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Business–IT fit in e-procurement systems: evidence from high-technology firms in China

Hsin-Lu Chang*, Kai Wang† & Iris Chiu*,‡

*National Chengchi University, Department of Management Information Systems, 64, Sec. 2, Zhi-nan Rd., Wenshan, Taipei 116, Taiwan, email: hchang@mis.nccu.edu.tw, ‡email: iris@alumni.nccu.edu.tw, and †Ming Chuan University, Department of Information Management, 5, De-Ming Rd., Gui-Shan, Taoyuan County 333, Taiwan, email: kwang@mcu.edu.tw

Abstract. *Because of the influence of globalization and updated information technologies (IT), firms in China face an urgent need to adopt e-procurement systems (EP) to deal with their daily procurement activities. However, implementing EP in China encounters various uncertainties from internal and external business environments. To address this issue, this research aims to examine the fit between business and the IT environment and to study its impact on system performance. The literature review allows the proposal of two internal business environmental uncertainties and two external business environmental uncertainties covering the perspectives of process, knowledge, partnership and environment. Based on a multiple-case study performed in four Chinese firms that supply various personal computer components to a Taiwanese original equipment manufacturer via an EP, it was found that the firms' external and internal uncertainty factors affected the performance of EP. In addition, an EP with a low level of integration – the EP type used most frequently in China – can only achieve great performance when the adopting firms faced a low uncertainty of environment, partnership and process, and had low levels of IT knowledge. It was also observed that lack of fit between the business environment and EP produced extra burdens and costs in the buyer–supplier relationship. This significantly reduced the system performance of the Chinese firms. Hence, the contribution of this research can be twofold. First, practitioners in China can use this framework to diagnose their environmental conditions and then choose the appropriate type of EP to implement. Second, researchers can build upon this model to further examine the impact of fit on EP performance and generalize the results.*

Keywords: business–IT fit, electronic procurement, alignment, electronic commerce, IT adoption

INTRODUCTION

As a result of globalized division of labour to pursue lower labour costs, China has emerged as one of the most important manufacturing bases in the global supply chain. According to Jing (2006), the total output value of China's information communication technology (ICT) industry was US$27.83 billion in 1996 jumping to US$66.7 billion in 1999. China has become the third largest ICT production base in the world with 5.6% of the world's total production. Such figures illustrate the importance of China in today's high-technology industry.

Facing fierce competition and dropping profit margins, Taiwanese original equipment manufacturers (OEMs) in the ICT industry aggressively shifted their manufacturing facilities to China to maintain a cost advantage. According to the Market Intelligence Center of the Institute for Information Industry in Taiwan, the percentage of Taiwanese ICT manufacturers' production value in China grew from 65% in 2003 to 81% in 2005 with a total production value increase from US$37 161.2 million to US$65 593.8 million. With tighter linkage and increasing demand for purchasing activities conducted in China, OEMs often requested their Chinese suppliers to adopt a specific e-procurement system (EP) to facilitate communication and integration between both parties. Starting from July 1999, the Taiwan government initiated a series of 'Demonstration Projects' named Project A and Project B. Project A was designed to build a strong and agile e-procurement network between IBM, Compaq and Hewlett-Packard, and first-tier Taiwanese OEMs. The hope was that the success of Project A would further diffuse to the supply network of these OEMs and their second-tier suppliers. With the success of Project A, Project B effectively linked more than 1800 suppliers into the integrated network hosted by the 15 major OEMs, among which the cases of this study are selected suppliers of one of these OEMs.

The integration of information systems with internal and external business processes in Chinese suppliers, however, is greatly lagging behind that of their counterparts in developed countries (Tan & Wu, 2004). According to a survey conducted on 638 large and medium-sized enterprises by the Network Economy Research Center in Beijing University (2001), 16.5% of Chinese firms have significant integration with internal databases and information systems. This is below the global average of 23.9%. Only 7.9% of Chinese firms have serious electronic integration with suppliers and customers and only 4% of the firms had implemented online purchases.

These circumstances lead to the question of whether or not EP can deliver the promised benefits in China. A key concern is alignment – applying information technologies (IT) in an appropriate and timely manner while keeping harmony with business strategies, goals and needs (Luftman & Brier, 1999). Past studies indicated that a good fit between EP and the requirements of the business environment is an important performance driver (Bensaou & Venkatraman, 1995; Gribbins *et al.*, 2004; Premkumar *et al.*, 2005). Yet, it still cannot be explained why an EP works in certain situations but fails in others.

This study attempts to examine the business–IT alignment and its impact on firm performance in the context of China. Specific research questions are summarized as follows:

1 What uncertainty factors retard or encourage the successful implementation of EP in China?
2 Concerning the different environmental conditions, which type of EP is more suitable for organizations in terms of the system performance?

LITERATURE REVIEW

A typology of EP

OEMs in Taiwan used three types of EPs to connect with their Taiwanese and Chinese suppliers: (1) application-to-application (AP-to-AP); (2) e-commerce (EC) turnkey; and (3) web-based procurement systems (Chen *et al.*, 2004a). The idea of AP-to-AP connections is to use extensible markup language (XML)-based technology such as the RosettaNet process standard to integrate the procurement process of buyers with that of suppliers, so that procurement information can be automatically exchanged between the enterprise resource planning (ERP) systems of both parties. EPs that are implemented with AP-to-AP connections provide the strongest level of integration between buyers and sellers.

The concept of EC turnkey is that suppliers install turnkey software, like electronic data interchange (EDI), so that buyers can push their purchase orders to the suppliers' turnkey system electronically. Web-based procurement systems are a buyer's purchasing portal accessed by suppliers via web browsers. Whether data is sent by EDI turnkey or via a web browser, it is not transformed automatically into the formats and structures required by the information systems of the receiving parties. As a consequence, the data is sometimes incomplete or includes errors and thus, requires additional checks before it can be processed further. Hence, the integration level for both systems is weaker than for AP-to-AP connections. In China, the majority of suppliers have adopted web-based procurement systems to connect with their Taiwanese manufacturers. Most Chinese suppliers, however, lack the capabilities to implement highly automated EP (i.e. AP-to-AP) so far due to China's 'immature IT infrastructure' (Chen *et al.*, 2004b; Tan & Wu, 2004).

Studies of EP and uncertainty

Bensaou & Venkatraman (1995) and Premkumar *et al.* (2005) recognized uncertainty as a key explanatory factor of EP performance from the perspective of transaction cost economics, organization theory and political economy. They defined uncertainty as the risks and costs arising through the lack of information on firms' internal and external environments. Moreover, making use of the resource-based perspective and the dynamic capabilities approach, Yu *et al.* (2003) argued that EP could create changes in the way organizations conduct business internally and externally. This creates a high level of turbulence and, as a result, huge uncertainty for the involved parties. Building on their discussion, the EP related uncertainties can be summarized into four types:

1 Environment. Environment is the most commonly discussed uncertainty factor in previous research. Both the complexity and dynamism of the environment and the frequency of

environmental changes are captured in environmental uncertainty (Duncan, 1972; Premkumar *et al.*, 2005). As indicated by Tan & Wu (2004), the major demand and supply fluctuation in China comes from the increased number and intensity of competitors. Furthermore, logistics systems in China are far from reliable or efficient. This adds more uncertainty in bringing products to market (Wang, 2002).

2 Partnership. Given the interorganizational nature of EP, future partner behaviour is highly uncertain in firms (Bensaou & Venkatraman, 1995). Research on interorganizational systems (IOS) describes partnership uncertainty in terms of operations risk and opportunism risk (Clemons & Row, 1992). According to Wang (2002) and Tan & Wu (2004), Chinese firms consider partnership uncertainty the most prominent barrier to using e-commerce technologies. They fear their cost structure would be inappropriately revealed to their partners causing their margins to be squeezed. Many scholars also recognize 'guanxi' – a system of personal connections that carry long-term social obligations – playing a significant role in business relationships in China (Millington *et al.*, 2005).

3 Process. Subramaniam & Shaw (2004) stated that not all transaction processes were similar in terms of their search requirements, processing time and efforts, and propensity to make errors. The processes of EP are no exception and the realization of EP benefits is largely determined by how business-to-business processes are conducted between trading partners. Dzever *et al.* (2001) found that China has a relatively complicated procurement process compared with other Asia Pacific regions because there are relatively higher incidences of outsourcing and better integrative relationships within the channels of distribution.

4 Organizational knowledge. Numerous studies stated that a firm's knowledge of EP is a key to EP performance (Grant, 1996; Yu *et al.*, 2003). Tsang (1999) found that multinational corporations often had difficulties transferring knowledge to suppliers in China. Managerial skills, however, are more difficult to transfer and therefore require a longer time period before a mature and efficient managerial system can be cultivated. Based on Lu & Bjorkman (1997), Chinese firms established before 1979 were firmly embedded in the former socialist production model, and therefore the implementation of new managerial practices had to be handled with care and take into account sensitive cultural issues and local regulations.

The fit concept

From the viewpoint of structural contingency theory, an underlying premise is that context and structure must fit together for organizations to perform well (Drazin & Van de Ven, 1985). Over the past few decades, a considerable number of studies have been conducted using the task–technology fit (TTF) theory (Goodhue, 1995; Zigurs & Buckland, 1998; Dennis *et al.*, 2001; Gribbins *et al.*, 2004). Goodhue (1995) proposed that higher TTF would result in better user performance and that users could successfully evaluate TTF. Zigurs & Buckland (1998) found empirical support for this theory in the context of effective group support system (GSS) use. Dennis *et al.* (2001) developed the idea further by proposing a Fit-Appropriation Model for interpreting GSS effects on performance. Following that, Gribbins *et al.* (2004) expanded TTF to process–technology fit for better understanding the acceptance and use of EP in organizations.

In contrast to TTF, other authors use Galbraith's (1973) information processing theory to examine the fit between information processing needs and information processing capability. For example, Bensaou & Venkatraman (1995) used information processing theory to examine IOS values. The concept was then extended by Premkumar *et al.* (2005) to empirically examine the fit at the interorganizational level.

EP use in China

EP has been identified as the most significant e-commerce application that should be implemented in China. As indicated by Matteo (2003), 'sourcing in China offers foreign companies of all sizes ever-increasing opportunities to acquire high-quality, low-priced products' (p. 30). In addition, Wu *et al.* (2003) observed a significant shift in the existing procurement procedures due to the need for electronic coordination with suppliers calling for the ability to quickly assimilate and apply knowledge related to EP. Success stories in other businesses were also aggressively marketed by both firms in the enterprise relationship management area and marketplace enablers (e.g. SAP, I2, Oracle and Ariba) creating strong normative pressures to adopt EP in China.

There is, however, little knowledge about how to capture the value of EP in Chinese firms. The majority of past research conducted in China focused on general issues of e-commerce adoption with respect to business, technology, legislation and culture at the country level (e.g. Zao, 2002; Reimers *et al.*, 2004; Tan & Wu, 2004; Quan *et al.*, 2005). Few studies have addressed firm issues in EP adoption except Wong *et al.*, (1999). Their research found that similarities did exist between Chinese and North American supply chain partnerships. In addition, some significant determinants of EP adoption identified in previous US studies may be generalized to EP adoption in China. As far as is known, even though the Taiwanese OEMs requested that the suppliers in China invest in building EP systems, the conflict was sometimes seen as a mutual challenge that needed common consideration and solution in order to lead to full exchange, effective, mutually beneficial solutions and goal attainment.

DEVELOPMENT OF BUSINESS–IT FIT FRAMEWORK

Based on the discussion above, the argument stands that there is a need to consider both internal and external business environments in order to understand EP use in China. We propose the business–IT fit framework as shown in Figure 1.

There are several reasons for this proposition. First, while TTF scholars focus on internal characteristics, other IOS scholars pay considerable attention to external partnerships. Both views are quite unsatisfactory, given that they consider only one aspect of the problem. Second, more and more scholars believe that individual and task levels of analysis are not applicable to EP study (Gribbins *et al.*, 2004; Khazanchi, 2005). It is argued that EP is a process-based IT solution which usually consists of a suite of integrated applications to support the processes rather than independent tasks. This is the reason we suggest that process

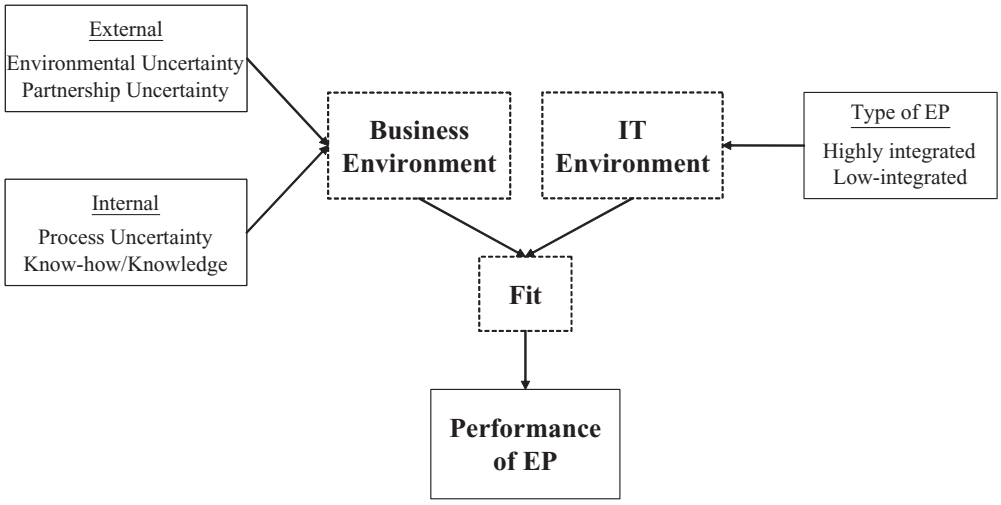

Figure 1. Business–IT fit framework.

rather than task characteristics be considered as a significant internal factor to impact EP performance. Third, organizations differ greatly in their knowledge-based ability to utilize and translate these applications into tangible benefits – how the organizational knowledge base impacts EP performance is not well discussed in previous IT alignment studies. Finally, with China's unique role in the global supply chain system, we suggest the need to go beyond the general e-commerce adoption issues and to further explore the uncertainties or constraints of EP adoption in China with a special focus on the alignment of business and IT strategies.

Based on the literature described earlier, we defined business environment, IT environment, the fit between the two and the effect of the fit on performance. Internal and external business environmental uncertainty and their underlying determinants are used to explain business environmental characteristics (Bensaou & Venkatraman, 1995; Premkumar *et al.*, 2005). Product customization, demand dynamics and supply dynamics are used to capture the external environmental uncertainty (Duncan, 1972; Wang, 2002; Premkumar *et al.*, 2005). In terms of partnership uncertainty, Bensaou & Venkatraman (1995) identified three variables to capture transaction risks: (1) the focal firm's asset specificity; (2) the partner's asset specificity; and (3) mutual trust. All of these were later used by Premkumar *et al.* (2005) to represent the uncertainty in a customer–seller relationship. This study makes use of a similar conceptualization to measure partnership uncertainty, but combines the focal firm's and the partner's asset specificity as one single item – reciprocal investment – in order to highlight the significance of inter-firm relation specific assets (Dyer & Singh, 1998). Process uncertainty refers to the dynamisms and complexity of the procurement process and of the underlying products (Subramaniam & Shaw, 2002; 2004; Daly & Cui, 2003; Premkumar *et al.*, 2005). Finally, technical IT skills and managerial IT skills are used to measure the knowledge and the know-how required for EP use (Wang, 2002; Yu *et al.*, 2003).

With regard to the IT environment, we used the 'type of EP' to capture different IT support for procurement activities. Three different EP technologies have been summarized earlier: AP-to-AP, EC turnkey and web-based procurement. In order to simplify the analysis, the first one is categorized as 'strongly integrated EP' and the last two 'weakly integrated EP'. Some previous studies showed that web-based procurement is suitable for commodities (e.g. Subramaniam & Shaw, 2002), but others demonstrated a more sophisticated application for other types of EP, including EPs for bespoke products (e.g. Choudhury, 1997). Building upon these previous studies, we believe the fit issue in terms of product, process and external environment should be well managed for different types of EP. We also believe that such considerations hold in the global market and not just particular in the Greater China market. China, however, provides us a specific example to explore this problem.

Fit is a construct that captures the interaction between business and IT environment. In our study, we determined that 'fit as moderation' (Venkatraman, 1989) is the best conceptualization of fit. In this conceptualization, 'the impact that a predictor variable has on a criterion variable is dependent on the level of a third variable, termed here as the moderator. The fit between the predictor and the moderator is the primary determinant of the criterion variable' (Venkatraman, 1989, p. 424). To make the conceptualization more concrete, the predictor variable is type of EP, the moderator variable is business environmental uncertainty and the criterion variable is performance. We operationalized fit as the interaction of type of EP and business environmental uncertainty on EP performance. According to Mukhopadhyay & Kekre (2002), the performance of EP is measured by (1) direct strategic benefits typically in terms of sales gains; and (2) direct operational benefits such as the improvement of the order-processing cycle and the timeliness of payments.

External uncertainty vs. EP type

Environmental uncertainty

In the procurement context, changes in demand and supply are the major environmental uncertainty that influences a firm's information need (Premkumar *et al.*, 2005). Due to distrust in Chinese suppliers, Western importers often enter into contracts with Chinese suppliers 6–9 months in advance of delivery. This makes it very difficult to predict consumer demand accurately and supplies are often delayed by inefficient logistics systems. According to Wang (2002), most of the 1.3 billion population in China is concentrated in the east and south-east regions. Traffic jams are a headache, especially in big cities. Under such conditions, a strongly integrated EP that provides near real-time information to trading partners results in higher performance due to better fit than a weakly integrated EP.

Product customization is another source of environmental uncertainty. Bensaou & Venkatraman (1995) mentioned that a customized product often involves high environmental uncertainty because the information processing necessary to coordinate between firms and suppliers in the procurement process is greater for customized products than for standard ones. The arrangement of a strongly integrated EP system, however, reduces coordination

costs over those incurred in a market by eliminating the firm's effort to gather and analyse a great deal of information about different trading partners. Accordingly, for firms producing customized products, the performance of a strongly integrated EP should be higher due to better fit than that of a weakly integrated EP. Proposition 1 is as follows:

A strongly integrated EP can lead to greater performance under higher levels of environmental uncertainty.

Partnership uncertainty

According to Son *et al.* (2005), firms and suppliers are more certain about their partnership when they have made reciprocal investments which provide a strong signal to the other party about their desire for long-term relationships (Premkumar *et al.*, 2005). In line with reciprocal investments, trust between firms and partners is recognized as an effective mechanism to reduce partnership uncertainty (Allen *et al.*, 2000; Bunduchi, 2005). When Western companies link up with Chinese suppliers, each party has suspicions about the other party's interests. Western companies worry that the suppliers would not deliver on time and Chinese suppliers fear that the importers might reject consignments by pretending that the quality did not adhere to the standard (Lee, 2004). Under those circumstances, the presence of a strongly integrated information system can help monitor and guarantee both parties' credibility (Tan & Wu, 2004). It can also reduce the coordination costs and protect against the risks of opportunistic bargaining. With respect to this, the fit between levels of EP integration and partnership uncertainty has a positive effect on performance. Proposition 2 is suggested as:

A strongly integrated EP can lead to greater performance under higher levels of partnership uncertainty.

Internal uncertainty vs. EP type

Process uncertainty

According to Subramaniam & Shaw (2002; 2004), procurement types are like the two ends of a continuum. At one end is the structured procurement of which processes are highly automated and product specifications do not change frequently. At the other end is the unstructured procurement of which processes are manually initiated and the technical or design requirement for the products are difficult to predict accurately. The practice of supply chain management in China used to be 'plan-driven'. This means a centrally developed plan was put into motion with little influence from market forces. The procurement was thus relatively structured. When more and more Chinese firms move towards a more flexible system driven by orders – 'order-initiating dynamic' (Daly & Cui, 2003) – they need to exchange information more frequently with their trading partners and trading partners need to deal with several different sources of information to process procurement activities successfully (Premkumar *et al.*, 2005). Consequently, a more integrated EP that allows firms and trading partners

to access relevant information in a timely manner is preferred. Since we expect firms that implement a strongly integrated EP under high levels of process uncertainty represent a better fit, Proposition 3 is:

A strongly integrated EP can lead to greater performance under higher process uncertainty.

Know-how/knowledge

Past literature recognized that the key skills and know-how of firms have persisting effects on relative performance (Kogut & Zander, 1992). The theory of diffusion of innovation helps account for this statement. Rogers (1995) stated that organizations often delay adoption of complex technologies until they obtain sufficient know-how to implement the computer innovation successfully. Wang (2002) also mentioned that a lack of technical knowledge is a barrier to e-business implementation in China. In addition to technical IT skills, Mata *et al.* (1995) suggested that firms need to possess managerial IT skills to realize the full potential of EP. According to the case study by Tsang (1999) on 19 Singapore companies and their operations in China, 'failure to introduce the managerial practices of their Singapore parent companies with few local adjustments resulted in problems' (p. 92). We can expect that a strongly integrated EP requires more technical and managerial skills than EP at low levels of integration due to better fit. Hence, Proposition 4:

A strongly integrated EP can lead to greater performance under higher levels of knowledge skills.

CASE ANALYSIS

Web-based EP implemented between four Chinese personal computer (PC)–notebook (NB) component suppliers and one large OEM was examined. This EP was part of the Project B sponsored by the Taiwanese Ministry of Economic Affairs. As described earlier, the OEM is one of the fifteen companies who participated in the project. After successfully implementing this system in Taiwan, the OEM transferred the entire EP experience (including systems and personnel) to China. Chinese suppliers were coerced to adopt the system in 2004. Up to the present time, there are around 500 Chinese suppliers who use this system to transact with this OEM.

Despite the success in Taiwan, the system performance of Chinese suppliers varied. Some suppliers complained about this system quite frequently, while others were satisfied with it. Eager to find the reasoning behind this, the OEM partnered with us to test the system fitness among different suppliers. The Chief Operational Officer of the OEM was asked to identify major supplier groups on the basis of materials and parts sold. Six categories of personal computer component suppliers were identified: motherboards, chips, mechanisms, cables, packages/labels and passive components. Except for the suppliers of motherboard and chips, the other four types of component suppliers used the EP to process orders.

Next, the senior procurement executives of each of the four component supplier groups were asked to select the suppliers that were located in the same area of the OEM: Kunshan, Jiangsu

Table 1. Description of the four case companies in this study

Firm	1	2	3	4
Industry	Computer peripheral	Label and printing	Computer peripheral	Manufacturing
Capital (NT$ billions)	2.82	0.49	32.3	31.7
Employees	21 000	240	200 000	7000
Major products	Aluminum die casting Magnesium die casting	Labels Nameplates, overlays and tear-drop doming In-mould labelling In-mould decoration	Cable Connector Flexible printed circuit board	Multilayer chip capacitors Electrolytic capacitor Fixed resistors Leaded resistors Inductor HF products
Material category in the OEM's typology	Mechanical	Packaging	Electrical engineering	Electrical engineering
Delivery instructions	Direct shipping	Direct shipping	Direct shipping	VMI hub

Province of China. By doing so some external factors that may have affected the EP performance could be controlled. For example, these suppliers shared equal opportunities to interact with the OEM procurement staff due to their geographic proximity. Fifty suppliers were selected from the pool of 500 firms. The senior executives were then asked to suggest one to three suppliers for each component category that have generated large trading volumes with the OEM over the past 3 years. A 3-year period was requested to ensure that each selected case had developed a long-term and profitable partnership with the OEM. From these selected suppliers, one supplier was chosen for each component category according to accessibility and availability. Following the promise of anonymity to participating companies in this study, they are referred to as Firm 1, Firm 2, Firm 3 and Firm 4. The backgrounds of these companies are summarized in Table 1.

Although these four firms differ in size, each holds a leading position in its industry sector. Firm 1 is the largest supplier for laptop cases and second largest for cell phone cases in the market. Firm 2 ranks 52 in the top 100 Chinese printing companies and ranks second in computer-labelling materials. Firm 3 is a subsidiary of a leading electronic manufacturing services provider in the global ICT industry. Firm 4 is one of the top three multilayer chip capacitors suppliers in the global market.

Data collection

The primary data sources were telephone interviews conducted from December 2005 to January 2006. For each firm, the interviews were carried out with one sales manager in charge of the OEM account and with two sales clerks who had used the EP to process orders. Each

Table 2. An analysis example of business–IT fit analysis for one case company's EP use

Factors	Items	Evidence
Environmental uncertainty	Product customization	10 part numbers were requested for customization efforts
	Demand dynamics	Urgent orders occurred very frequently
	Supply dynamics	The monthly updated shipping information made reverse logistics difficult
Partner uncertainty	Reciprocal investment	R&D co-design activities happened from time to time.
	Trust	The OEM made a lot of efforts designing the EP systems
Process uncertainty	Dynamics of process	Besides regular procurement activities, the sales people needed to manage the return of defective items, which occurred frequently.
	Dynamics of product	Each NB module change required entire redesigns of our supplies, including forms, operations, raw materials, functions and structure.
	Complexity of product	Our products must go through several stages before commercial production, such as material authorization, pilot engineering and pilot production. Besides, the lead time of our products is approximately 1 month and the duration of a batch production lasts for 3–5 days.
Know-how /knowledge	Technical IT skills	The EP system was run without implementation difficulties.
	Managerial IT skills	The current procurement practice is very routine and easy to follow.
Performance of EP	Strategic benefits	The OEM's orders can only be received through the EP.
	Operational benefits	Substantial improvements were made in the packing and shipping process.

interview was limited to 1–2 hours. Follow-up email inquiries were conducted when necessary. According to the telephone interview guide suggested by Sambamurthy & Zmud (1999), extensive notes were taken during each telephone interview with a structured interview protocol (see Appendix) designed beforehand to accommodate note taking. The notes were summarized at the end of each interview. Interviewers then forwarded these summaries to interviewees for comments and correction. Documentation of the firm's financial statements, industry white papers, system handbook, standard operating procedures and so on were also gathered and examined for cross-reference purposes.

The information collected was arranged into a table to help interpret the EP use. This allowed several pieces of evidence in each case to be identified which were associated with internal and external uncertainties and IT performance. An example of how a case company's EP use was analysed with the proposed research framework is presented in Table 2. To ensure construct validity, internal validity, external validity and reliability the recommended case study tactics (Yin, 2003) were also followed. These are presented in Table 3.

System background

For the OEM, the daily purchasing is administered by the local procurement departments in China and is facilitated by the EP shown in Figure 2. Although with this EP it was initially attempted to automate the entire purchasing cycle (indicated by the dotted rectangle in Figure 2), its active function was reduced to merely ordering and shipping processes. Via the

Table 3. Validities and reliability tests

Tests	Tactic (Yin, 2003)	Implementation in this study
Construct validity	Use multiple sources of evidence in data collection phase	The primary data sources were collected via phone interviews. Other information from each firm's official web site and industry white papers were considered simultaneously.
Reliability	Use case study protocol in data collection phase	A structured interview guide was used for all interviews. The interview guide included several open format questions to provide participants flexibility in their responses.
External validity	Use replication logic in research design phase	Each case applied the same theoretical framework for the analysis (Figure 1). With these replications the theoretical framework could later become the vehicle for generalizing findings.
Internal validity	Build explanations in data analysis phase	A series of literary works were conducted to examine the framework, leading to a cross-case analysis in our multiple-case study.

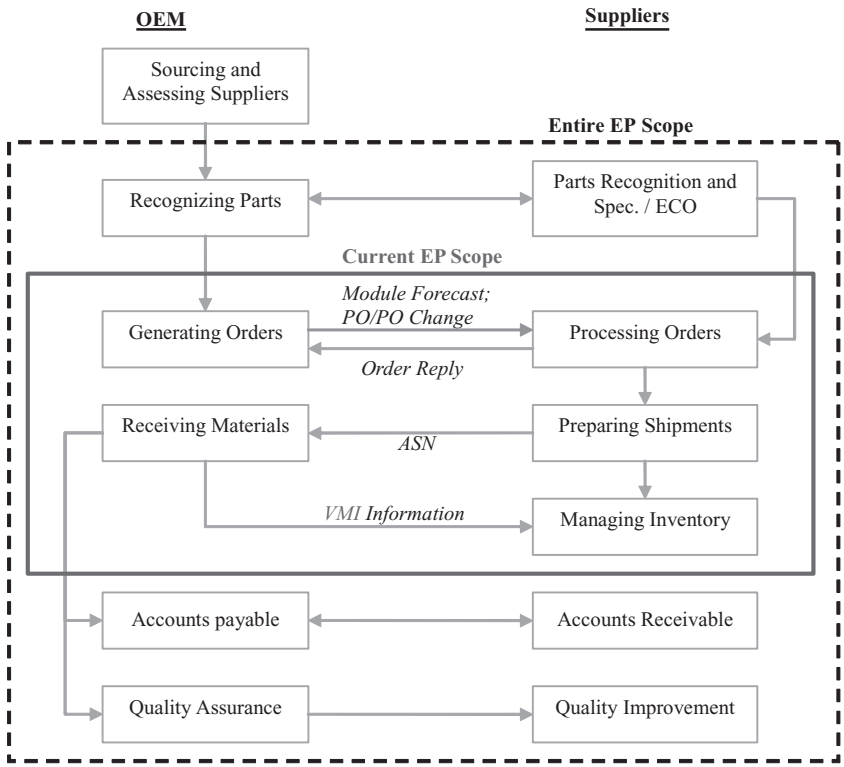

Figure 2. The EP scope in this case.

system, suppliers can transform purchase orders (PO) into advanced shipping notices (ASN). However, system-to-system integration is not available. OEM buyers need to rekey the ASN into their ERP and then generate the invoices on a monthly basis. With the vendor-managed inventory (VMI), extra hub information is sent to the suppliers for decision-making. In this case, the OEM adopted a just-in-time shipping policy with Firms 1, 2 and 3. VMI is used with Firm 4.

Framework application

Under different business environmental conditions, is the EP more suitable for this case than for other cases in terms of system performance? How does each case company accommodate the EP to better align with its corporate environment? To answer these questions, the cases were interpreted in light of the proposed research framework. For the evidence identified in a specific case, other cases with similar evidence were compared and contrasted to realize the level of influence. The cross-case analysis is presented as follows and summarized in Table 4.

Environmental uncertainty

The context of environmental uncertainty (row I in Table 4) consists of product customization, dynamics of demand and dynamics of supply:

1 Product customization. In the procurement practice, each component provided by suppliers was assigned a part number (PN) by the OEM. Usually a more customizable product needed more PNs to accommodate flexibility. As a result, suppliers who had to tailor more PNs to meet the OEM's requisitions were more capable to provide customized products or solutions than others. With respect to these cases, Firm 1 provided the OEM with about 10 PNs of NB modules. Firm 2 provided components for seven separate production lines in the OEM with each line demanding three to four PNs. Firm 3 provided the OEM over 100 PNs. As for Firm 4, using the capacitor as an example, there were 700–800 different specifications, which turned out to be more than 1000 PNs. In addition, these PNs could not be used interchangeably among the OEM's three factories. Such practices tripled the number of PNs.
2 Demand dynamics. Because of tight cooperative design efforts with the OEM, Firm 1's demand was relatively stable in terms of few order cancellations and order changes. Similarly, the demand of Firm 2 did not change frequently. But since the labelling materials had a short lead time and were only needed at the end of the production stage – a stage when the NB was close to shipment – Firm 2 often needed to deal with urgent orders, which need to be fulfilled on a short notice. In contrast to Firms 1 and 2, the demands made by Firms 3 and 4 fluctuated more dramatically. The informant from Firm 4 indicated that 'usually, there was over 30% of product specifications and usage change after order submission'. On the other hand, since the products from Firms 3 and 4 were standardized and had little research and development (R&D) relatedness, plenty of substitute suppliers existed in the OEM vendor pool. The informant at Firm 3 also stated that the huge gap between forecast and actual order required them to 'confirm demand on a daily basis'.

Table 4. Cross-case analysis

Factors	Items	Concept	Firm 1	Firm 2	Firm 3	Firm 4
I. Environmental uncertainty	Product customization (degree)	Number of parts available for customization	10 (Low)	20 (Low)	100 (Medium)	1000 (High)
	Demand dynamics	Frequency of urgent orders	Low	Medium	High	High
		Frequency of order change	Low	Medium	High	High
	Supply dynamics	The complexity of reverse logistics	High	Low	Low	Low
		Levels of coordination required for shipment	Low	Low	High	High
	Overall assessment		Low	Low to medium	Medium to high	High
II. Partnership uncertainty	Reciprocal investment	Intensity of co-design activity	Medium	Medium	Low	Low
	Trust	Long-lasting relationship	Yes	No	No	No
		The perception of partner's opportunistic behaviour	Low	Medium	Medium to high	High
	Overall assessment		Low	Medium	Medium to high	High
III. Process uncertainty	Dynamics of processes	Task complexity	Medium	Low	High	High
	Dynamics of products	The extent of changes in product specifications for each module	High	Low to medium	Low	Low
	Complexity of products	Lead time for production	1 month	1 week	1 month	1–2 months
		Duration of a batch production (days)	3–5	1	1–2	3
	Overall assessment:		High	Low	Medium	Medium to high
IV. EP knowledge	Technical skills	Past IT implementation experience	Web EP	Web EP	Web EP	Web EP, EDI, XML
	Managerial skills	Coordination capability	Low	Medium	Medium	High
	Overall assessment		Low to medium	Medium	Medium	High
V. EP performance	Strategic benefits	Perceived strategic benefits	High	High	High	High
	Operational benefits	Error reduction	Yes	Yes	No	No
		Timeliness	Yes	No	No	No
		Data consistency	Yes	Yes	Yes	No
	Overall assessment		High	Medium to high	Medium	Low to medium

3 Supply dynamics. The biggest supply difficulty that Firm 1 suffered was the handling of defective items. Because casting materials were expensive and occupied a great amount of space, overflow backups were usually minimized. While all of the quality information was updated monthly, Firm 1 did not have time to handle returned goods. Such problems were not as severe in Firm 2 due to the material characteristics. The supply availability of Firm 2 could be affected by urgent orders. However, short lead time and transportation time made the supply uncertainty not as influential as in Firm 1.

The volatile demand required Firm 3 to hire an on-site person to coordinate daily shipments in the OEM's warehouse. This person also gathered 2-day demand information from which Firm 3 prepared the product for delivery. Concerning Firm 4, there was no fixed shipping schedule but they maintained approximately a 10-day inventory level in the hub. The OEM procurement staff pulled inventories from the hub when needed. An imbalance between demand and supply was common.

Facing a higher level of environmental uncertainty than Firm 1 and Firm 2, the respondents in Firm 3 and Firm 4 commented a lack of fit between the current weakly integrated EP and business environment.

> The current EP system only allows 10 items at most to be processed in a Web page, but for us there are usually more than a hundred items in a purchase order. (Firm 3 sales representative)

> The system does not support re-do function, which creates a lot of frustration. Usually I need to check hundreds of boxes to fulfil a purchase order. Once I check a wrong box, I start again from the beginning. (Firm 3 sales representative)

> When the OEM updates its forecasts, which occurred very frequently, the changed parts were not highlighted in the system, so we had to find out what was being changed by ourselves. (Firm 4 sales manager)

Partnership uncertainty

Partnership uncertainty includes two major subcategories, as shown in Table 4 (row II): reciprocal investment and trust:

1 Reciprocal investment. Comparing the four cases revealed that Firms 3 and 4 had relatively fewer mutual investments with the OEM than Firms 1 and 2. This was due to the fact that cable materials and passive components were standardized products and did not require much co-engineering effort with the OEM.

2 Trust. From the interview, it appeared that Firm 1 had a better mutual trust and reciprocal relationship with the OEM than the other three firms had. The informant from Firm 1 talked about a long-lasting cooperation history with the OEM and held a very positive view about its efforts on this EP development. Firm 2's trust in the OEM was moderate. Labelling materials faced the problem of version change after commercial production. Although the OEM might consult Firm 2 for the quantity of inventory in stock and then negotiate contract terms to share

the loss of abandoned materials, Firm 2 still had the potential to suffer a loss. Furthermore, complaints usually arose when the OEM's warehouse mishandled or lost track of a certain batch of shipments and the expense was shifted to the supplier. Whenever this occurred, Firm 2 had no way to track what happened and complaints seemed to be made in vain. Hence, the lack of a well-developed communication system to deal with these exceptions raised Firm 2's distrust. Firm 3 and Firm 4's trust in the OEM was even worse. Both Firm 3 and Firm 4 suspected that procurement executives of the OEM would change the contract allocation among suppliers arbitrarily. This was especially true for Firm 4 who delivered products through the hub. Products shipped to the hub could not be sold to other companies, but the transaction was not committed until the OEM pulled inventories from the hub. Any unexpected demand change could cause the products stored in Firm 4's hub to become obsolete.

Process uncertainty

Table 4 (row III) shows the assessment of process uncertainty across four firms:

1 Dynamics of processes. In Firm 1, the sales representatives were responsible for fulfilling orders, coordinating and contacting R&D personnel of both sides, as well as managing the return of defective items. Sales people in Firm 2, in contrast, only needed to manage order fulfillment and trace the design chart in case of missing shipments because the R&D design and reverse logistics were not as complicated as those in Firm 1. In Firm 3, though, sales people needed to take care of more complicated tasks due to the volatile demand. They had to contact the procurement executives of the OEM and on-site assistants to get accurate shipping information. Accordingly, most of their working time was spent on PO maintenance. In Firm 4, the sales people poured even greater efforts into fulfilling orders. They needed to coordinate with third party hub personnel, other than the procurement executives of the OEM, to ensure the fulfillment of orders. In their opinion, the hub personnel were not very receptive or cooperative, which resulted in poor exception handling. As a result, they were forced to move forward with processing orders alone most of the time.

The current weakly integrated EP cannot fulfil the needs of dynamic processes in Firm 3 and Firm 4. The lack of fit between the current EP and the business internal environment was shown in the comments of their respondents.

> When customers return defective items the OEM requires us to carry them back. However, the current system does not provide real-time quality information. The OEM always informs us in an urgent manner which increases the difficulty to efficiently arrange the return. (Firm 3 sales representative)

> The OEM requires us to coordinate with the hub to fulfil the orders. However the order information shown in our system is often inconsistent with the information at the hub. (Firm 4 sales representative)

2 Dynamics of products. The casting materials provided by Firm 1 were special materials which were incompatible across different NB modules. As a result, Firm 1 needed to discuss

the form, the operation, the material, the function and the structure of a cast with the OEM before production. On the other hand, given that the labels were simple materials and cables – as well as passive components – were relatively standardized materials, Firms 2, 3 and 4 had no cooperative R&D problems. Even so, Firm 2 faced more frequent product changes because labels needed to be designed in accordance with specifications of separate modules. These modules, however, changed frequently with the requirements of customers or the upgrades of NB versions.

3 Complexity of products. The casting materials produced by Firm 1 belonged to dedicated/special materials and had to go through several stages before commercial production. Besides this, the lead time for casting materials was approximately 1 month and the duration of a batch production lasted 3–5 days. The product complexity was relatively high compared with the other three firms. The labelling materials provided by Firm 2 were part of dedicated materials, but there was no complicated R&D. The lead time for labelling materials was about 1 week and the duration of a batch production lasted only 1 day. The cable materials supplied by Firm 3 were standardized materials with medium technological complexity. The lead time for these materials was about 1 month and the duration of a batch production lasted 1–2 days. Firm 4 produced passive components which were also standardized materials with low technology complexity. The lead time for most passive components was approximately 1 month, but some required a lead time of 2 months. Batch production lasted 2–3 days.

Know-how/knowledge

EP knowledge can be classified into two broad subcategories: technical IT skills and managerial IT skills (see Table 4, row IV).

1 Technical IT skills. Since all four companies ran the weakly integrated, web-based EP without implementation difficulties, it could be said that all of them had a certain degree of satisfactory technical IT skills in terms of knowledge and experience with the operating systems and programming language. Among these firms, Firm 4 seemed to have the highest technical level of IT skills, because it had implemented various EPs such as EDI and XML-based connections with other companies and some of the systems required a higher level of technical skills than the EP discussed here.

2 Managerial IT skills. Each case company showed different levels of managerial skills. Firm 1 did not show many managerial skills as their procurement practice was not in the least complicated. Firm 2 and Firm 3 had higher coordination skills because their procurement activities required frequent interactions with the OEM executives. Firm 4 showed the highest motivation and capability to improve the procurement collaboration. In order to avoid delays, Firm 4 proposed a solution in which the current EP directly linked to its enterprise systems via electronic links. They stated, ‘we try to be a good supplier and keep our customers informed about their order status whenever needed’.

Performance

EP benefits are illustrated in Table 4 (row V):

1 Strategic benefits. All of the suppliers understood well that the EP had become the only channel for the OEM to place orders and they could not get any orders if they refused to use the system. Hence the EP is a strategic necessity rather than just a strategic benefit.
2 Operational benefits. Operational benefits such as time and error reductions on payments and order confirmation and increasing accuracy of order processing were mentioned by Firms 1, 2 and 3 to some extent. They also pointed out substantial improvements in packing and shipping processes. Given that the EP could transform a PO into an ASN automatically, the inconsistencies between the PO and ASN were greatly reduced. Situations like denial of in-warehouse receiving or delivery error to the wrong factory did not occur. Despite these benefits, Firm 2 still complained frequently about the system's inability to handle product returns and Firm 3 still struggled with inaccurate and inconsistent order information.

Things were worse for Firm 4. Their sales people did not think that the current EP brought much convenience to their daily operation. Instead, they complained that most information provided by the system was inaccurate and out of date. Further, unfortunately, because an ASN was not used in Firm 4's case, the corresponding benefits of ASN do not exist.

Summary

Figure 3 summarizes the analysis. Firms 1 and 2 perceived better benefits and performance than their counterparts, from which it may be derived that the current EP fits the business environment of Firms 1 and 2 better than that of Firms 3 and 4. Since Firms 1 and 2 averaged lower uncertainties than Firms 3 and 4 and all four firms implemented a weakly integrated EP, it can be concluded that EP use in the form of a weakly integrated system cannot fulfil the needs of firms that deal with higher uncertainties. We discuss this further in the next section.

DISCUSSIONS

External uncertainties and EP performance

The results show that high-technology firms in China face several external uncertainties. This makes their EP performance largely dependent on the capability of the EP to resolve uncertainties coming from products, market demand and supply, and partnership. For firms that supply more customized IT components to the OEM the demand often fluctuated and a simple web-based EP made the order processing a time-consuming job.

Partnership uncertainty also constrained the EP performance. Firms with close design collaboration with the OEM were more likely to realize the benefits of EP, even if the system was not strongly integrated. This may be because such collaboration experience can process into a more durable association supported by shared goals, planning and commitment to the relationship allowing suppliers to work out difficulties in EP practices. However, since most suppliers are small- to medium-sized enterprises and lack the required capabilities to co-design, close design collaboration is not very common in a relationship between OEMs and

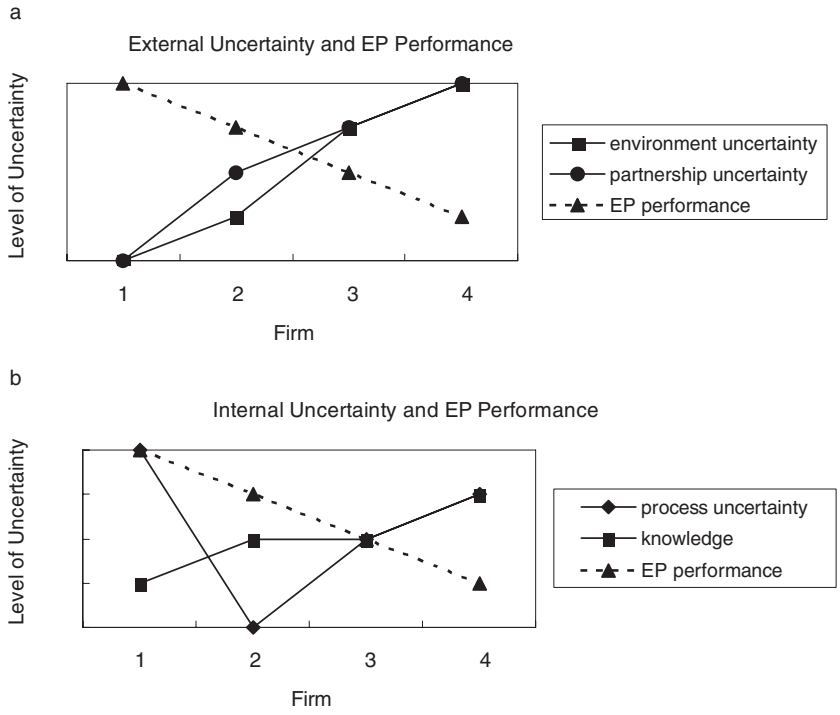

Figure 3. Summary of case analysis: (a) external uncertainty and EP performance and (b) internal uncertainty and EP performance.

their local Chinese suppliers. In these cases, only Firm 1 expressed that they had developed a continuous, cooperative R&D initiative with the OEM.

The respondents generally agreed that trust affected EP performance quite a bit. However, as Chinese suppliers are coerced to adopt the EP rather than to do so voluntarily, they need to prevent their partners' possible opportunistic behaviours. The OEMs' opportunistic behaviour comes in different forms such as arbitrary changes in predefined volume allocation, last-minute order changes or cancellations, or mishandling of suppliers' shipments. Such opportunistic behaviour creates a great deal of tension in the OEM–supplier relationship in China and some big Chinese suppliers start to interact with customers directly. For example, Firm 4 attempted to bypass the OEM and directly shipped some customized parts to the customers so it could trace the items more easily without interference from the OEM, even though the OEM asked Firm 4 to deliver those parts via their own hub. This behaviour of distrust from suppliers towards the OEM greatly increased the difficulty to implement a successful EP system in these cases.

However, it should be noted that these cases did not provide a clear demonstration that a strongly integrated EP can perform better in the environment with a high level of external

uncertainty, as proposed earlier. From these cases, it can only be suggested that EP use in the form of weakly integrated system cannot fit with the procurement environments that entail a high level of external uncertainty. Nevertheless, evidence did suggest that firms may reduce such uncertainty with more integrated information.

Internal uncertainties and EP performance

The impacts of internal uncertainties on EP performance are mixed. Suppliers who provide standardized products are not only coerced to adopt the EP but are also asked to follow the transaction rules made by the OEM. Suppliers in such circumstances need to be agile enough to handle external disruptions smoothly. According to Porter (2001), the competitive advantage for these suppliers depends on the provision of the same products but in a more efficient manner and, therefore, an integrated EP which speeds up the procurement processes becomes more preferable. Firms 3 and 4 provided relatively more standardized products than others and expressed that the current weakly integrated EP system could not fully support their order fulfillment activities.

Firm 1 is an exceptional case in our analysis. Their process was very uncertain but they seemed satisfied with the current weakly integrated system. Since the previous discussion has demonstrated that a long-standing trusting relationship does not exist between Firm 1 and the OEM, this phenomenon may be due to the fact that the casting materials provided by Firm 1 were much more specific and customized than the cables and passive components provided by Firms 3 and 4. As a result, the OEM was more willing to handle most of the challenges that occurred in the order fulfillment processes, making things much easier for Firm 1.

The analysis also shows that weakly integrated EP can only bring benefits to firms with low levels of knowledge. In three out of the four case firms, the EP was their first attempt to develop an IOS link with the major customers. According to the case firms, only a 1-day training course and 2 weeks of orientation were offered to the suppliers before this EP went officially live. Most of the suppliers just fumbled around to understand the system's function on their own. In light of low IT knowledge and limited customer support, most of the suppliers admitted that they preferred simple systems. That may explain why Firms 1 and 2 expressed the highest satisfaction, but at the same time their level of IT knowledge was lower than the other two firms.

Another interesting point is that the more IT knowledge firms had, the fewer benefits they perceived from the current weakly integrated system. Firm 4, for example, logged the most complaints about the current EP. The primary reason was that they had more IT skills than the other suppliers and the OEM. They also had plenty of IOS development experiences and they clearly knew where the current system needed to be improved.

In conclusion, when firms have low levels of process uncertainty and IT knowledge, the only successfully implemented EPs are those with low integration. Firms may prefer to maintain a unique EP that fits better with their internal and external environments. Therefore, to develop a strong customer–supplier relationship in China, the initiator should develop a customized alignment strategy that assures different adopters get maximum benefits. In other words, a

traditional one-for-all IT strategy cannot fit with the complicated and diverse business environment in China. An improper IOS may cause suppliers to fail to cooperate and will eventually harm the focal firms.

CONCLUSIONS

Through a multiple-case study conducted in China, it was found that EP use in the form of weakly integrated systems leads to great performance improvement for firms facing low uncertainty of environment, partnership or process and having limited IT knowledge. It was also observed that lack of fit between procurement practices and EP systems produces extra burdens and costs to Chinese companies. Such costs are reflected in the performance of both the buyer and the supplier. Therefore, companies should align their EP with different trading partners to get maximum efficiency and benefits.

The coercive adoption of the EP in these cases impacts the presented model in three aspects. First, the perceived strategic value of all suppliers was surprisingly high, because all of them knew they could not get any orders if they refused to use this system. Second, external uncertainties increased. The results showed that relationships between most Chinese suppliers and their OEMs were not all trusting, which lead to more information needs to prevent partners' opportunistic behaviours. Last, the coercion increased internal uncertainty especially for suppliers with standardized products. thus, suppliers needed to be agile to handle external disruptions. Furthermore, the coercive adoption behaviour also implied that business–IT fit may have a stronger effect on system performance in the circumstance of mandatory adoption than that of voluntary cases. Further validation via comparative case studies is suggested.

There are limitations to this study. Because of the representativeness and accessibility of cases, this study focused on the impact of weakly integrated, web-based systems which are the most popular form of EP in today's IT manufacturing industry in China. Since all the case data that were collected did not address the implementation of a strongly integrated EP, the propositions could not be demonstrated directly. However, it was discovered that a weakly integrated EP is only beneficial to firms with low levels of uncertainty. Therefore, this framework provided an opportunity to fully test the propositions in the future. Results are derived from the case study can also be further validated via an industry-wide survey.

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Biographies

Hsin-Lu Chang is an Assistant Professor in the Department of Management Information Systems, National Chengchi University, Taiwan. She received a PhD in Information Systems at the School of Commerce, University of Illinois at Urbana-Champaign. Her research areas are on B2B e-commerce, IT value and technology adoption. She has numerous publications in past issues of *Information Systems and e-Business Management, International Journal of Electronic Commerce, Mathematical and Computer Modelling, Journal of Industrial Management and Data Systems*, etc.

Kai Wang is an Assistant Professor of Department of Information Management at Ming Chuan University, Taiwan. He received a PhD in Business Administration from the School of Management, National Central University, Taiwan. Dr. Wang was Senior Industry Analyst and Research Manager at Market Intelligence Center, Institute for Information Industry, Taiwan. His research interests include online consumer behaviour, Internet advertising and marketing, and topics on IT implementation and applications. His research has appeared in *International Journal of Information Management, Journal of Information*

Management (in Chinese), *Sun Yat-Sen Management Review* (in Chinese) and others.

Iris Chiu received her bachelor's and master's degrees in the Department of Management Information Systems at the College of Business, National Chengchi University, Taiwan. She has research interests in the strategic and managerial issues of enterprise systems, process re-engineering, IT-enabled supply chain collaboration and IT security.

APPENDIX: INTERVIEW PROTOCOL FOR CASE INTERVIEWS

The following structured protocol is designed to guide telephone interviews:

SECTION 1: Company background

1 What main products do you provide for this OEM? Please describe them briefly.
2 Who are your major customers besides this OEM?
3 How long has your company been doing business with this OEM?

SECTION 2: Procurement process

1 What is your major work content?
2 Please describe your order fulfillment process in detail.
3 How do you process forecast and purchase orders?
4 How do you negotiate and communicate with the OEM's procurement staff?
5 How do you arrange the production of your factory to fulfil POs?
6 How do you arrange shipments?
7 Does the current EP system perform well? Is there any additional effort needed to fulfil orders?

SECTION 3: Usage of the current EP system

1 How long has your company adopted the current EP system?
2 How long have you used the current EP system?
3 In your opinion, what are the advantages and disadvantages of the current EP system?
4 Who is your contact window for the OEM when exceptions happen?
5 Do you ever try to fix the problems of the current EP system together with the OEM's procurement staff?

