "trust." This implies that a partner relationship is a long-term orientation. It is worth noting that company B takes price and quality into account prior to the consideration of partner relationships when making transactions. This is because company B is in the steel industry. As a result, it could be inferred that the implementation of partner relationship strategy might differ among distinct industries. For the consideration of information sharing, the case companies all have high-level communication information with their partners in the supply chain. Case companies evaluate information sharing by not only information exchanges themselves, but also by the quality of information (e.g. accuracy, value, and criticality, among others). Supply chain integration is treated as a comprehensive function that has a high influence on supply chain performance. This implies that its importance is higher than partner relationships and information sharing. In addition, coordination and activity integration are the main subsections within the implementation of supply chain integration.

The appropriateness of theoretical framework

In order to understand the appropriateness of the theoretical framework, the main issue we examined was the roles of partner relationships, information sharing and supply chain integration in delivering the influence from e-procurement to supply chain performance. In general, the case companies all recognize that partner relationships, information sharing and supply chain integration are three important strategies that accompany the application of e-procurement. More specifically, e-procurement can enhance partner relationships, information sharing and supply chain integration, and hence, it contributes to the growth of supply chain performance. In particular, partner relationships are treated as an important factor for improving supply chain performance. The benefits of partner relationships are cost reduction and time savings. Information sharing can be facilitated by e-procurement. The benefits of information sharing are related to the effectiveness of supply chain management. Supply chain integration is treated as a platform to integrated supply chain related activities. It could potentially be influenced by an e-procurement system.

Based on the previous discussions, partner relationships, information sharing and supply chain integration are acknowledged as three key elements that reflect the influences of e-procurement; and link it with supply chain performance. Thus, the underlying rationales of the theoretical framework are reasonable based on the interviews discussed previously.

Results of empirical study

Based on the interviews, it was reasonable to test the theoretical framework. We conducted an empirical survey study to test the hypotheses. The measurements, sampling procedure, sample characteristics and data analysis results are presented as follows:

Measurements and pretests

A seven-point Likert scale was used to measure all of the research constructs. The measurement items were taken from relevant literature, and the content validity was confirmed in the case study. Table I presents the definition and measurements of latent variables. For measuring supply chain performance, different measurement approaches are suggested in supply chain literature. For example, tangible and intangible dimensions (Croom and Johnson, 2003; Eng, 2004; Presutti, 2003; Tan *et al.*, 2002), the framework of supply chain operational references (SCOR model) (Lockamy and McCormack, 2004; Gunasekaran *et al.*, 2004), dynamic modeling approaches (Perea *et al.*, 2000; Puigjaner and Laínez, 2008), agility and flexibility (Swafford *et al.*, 2008). Based on a literature review and analysis, a recent study, it was found that Akyuz and Erkan (2010) suggested that in the new era of competition, supply chain performance should include the measures of partnership, collaboration, agility, flexibility, productivity, and excellence metrics. However, Akyuz and Erkan (2010) also acknowledged that it is a challenging task to include all the measures from all aspects of supply chain performance.

In our study, we conducted questionnaires to survey practicing managers' opinions. For survey-based research, researchers need to both maintain the construct validity and control the length of the questionnaire in order to minimize measurement errors (Malhotra and Grover, 1998). Therefore, we adopted tangible and intangible dimensions to measure supply chain performance (Croom and Johnson, 2003; Eng, 2004; Presutti, 2003; Tan *et al.*, 2002). Tangible dimensions refer to costs and benefits, whereas intangible dimensions capture the aspect of subjective evaluations of capacity utilization and flexibility judgments (Croom and Johnson, 2003; Eng, 2004; Presutti, 2003; Tan *et al.*, 2002).

E-procurement is measured by four dimensions: e-design, e-sourcing, e-negotiation, and e-evaluation (Albrecht *et al.*, 2005; Croom, 2000; Kim and Shunk, 2004; Presutti, 2003; Sain *et al.*, 2004; Tatsis *et al.* 2006). Reciprocity and bonding are two dimensions used to measure partner relationships. Reciprocity refers to the empathy aspect of relationships, whereas bonding measures the structural aspects (Ellram and Krause, 1994; Li *et al.*, 2005; Liker and Choi, 2004; Panayides and So, 2005; Skjøtt-Larsen *et al.*, 2003).

Information sharing is measured by information flow and information quality, and by measuring these two dimensions, both the quantity and quality aspects of information sharing can be measured (Lee *et al.*, 1997; Li *et al.*, 2005; Monczka *et al.*, 1998; Tan *et al.*, 2002). Coordination and activity integration are used to measure supply chain integration (Lee and Whang, 2001; Morash and Clinton, 1997; Tan, 2001; Tan *et al.*, 2002; Virolainen, 1998; Zhang *et al.*, 2006). When constructing the questionnaire, we discussed the questions with case interviewees and accordingly adjusted the items based on their opinions. After ensuring the content validity, thirty questionnaires were posted to three case companies for the purpose of a pretest. Consequently, the Cronbach's α of each constructs were above 0.7: e-procurement (0.932), partner relationships (0.899), information sharing (0.924), supply chain integration (0.912), and supply chain performance (0.897). Thus, no changes were made during the pretest stage.

Sampling procedure and sample characteristics

According to the nature of each construct, the unit-of-analysis of the research framework was at the enterprise level, and hence, data were collected by a mail survey based on the list of "The 5,000 Largest Corporations in Taiwan" (China Credit Information Services, 2005). Questionnaires, along with a prepaid-return envelope, were mailed to 700 firms chosen randomly. As suggested by previous research (Roth and Bevier, 1998), we relied on research procedures to ensure that the answers came from the right informants. Explanations about the purpose of the study were presented on the first half page of the questionnaire to facilitate survey respondents understanding of the questionnaire. We then relied on asking the surveyed company to find the relevant employees who are familiar with the topic to fill out the questionnaire. The resulting sample consisted of 108 usable questionnaires, a response rate of 15.43 per cent, and the sample characteristics are presented in Table II. There might be three reasons of such low response rate. First, it might be due to the high number of measurement items in the questionnaire (a total of 71 items needed to be filled out). Second, this result is consistent with the notion which indicates that the response rate of company-survey studies has been declining in recent years (Cycyota and Harrison, 2006). Third, since we did not provide any incentive for companies to fill out the questionnaire, this might have resulted in a low response rate as well (Rose et al., 2007). Among 108 usable

Table I Construct definition and measurement items

Construct definition and measurement items	
Supply chain performance	
The evaluation of supply chain management includes both tangible (e.g. cost) and intangible (e.g. capacity utilization) factors	
Tangible dimension	
SCP1	Our company manages costs well
SCP2	Our company manages profit well
SCP3	Our company manages cash turnover well
Intangible dimension	
SCP4	Our company predicts customers' potential needs accurately
SCP5	Our company utilizes capacity well
SCP6	Our company manages product quality well
SCP7	Our company manages inventory turnover well
SCP8	Our company has sufficient material availability
SCP9	Our customers are satisfied
SCP10	Our company manages lead time well
SCP11	Our company manages the deadlines for products/services well
SCP12	Our company reacts to customer problems effectively
E-procurement	
The electronic (technology-based) procurement system consists of four functions: e-design, e-sourcing, e-negotiation, and e-evaluation.	
E-design	
EP1	Our company uses an electronic system to gather information at the procurement request stage
EP2	Each department within the organization shares the same network platform for purchasing requests
EP3	Each department within the company requests purchases from one specific department unit
EP4	The design of the purchase requirement or the standardized purchasing norm between the organization and the supplier will be communicated or negotiated via the internet
EP5	Our company designs the format of marketing demands using the information system
E-sourcing	
EP6	Our company selects the most appropriate supplier through the information system
EP7	Our company gathers the demand proposals about procurement information or related information through the information system
EP8	Our company releases the company requirements or rules via the information system
EP9	Our company notifies the supplier on the arrival of an authorized procurement contract via the information system
E-negotiation	
EP10	Our company negotiates with the supplier through the internet
EP11	Our company confirms the procedures concerning daily purchases with the supplier through the internet
EP12	Our company negotiates the general procedures of purchasing with the supplier through the internet
E-evaluation	
EP13	Our company documents past purchasing information in an electronic form
EP14	Our company sets up a database about procurement and utilizes it in the purchasing process
EP15	Our company evaluates the performance of suppliers from past purchasing information in the information system
Partner relationships	
The mutual commitment relationship between an enterprise and its partners (e.g. suppliers, the same tier manufactures and channel members) in the supply chain.	
Reciprocity	
PR1	We trust each other
PR2	We both try very hard to establish a long-term relationship
PR3	We work in close co-operation
PR4	We communicate and express our opinions to each other frequently
PR5	We can show our discontent towards each other through communication
PR6	*We share the same opinions about most things*
PR7	*We always see things from each other's viewpoints*
PR8	We understand each other's values and goals
PR9	We care about each other's feelings
PR10	*We keep promises to each other in any situation*

(continued)

Table I

Construct definition and measurement items

Bonding	
PR11	We regularly solve problems jointly with our suppliers and partners
PR12	*We consider quality as our number one criterion in selecting suppliers and partners*
PR13	We have helped our suppliers and partners to improve their product quality
PR14	We have continuous improvement programs that include our key suppliers and partners
PR15	We include our key suppliers and partners in our planning and goal-setting activities
PR16	*We actively involve our key suppliers and partners in the new product development process*
Information sharing	
Good-quality information flow between an enterprise and its partners (e.g. suppliers, the same tier manufactures and channel members) in the supply chain	
Information flow	
IS1	*Our company has committed to a formal contract for information interchanges between us and our trading partners*
IS2	*There are informal information interchanges between our company and our trading partners*
IS3	*Our company has participated during decisions about purchase policies established by the suppliers*
IS4	The members in the supply chain, including internal or external manufacturers, would discuss future needs together
IS5	Our trading partners share proprietary information with us
IS6	Our trading partners keep us fully informed about issues that affect our business
IS7	Our trading partners share business knowledge about core business processes with us
IS8	We and our trading partners exchange information that helps business planning between us
Information quality	
IS9	Information exchange between us and our trading partners is timely
IS10	Information exchange between us and our trading partners is accurate
IS11	Information exchange between us and our trading partners is adequate
IS12	Information exchange between us and our trading partners is critical
IS13	Information exchange between us and our trading partners is reliable
IS14	Information exchange between us and our trading partners is complete
Supply chain integration	
The coordination and activity integration of supply chain process between an enterprise and its partners (e.g. suppliers, the same tier manufactures and channel members) in the supply chain.	
Coordination	
SCI1	There are cross-functional coordination and integration events or organizations within the company
SCI2	We and our trading partners have strategy alliances
SCI3	The company has plans for coordination and integration with our suppliers
Activity integration	
SCI4	*Our trading partners are able to use our company's network platform for procurement-related work such as stock checking or provision of catalogs*
SCI5	The company searches for new ways to integrate the supply chain
SCI6	The company carries out related events to reduce response time across the supply chain
SCI7	The company improves integration activities across the supply chain
SCI8	The company establishes frequent contact with supply chain members
SCI9	The company creates a compatible communication/information system

Note: Italic words are the items deleted after measurement model assessment

questionnaires, the electric and metal industries accounted for approximately 41 per cent of firms. Capital of "more than 122 million USD" accounted for 47 per cent of the sample. For the number of employees, "more than 2,000" accounted for 34 per cent; and most of the companies were older than 15 years (65.74 per cent). Half of the respondents' job titles were "manager", and 65.74 per cent were in the procurement department. Of the companies 57.41 per cent were in the midstream position of the supply chain.

To further ensure that the sample was representative, we profiled the four questionnaires, which came from sales department employees, by "industry chain" to examine sample representativeness. It shows that three questionnaires came from "midstream" position enterprises, and that one came from an "upstream" position. Since their enterprises are all at midstream and above positions, at this position in the supply chain, the duties of sales personnel might consist of purchase negotiations with suppliers and information sharing with partners. Thus, it could be inferred that employees who filled out these four questionnaires are familiar with purchasing transactions and procurement systems, implying that they are representative.

Table II Sample characteristics

		Frequency (%)
Industry		
Medicine and biochemistry	3	2.78
Environment and health	2	1.85
Plastic	4	3.70
Metal	17	15.74
Electric machinery	1	0.93
Machinery	5	4.63
Transportation	4	3.70
Textiles	12	11.11
Food	9	8.33
Computers	10	9.26
Electronics	27	25.00
Steel	9	8.33
Others	5	4.63
Capital (USD)		
Less than $30 million	28	25.93
$33.3 to $60 million	7	6.48
$63.6 to $91 million	16	14.81
$93.9 to $122 million	4	3.70
More than $122 million	51	47.22
Not available	2	1.85
Number of employees		
Less than 100	12	11.11
101-500	9	8.33
501-1,000	25	23.15
1,001-2,000	20	18.52
More than 2,000	37	34.26
Not available	5	4.63
Company history		
Less than 1 year	1	0.93
1 to 5 years	10	9.26
6 to 10 years	16	14.81
11 to 15 years	10	9.26
More than 15 years	71	65.74
Department		
Sales	4	3.70
Procurement	71	65.74
Logistics	6	5.56
IT	17	15.74
Manufacturing	5	4.63
Others	4	4.63
Job title		
Executive	4	3.70
Manager	54	50.00
Engineer	24	22.22
Administration and management	19	17.59
Others	7	6.48
Industry chain		
Upstream	24	22.22
Midstream	62	57.41
Downstream	21	19.44
Not available	1	0.93

Data analysis results

Structural equation modeling was conducted and Amos 4.0 software was used (Arbuckle and Wothke, 1997). We followed a two-step approach that evaluated the measurement model prior to estimating the hypothesized structural model (Anderson and Gerbing, 1988). In the first step, measurement quality was assessed. Second-order conceptualization of each construct was examined followed by a five-construct measurement model. In the second step, the structural model was estimated to test the hypotheses.

Measurement assessment. We first assessed the second-order conceptualization of all research constructs. The purpose for this was to examine the appropriateness of each measurement item, and Table III presents the results of this examination. It can be seen that supply chain performance is conceptualized by tangible performance (with three indicators) and intangible performance (with nine indicators). The results indicated that all items were appropriate, with a standardized loading higher than 0.7. E-procurement is conceptualized by e-design (with five indicators), e-sourcing (with four indicators), e-negotiation (with three indicators), and e-evaluation (with three indicators). The results revealed the standardized loading of "EP13" (Our company documents the past purchasing information in an electronic form.) to be lower than 0.7; however, since this item is an important indicator for measuring e-evaluation, we attempted to preserve it.

Partner relationships are conceptualized by reciprocity (with ten indicators) and bonding (with six indicators). The results indicated the standardized loadings of the following five items were below 0.7: "PR6" (We share the same opinion about most things.), "PR7" (We always see things from each other's viewpoint.), "PR10" (We keep promises to each other in any situation.), "PR12" (We consider quality as our number one criterion in selecting suppliers and partners.), "PR16" (We actively involve our key suppliers and partners in the new product development process.). Thus, these five items were deleted. Information sharing is conceptualized by information flow (with eight indicators) and information quality (with six indicators). "IS1" (Our company has committed to a formal contract for information interchanges between us and our trading partners.), "IS2" (There are informal information interchanges between our company and our trading partners.), "IS3" (Our company has participated during decisions on purchase policies established by the suppliers) were deleted since the standardized loadings were found to be below 0.7. Supply chain integration is conceptualized by coordination (with three indicators) and activity integration (with six indicators). "SCI4" (Our trading partners are able to use our company's network platform for procurement-related work such as stock checking or provision of catalogs.) was deleted since the standardized loading was below 0.7.

After examining the appropriateness of each item, a five-construct measurement model was constructed to investigate the overall assessment of the measurement model. Within this model, the indicators of each research construct were represented by the average score of each respective dimension, and Tables IV and V presents the results of the overall assessment. Model fit indexes are shown to be at the acceptable level (chi-square = 112.830; df = 44; p-value < 0.000; chi-square/df = 2.564; GFI = 0.852; CFI = 0.929; NFI = 0.891, and RMR = 0.076), and the composite reliability and variance extracted of all research constructs are higher than the acceptable level. Therefore, the

Table III Second-order conceptualization of each latent variable

Indicator	Direction	Construct	Standardized Loading
Supply chain performance			
SCP1	←	Tangible dimension	0.821
SCP2	←	Tangible dimension	0.839
SCP3	←	Tangible dimension	0.768
SCP4	←	Intangible dimension	0.738
SCP5	←	Intangible dimension	0.801
SCP6	←	Intangible dimension	0.726
SCP7	←	Intangible dimension	0.809
SCP8	←	Intangible dimension	0.741
SCP9	←	Intangible dimension	0.797
SCP10	←	Intangible dimension	0.773
SCP11	←	Intangible dimension	0.801
SCP12	←	Intangible dimension	0.772
Tangible dimension[a]	←	Supply chain performance[b]	0.951
Intangible dimension[a]	←	Supply chain performance[b]	0.871
Chi-square = 146.289, df = 53, *p*-value < 0.001			
Chi-square/df = 2.760, GFI = 0.817, CFI = 0.896, NFI = 0.849, RMR = 0.072			
E-procurement			
EP1	←	E-design	0.769
EP2	←	E-design	0.795
EP3	←	E-design	0.830
EP4	←	E-design	0.824
EP5	←	E-design	0.776
EP6	←	E-sourcing	0.872
EP7	←	E-sourcing	0.879
EP8	←	E-sourcing	0.811
EP9	←	E-sourcing	0.811
EP10	←	E-negotiation	0.760
EP11	←	E-negotiation	0.861
EP12	←	E-negotiation	0.947
EP13	←	E-evaluation	0.639
EP14	←	E-evaluation	0.829
EP15	←	E-evaluation	0.854
E-design[a]	←	E-procurement[b]	0.930
E-sourcing[a]	←	E-procurement[b]	0.920
E-negotiation[a]	←	E-procurement[b]	0.896
E-evaluation[a]	←	E-procurement[b]	0.656
Chi-square = 251.194, df = 86, *p*-value < 0.001,			
Chi-square/df = 2.921, GFI = 0.749, CFI = 0.873, NFI = 0.821, RMR = 0.154			
Partner relationships			
PR1	←	Reciprocity	0.846
PR2	←	Reciprocity	0.793
PR3	←	Reciprocity	0.831
PR4	←	Reciprocity	0.873
PR5	←	Reciprocity	0.819
PR6	←	Reciprocity	deleted (< 0.7)
PR7	←	Reciprocity	deleted (< 0.7)
PR8	←	Reciprocity	0.768
PR9	←	Reciprocity	0.808
PR10	←	Reciprocity	deleted (< 0.7)
PR11	←	Bonding	0.787
PR12	←	Bonding	deleted (< 0.7)
PR13	←	Bonding	0.843
PR14	←	Bonding	0.923
PR15	←	Bonding	0.844

(continued)

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Table III

Indicator	Direction	Construct	Standardized Loading
PR16	←	Bonding	deleted (< 0.7)
Reciprocity[a]	←	Partner relationships[b]	0.978
Bonding[a]	←	Partner relationships[b]	0.844
Chi-square = 146.356, df = 43, *p*-value < 0.001,			
Chi-square/df = 3.404, GFI = 0.823, CFI = 0.900, NFI = 0.866, RMR = 0.074			
Information sharing			
IS1	←	Information flow	deleted (< 0.7)
IS2	←	Information flow	deleted (< 0.7)
IS3	←	Information flow	deleted (< 0.7)
IS4	←	Information flow	0.702
IS5	←	Information flow	0.833
IS6	←	Information flow	0.826
IS7	←	Information flow	0.841
IS8	←	Information flow	0.842
IS9	←	Information quality	0.910
IS10	←	Information quality	0.952
IS11	←	Information quality	0.928
IS12	←	Information quality	0.896
IS13	←	Information quality	0.891
IS14	←	Information quality	0.852
Information flow[a]	←	Information sharing[b]	0.994
Information quality[a]	←	Information sharing[b]	0.844
Chi-square = 99.631, df = 43, *p*-value < 0.001			
Chi-square/df = 2.317, GFI = 0.863, CFI = 0.954, NFI = 0.923, RMR = 0.070			
Supply chain integration			
SCI1	←	Coordination	0.665
SCI2	←	Coordination	0.854
SCI3	←	Coordination	0.950
SCI4	←	Activity integration	Deleted (< 0.7)
SCI5	←	Activity integration	0.829
SCI6	←	Activity integration	0.897
SCI7	←	Activity integration	0.907
SCI8	←	Activity integration	0.787
SCI9	←	Activity integration	0.780
Coordination[a]	←	Supply chain integration[b]	0.936
Activity integration[a]	←	Supply chain integration[b]	0.775
Chi-square = 67.880, df = 19, *p*-value < 0.001			
Chi-square/df = 3.573, GFI = 0.864, CFI = 0.927, NFI = 0.903, RMR = 0.096			

Notes: [a]Second-order indicator; [b]Second-order latent construct

Table IV Measurement model results

Model fit indexes	*n*
Chi-square	112.830
Df	44
***p*-value**	< 0.000
Chi-square/df	2.564
GFI	0.852
CFI	0.929
NFI	0.891
RMR	0.076

reliability and convergent validity are acceptable for these constructs (Fornell and Larcker, 1981). Table VI summarizes the correlation estimates between research constructs. Discriminant validity was tested through the comparison of the variance extracted and the respective correlation estimates of each paired construct. As indicated, the evidence indicates that the discriminant validity of the measurement model is acceptable (Fornell and Larcker, 1981). Further, Harmon's one-factor measurement model was used to assess the extent to which a single latent variable would account for all the indicators, and hence, to test for common method variance (Podsakoff *et al.*, 2003). The results are presented in Table VII, showing that the fit of the one-factor measurement model is significantly worse than that for the five-construct model. Therefore, the quality of the measurement model was acceptable for further analysis.

Structural model estimating and hypothesis testing. Hypotheses were tested by structural model estimation, and the results are presented in Table VIII and Figure 2. The model fit indexes found were at an acceptable level (chi-square = 117.455;

Table V Measurement model results

Indicator	Direction	Construct	Standardized loading	*t*-value
Supply chain performance (CR = 0.80, VE = 0.73)				
Tangible dimension[a]	←	Supply chain performance[b]	0.835	–
Intangible dimension[a]	←	Supply chain performance[b]	0.878	9.473
E-procurement (CR = 0.85, VE = 0.68)				
E-design[a]	←	E-procurement[b]	0.864	–
E-sourcing[a]	←	E-procurement[b]	0.894	12.325
E-negotiation[a]	←	E-procurement[b]	0.884	12.095
E-evaluation[a]	←	E-procurement[b]	0.624	7.125
Partner relationships (CR = 0.85, VE = 0.78)				
Reciprocity[a]	←	Partner relationships[b]	0.925	–
Bonding[a]	←	Partner relationships[b]	0.841	11.866
Information sharing (CR = 0.85, VE = 0.78)				
Information flow[a]	←	Information sharing[b]	0.841	–
Information quality[a]	←	Information sharing[b]	0.927	11.061
Supply chain integration (CR = 0.77, VE = 0.70)				
Coordination[a]	←	Supply chain integration[b]	0.845	–
Activity integration[a]	←	Supply chain integration[b]	0.828	10.161

Notes: [a]First-order indicator: using average score of measurement items; [b]First-order construct. CR: Composite Reliability; VE: Variance Extracted

Table VI Correlation matrix

	Construct	1	2	3	4	5
1	Supply chain performance	0.857[a]				
2	E-procurement	0.617	0.824[a]			
3	Partner relationships	0.697	0.384	0.884[a]		
4	Information sharing	0.682	0.399	0.826	0.885[a]	
5	Supply chain integration	0.708	0.693	0.854	0.756	0.847[a]

Note: [a]Root-square of variance extracted of each construct

df = 45; *p*-value < 0.000; chi-square/df = 2.610; GFI = 0.849; CFI = 0.925; NFI = 0.887, and RMR = 0.077). E-procurement has no significant effect on partner relationships (0.059, *t*-value = 0.725), whereas it has positive significant effects on information sharing (0.400, *t*-value = 3.805) and Supply Chain integration (0.445, *t*-value = 5.830). Therefore, *H1* is not supported, while *H2* and *H3* are supported. For the relationships among partner relationships, information sharing and supply chain integration, information sharing has a significant effect on partner relationships (0.810, *t*-value = 8.345); and partner relationships has a significant effect on supply chain integration (0.742, *t*-value = 4.605). Thus, *H4* and *H6* are supported, but *H5* is not. Lastly, supply chain performance is only influenced by supply chain integration (0.839, *t*-value = 3.679).

We summarize the standardized effect of each construct on supply chain performance in Table IX. The standardized total effect of e-procurement on supply chain performance is 0.602. Partner relationships and information sharing influence supply chain performance both directly and indirectly, and the standardized total effects are 0.307 and 0.526, respectively. Supply chain integration influences supply chain performance directly, and the standardized total effect is 0.839.

Standardized total effect of e-procurement dimensions on endogenous constructs. Because our research purpose is to understand the effects from e-procurement to supply chain

Table VII Test for common method variance

	n
Measurement model	
Chi-square	112.830
Df	44
***p*-value**	< 0.000
Chi-square/df	2.564
GFI	0.852
CFI	0.929
NFI	0.891
RMR	0.076
Harmon's One-Factor Measurement Model	
Chi-square	395.941
Df	54
***p*-value**	< 0.000
Chi-square/df	7.332
GFI	0.578
CFI	0.647
NFI	0.618
RMR	0.205

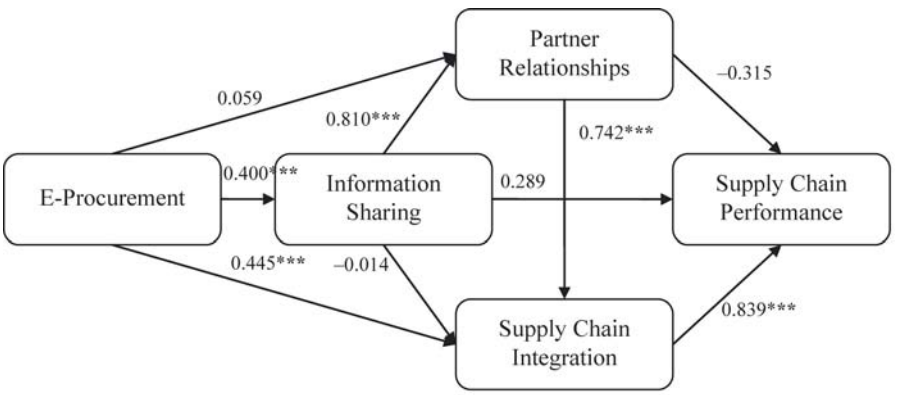
Notes: Test for difference between the two models: ΔChi-square = 283.111; Δdf= 10; *p*-value = < 0.000

Table VIII Structural model results

Hypothesis				Standardized coefficient	*t*-value
H1	E-procurement	→	Partner relationships	0.059	0.725
H2	E-procurement	→	Information sharing	0.400***	3.805
H3	E-procurement	→	Supply chain integration	0.445***	5.830
H4	Information sharing	→	Partner relationships	0.810***	8.345
H5	Information sharing	→	Supply chain integration	−0.014	−0.092
H6	Partner relationships	→	Supply chain integration	0.742***	4.605
H7	Information sharing	→	Supply chain performance	0.289	1.446
H8	Partner relationships	→	Supply chain performance	−0.315	−1.177
H9	Supply chain integration	→	Supply chain performance	0.839***	3.679

Notes: Chi-square=117.455; df=45; *p*-value < 0.000; Chi-square/df=2.610; GFI=0.849; CFI=0.925; NFI=0.887; RMR=0.077

Figure 2 Structural model results



Notes: Hypothesis testing; ***$p < 0.001$; $\chi^2 = 117.455$, df = 45, p-Value < 0.000; χ^2/df = 2.610; GFI = 0.849; CFI = 0.925; NFI = 0.887; RMR = 0.077

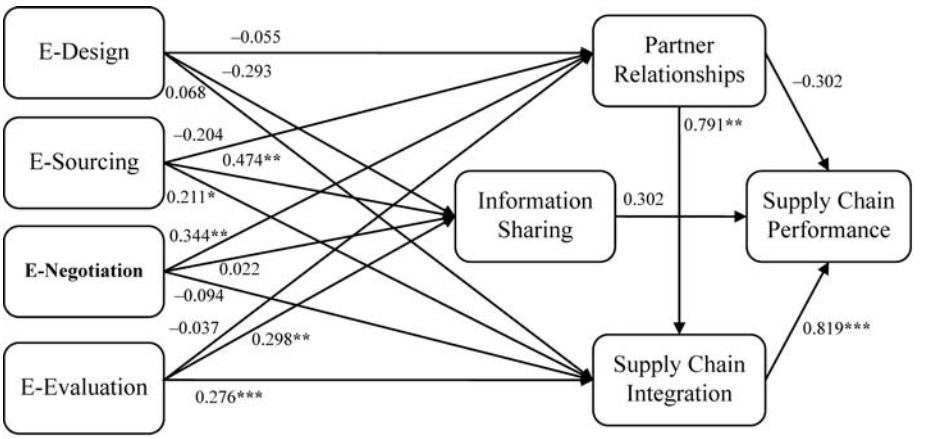
Table IX Standardized effect of each construct on supply chain performance

	Construct	Standardized direct effect	Standardized indirect effect	Standardized total effect
1	E-procurement	–	0.602	0.602
2	Partner relationships	−0.315	0.622	0.307
3	Information sharing	0.289	0.237	0.526
4	Supply chain integration	0.839	–	0.839

performance, we further analyzed the effects of four e-procurement dimensions on the endogenous constructs. Figure 3 present the results. In model specification, for parsimonious purposes (Kline, 2005), exogenous constructs (i.e. four e-procurement dimensions: e-design, e-sourcing, e-negotiation, e-evaluation) were treated as observed variables represented by the average scores of indicators (e.g. e-design is represented by the average score of its indicators: items EP1 to EP5). Endogenous constructs (partner relationships, information sharing, supply chain integration, and supply chain performance) were treated as latent variables measured by their respective dimensions. In general, model fit indexes are acceptable (chi-square = 75.004; df = 34; *p*-value < 0.000; chi-square/df = 2.206; GFI = 0.900; CFI = 0.958; NFI = 0.928, and RMR = 0.043).

We summarize the standardized total effects in Table X to present the influences of four e-procurement dimensions on endogenous constructs. Table X shows that e-sourcing, e-negotiation, and e-evaluation have positive standardized total effects on the endogenous constructs, whereas e-design has negative standardized total effects. In this study, e-design refers to the design of platforms and formats for applying e-procurement systems. It is the infrastructure aspect among the four e-procurement dimensions. Theoretically, it is reasonable to expect that e-design would bring companies benefits (e.g. higher levels of partner relationships, improved supply chain performance). However, this result is contrary to our expectations. Two reasons might account for this result: companies in the era of a modern economy might focus on the infrastructure aspects of e-procurement system too heavily to offset the benefits; the relationship between e-design and the benefit outcomes of supply chain management might be more complex than is the case for linear relationships. For instance, an Inverse-U relationship could be expected, and there might be an optimal level of its implementation on supply chain management.

Figure 3 Structural model results



Notes: The effect of e-procurement dimensions on endogenous constructs; *$p < 0.05$; **$p < 0.01$, ***$p < 0.001$; $\chi^2 = 75.004$; df = 34; p-Value < 0.000; χ^2/df = 2.206; GFI = 0.900; CFI = 0.958; NFI = 0.928; RMR = 0.043

Table X Standardized total effect of e-procurement dimensions on endogenous constructs

		Endogenous constructs			
	E-procurement dimensions	Partner relationships	Information sharing	Supply chain integration	Supply chain performance
1	E-design	− 0.293	− 0.293	− 0.040	− 0.033
2	E-sourcing	0.183	0.474	0.318	0.348
3	E-negotiation	0.362	0.022	0.190	0.053
4	E-evaluation	0.205	0.298	0.414	0.367

On the other hand, e-sourcing, e-negotiation, and e-evaluation have positive standardized total effects on the endogenous constructs. In addition, the relative influences of these dimensions are different. E-sourcing influences mostly information sharing; e-negotiation influences mostly partner relationships; e-evaluation influences mostly supply chain integration. In the case of supply chain performance, e-sourcing and e-evaluation have higher standardized total effects than do the other two dimensions. This result shows that e-procurement dimensions complement each other and lead to different outcomes with regard to benefits. This notion, in a broader context, is also consistent with supply chain literature that suggested an integrated approach for improving supply chain performance (Park, 2005).

Conclusions and managerial implications

Conclusions

This study was conducted to understand how e-procurement contributes to supply chain performance. E-procurement is a technological function of a procurement system consisting of four aspects: e-design, e-sourcing, e-negotiation, and e-evaluation (Croom, 2000; Kim and Shunk, 2004). Based on the technological nature of e-procurement, partner relationships, information sharing and supply chain integration are proposed as three intermediated variables which could potentially capture basic strategies applied through technological functions and also represent the rationales of the impact of e-procurement on supply chain performance. Interviews revealed that these factors are all important and appropriate as linkages between e-procurement and supply chain performance. The empirical study indicated that information sharing and supply chain integration are two important factors. Thus, it could be inferred that e-procurement systems can facilitate the information flow and activity coordination among supply chain partners. This is consistent with the business practice of Wal-Mart's and Mattel's inventory systems (Johnson, 2002). Further, based on the results of standardized effect analysis, supply chain integration is the most important factor that derives effects from e-procurement to supply chain management, implying that supply chain integration represents the main reason explaining the processes through which e-procurement contributes to supply chain performance. This notion is consistent with previous studies on this topic (Walters, 2008).

Research implications

This study contributes to supply chain literature by studying the process through which e-procurement system leads to supply chain performance. We found that partner relationships, information sharing, and supply chain integration are important factors. In information sharing literature, previous studies have found that information exchange between partners can reduce uncertainty, improve order fulfillment rate, and increase supply chain performance (Lin *et al.*, 2002). In other words, information sharing increases supply chain performance by increasing the level of trust among business partners. Yu *et al.* (2001) found that sharing information among business partners can lead to cost savings and inventory level control and increase their

partnerships. Kohli and Grover (2008) also suggested that e-business value (e.g. its impact on performance) is created by the interactions between members in the supply chain. This suggestion is consistent with and confirmed by our findings.

In our study, partner relationships and information sharing are found to influence supply chain performance through supply chain integration. This implies that information sharing and partnerships are the requirements for supply chain integration. This finding is consistent with the notions proposed by previous studies. Lee and Whang (2000) suggested that information sharing among supply chain partners is the basic enabler by which to facilitate higher levels of coordination. Horvath (2001) also suggested that date models and common architecture are necessary for business networks to integrate and coordinate.

By analyzing the effects of four e-procurement dimensions, we found that different dimensions have different influences on endogenous constructs. Specifically, information sharing is mainly influenced by e-sourcing; partner relationships are mainly influenced by e-negotiation; supply chain integration is mainly influenced by e-evaluation. This implies that e-procurement dimensions focus on different aspects (e.g. different functions) and that they complement each other in terms of the benefits for supply chain management. Amit and Zott (2001) suggested that efficiency, novelty, complementarities, and lock-in are the main sources of value creation for e-business. Therefore, e-procurement syetems can be viewed as a combination of sub-systems that are complementary and benefitial for value creation. Wiengarten *et al.* (2010) also suggested that e-business systems can be a component of value creation processes in the supply chain.

Managerial implications

Supply chains consist of all associated activities, from raw material flows to good transformations, to the end users. Management of the integration of supply chain activities in order to improve supply chain relationships and competitive advantage is an important topic (Handfield and Nichols, 1999). Since e-procurement is at the input end of the supply chain, it is worth developing an understanding on the part of practitioners of other aspects of supply chain (e.g. the mid-end of supply chain) when discussing the impact of e-procurement on supply chain performance.

In this study, we propose that partner relationships, information sharing and supply chain integration are the relevant factors and suggest that supply chain integration is the most important one. This implies that a joint-learning practice (Walters, 2008) could be implemented for managing the supply chain well. Joint-learning strategy reflects the strategy underlying the concept of supply chain integration and focuses on know-how collaboration and mutual competency creation (Walters, 2008). Based on our findings, four managerial implications are proposed as follows: First, an enterprise's know-how could be documented and collaborated with partners through an e-procurement system. For instance, know-how and cooperation with regard to product designs could be incorporated into the e-procurement system, thus enhancing supply management performance, such as the "electronic visibility" system in Timken Company (Bylinsky, 2001). Second, supply chain members could integrate business activities to achieve a mutual goal through an e-procurement system. For instance, IBM's "global cross functional enterprise system" allows its customer to be cooperative and reflect real-time feedback for improving the efficiency of order configuring, implying an improvement in supply chain performance (Sawhney and Zabin, 2001).

Third, whereas procurements system could be subjected to outsourcing for cost-down implementation (Parry *et al.*, 2006), managers should consider implementing e-procurement systems because they can provide such benefits as the lowering of process and procurement costs (Puschmann and Alt, 2005). However, the benefits of e-procurement implementation could depend on factors such as firm size (Pearcy and Giuniper, 2008). Forth, consistent with previous findings (Angeles and Nath, 2007), the current study suggests that when evaluating the implementation of e-procurement systems, managers should consider the issues of end-user resistance, partner relationships, information infrastructure system integration and standardization in order to achieve supply chain performance.

Limitations and suggestions for future research

Limitations of this study are stated as follows: Since we collected data across different industries, some underlying industry characteristics were not investigated in this research. As a result, the relatively low level of respondents in the category of "administration and management" might be a limitation of this study. In addition to limitations, further suggestions are discussed as follows: First, results indicated that supply chain integration is the most important factor between e-procurement and supply chain performance, implying an important issue of determining how e-procurement enhances supply chain integration, and this notion has been proposed by a previous study (Zhang *et al.*, 2006). Second, other variables could be further explored and incorporated into the framework. For instance, in a service-oriented economy, relationship marketing variables can enhance business performance (Sin *et al.*, 2002), implying that a potential influence on the supply chain performance might exist as well.

Third, this study analyzed the influences of e-procurement system on supply chain performance. We suggest that future studies can focus on other e-business applications and analyze the influences systematically to enhance the generalization of the results. Forth, tangible and intangible dimensions were used to measure supply chain performance in this study. Future research could adopt different measurement approaches to measure supply chain performance (e.g. the framework of supply chain operations reference, agility and flexibility) (Lockamy and McCormack, 2004; Swafford *et al.*, 2008). From different perspectives of measurements, relative influences on supply chain performance can be further compared. Last, this study is conducted at the enterprise level; future studies could explore the potential linkages based on the individual level. For example, the question of how employee behavior with regard to technology-usage influences the linkage between e-procurement and supply chain performance is worthy of investigation for a cross-level analysis (Kreft and de Leeuw, 1998).

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Further reading

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Appendix 1

Table AI Background information of case companies

	Company A	Company B	Company C
Headquarters	Taiwan	Taiwan	Taiwan
Founded	1984	1971	1967
Industry	Hard disk drive and telecommunication industry	Steel industry	Biochemistry industry
Main products	Magnesium die casting	Carbon steel and stainless steel	Consumer foods (e.g. Soft drinks, instant noodles, dairy products)

Appendix 2

Table AII Background information of interviewees

Case company	Participant	Department	Position	Work experience (yrs)
A	Miss Ling	Inventory control	Deputy manager	17
	Mr Lee	Material science and mechanical	Consultant	15
B	Mr Tai	Purchasing	Senior buyer	18
C	Mr Liu	Purchasing	Project manager	22

Appendix 3

Table AIII Interview questions

Constructs	Interview questions
Supply chain performance	What is the supply chain performance defined by your company? How does your company think about the concept of supply chain performance in terms of criteria or measures?
E-procurement	What is the e-procurement system defined by your company? How does your company use the e-procurement system? Does supply chain performance benefit from the implementation of an e-procurement system? And how?
Partner relationships	What are partner relationships as defined by your company? How does your company maintain partner relationships? Does supply chain performance benefit from these partner relationships? And how?
Information sharing	What is the information sharing defined by your company? How does your company implement the information sharing? Does supply chain performance benefit from the information sharing? And how?
Supply chain integration	What is the supply chain integration defined by your company? How does your company implement the supply chain integration? Does supply chain performance benefit from the supply chain integration? And how?

Appendix 4

Table AIV Results of the case study

Constructs	Company	Results
Supply chain performance	A	Cost, quality, delivery time are considered to be the measures
	B	Time, cost and quality are the important indicators of supply chain performance
	C	Time, quality, service and coordination are preferred as performance indicators
E-procurement	A	E-procurement is used in gathering information and documenting files E-procurement has been performed in depth An e-procurement system can influence supply chain performance
	B	E-procurement is a comprehensive system It consists of three functions: e-sales, e-purchases, and e-transportation
	C	E-procurement is applied in each purchasing process E-procurement is a tool for communicating and sharing information An e-procurement system will be used in online payment and catalog displays
Partner relationships	A	Partner relationships is an important factor for supply chain management A good partner relationship is enhanced by useful information sharing The benefits of partner relationships are cost, time, and product quality
	B	They treat their partners case by case Bonding and reciprocity with partners are the two indicators
	C	The benefits of partner relationships are product quality, response time, and material source availability Empathy, trust, and reciprocity are important indicators
Information sharing	A	Company A has high-level information sharing with its suppliers Information regarding manufacturing processes, technology, and useful suggestions is shared
	B	Information is shared with permitted partners The accuracy of information sharing is the most important indicator
	C	Information is shared with permitted partners Accuracy, timeliness, adequacy, credibility, value of information are considered as important indicators
Supply chain integration	A	Cross-function cooperation is implemented Supply chain integration has the highest influence on supply chain performance among three strategies (i.e. partner relationships, information sharing)
	B	A cross-function team will be established in the future Through the application of e-procurement, the supply chain is integrated more efficiently
	C	The coordination network is applied when implementing an integration of supply chain activities

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