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Identifying the drivers of enterprise resource planning and assessing its impacts on supply chain performances

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Abstract

Purpose – Enterprise resource planning (ERP) is intended to integrate all facets of a company's business operations encompassing production planning, material purchasing, inventory control, logistics, accounting, finance, marketing, and human resource management by creating a single depository of the database that can be shared by the entire organization and its trading partners. Through an empirical study, the purpose of this paper is to identify a multitude of drivers that facilitate or hinder the implementation of ERP in business environments. Also, this paper determines its role in supply chain operations and assesses its impact on supply chain performances.

Design/methodology/approach – To examine which factors drive the ERP adoption and gauge the level of the ERP success, the authors develop a research framework based on two well-known theories in the strategy literature: a contingency theory; and a resource-based view of the firm. This research framework allowed us to develop a series of hypotheses regarding the use of ERP for strategic sourcing. To test hypotheses, the authors carried out the study in three phases: a pre-pilot; a pilot; and a large-scale questionnaire survey. In the pre-pilot phase, the authors generated potential survey items through theory development and a literature review. In the pilot phase, the authors develop a structural equation model along with the identification of valid constructs based on structural interviews and the Q-sort method. At the last stage, the authors conducted a large-scale survey via mail questionnaires primarily targeting the Korean industry comprised of manufacturers and their suppliers and customers.

Findings – The firm's ERP adoption and implementation decision is mainly affected by its internal environment. Defying the conventional wisdom, the firm's external environment has little influence on its decision to adopt and implement ERP. However, through the mediating role of an internal environment, an external environment still indirectly influences the ERP adoption and ERP implementation decision. Also, the authors found that ERP could enhance the ERP adopter's organizational capability and supplier capability.

Originality/value – This study is one of a few attempts to investigate the role of ERP in the supply chain and identify important determinants influencing the ERP adoption and implementation decisions. Especially, in contrast with the previous literature which often gauged the benefits of ERP from an ERP adopter's standpoint, this paper is one of the few to assess the benefits of ERP from the ERP adopter's supply chain partners standpoints. Also, it is one of the first to assess the impact of ERP on supplier capability, organizational capability, and customer value.

Keywords Supply chain performance, Enterprise resource planning

Paper type Research paper

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1. Introduction

Faced with avalanche of information to be processed in the extended enterprise, enterprise resource planning (ERP) has emerged as one of the major breakthrough information technologies that can re-shape business practices. Despite some missteps and implementation failure, the popularity of ERP continued to increase for the last few years. As a matter of fact, the ERP market grew from $28.8 billion in 2006 to $47.5 billion in 2011 and is expected to grow to an estimated $67.7 billion by 2017 (Jacobson *et al.*, 2007; Lucintel, 2013). The ERP spending in 2011 soared by 31 percent compared to 2010 and then the ERP spending in 2012 rose by 4.5 percent compared to 2011 (The Business Technology Forum, 2011; Low, 2012). Reflecting this trend, almost three quarters (72 percent) of the manufacturers recently surveyed by the Aberdeen Group (2011) are currently using ERP for their improvement in operating efficiency and subsequent organizational growth. This continued popularity of ERP has been attributed to its ability to process transaction information faster, track product orders and inventory, automate orders and payment, lower setup costs, reduce order cycle time, reduce administrative overhead expenditures, improve cash management, avoid data duplication, and integrate business processes throughout the entire supply chain (Davenport, 2000; Trott and Hoecht, 2004; O'Leary, 2004). In other words, ERP can enhance supply chain visibility and subsequently improve supply chain efficiency. Evolved from manufacturing requirement planning, ERP is generally referred to as a cutting edge information technology that helps the firm coordinate and integrate company-wide business processes including sales, marketing, manufacturing, logistics, purchasing, accounting, and human resources management using a common database and shared management reporting tools (Brady *et al.*, 2001). In a sense, ERP is a "dashboard" that provides some levels of central oversight and controls that are needed to ensure that all of the company's resources are working together toward the same goal.

In particular, ERP can play a significant role in managing the supply chain, since ERP is known to improve inventory record and bills of materials accuracy, achieve on-time delivery services, and reduce pipeline inventory throughout the supply chain (Buker Inc. Management Education and Consulting, 2011). Unlike a traditional business paradigm which focusses on what is happening within one particular organization and how it can improve its own internal efficiency, a supply chain concept revolutionizes the way we manage things by thinking of an individual organization as a vital component of interconnected business activities involving sourcing, making, delivering, and selling. As such, the company's survival and competitiveness rest on its contribution to the supply chain strength and connectivity to its supply chain partners. In other words, the true impact of information technology such as ERP should be assessed from a holistic supply chain standpoint rather than simply an individual organization's well-being. In the existing literature, however, this holistic supply chain view has been neglected in assessing the impact of ERP. This negligence casted doubt about the potential benefits of ERP described earlier and consequently might have limited the effort to adopt and exploit ERP.

Indeed, some firms are still hesitant to utilize ERP in improving supply chain operations for many reasons. These reasons may include: longer payback periods resulting from exorbitantly expensive ERP implementation; a lack of technological sales and operational planning; a lack of user friendliness of ERP systems; incompatibility among multiple versions of ERP software/hardware; poor data bases; a difficulty in providing a seamless interface to different business units; a lack of ERP performance metrics; and organizational resistance to change. That is to say, the adoption of ERP in the supply chain setting depends heavily on the firm's ability to overcome a host of inhibitors or make a compelling case for the dramatic improvement in supply chain efficiency. Therefore, there is a need to identify key drivers of ERP which can maximize ERP benefits from supply chain perspectives and then provide guidance for those who would like to improve its ERP applications to supply chain management or those who may consider using ERP for supply chain improvement in the future (Yang and Su, 2009, Li *et al.*, 2009). Herein, it should be noted that ERP benefits go beyond a greater return on investment (ROI) which is typically delivered through the financial paybacks of the firm's resources and business processes. Also, given a difficulty in calculating the accurate ROI for Information and Communication Technology (ICT) implementation as observed by Li *et al.* (2009) and HassabElnaby *et al.* (2012), we consider a host of performance metrics or surrogate measures relevant to supply chain performance. These may include: cost savings (e.g. inventory reduction), reliability (e.g. consistent delivery and quality), responsiveness (e.g. time-to-market, delivery time), flexibility (e.g. product variety), and asset utilization (Gulledge and Chavusholu, 2008; Chae, 2009; Stank *et al.*, 2011; Gopal and Thakkar, 2012).

With above discussions in mind, the main objective of this paper is threefold: to identify both critical success factors (both endogenous and exogenous factors) most essential for successful ERP applications to supply chain management; to evaluate the seriousness of obstacles for implementing ERP for supply chain operations; and to assess the impact of ERP on organizational capability, organizational performance, and supply chain performances. In other words, this paper intends to provide new perspectives (i.e. supply chain perspectives) in understanding both the key drivers of successful ERP implementation and the role of ERP in supply chain management.

2. Prior literature

If successfully implemented, ERP can create value in a number of different ways by integrating the firm's multifarious business activities into a single system, facilitating organizational standardization, increasing access to online and real time information, improving intra- and inter-organizational communication and collaboration, and enhancing decision-making capabilities (O'Leary, 2000). ERP implementation, however, poses enormous managerial challenges not to mention high cost of start-up investment. The failure to deal with these challenges often spells disaster as illustrated by the ERP nightmares of Hershey Foods, Nike, HP, and Waste Management. To help ERP adopters avoid this disaster, most prior studies on ERP (Zhang *et al.*, 2002; Al-Mashari *et al.*, 2003; Umble *et al.*, 2003; Nah *et al.*, 2001, 2003; Nah and Delgado, 2006; Soja, 2006; Ulrich, 2007; Chung *et al.*, 2008; Doom *et al.*, 2010; Liu, 2011; Ram *et al.*, 2013; Ram and Corkindale, 2014) have focussed on the identification of critical success factors for ERP implementation. Much of these earlier studies attempted to uncover the main sources of ERP implementation failures and successes. These sources include: top management commitment, project management, changes in organizational culture, data accuracy, user training and education, user involvement, multi-site applications, ERP software vendor support, perceived usefulness, and perceived ease of use. In addition, other studies (Hong and Kim, 2002; Abdinnour-Helm *et al.*, 2003; Ke and Wei, 2008; Morton and Hu, 2008; Dezdar and Ainin, 2011) reported that organizational fit, internal restructuring, enterprise-wide communication and pre-implementation attitudes can influence the ERP implementation success. The key research framework that these prior studies used is similar to a technology acceptance model introduced by

Davis (1986) which aims to examine how prospective user behavior, attitude, and his/her external environments influence technology adoption decisions. This kind of research framework, however, is not designed to understand how ERP adoption impacts the firm's business performances, nor does it assess the extent of ERP impact on business outcomes.

Recognizing such a shortcoming, O'Leary (2004) examined the potential benefits to be gained from ERP implementation based on the empirical analysis. These benefits include: enhanced visibility, improved customer responsiveness, reduced inventory, labor savings, higher productivity, and improved order management. He found that the extent of these benefits, however, varied across the industry. Bendoly and Schoenherr (2005) also found that ERP brought a number of benefits such as the elimination of process bottlenecks, elimination of (data) redundancy, transaction time reduction, and standardized interfaces between human and computer. In particular, they discovered that the firms with a longer history of ERP usage garnished greater benefits (especially B2B e-procurement cost savings) than the firms with a shorter history of ERP usage. Similar to the finding of Bendoly and Schoenherr (2005), Gattiker and Goodhue (2005) found that the impact of ERP on task efficiency improved over time but at a decreasing rate. They also found that the customization of ERP implementation improved the task efficiency at the plant level, since ERP benefits might vary from one plant to another. In other words, without tailoring ERP for the unique setting of each plant, some benefits of ERP may not fully materialize. Considering the evolving benefits of ERP over time, Schubert and Williams (2009) focussed on the evaluation of ERP implementation benefits over time by dividing the ERP implementation phases into *ex ante* (ERP selection and introduction) and *ex post* (actual ERP use, upgrade, and possible replacement) implementation phases. Although these prior studies realized variations in ERP benefits depending on the industry, timeline, an organizational setting, and a functional area, they did not investigate how significantly ERP can affect the supplier capability, organizational capability, and performance from a supply chain perspective. The dearth of the published literature regarding the ERP applications in SCM lies in the difficulty of assessing the ERP impact from the perspective of multiple supply chain partners (e.g. both the focal company and its suppliers) representing different values and corporate goals as opposed to the context of a single focal company. Although Hwang and Min (2013) recently assessed the impact of ERP on supplier capabilities and performance, their study focussed only on a supplier's perspective and thus overlooked both the focal company and its customers' perspectives.

To fill the void in aforementioned prior studies, this paper investigates both endogenous and exogenous variables (factors) that dictate the ERP success, examines what roles ERP plays in enhancing the focal company's sourcing capabilities, and assesses the impact of ERP on the focal company's suppliers' capabilities and competitive advantages. This paper is one of the first to provide a holistic view of ERP impacts on supply chain (especially sourcing) operations based on the contingency theory and a resource-based view (RBV) of the firm theory. To elaborate, this paper attempts to answer the following research questions:

RQ1. What are the key driving factors (both internal and external) of ERP implementation?

RQ2. What are the most important incentives (or benefits) for utilizing ERP in the supply chain?

RQ3. How significantly does ERP affect the focal company's sourcing efficiency?

RQ4. What are the mediating variables between ERP implementation and the focal company's organizational capability, its supplier's capability, and supply chain performances?

RQ5. How significantly does ERP create the customer value?

3. Theory development and hypotheses

To examine which factors drive the ERP adoption and gauge the level of the ERP success, we employed two well-known theories in the strategic management literature: a contingency theory; and a RBV of the firm. To elaborate, contingency theory, which was developed in the late 1960s, is one of the behavioral theories that study how environmental variables influence the behaviors of organizations (Lawrence and Lorsch, 1967; Chandra and Kumar, 2000). Contingency theory is predicated on the premise that the firm's strategy including ICT adoption strategy depends on its endogenous and exogenous business environments (Donaldson, 2001). For instance, in highly turbulent business environments where a firm faces difficulty in recognizing the needs and preferences of its customers due to a greater uncertainty, an access to accurate and timely information needed for a strategic decision can dictate the success of the firm (Citrin *et al.*, 2007). In other words, ICT can be seen as a strategic differentiator in unstable and uncertain business environments. As such, the ICT adoption/investment is essential for the improvement of the firm's performances in highly turbulent business environments. On the other hand, a firm which is resistant to any changes, or reluctant to bear risk, or not ready to embrace new ICT for technical or economic reasons, may not be a good fit for ICT adoption. Therefore, the contingency theory may help the firm understand what truly drives the ERP adoption and then identify a set of external and internal environmental variables influencing the firm's ERP success.

A RBV of the firm theorizes that the firm which possesses a bundle of unique resources (e.g. assets, human capitals, capabilities, organizational process, information, knowledge) can improve its performances and subsequently achieve competitive advantages in the market (Wernerfelt, 1984; Barney, 1991; Wade and Hulland, 2004). To put it simply, the RBV theory is predicated on a premise that the firm competes on the basis of "unique" corporate resources that are valuable, rare, difficult to imitate, and non-substitutable (VRIN) by competitors (Barney, 1991; Wade and Hulland, 2004). Considering that ERP can be regarded as a unique corporate resource, the RBV theory may be useful for explaining how ERP implementation improves the firm's capabilities and performances.

3.1 Defining the hypothetical model and constructs

Under both the contingency and RBV theories described earlier, we develop a research framework that is comprised of eight constructs: an external environment, an internal environment, ERP implementation, supplier capability, organizational capability, supplier performance, organizational performance, and customer value. Herein, the external environment is generally referred to as exogenous factors (physical and social) that form the context for organizational actions and decision making (Li *et al.*, 2006). Even though the firm has little or no control over its external environment, a greater awareness of its external environment helps the firm better adapt and develop appropriate ICT adoption strategies (Lusthaus *et al.*, 1999). As summarized in Table I, the external environment surrounding the ERP implementation includes a technological change, the level of competition, a rapid market change, and supplier uncertainty (Doll and Vonderembse, 1991; Vonderembse *et al.*, 1997; Nahm and Vonderembse, 2002).

An internal environment is referred to as an organization's endogenous resources and capabilities. A mere command of some central authority, such as an executive or a senior manager, alone cannot make ERP implementation successful. ERP implementation requires effective, committed, and persistent leadership to achieve the goals of an entire firm. Therefore, to successfully implement ERP, the firm should consider its organizational readiness and resource capabilities defined by endogenous factors such as top management support, organizational culture, communication, business process reengineering, and ICT readiness (see Table II). Many researchers emphasize the importance of top management support, business process reengineering, and communication during ICT implementation (Bingi *et al.*, 1999; Buckhout *et al.*, 1999). To elaborate, top management support is critical for an ERP project's success given the required resource commitment (Buckhout *et al.*, 1999; Parr and Shanks, 2000; Loh and Koh, 2004). Also, the firm's inclination for open communication which can facilitate information sharing can make ERP implementation successful (Motwani *et al.*, 2002). Furthermore, organizational culture is regarded as one of the critical success factors for an ICT success, since the organization culture has profound effects on the ICT planning process, the implementation process, and the follow-through operation of the completed project (Stewart *et al.*, 2000). In particular, Jones *et al.* (2006) discovered that organizational culture directly affected the ERP implementation team's ability to share knowledge and perspectives across the different functional units of the firm.

Table I.
List of sub-constructs for an external environment

Constructs	Definition
Technological change	The degree to which technologies are evolving and transforming business practices
Level of competition	The degree to which a firm's rivals can offer more favorable deals to customers
Rapid market change	The degree and rate of a change in customer expectations
Supplier uncertainty	The degree to which a firm's supplier's product quality and delivery performances are unpredictable

Table II.
List of sub-constructs for an internal environment

Constructs	Definition
Top management support	The degree to which executives understand the ERP benefits and then encourage ERP implementation
Organizational culture	A firm's shared values and beliefs
Communication	The degree to which a firm shares decisions, expectations and goals throughout its supply chain
Business process reengineering	The degree to which a firm analyzes and designs its workflows and processes
ICT readiness	The degree to which a firm prepares the environment and workforce to accept and configure new technology

The ERP implementation is defined as a firm's extent to adapt, configure, and integrate the information flow and business processes necessary to support different departments and functions in an organization through the use of ICT architecture that collects and stores data in real time (Davenport, 2000; Hong and Kim, 2002; Loh and Koh, 2004; Klein, 2007). As summarized in Table III, essential elements for ERP implementation include: the integration of different modules, software, and legacy systems to achieve unity in an organization, matching the software to the needs of organizational processes, adjusting new technology to cope with changes, and preparing and developing the ICT workforce (Davenport, 1998; Hong and Kim, 2002; Morton and Hu, 2008).

Supplier capability is referred to as a suppliers' ability to utilize its resources to meet its buying firm's needs and business goals. One example of such capability may include the supplier's ability to coordinate its production operations with its buying firm based on the end-customer demand information provided by its downstream supply chain partners. Also, the supplier can participate in new product development through an early supplier involvement program offered by its buying firm. A basic enabler for this kind of close coordination and cooperation is information sharing, which can be facilitated by advances in ICT such as ERP. For example, joint demand forecasting by the buying firm and its suppliers within the ERP framework can reduce inventories and improve resource utilization throughout the supply chain. As recapitulated in Table IV, supplier capability is comprised of information access, process improvement, and product innovation.

Organizational capability is referred to as a company's ability to perform a set of tasks, while utilizing organizational resources efficiently (Carmeli and Tishler, 2004; Peng *et al.*, 2008). This capability includes the focal company's organization-specific competencies (e.g. cross-functional coordination, information access, and process improvement) and customer responsiveness (e.g. flexibility and agility) as summarized in Table V. ERP implementation can facilitate such organization-specific competencies. For example, ERP enables the focal company to utilize its human resources through the

Constructs	Definition
Integration	The degree to which a firm achieves unity in organizational subsystems by harmonizing the different modules, software and legacy system
Configuration	The degree to which a firm tailors ERP to its supply chain needs
Adaptation	The degree to which a firm accepts and adjusts its ERP system to cope with changes in the external environment
User training	The degree to which a firm nurtures the necessary skills of its ICT workforce

Table III. List of sub-constructs for the ERP implementation

Constructs	Definition
Information access	The extent of a supplier's ability to obtain the necessary data in a timely manner
Process improvement	The degree to which a supplier adds value to its business processes
Product innovation	The extent of a supplier's ability to enhance its product content, feature, and function

Table IV. List of sub-constructs for supplier capability

Table V. List of sub-constructs for organizational capability

Constructs	Definition
Cross-functional coordination	The degree to which a focal company achieves goal and consistent action for all departments and work functions
Information access	The degree to which a focal company supports organizational production through fast data gathering and processing
Process improvement	The degree to which a focal company enhances existing programs and procedures within its organization
Flexibility	The degree to which a focal company design products to meet the needs of the market without excessive costs, time, organizational disruption, or loss of performance
Agility	The degree to which a focal company copes with unexpected changes, to survive unprecedented threats from external business environments, and to take advantage of changes as opportunities

management of worker-related documents, work-flows, and employee talents/skills, while ensuring that the right employees can access the right information seamlessly. Since the implementation of ERP systems enables a firm to establish backbone data warehouses, ERP systems offer better accessibility to up-to-date information for decision making and managerial control. Also, ERP can enhance the customer responsiveness by automating invoice/payment systems and tracking order history.

Supplier performance is referred to as the extent of the supplier's ability to deliver materials, components, or products to its buying firm in accordance with the buying firm's specific needs, schedules, and requirements (Beamon, 1998; Vonderembse and Tracey, 1999; Shin *et al.*, 2000; Hwang and Min, 2013). Supplier performance has significant impact on the buying firm's operational success, since the supplier's poor incoming product quality and erratic delivery often lead to a higher level of inventory and order backlogs (Davis, 1993; Vonderembse and Tracey, 1999; Shin *et al.*, 2000; Li *et al.*, 2006). Generally, supplier performance can be classified into five categories: short lead time; product variety; delivery reliability; cost; and quality (Shin *et al.*, 2000). The list of sub-constructs, along with their definitions, is summarized in Table VI.

The successful implementation of ICT such as ERP is known to improve organizational performance with respect to cost, quality, delivery, product variety, and time-to-market as shown in Table VII (Koufteros *et al.*, 2002; McAfee, 2002; HassabElnaby *et al.*, 2012). After implementing an ERP system, a company can readily

Table VI. List of sub-constructs for supplier performance

Constructs	Definition
Short lead times	The degree to which a supplier provides its buying with products or services within a short period of time
Product variety	The degree to which a supplier provides its buying firm with products and/or services with additional features and a wide assortment of products (e.g. product mix)
Delivery reliability	The degree to which a supplier delivers products or services to its buying firm according to the promised schedule at the time of the order
Cost	The degree of a supplier's ability to offer products or services to its buying firm at competitive price
Quality	The degree to which a supplier conforms to the buying firm's product/service specifications and requirements

build a customer database and effectively analyze customer information. This database helps the company understand customer needs and preferences, thereby finding the correct position and market segment for the product and subsequently enhancing the focal company's competitiveness in the marketplace (Huang *et al.*, 2007).

Customer value is referred to as the degree of benefits perceived by customers as a tradeoff between what customers receive and what they sacrifice. Customer value is a source of competitive advantage for business firms. Tu *et al.* (2001) defined it as the extent to which customers perceive a firm's products as having higher value, as well as their degree of satisfaction with these products. Customer value comes from meeting the current needs of customers more efficiently, from identifying the customer needs proactively, and from meeting new customer needs or new needs of existing customers (Chand *et al.*, 2005). Increased customer satisfaction and more increased value for customers are expected once the company enhances its ERP package with a new module (e.g. the sales and distribution module). Joo (2007) identified four factors comprising customer value created by ERP. These factors are summarized in Table VIII.

3.2 Developing hypotheses

In the earlier sub-section, the literature was reviewed to establish the content validity of each construct. Our review of the literature suggests that four constructs (external environment, internal environment, ERP implementation, and supplier capability) can potentially influence the focal company's supplier's performance, as shown in Figure 1. To identify factors that are essential for the successful implementation of ERP and

Constructs	Definition
Time to market	The degree to which a focal company introduces new products faster than its competitors
Product variety	The degree to which a focal company introduces new products and/or services with additional features and improved performance with wide assortments
Delivery reliability	The degree to which a focal company provides products or services according to the promised delivery terms at the time of sale
Cost	The degree to which a focal company can attract customers primarily at low price
Quality	The degree to which a focal company offers a product which creates higher value to its customers

Table VII. List of sub-constructs for organizational performance

Constructs	Definition
Value for money	The degree to which a customer perceives value because a focal company has lowered a product's price
Convenience	The degree to which a customer perceives value because the focal company has provided convenient information and service
Timely response	The degree to which a customer perceives time saving because a focal company quickly acts upon customer needs
Reputation for quality	The degree to which a customer perceives product quality and performance

Table VIII. List of sub-constructs for customer value

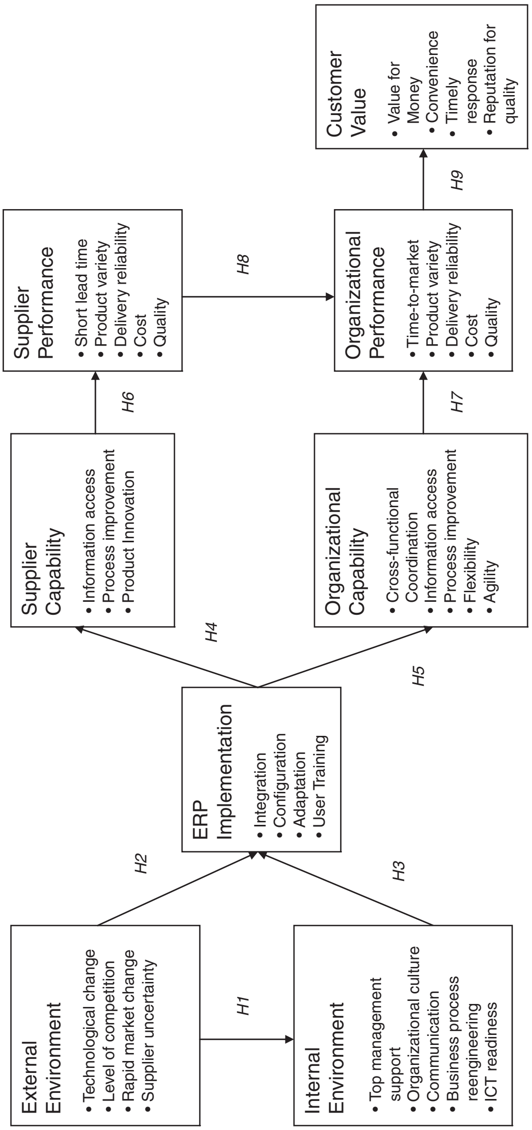

External Environment
• Technological change
• Level of competition
• Rapid market change
• Supplier uncertainty
Internal Environment
• Top management support
• Organizational culture
• Communication
• Business process reengineering
• ICT readiness
H1
H2
H3
ERP Implementation
• Integration
• Configuration
• Adaptation
• User Training
H4
H5
Supplier Capability
• Information access
• Process improvement
• Product Innovation
Organizational Capability
• Cross-functional Coordination
• Information access
• Process improvement
• Flexibility
• Agility
H6
H7
Supplier Performance
• Short lead time
• Product variety
• Delivery reliability
• Cost
• Quality
Organizational Performance
• Time-to-market
• Product variety
• Delivery reliability
• Cost
• Quality
H8
H9
Customer Value
• Value for Money
• Convenience
• Timely response
• Reputation for quality

Figure 1.
The hypothetical model

assess their impact on the focal company's performance and its supplier's performance, we developed a number of hypotheses and then tested their validity using empirical data. In the following section, the rationale for these hypothesized relationships is described in detail.

3.2.1 External environment and internal environment. Gordon (1991) and Nahm *et al.* (2003) found that the external environment and the internal environment of an organization were loosely coupled. For instance, Swamidass and Newell (1987) empirically proved that environmental uncertainty was positively related to top management pursuit of flexibility and centralized decision making that shape up the internal environment. As such, the firm facing a volatile external environment tended to have more frequent communication among its internal departments or divisions than those in a stable external environment (Lawrence and Lorsch, 1967; Duncan, 1972). In other words, an increase in the amount of work-related communication allows the firm to reduce uncertainty with more accurate and timely information transmitted through frequent communication. Also, a rapid advance in ICT would help the firm improve technological readiness for innovative ICT such as ERP and thus revitalized the firm's internal environment (Lee *et al.*, 2007). Therefore, we hypothesized that:

H1. A firm which operates in highly uncertain, competitive and rapidly changing environments will have a high level of adjustment and improvement in internal environments.

3.2.2 External environment and ERP implementation. The external environment is known to be one of the key drivers for ICT implementation (Lawrence and Lorsch, 1967; Chandra and Kumar, 2000). More specifically, Mentzer *et al.* (2000) suggested that rapid technological changes would allow the firm to leverage innovative ICT and thus would encourage the firm to share information with its suppliers so that both the buying firm and its supplier could reduce uncertainty in volatile external environments. For example, a retail giant, Wal-Mart and its supplier, Warner-Lambert shared the sales and demand forecast information through their collaborative planning, forecasting, and replenishment system and then successfully reduced both companies' inventory while preventing out-of-stocks (Seifert, 2003). Also, the increased competition would compel organizations to learn more about the changing demands and preferences of customers and thus increase the need for adopting innovative ICT such as ERP. As a matter of fact, Grover and Goslar (1993) and Kim and Lee (2008) found that companies in more fluid and competitive environments were more likely to adopt and implement ICT than those in stable environments. Therefore, we hypothesize that:

H2. The more frequently a firm operates in highly uncertain, competitive and rapidly changing environments, the more likely ERP implementation will take place.

3.2.3 Internal environment and ERP implementation. Without organizational readiness and proper change management, ERP implementation is doomed to fail (Motwani *et al.*, 2002). Considering the importance of organizational compatibility to successful ERP implementation, Zhang *et al.* (2002) listed five critical success factors for ERP implementation: top management support; people characteristics, including education, training and user involvement; suitability of software, hardware and data accuracy; ERP vendor commitment; and organizational culture. In particular, top management's willingness to commit the company's both financial and human resources to an ERP project could dictate the organizational readiness for the ERP implementation (Kwahk and Lee, 2008). Also, the firm's organizational culture that could foster and reward open communication and frequent interaction among the firm's employees turned out to be an important prerequisite for successful ERP implementation, since it would improve ERP-related problem-solving capability (Stewart *et al.*, 2000; Jones and Price, 2001). Indeed, more adaptive organizational culture with "fluid job descriptions, loose organizational structures, and few restrictive rules" tended to help the firm successfully implement innovative ICT such as ERP (Brown and Eisenhardt, 1997). Furthermore, user education and training enhances the user's familiarity with ERP and thus users will be more willing to embrace ERP (Loh and Koh, 2004). ERP vendor commitment enhances the ICT staff's ability to configure and maintain ERP and thus make transition from the legacy system to ERP system smoother. Therefore, we hypothesize that:

> *H3.* The more a firm is internally ready for a technological change, the more likely ERP implementation will take place.

3.2.4 ERP implementation and supplier capability. The ERP implementation which connects a firm to its suppliers will enhance information integration and coordination between the firm and its suppliers. Through information integration and coordination facilitated by ERP, a supplier can share operational, tactical, and strategic information with its downstream supply chain partners and subsequently can improve its sourcing capability and their performance (Shin *et al.*, 2000). To elaborate, Seidmann and Sundararajan (1997) observed that a supplier's willingness to share information with its buying firm could help it to leverage managerial knowledge and expertise across the supply chain. Indeed, information sharing allows the supplier to improve its demand forecasts, synchronize its production and logistics activities, coordinate inventory-related decisions, avoid bottlenecks, and mitigate the bullwhip effects (Lee and Whang, 2000). As such, information sharing between the supplier and its buying firm improves the supplier's visibility and the subsequent capability to meet its demand and delivery schedules (Brennan and Turnbull, 1999; Handfield and Bechtel, 2002).

In other words, when accurate and real-time demand information becomes available from ERP, the supplier can better react to changing demand patterns and thus more readily identify what customers really want and need. For example, the buying firm's ERP implementation which can transmit necessary demand information to its supplier may facilitate new product development (or product innovation), while streamlining product and logistics processes. The availability of such information enables the supplier to change its product volume and mix in a relatively short period of time and thus help the supplier consistently accommodate the buying firm's changing sourcing requirements. From the above, we can make a premise that the ERP implementation enables the supplier to speed up its response to rapidly changing business environments and consequently improve the supplier's capability including greater information access, process improvement, and product innovation. Therefore, we hypothesize that:

> *H4.* The higher the level of ERP implementation, the higher the level of a supplier capability.

3.2.5 ERP implementation and organizational capability. ERP enables a firm to coordinate more accurate and timely information across its functional boundaries, which reduces inventory and improves market responsiveness (Lee *et al.*, 1997). Inventory reduction and improved marker responsiveness enhances the organizational capability (Mentzer *et al.*, 2000; Shang and Seddon, 2002). More specifically, ERP enables the firm to flexibly assemble requisite assets, knowledge, and business relationships and consequently allows the firm to promptly detect environmental changes and then better respond to these changes through its backbone data warehouses (Sambamurthy *et al.*, 2003). This flexibility helps the firm improve customization processes according to changing customer needs and preferences. Furthermore, through improved connectivity facilitated by ERP implementation, ERP can strengthen a relationship between the focal company and its supply chain partners (e.g. suppliers) and thus increase the chance that the focal company will offer long-term contracts for its supply chain partners. Under long-term contracts, both the focal company and its supply chain partner can better utilize their distinctive resources by removing redundancy and encouraging long-term investment in product development and quality improvement through inter-firm collaboration and cooperation (Hamel, 1991). That is to say, ERP can enhance organizational capability to coordinate and process information, while improving agility and flexibility. Therefore, it is expected that:

H5. The higher the level of ERP implementation, the higher the level of an organizational capability.

3.2.6 Supplier capability and supplier performance. Through improved connectivity facilitated by ERP implementation, ERP could strengthen a relationship between the buying firm and its supplier and thus increase the chance that the buying firm will offer long-term contracts for its supplier. This strengthened relationship resultant from long-term contracts would increase the stability for the supplier. With a greater stability, the supplier can afford to make a long-term investment in research and development efforts and engage in continuous quality improvement processes. Also, through inter-firm cooperation and collaboration facilitated by ERP, the supplier could streamline its organizational processes and subsequently enhance its organizational performance (Bello and Gilliland, 1997). Rationale being that knowledge and information obtained from the buying firm through ERP links could improve the supplier's business acumen and stimulate the supplier's new product development and value-adding processes (Moorman and Miner, 1997; Thatte *et al.*, 2008). That is to say, the ERP implementation which facilitates greater information access, process improvement, and product innovation can enhance supplier performance and the subsequent competitiveness in the marketplace. Therefore, we hypothesize that:

H6. The higher the level of a supplier capability, the higher the level of supplier performance.

3.2.7 Organizational capability and organizational performance. Organizational capability is characterized as the most intangible of the company's resources (Tomer, 1987). Since organizational capability reflects the company's ability to improve productivity, organizational capability can be viewed as a source of competitive advantage and adaptive strengths (Barney, 1991). Especially, organizational capability may foster certain behavior influencing mechanisms (knowledge sharing) that allow and inspire organizational members to perform better with a minimum expenditure of energy, time, or resources (Eikelenboom, 2005). That is to say, organizational capability is viewed as a key driver of organizational performance which reflects the extent of the achievement an organization made with respect to its pre-targeted goals. These goals can be improved productivity, customer service, employee morale, shareholder returns, competitiveness, and financial gains such as ROI. According to March and Sutton (1997), organizational performance can be measured at either disaggregate or aggregate level. Since ERP is intended to improve broader, enterprise-wide efficiency and effectiveness, we feel that a holistic, aggregate measure makes more sense to the assessment of ERP impacts than focussing on a disaggregate measure such as ROI which does not account for all other potential performance drivers (especially non-financial drivers including supply chain partnership between the focal company and its suppliers). From the above discussion, organizational capability which plays a key performance driver role can enhance organizational performance. Therefore, we hypothesize that:

H7. The higher the level of an organizational capability, the higher the level of organizational performance.

3.2.8 Supplier performance and organizational performance. Supplier performance is known to influence a buying firm's performance in terms of inventory level, production planning and control, cash flows, and product quality (Choi and Hartley, 1996). For instance, Shin *et al.* (2000) discovered that poor incoming quality of the product from suppliers and delivery performance caused higher levels of inventory and order backlogs. On the other hand, improved quality and shorter lead times at the source of supply led to lower cost of quality and production costs for a buying firm (Carter, 2005). Likewise, Fynes and Voss (2002) found that improvements in internal scrap rates and defect rates resulting from improved supplier performance led to increased profits for a buying firm. Also, Thatte *et al.* (2008) discovered that improved supplier responsiveness enhanced a buying firm's time-to-market performance. Therefore, we hypothesize that:

H8. The higher the level of supplier performance, the higher the level of organizational performance.

3.2.9 Organizational performance and customer value. High-value customers increase the value of an organization (Slywotzky, 1996). To attract and retain these high-value customers, the organizational has to improve customer value that these customers would appreciate. Generally, customer value is defined as the customer's overall assessment of the utility of a product based on what is received and what is given (Zeithaml, 1988). Such utility may include: lower price, convenience, timely response, and reputation for quality. Improved organizational performance such as cost reduction and faster market responsiveness resulting from ERP implementation allows the firm offer lower price and speed up the customization process and thus can enhance customer value. Therefore, we hypothesize that:

H9. The higher the level of supplier performance, the higher the level of customer value.

4. Research methodology

To test the hypotheses, we carried out the current study in three phases: a pre-pilot; a pilot; and a large-scale questionnaire survey. In the pre-pilot phase, we generated potential survey items through theory development and a literature review. In the pilot phase, we develop a structural equation model (SEM) along with the identification of valid constructs based on structural interviews and the Q-sort method. At the last stage, we conducted a large-scale survey via mail questionnaires primarily targeting the Korean industry comprised of manufacturers and their suppliers. Using the data obtained from this survey, we employed the partial least square (PLS) approach to test the validity of the proposed SEM. Specific details of the current research methodology are described below.

4.1 Item generation

The object of item generation is to create a pool of items that would cover the sampling domain of each construct (Churchill, 1979). The generated items should ensure content validity to have valid and reliable empirical research (Nunnally, 1994). Content validity is usually achieved through intensive and comprehensive literature review and feedback from practitioners and academicians. Item generation was first carried out by searching the literature for previously developed items that can measure the sub-constructs in the research model. When there were no such items found, measurement items were developed based on the definition of sub-constructs.

4.2 Structured interviews

After creating the item pools, items for each sub-construct were reexamined through structured interviews with two academicians and four practitioners from different manufacturing firms utilizing ERP. The main purpose was to check the relevance of each sub-construct's definition, clarity of words, and structure of the model. Since the measurement items for all constructs were developed or modified from the previous literature, measurement items for the sub-constructs of all five variables were reevaluated. Based on the comments and feedback from the academicians and practitioners, redundant or ambiguous items were either modified or eliminated.

4.3 The Q-sort method

For the pilot study, the Q-sort methodology was used. The purpose of the Q-sort method is to assess the convergent and discriminant validity of each construct by observing how the items were sorted into various sub-construct categories. Items placed in a common pool were subjected to two or three Q-sorting rounds by two independent judges per round. In the Q-sort, practitioners from the manufacturing industry acted as judges and sorted the items into separate sub-constructs, based on the definition of each sub-construct. The convergence and divergence of items within the categories indicates construct validity. For example, if the judges consistently placed an item within a particular category, it was determined to show convergent validity with related constructs. It also showed discriminant validity with the others. Through analysis of inter-judge disagreements about item placement, bad items for each sub-construct were identified. Based on the results, inappropriate or ambiguous items were modified or deleted.

4.4 Questionnaire survey and sample characteristics

A total of 140 questionnaire items were distributed to academic reviewers, who reviewed each item and indicated to keep, delete, or modify them. The focus of this analysis was to assess whether the items were thought to accurately measure the proposed sub-constructs according to the definitions provided, and if any additional domains needed to be covered. After deleting and purifying a number of items based on the feedback from the reviewers, 120 items were used as the large-scale questionnaire survey. Via e-mail, a survey questionnaire containing these items was sent to 593 randomly selected Korean manufacturing firms listed on the KOSPI and KOSDAQ Stock Market (www.daum.net). The typical respondent to the questionnaire held the title of Manager/Director of Operations or Information Technology. More than 88 percent of the survey respondents actively used ERP in their firms at the time of survey. To increase variability in the data and generalizability of the survey results, the instrument was targeted for eight different sectors of the Korean manufacturing firms. These industries included: SIC code 20 "Food and kindred products"; 26 "Paper and allied products"; 28 "Chemicals and allied products"; 32 "Stone, clay, glass, and concrete products"; 34 "Fabricated metal products"; 35 "Industrial machinery and equipment"; 36 "Electronic and other electric equipment": and 37 "Transportation equipment."

Of the 593 questionnaires, 205 valid responses were received. These responses produced a total response rate 34.6 percent which had surpassed the targeted overall response rate of over 20 percent for a valid assessment. For example, Malhotra and Grover (1998) observed that a response rate over 20 percent was needed for a positive assessment of questionnaire survey results. In total, 8 percent of the responding firms had less than 100 employees and 25 percent (25 percent) of the responding firms have 100-249 employees. The firms employed between 250 and 499 individuals accounted for 26 percent of the respondents, while the firms with between 500 and 999 employees accounted for 20 percent of the respondents. Approximately 10 percent of the responding firms had between 1,000 and 2,499 employees, while 11 percent of the responding firms had more than 2,500 employees. More than half (51 percent) of the respondents said the level of complexity of their products was above average ("high" – 38 percent or "very high" – 15 percent). More than one-third (38 percent) of the respondents represented manufacturing firms with moderate product complexity. Product complexity was reflected by the number of product variants a firm produces. Since the degree of product complexity was tied to the complexity of working environments, the firms with a high level of product complexity were likely to utilize ERP.

4.5 Non-response bias test

Considering the potential non-response error associated with a questionnaire survey, we conducted a χ^2 test of homogeneity for non-response bias by comparing the SIC group distribution for the sample population and total responses (Armstrong and Overton, 1977). As summarized in Table IX, there were no statistically significant differences in group means for the eight different industry samples at $\alpha = 0.05$ on any of the item responses described earlier. Therefore, non-response bias did not appear to be a concern.

5. Analysis and results

The preliminary statistical validity of the five hypotheses presented earlier was checked, using the Pearson correlation. For each construct, a composite score was computed by taking the average scores of all items. The results are presented in Table X. All correlations but one between external environment and ERP

SIC	Total sample distribution	Response	Expected frequency	χ^2
20	0.061	17	12	1.67
26	0.040	13	8	2.67
28	0.216	41	44	0.24
32	0.052	14	11	1.01
34	0.185	36	38	0.11
35	0.196	28	40	3.65
36	0.103	29	21	2.97
37	0.147	27	30	0.31
Total	1.000	205	205.00	12.62

Note: Sample population and response group are homogeneous in SIC code distribution at degree of freedom (df) = 7, $\alpha = 0.05$ (χ^2 critical value = 14.067)

Table IX.
A χ^2 test of non-response biases

Hypotheses	Independent variable	Dependent variable	Pearson correlation
H1	External environment (EE)	Internal environment (IE)	0.179*
H2	External environment (EE)	ERP implementation (ERPI)	0.018
H3	Internal environment (IE)	ERP implementation (ERPI)	0.572**
H4	ERP implementation (ERPI)	Supplier capabilities (SCAP)	0.642**
H5	ERP implementation (ERPI)	Organizational capabilities (OCAP)	0.615**
H6	Supplier capabilities (SCAP)	Supplier performance (SPERF)	0.699**
H7	Organizational capabilities (OCAP)	Organizational performance (OPERF)	0.764**
H8	Supplier performance (SPERF)	Organizational performance (OPERF)	0.823**
H9	Organizational performance (OPERF)	Customer value (CVALUE)	0.733**

Notes: *,**Significant at $\alpha = 0.05$ and $\alpha = 0.01$ (two-tail test), respectively

Table X.
Construct-level correlation analysis results

implementation (with a correlation coefficient of 0.018) are statistically significant at the 0.05 level. The correlation coefficients are 0.179 (external environment and internal environment), 0.572 (internal environment and ERP implementation), 0.642 (ERP implementation and supplier capability), 0.615 (ERP implementation and organizational capability), 0.699 (supplier capability and supplier performance), 0.764 (organizational capability and organizational performance), 0.823 (supplier performance and organizational performance), and 0.733 (organizational performance and customer value). It appears that there are high correlations among all the constructs except the relationship between external environment and ERP implementation.

To further examine causal relationships among the constructs, we tested the nine proposed hypotheses with valid and reliable scales that measured some critical dimensions of the constructs.

5.1 The causal model

A SEM was used to test and estimate the causal relationships among various constructs (Bollen and Long, 1993). In general, the SEM is composed of two elements:

the measurement model and the structural model. The measurement model in SEM is used to measure and assess the reliability and validity of latent variables, whereas the structural model is applied to investigate the complex interrelations among latent variables (Jöreskog and Sörbom, 1989). Since the reliability and validity of each construct were checked earlier through rigorous analysis, the SEM analysis focused on the structural model. To explore relationships among EE, IE, ERPI, SCAP, and SPERF, the SMART PLS software was used. Since it would be better to use several indicators of a construct than a single indicator, we used composite measures as multiple indicators for each construct (Hair *et al.*, 1995). Composite measures were calculated by dividing the sum of individual scores of items in each sub-construct by the number of items. These composite measures were used as observable indicators of the exogenous latent construct (EE) and endogenous latent constructs (IE, ERPI, SCAP, and SPERF).

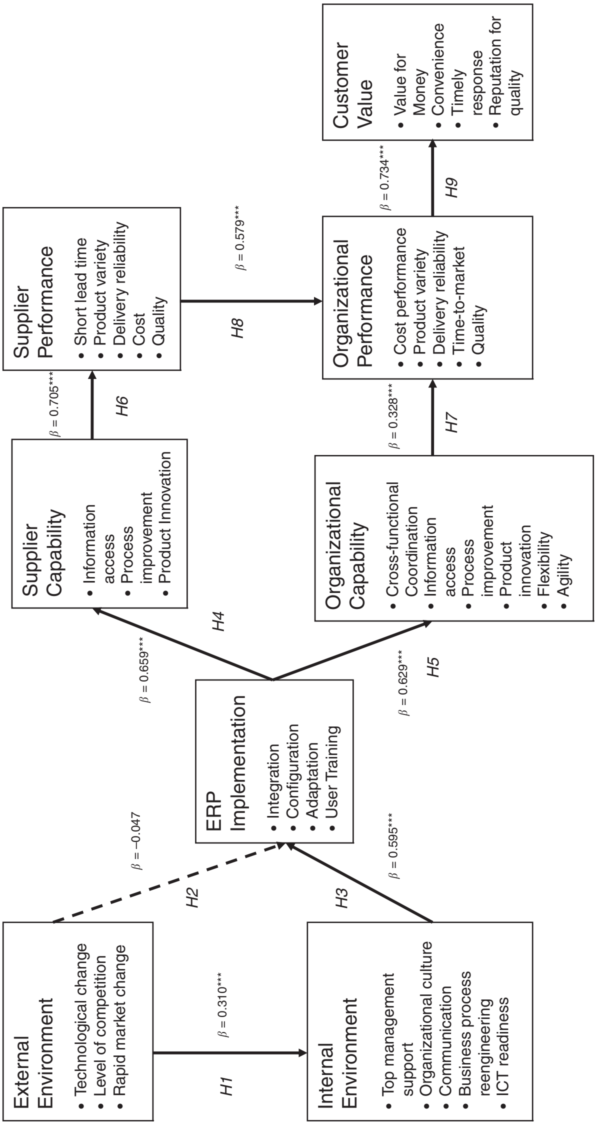
5.2 Results of the causal model testing

PLS regression provides a vigorous method for testing causal models with both observable and latent variables. It is capable of simultaneously evaluating both the measurement and causal components of complex models (Chin *et al.*, 2003). In PLS analysis, *t*-value, β coefficient, and R^2 of the causal relationships between exogenous and endogenous constructs were used as the SEM evaluation indicators to test the five hypotheses stated earlier. A *t*-value indicates a significant level of the relationship in the proposed hypothesis (Rosnow, 2000; Chin *et al.*, 2003). To generate *t*-statistics, a bootstrapping procedure was used. A *t*-value <1.6 indicates that the relationship between variables is not significant at $\alpha = 0.05$. At this level of *t*-value, the hypothesis cannot be supported. For a *t*-value between 1.6 and 2.00, a hypothesized relationship between variables is considered significant at $\alpha = 0.05$. For a *t*–value more than 2.00, the hypothesized relationship is significant at $\alpha = 0.05$ (Chin *et al.*, 2003). β coefficient indicates the strength of a relationship and assesses the interaction of the path coefficient between two constructs (Chin, 1998). The cut-off value for the standardized β coefficient is 0.20. The coefficient that is higher than this cut-off value indicates a meaningful relationship between the constructs (Chin, 1998). Finally, R^2 examines the impact of independent variables on dependent variables (Chin, 1998). To calculate both the standardized coefficient (β coefficient) and R^2, we used the PLS algorithm procedure using a path weighting scheme technique.

Based on the PLS analysis, we eliminated the "supplier uncertainty" sub-construct from the external environment, since it has a negative standardized coefficient and its *t*-value is below the minimum acceptable value of 1.6 (at $\alpha = 0.05$ for two-tailed *t*-test). After removing that sub-construct, we conducted a series of hypotheses tests. The test results are discussed in the next section.

5.3 Results of hypotheses testing

As displayed in Figure 2, we support the hypothesis (*H1*) that a firm which operates in highly uncertain, competitive and rapidly changing external environments will have a high level of adjustment and improvement in internal environments as evidenced by a strong relationship between the external environment construct and the internal environment construct at $\alpha = 0.01$ (with β coefficient $\beta = 0.310$, $t = 3.51$). This result is consistent with the findings of Gordon (1991) and Nahm *et al.* (2003) that an organization's internal environment was often affected by its external environment. On the other hand, as summarized in Table XI, we found a relationship between the


External Environment
• Technological change
• Level of competition
• Rapid market change
Internal Environment
• Top management support
• Organizational culture
• Communication
• Business process reengineering
• ICT readiness
H1
β = 0.310***
H2
β = −0.047
H3
β = 0.595***
ERP Implementation
• Integration
• Configuration
• Adaptation
• User Training
H4
β = 0.659***
H5
β = 0.629***
Supplier Capability
• Information access
• Process improvement
• Product Innovation
Organizational Capability
• Cross-functional Coordination
• Information access
• Process improvement
• Product innovation
• Flexibility
• Agility
H6
β = 0.705***
H7
β = 0.328***
Supplier Performance
• Short lead time
• Product variety
• Delivery reliability
• Cost
• Quality
Organizational Performance
• Cost performance
• Product variety
• Delivery reliability
• Time-to-market
• Quality
H8
β = 0.579***
H9
β = 0.734***
Customer Value
• Value for Money
• Convenience
• Timely response
• Reputation for quality

Note: *** is equal to 0.01

Figure 2.
The results of PLS analysis

Table XI.
A summary of test results from the PLS analysis

Relationship	Standardized coefficient	t-value	Significant?	Hypotheses testing
EE→IE	0.310	5.059**	Yes ($\alpha < 0.01$)	*H1*: supported
EE→ERPI	−0.047	0.724	No	*H2*: not supported
IE→ERPI	0.595	11.225**	Yes ($\alpha < 0.01$)	*H3*: supported
ERPI→SCAP	0.659	12.978**	Yes ($\alpha < 0.01$)	*H4*: supported
ERPI→OCAP	0.629	14.271**	Yes ($\alpha < 0.01$)	*H5*: supported
SCAP→SPERF	0.705	18.352**	Yes ($\alpha < 0.01$)	*H6*: supported
OCARP→OPERF	0.328	3.406**	Yes ($\alpha < 0.01$)	*H7*: supported
SPERF→OPERF	0.579	6.212**	Yes ($\alpha < 0.01$)	*H8*: supported
OPERF→CVALUE	0.734	18.584**	Yes ($\alpha < 0.01$)	*H9*: supported

Note: **Significant at $\alpha < 0.01$ (one-tailed t-test)

external environment and the ERP implementation to be statistically insignificant at $\alpha = 0.05$ (with β coefficient $\beta = -0.047$, $t = 0.724$). Thus, we reject the hypothesis (*H2*) that a firm that operates in highly uncertain, competitive and rapidly changing environments is more likely to adopt and implement ERP. This result contradicts that of Grover and Goslar (1993) indicating that environmental uncertainty has a significant impact on the adoption of ICT. Our unexpected result can be explained by the following.

First, a firm may have implemented ERP, not because of the external pressure but because of its internal motive to improve organizational performance in more competitive business environments. Indeed, Premkumar and Ramamurthy (1995) observed that a firm could be motivated to adopt ICT due to its internal needs. Second, ERP may be no longer unique in today's business environments and thus has become a common practice for the firm seeking performance improvement regardless of its external environmental surroundings. To further examine a relationship between the external environment and the ERP implementation, we estimated the coefficients of both total and indirect effects. The coefficient of a total effect between the EE and the ERPI constructs was calculated by adding the coefficient of both direct and indirect paths between them. The coefficient of the direct path between them was −0.047. The coefficient of an indirect effect was calculated by multiplying the coefficient of a direct effect (0.310) between the EE and the IE construct by that of a direct effect between the IE and the ERPI construct (0.595), resulting in 0.185. Thus, the coefficient of a total effect was 0.138 and turned out to be statistically significant $\alpha = 0.01$ (with $t = 2.14$). This result indicates that although the external environment has no direct bearing on the ERP implementation, there was a positive and significant indirect relationship between the external environment and the ERP implementation. In other words, a relationship between the external environment and the ERP implementation was mediated through an internal environment (e.g. top management support, organizational culture, communication, business process reengineering, and ICT readiness).

Our PLS analysis also indicated that the firm's internal environments significantly influence its ERP implementation as evidenced by a significant positive relationship between the IE and the ERPI construct at $\alpha = 0.01$ (with $\beta = 0.595$, $t = 11.225$). This finding is consistent with the findings of several prior studies conducted by Motwani *et al.* (2002), Zhang *et al.* (2002), and Kwahk and Lee (2008) indicating that the firm's internal environment led to successful ERP implementation. For instance, organizational readiness and proper change management could lead to the successful implementation of ERP by mitigating the organizational resistance to ERP implementation. As a matter of fact, in our experiments, all the internal environment sub-constructs but organizational structure were proven to be critical for successful ERP implementation.

Although the impact of ERP on the individual firm was well documented by many prior ERP studies, its impact on the focal company's upstream supply chain partners such as a supplier has not been reported in the published literature. To assess the potential impact of ERP on supplier capability, we checked to see if there exited any positive relationship between the ERP implementation and the supplier capability. Out test revealed that ERP implementation significantly affected supplier capability in a positive manner at $\alpha = 0.01$ (with $\beta = 0.659$, $t = 12.978$). This finding implied that a buying firm's successful ERP implementation could enhance its supplier's capability and thus could make the entire supply chain more resilient by solidifying business ties between the buying firm and its supplier. The rationale being that the ERP success facilitates information sharing between the buying firm and its supplier and subsequently enables the supplier to improve its demand forecasts, synchronize production and logistics activities, coordinate inventory planning, and then reduce supply disruptions and bottlenecks (Lee and Whang, 2000). Similarly, ERP implementation significantly influenced organizational capability in a positive manner at $\alpha = 0.01$ (with $\beta = 0.659$, $t = 14.271$).

Furthermore, we wanted to check whether improved supplier capability can be translated into the supplier's improved performance. Thus, we tested a relationship between supplier capability and the supplier performance. Our test results revealed that supplier capability had a significantly positive relationship with the supplier performance at $\alpha = 0.01$ (with $\beta = 0.705$, $t = 18.352$). This finding is consistent with the RBV of firm theory of Barney (1991) and Wernerfelt (1984), indicating that a firm's unique resources and capabilities tend to enhance its organizational performance. The rationale being that the supplier's improved capability resulting from faster information access, process improvement, and product innovation capabilities can contribute to the supplier's order fulfillment performances and the subsequent competitiveness in the marketplace. Similarly, we found a positive relationship between organizational capability and organizational performance at $\alpha = 0.01$ (with $\beta = 0.328$, $t = 3.406$).

Finally, we discovered a strong direct ties between supplier performance and organizational performance at $\alpha = 0.01$ (with $\beta = 0.579$, $t = 6.212$). This finding is congruent with the findings of Shin *et al.* (2000), Li *et al.* (2006), and Thatte *et al.* (2008), indicating that improved supplier performance is directly tied to its buying firm's operational success. Also, we found a positive relationship between operational performance and customer value at $\alpha = 0.01$ (with $\beta = 0.734$, $t = 18{,}584$). This implies that the buying firm's operational success could be translated into improved customer value.

6. Key findings and managerial implications

This section summarizes key findings of our ERP study and their practical implications for firms which must cope with the challenges of more volatile supply chain operations in an era of technological innovations.

First, the firm's ERP adoption and implementation decision is mainly affected by its internal environment. Defying the conventional wisdom, the firm's external environment has little influence on its decision to adopt and implement ERP. However, through the mediating role of an internal environment, an external environment still indirectly influences the ERP adoption and ERP implementation decision. This finding implies that the successful ERP implementation hinges on the firm's organizational compatibility with ERP. In other words, without garnering top management support, fostering the adaptive organizational culture, developing the open communication channel, stressing business process reengineering, and establishing the necessary infrastructure for new ICT adoption, the firm will encounter severe difficulty in reaping the full benefits of ERP. As such, before making a sizable investment in the ERP project, the firm should first investigate whether or not ERP is a good strategic fit for its organization in terms of resource commitments, user familiarity, technical expertise, and potential application areas.

Second, we found that ERP could enhance the ERP adopter's organizational capability as well as the ERP adopter's supplier capability. Herein, the supplier capability includes the supplier's information accessibility, process improvement ability, and product innovation involvement. Since this improved supplier capability could make the buying firm's supply base more reliable and stable, it would eventually help the buying firm reduce the risk of supply disruptions. Also, we learned that the improved supplier capability would lead to the improved supplier performance. We found another parallel that the improved organizational capability would lead to the improved organizational performance. That is to say, the ERP implementation could create "win-win" situations for both the buying firm and its supplier(s) and thus make the supply chain more resilient.

Judging from the above findings, to better exploit ERP for supply chain operations, the potential ERP adopter or the ERP user should start with the feasibility study, the establishment of a collaborative partnership with its supplier(s), user training/education, and development of ERP performance metrics. The rationale being that a feasibility study allows the potential adopter to check the suitability of ERP to its specific organization settings (e.g. organizational characteristics, culture, and ICT infrastructure) and supply chain needs (e.g. order fulfillment, sourcing efficiency). The establishment of a collaborative partnership with the supplier increases the chances of information sharing and the supplier's early involvement in new product development which would create "win-win" situations for both the buying firm and its supplier(s) through the ERP links. User training/education is essential because it would enhance the user's familiarity with ERP and thus mitigate any fear of uncertainty/risk associated with ERP implementation. Since it may take years for the firm to successfully implement ERP, the progress of ERP during transition from the legacy system should be monitored with specific performance metrics such as order cycle time, product assortment, delivery reliability, purchasing cost savings and quality at the source. Finally, we learned that the successful implementation of ERP would eventually lead to the improved customer value by enhancing the bottom-line performances of both the focal company and its supplier. These bottom-line performances include ROI that serves as the base from which all informed future ICT investment and funding decisions are made and other key performance indicators such as an order fulfillment rate which measures how well a promise made to customers is kept through supply chain operations.

As discussed above, this paper attempted to extend the scope of ERP influences and identify a multitude of critical success factors affecting ERP implementation based on the empirical study. This study, however, is not perfect. Its limitations that need to be addressed in the future studies include the use of a single respondent for each organization. This respondent was asked to respond to an array of complex managerial issues such as ERP implementation, supplier capabilities and performance, organizational capabilities and performance, and customer value. In particular, supply chain performance that takes into account the managerial outcomes of multiple stakeholders (e.g. suppliers, focal company, and customers) is hard for one individual to measure. Also, individual perception and opinion may not represent those of the entire organization. Thus, targeted respondents should have been more than one individual with different roles (e.g. ERP user vs policy maker) in a company. Second, some of the responding firms in our survey had less than five years of ERP system use and thus might have experienced the full impact of ERP. For instance, those firms at an earlier stage of ERP use might be still in the process of adding more modules or upgrading the ERP systems consistently. As such, it was difficult for us to measure the extent of impact of ERP implementation with cross-sectional data, since ERP has been evolving over time. Third, our survey data are based on the Korean sample which may reflect typical practices in Korea. Thus, conclusions drawn from this particular sample may not be generalized to other countries' business settings. Since the critical successful factors may vary from one country to another due to cultural differences, a future study should look into cross-cultural data bases.

To conclude, this study is one of a few attempts to investigate the role of ERP in the supply chain and identify important determinants influencing the ERP adoption and implementation decisions. Some premises regarding ERP benefits were made and then tested to see if those were true using the PLS analyses. Especially, in contrast with the previous literature which often gauged the benefits of ERP from an ERP adopter's standpoint only, this paper is one of the first to assess the benefits of ERP from both the ERP adopter and its supply chain partner's holistic standpoints. Also, notice that this paper assessed the impact of ERP on the end-customer's value which was often overlooked by most of the existing literature on ICT adoption.

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