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Do Enterprise Systems Necessarily Lead to Innovation? Identifying the Missing Links with A Moderated Mediation Model

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Abstract

Background: *Despite widely implemented, enterprise systems remain an unsettled role in organizational innovation. This study purposes to address the effects of enterprise systems (ES) on firm innovation by adopting resource-based theory and capability building theory to focus on ES-enabled competence, rather than ES investment or implementation. ES-enabled competence is proposed to mediate the effect of ES integration on innovation performance. We further propose that continuous improvement moderates (1) the relationship between ES integration and ES-enabled competence, and (2) the relationship between ES-enabled competence and innovation performance. By examining these effects, we aim to discover how ES enables innovation at operational and strategic levels separately.*

Method: *A survey method is conducted to explore the relationship between enterprise systems (ES) and innovation. Data are collected from manufacturing companies in 10 countries of three regions, i.e., Europe, Asia-Pacific, and the USA, and analyzed by using structural equation modeling technique.*

Results: *We confirm the roles of enterprise systems as a resource and a capability and the effects of these roles on innovation—including the operational outcome, new product development performance, and the strategic one, innovation uniqueness. We demonstrate that continuous improvement moderates the mediation paths, namely "ES integration – ES-enabled competence – innovation performance". The moderated mediation effect exists among continuous improvement, ES integration, ES-enabled competence, and innovation uniqueness.*

Conclusion: *This study contributes to the ES and innovation research by uncovering the micro-foundation underlying ES-enabled innovation from a capability-based framework and elaborating the moderating role of continuous improvement in enhancing innovation.*

Keywords: Enterprise System (ES), ES-enabled Competence, Innovation, New Product Development (NPD) Performance, Continuous Improvement.

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Introduction

With increasing global competition, innovation has become a crucial source of competitive advantage and a key driver of an enterprise's success (e.g., Gunday et al., 2011; Kleis et al., 2012). Companies are trying to create new product and service offerings to achieve organic growth in the long run (Yalcinkaya et al., 2007). Among the endeavor, information technology (IT) not only boosts a firm's abilities to survive in a turbulent competitive environment (Wu et al., 2015) but also becomes one of the most effective means to facilitate innovation with its strong transformational capacity in comprehensive business areas (Barczak et al., 2007; Marion et al., 2015; Nambisan, 2013). For example, enterprise systems (ES), the large-scale integrated packaged systems with embedded industry best practices (Wagner et al., 2010), have been extensively implemented to support business practices and strategies (Powell, 2013). Now, it has become one of the most important and widely implemented technologies in companies and is recognized to have a positive influence on firm financial (Anderson et al., 2011), stock market (Morris, 2011b), and nonfinancial performance (Shang & Seddon, 2002).

However, the increasing penetration of IT in the business world raises a problem – the vanishing competitive advantage brought by IT: "when every company is equipped with nearly similar IT capability, superior IT capability no longer offers a clearly discernible competitive advantage." (Chae et al., 2014, p321). Therefore, this study aims to find out how to break through such similar IT capability to achieve the competitive advantage with ES-enabled innovation, including the innovative practice and the uniqueness of the innovation. This study adopts the resource-based theory and capability building theory (also known as dynamic capability theory) to build the research model.

According to the resource-based theory, there are two distinctive strategic mechanisms: resource picking (identifying or creating resources) and capability-building (building unique capabilities from resources) (Makadok, 2001). The capability building theory focuses on the latter and indicates the importance of integrating, building, and reconfiguring resources after picking them to create capabilities (Teece, 2010). The resource-based theory is more appropriate to explain value creation in stable environments while the capability building theory is more suitable for dynamic environments (Wang et al., 2012). We include both of them in this study as our theoretical lens. The recourse-based theory helps to identify two important antecedents for innovation, the IT resource to be picked, namely ES integration, and the capability to be built, namely ES-enabled competence. ES integration refers to the extent to which different functional modules of an ES are integrated through using a common database, transaction processing, or a decision support system (Stratman & Roth, 2002). ES-enabled competence is defined as the core competence generated directly and inspired through integrating and reconfiguring ES in a competitive environment. In addition, based on capability building theory, ES-enabled competence is identified as the mediator from ES integration towards the innovation performance.

In addition, previous research has suggested the incorporation of moderating effects of organizational learning and improvement in resource-based-view papers (Benitez-Amado, 2012). In response to these suggestions, we introduce continuous improvement as the moderator in the model, to enrich the resource-based theory and provide a better understanding of ES-enabled innovation. Continuous improvement is defined as a firm's capability to consistently, continually, systematically and dynamically reconfigure old ways of performing tasks and learn/apply new ones (Huang et al., 2011). This study attempts to explore whether continuous improvement moderates the capability building process, especially along the mediation path from ES-integration to innovation performance through ES-enabled competence.

We further examine the influence of ES on innovation from different perspectives to get a clearer picture. Innovation is a multi-faceted concept with different types (Prajogo, 2016).

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A firm's innovation performance can be operational-focused or strategic-oriented (Birchall et al., 2011). Innovation can be both operational and strategic drivers for practitioners to create competitive advantage in turbulent business environment (McAdam & Keogh, 2004). Therefore, it is necessary to investigate how ES affects innovation operationally (the innovative practice) and strategically (the uniqueness of the innovation). This study examines two types of innovation to highlight the competitive advantage, namely new product development (NPD) performance and innovation uniqueness. NPD performance refers to a firm's performance on developing new products compared with its rivals and the innovation uniqueness is defined as the extent that the innovation is distinctive from its competitors. Given these opportunities, our study addresses three research questions as follows:

- What is the role of ES-enabled competence in the process of increasing innovation from ES?
- How does continuous improvement impact the above-mentioned process?
- How does ES enable innovation at operational and strategic levels separately?

To answer these questions, we propose a research model to examine the relationships between ES integration, ES-enabled competence, continuous improvement, and operational and strategic innovation performance. The empirical data from a multi-region firm-level dataset confirm most of the hypotheses. We find that ES integration positively influences innovation performance on both operational and strategic levels—namely, NPD performance and innovation uniqueness—and ES-enabled competence mediates these relationships. Our research also empirically supports that continuous improvement plays a critical role in ES-innovation relationship. In particular, continuous improvement moderates (1) the relationship between ES integration and ES-enabled competence, and (2) the relationship between ES-enabled competence and innovation uniqueness.

The major contribution of this study lies in the identification of the mechanism between ES integration and innovation performance, namely, the moderated mediation model with ES-enabled competence and continuous improvement. First, this study highlights the critical role of ES-enabled competence as the mediator from ES integration and two levels of innovation performance. Second, the continuous improvement is important to strengthen the mediation paths. The moderated mediation effect identified among the antecedents and innovation uniqueness provides both theoretical and practical implications, especially for how to leverage continuous improvement to strengthen innovation performance at post-implementation stage.

Literature Review

ES and Innovation

ES has been originally implemented in organizations to fulfill business activities and facilitate transactions of various functional areas (Swanson, 2020). ES changes fragmented approaches to work by breaking down functional silos, providing universal and standardized working environment for all business functions, and reducing conflicts within multifunctional product development teams (Hunton et al., 2003). Many studies have explored strategic value of ES, such as enhancing business innovation (Sedera et al., 2016). Although ES has brought much value in organizations, its effect on innovation is surprisingly found contradictory in the literature.

Some early studies are pessimistic about ES-enabled innovation, because ES may lead to process standardization (Cotteleer & Bendoly, 2006) that causes rigidity in resource allocation (Shang & Seddon, 2002), thus inhibiting firm innovation. In addition, routines and procedures promoted by a typical ES, enterprise resource planning (ERP), can reduce staff autonomy and inhibit their motivation to exercise creativity (Trott & Hoecht, 2004). However, little research effort has been made to understand capability building effects of ES, especially in post-implementation stage.

Extant research calls for academic attention on the intellectual technology nature of IT and its implications for innovation (Ashurst et al., 2012). The intellectual technology nature of ES has two connotations. First, ES contains knowledge and expertise with respect to routines and activities (Lee & Myers, 2009). The packaged or customized ES embodies knowledge (such as rules, procedures, routines, instructions, and standards) and expertise (Wagner et al., 2010), with which absorptive capacity of business processes and innovation could be enhanced. For example, Kleis et al. (2012) examined the relationship between IT, knowledge creation, and innovation output and found that IT infrastructure and enterprise applications (e.g., ERP modules) contribute to the innovation process.

Second, ES has the ability to process information, knowledge, and other intellectual assets (Tian & Xu, 2015). ES can greatly augment and enable firms' knowledge management capabilities (Joshi et al., 2010). This means ES has the potential to interact with, extend, and transform the intellects of implementers and users. More importantly, the continuous interaction between ES and individual intellect eventually shapes organizational intelligence. Thus, these intellect-transforming effects of ES form a micro-foundation of capability building mechanism of ES.

Resource-based Theory and Capability Building Theory

The resource-based theory attributes superior firm performance to rare, valuable, inimitable, and non-substitutable resources (Barney, 2001). According to resource-based theory, firms deploy resources to generate competitive advantages through two different mechanisms, i.e., resource picking and capability building (Makadok, 2001). Resource picking focuses on identifying or creating resources and stresses firm heterogeneity in selecting resources with differential productivity. In contrast, capability building emphasizes building unique capabilities from resources and reflects firms' ability to integrate, build, and reconfigure resources (Teece, 2010). A pile of tangible and intangible resources cannot be naturally transformed into innovative products or services without necessary capabilities to maneuver or manipulate those resources. Therefore, capability building plays an important role in creating business value, especially in a turbulent environment while the resource-based theory is widely applied to explain the value creation in stable environments (Wang et al., 2012).

IT has been found to have an essential role in both capability picking and building processes. As a valuable resource of firms, IT can leverage other complementary resources to build organizational capabilities which in turn enhance performance (Liang et al., 2010). Sambamurthy et al. (2003) conceptualize digital options as a set of IT-enabled capabilities that facilitate digitized business processes and knowledge systems. El Sawy and Pavlou (2008) identify three types of IT-enabled capabilities (i.e., operational capabilities, dynamic capabilities, and improvisational capabilities), and empirically verify the effects of these capabilities on organizational strategic advantages in turbulent environment. Dong et al. (2009) empirically demonstrate that IT-enabled supply chain integration capability contributes to supply chain process performance. In addition, the capability building facilitated by IT is found to benefit innovation. Joshi et al. (2010) argue that IT-enabled knowledge capabilities contribute to firm innovation. Saldanha et al. (2017) find IT-enabled relational and analytical information processing capabilities play a role in facilitating innovation.

Given the potential of IT in facilitating innovation-related organizational capabilities, the capability building theory is also highly applicable to ES-enabled innovation. Prior research offers fragmented support for our proposition of the capability building effects of ES on innovation. For example, ES updates product design and specification data and circulate them

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through the value chain in a timely way (Masini & Wassenhove, 2009), which shortens new-product launch time (Stratman, 2007). The strategic benefits of ES (e.g., the routine development of business innovations and absorption of radical change) are significant predictors of efficient supply chain management, which is closely related to NPD and shortens the time to market (Su & Yang, 2010). Based on capability building, it is necessary to investigate the ES-enabled competence in developing firm innovation.

Continuous Improvement

Continuous improvement refers to a firm's capability to consistently, continually, systematically and dynamically reconfigure old ways of performing tasks and learn/apply new ones (Huang et al., 2011). It is an important construct for lean production (Henrique et al., 2021) and, in recent years, researchers found that it can be affected by transformation leadership, trust (Khattak et al., 2020), and employee involvement (Assen, 2021).

Continuous improvement is involving everyone cooperating to make a progress (Bhuiyan & Baghel, 2005) and focuses on sustained and innovative improvements in processes, products, and services (Blazey, 2006). Because it reflects the desire to enhance performance in an organic and sustainable way (Matthews et al., 2017), it can benefit the companies directly. For example, the continuous use and improvement of information systems is indispensable for generating business value (Chau et al., 2007). To successfully adopt ES, it is critical to have a company-wide continuous improvement effort that covers both initial and post-implementation phases (McGinnis, 2007). Continuous improvement can help to resolve behavioral problems after ES was implemented (Ip et al., 2002).

Furthermore, continuous improvement can enable sustainable development of new capabilities. Namely, it is important for capability building (Huang et al., 2011). Continuous improvement stresses continually enhancing a firm's ability to efficiently and effectively exploit existing capabilities and resources. It is a form of dynamic capability enabling the development of new skills and knowledge in pursuit of improvement. Researchers have found that ccontinuous improvement can change a firm's resources for improving processes and products (Galeazzo et al., 2017; Peng et al., 2008; Su & Linderman, 2016). Such a changing process is to further encourage the abilities of identifying new skills to solve problems, exploring new opportunities, and learning from that exploration (Teece, 2012). Accordingly, continuous improvement may also moderate the effects of the organizational resources and capabilities.

Model and Hypothesis Development

To explain and predict how ES affects innovation, we propose the research model shown in Figure 1. This model applies resource-based theory and capability building theory to examine the relationships between ES integration, ES-enabled competence, continuous improvement, and innovation performance, including the NPD performance and the innovation uniqueness.

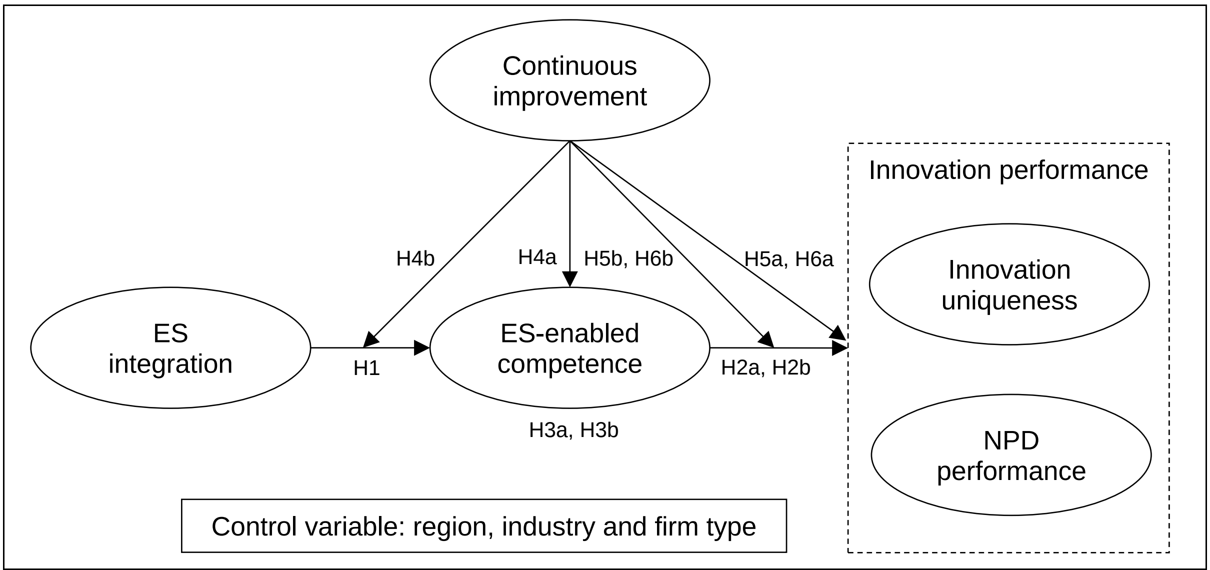

Figure 1 - Proposed Research Model

Extant studies have employed competitive advantage in NPD (Pavlou & El Sawy, 2006), NPD speed/time-to-market (Chen et al., 2010), and market and quality performance (Durmuşoğlu & Barczak, 2011). We classified these aspects from the literature into two levels, operational and strategic levels and further operationalized and expanded them into two concepts. The operational outcome is NPD performance that refers to a firm's performance on developing new products compared with its rivals, including applicability, dependability, and flexibility of NPD, to operationalize NPD speed/time-to-market and market and quality performance The strategic outcome is developed from the aspect of NPD competitive advantage and further expanded into innovation uniqueness (Hallin et al., 2011) that refers to the extent that innovative practices of an organization (such as NPD) is distinctive from its competitors. Innovation uniqueness reflects the newness in a firm's innovation and its potential to build differentiation-based competitive advantage. For example, owing to its unique digital products, such as iPhone and iPad, Apple became one of the most valuable companies in history.

The Effects of ES Integration on ES-enabled Competence

A major objective of designing and implementing ES is to automate, integrate and support business processes, operations, and strategies (Lee & Chang, 2020). Because of temporal nonlinearity of system implementation and composite nature of underlying technologies, ES integration is critical to deal with companies' infrastructure complexity (Sawyer & Southwick, 2002). ES integration, as an IT-related resource, can contribute to enterprise-wide competence with an essential role in facilitating hierarchical and horizontal transparency (Bi et al., 2011). First, information system integration enhances hierarchical visibility of decisions in organizations (Kramer & Simons, 2011). In an ES integrated organization, the data facilitating organizational activities and processes are available and observable across hierarchical levels. Moreover, managers are allowed to dig into more detailed records of organizational activities at different levels from aggregated data. ES integration provides the basis for developing the core competence of ES in a competitive environment.

Second, ES integration enhances horizontal transparency across functional areas and processes, such as decision making, transactions, and any organizational activities (Chapman & Kihn, 2009). A company with integrated ES has a common, organization-wide database and standardized IT infrastructure, where technical skills and expertise can be largely enhanced across functional areas. The presence of a seamless IT infrastructure and digitalized foundation offers a company the ability to leverage IT for business purposes in the competitive market. Further, ES integration plays a key role in enhancing managerial capabilities by facilitating information sharing (Ganotakis et al., 2013), environmental transparency (Dorantes et al., 2013), control (Morris, 2011a), coordination (Seddon et al., 2010), and information authenticity and accuracy (Duan et al., 2017). In sum, ES integration contributes to ES-enabled competence by facilitating hierarchical and horizontal transparency. Therefore,

H1. An organization's ES integration positively affects its ES-enabled competence.

The Effects of ES-enabled Competence on Innovation Performance

The ES-enabled competence is expected to enhance innovation performance at both operational and strategic levels. First, it facilitates NPD by enhancing coordination across various functional groups. Product or service innovation inevitably depends on multiple business functions, among which research and development (R&D), operations, and marketing are of primary importance (Garrett et al., 2006). Cross-functional integration in product development can be enhanced with the assistance of ES, especially competitive core competence of ES. Communication and decision-making abilities are important in reducing R&D and marketing barriers such as physical separation, goal incongruence, and cultural difference (Song & Song, 2010). In addition, ES-enabled competence contains technical, managerial, and organizational skills and expertise. Such skills and expertise can facilitate the integration and coordination within or across organizational boundaries, which is critical for the success of NPD (Bendoly et al., 2012). Therefore,

H2a. An organization's ES-enabled competence positively affects its NPD performance.

In addition to the impacts on operational innovation outcome (i.e., NPD performance), we further argue that ES-enabled competence has an influence on strategic innovation outcome (i.e., innovation uniqueness). ES-enabled competence contributes to innovation uniqueness by providing strong market sensing and customer responding capabilities (Lin et al., 2018; Trinh et al., 2012). By leveraging these core competences enabled by ES, companies have access to accurate, consistent, complete, real-time information about their customers and competitors and make better decisions of their strategies. For example, efficient, transparent and "frictionless" real-time decision-making capabilities empowered by ES (Seddon et al., 2010) can significantly shorten the time to market of products and increase their variety, and directly improve innovation uniqueness (Hwang & Min, 2013). Finally, ES-enabled competence can help to reduce firm's risk (Tian & Xu, 2015) that mitigates failure possibility, allowing companies to conduct distinctive innovative activities and keep innovation differentiated from that of their rivals. Thus,

H2b. An organization's ES-enabled competence positively affects its innovation uniqueness.

The Mediation Effects of ES-enabled competence

ES must be accompanied by capability building to influence business performance (Wang et al., 2012), which implies that ES integration may have indirect impacts on innovation performance through ES-enabled competence. Although system integration is positively related to system success (Chapman & Kihn, 2009), it is not easy to directly influence business performance and competitive advantage without translating into strategic capabilities. This is consistent with Beard and Sumner's (2004) argument that the source of competitive advantage may come from post-implementation alignment of ES with strategic direction. We posit that a lack of ES-enabled competence may hinder NPD performance and innovation uniqueness, even if ES has been well integrated. Unless this core capability is established, ES integration may fail to eventually improve innovation because innovation needs core competencies, such as information processing and decision-making abilities. Thus, ES-enabled competence—the core capability conferred by ES integration—is the key to improving NPD performance and innovation uniqueness. Thus,

> *H3. An organization's ES-enabled competence fully mediates the relationship between its ES integration and innovation performance, including (a) NPD performance and (b) innovation uniqueness.*

The Effects of Continuous Improvement

Continuous improvement is expected to directly contribute to ES-enabled competence. First, continuous improvement contributes to organizational ES-enabled competence through enhancing sharing and disseminating information and knowledge among employees (Singh & Singh, 2015). In a company highlighting continuous improvement, employees from different functional areas tend to share information and knowledge, including ES-related knowledge, which helps to improve their understanding of the links between ES and business processes. This better understanding of ES and business practices increases employees' ability to leverage ES to fulfill tasks and solve business problems (Deng et al., 2008). Second, continuous improvement indicates an organizational culture with learning orientation that constantly motivates organizational members to seek nonstop improvements (Sadikoglu & Zehir, 2010). This company-wide learning orientation can provide intrinsic incentives for employees to enhance their technical competence to understand and absorb ES knowledge and expertise in building a competitive core competence for a company. Thus,

> *H4a. An organization's continuous improvement positively affects its ES-enabled competence.*

Recent studies have investigated the moderating effects of dynamic capability (Chakrabarty & Wang, 2012; Lin & Wang, 2015). We, therefore, propose that continuous improvement not only directly contributes to ES-enabled competence, but also facilitates the ES-enabled capability building from ES-integration. With the learning and improvement orientation of continuous improvement, the transformation from ES integration to enhanced organizational competence can be either intensively strengthened or widely expanded. In a continuously improving company, individuals tend to take more effort to discover knowledge and expertise embedded in ES and leverage ES to improve task performance. Skills, routines, and expertise are continuously updated and improved. Such a culture can increase employees' organizational commitment (Joo & Shim, 2010) and help to strengthen the transformation from ES integration to ES-enabled competence. It empowers people to have a collective vision. Continuous improvement can also accelerate the process of building ES-enabled competence from ES integration because the possible heterogeneity and synchronicity in realizing and appreciating benefits of ES among different functional departments can be gradually eliminated by knowledge transfer across various areas. Thus,

> *H4b. An organization's continuous improvement positively moderates the relationship between its ES integration and ES-enabled competence.*

With strong performance orientation and belief in nonstop enhancement, organizations with continuous improvement tend to incorporate knowledge to make tangible improvements in routines and processes. By focusing on continuous improvement, the performance of existing products/processes is constantly under scrutiny for improvement opportunities (Peng et al., 2008). Employees from R&D department, for instance, are motivated and required to leverage skills and expertise to incrementally improve their outputs to be more applicable and dependable. More crucially, continuous improvement indicates the engagement of the company in responding to changing customer needs (Bhuiyan et al., 2006), which is critically required for superiority and flexibility of NPD practices. Taking Procter & Gamble as an example, its continual improvement culture helped to develop superior innovation capability, which increased the number of new product introductions and R&D productivity by almost 60 percent (Dodgson et al., 2006; Huston & Sakkab, 2006). Thus,

> *H5a. An organization's continuous improvement positively affects its NPD performance.*

Continuous improvement has been found to moderate the relationship between some performance variables and their antecedents (Salge & Vera, 2012). We posit such a mechanism can be generalized to ES-enabled competence and NPD performance. An organization with high continuous improvement is committed to innovation through more effective mechanisms. Business knowledge and intelligence embedded in ES can be accrued, interpreted, shared, and disseminated, which generate crucial information and knowledge for decision making (Liang & Liu, 2018) within an organization. The knowledge management process greatly accelerates functional and cross-functional business processes, including R&D, market demand analysis, and new product launch, thereby translating ES-enabled capabilities into organizational ability to develop new products. Thus,

> *H5b. An organization's continuous improvement positively moderates the relationship between its ES-enabled competence and NPD performance.*

In addition, continuous improvement is crucial for firms to develop unique products and processes. First, in a firm emphasizing continuous improvement, employees tend to constantly acquire new knowledge and explore new ways of leveraging the acquired knowledge to improve work processes (Anand et al., 2009). Knowledge facilitates employees to identify unique business opportunities and generate novel solutions, which increases employee creativity (Birdi et al., 2016; Kremer et al., 2019). For example, with high continuous improvement, employees in the marketing department make sustained efforts to accrue the understanding of changing customers' demands, which helps a company easily capture unique opportunities to serve customers. Moreover, continuous improvement implies the propensity of a firm to incorporate internal knowledge, especially tacit knowledge, to improve teamwork, coordination, and organizational performance (Andrews & Smits, 2018). This reliance on internal and tacit knowledge makes innovation relatively inimitable by competitors. Thus,

> *H6a. An organization's continuous improvement positively affects its innovation uniqueness.*

Because knowledge drives continuous improvement (Singh & Singh, 2015), knowledge and expertise embedded within ES can be easily transformed into capacity to generate innovative ideas and develop unique products or processes within a firm focusing on continuous improvement. Continuous improvement helps to make profound business knowledge incorporated in implemented ES to be more likely fully assimilated by non-IT employees, which increases a firm's ability to leverage ES-related technological competence to reshape routines, transform processes, and improve decision making. More importantly, a company with a continuous improvement orientation is less likely to encounter tension between innovation and existing routines. It is easier to realize employee commitment in an environment where sustained improvements are expected and encouraged (Lam et al., 2015). Employees then are capable of leveraging ES-enabled competence to generate innovative ideas and unique solutions that cannot be easily imitated by rivals. continuous improvement helps to develop both cognitively and intellectually readiness for unique innovation at various levels. The organizational innovation uniqueness transferred from ES-enabled competence also requires the accumulated knowledge and experience to be continuously maintained and enhanced. Thus,

> *H6b. An organization's continuous improvement positively moderates the relationship between its ES-enabled competence and innovation uniqueness*

Methodology

Data Collection

The data were collected from manufacturing companies in 10 countries of three regions: Europe, Asia-Pacific, and the USA, which represent major economic engines in the world. The design of data collection in multiple countries with a diversity of cultures and economies was to ensure generalizability of research findings (Bozarth et al., 2009). Because of the importance of electronics, machinery, and auto supply in the manufacturing sector (Huang et al., 2011), companies in these three industries were randomly selected from a list provided by the local research group in each country. The companies selected must hire at least 250 employees to ensure that they are mid- to large-sized enterprises. The English questionnaire was first translated into the local language by some doctoral students, and then the local language version was translated back into English by other research group members. This step was to make sure that the translation reflected original context and literal accuracy. We followed the same procedure of data collection in these different countries. A pilot-test was conducted to refine measurement items in the questionnaire before formal data collection. In the formal data collection, the local research group in each country visited target companies and met management teams. The management teams introduced their companies. The research group presented data collection purposes and procedure. Training workshops were offered to the respondent managers and employees to understand the research plan and questionnaires. These measures were used to increase data quality. The questionnaires were then distributed to the relevant managers and employees. After the questionnaires were filled, they were collected by the local research group. Because the data were collected in a cross-sectional method, most questions were answered by multiple informants in a company to reduce the common method bias/single-respondent bias and ensure greater reliability. The data were then aggregated after the data collection for further analysis. In total, we received 233 valid firm responses from different countries.

Respondent Profile

Our 233 organizational samples represent a variety of regions, industries, and organizational types. The percentages of respondents from Europe, Asia-Pacific, and America are 61.80%, 31.33%, and 6.87%, respectively. The distribution of the three industries is virtually evenly distributed, all a little above 30%. The percentages of the manufacturers in electronics, transportation components, and machinery are 37.77%, 31.33%, and 30.90%, respectively. 70% of the companies are traditional manufacturers and the other 30% are world-class companies (World-class companies are usually industry leaders with a reputation for excellence in manufacturing strategies and practices and global competitive advantage, such as, Caterpillar in the heavy equipment industry, Samsung in the electronics industry, and Toyota in the auto industry.).

Measures

Appendix A provides all measurement details. Here, we summarize key aspects of construct operationalization. The measurements of most constructs are multi-statements. The measurement of ES integration is developed based on previous studies (Gattiker & Goodhue, 2005; Saraf et al., 2013): we measured it by the percentage of different modules that are integrated with each other in a given organization. IS managers answered whether each item of all five subsystems of enterprises has been integrated with each other and the average of the integration percentage of these systems is used for the value of ES integration.

ES-enabled competence was measured from product management, quality management, and top management perspectives based on Peppard & Ward (2004) study. Three questions for

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evaluating a given organization's ES-enabled competence compared with that of competitors in its industry on a global basis were asked with a 5-point-scale. General managers, quality managers, and superintendents were invited to answer questions corresponding to their perspectives.

The measurement of NPD performance was developed based on new product market performance and quality performance concepts (Durmuşoğlu & Barczak, 2011). NPD performance, as a second order construct, was measured by three first-order dimensions: applicability, dependability, and flexibility. The respondents were asked to compare their typical new product with similar products manufactured and sold by their competitors with respect to its characteristics. The applicability includes performance, features, aesthetic appeal, and perception. The dependability includes durability, reliability, conformance quality, and ease of service. The flexibility includes speed of delivery and ability to be customized. The questions were answered by members of product development team with a 7-point-scale.

Innovation uniqueness was measured previously by a single item regarding the extent to which innovation resembles other innovations in the recipient subsidiary's local market (Hallin et al., 2011). We extended this measurement by including three items: innovation's prominence (i.e., how well the innovation is known), difficulty of imitating the innovation, and innovation's competitive advantage. The questions were answered by process engineers, supervisors, and superintendents because these employees are in an excellent position to understand the uniqueness of a product. They answered each of the items with a 7-point-scale, respectively, and their responses for each item are averaged for further use.

The measurement of continuous improvement was developed from Huang et al.'s (2011) study. It is measured by four items: endeavor of continuous improvement, moving target of the performance, belief in nonstop improvement, and an organization's engagement in dynamic change. The questions were answered by direct laborers, quality managers, and supervisors with a 7-point-scale, respectively, with the average for each item calculated. The design of the data collected from different respondents, as an effective ex ante remedy, helped to eliminate common method bias (CMB) because obtaining the measures from the same rater or source is believed to be one of the major causes of CMB (Podsakoff et al., 2003). For multiple responses on the same item, the inter-rater agreement was also tested by calculating the Fleiss' kappa value to ensure a good level of agreement (Fleiss et al., 2003). The control variables comprise the regions of the companies (Europe, Asia-Pacific, or America), the company types (world-class or traditional), and the industries (machinery, electronics, or transportation).

Data Analysis and Results

We analyzed the data by using SPSS 22 and SmartPLS 3.0. We chose SmartPLS 3.0 because it can test moderated mediation effect in a more convenient way and it can process the model with both reflective and formative constructs more effectively than the covariance-based SEM tools. Our model is a moderated mediation one and it also has a formative construct (IS integration). Therefore, partial least squares (PLS)-SEM is preferred. SmartPLS is also flexible in dealing with different types of measurement, such as second-order constructs (Lowry & Gaskin, 2014). In our research model, NPD performance is a second-order construct with first-order constructs, applicability, dependability, and flexibility. In addition, our research model hypothesized both mediating and moderating effects, and SmartPLS can obtain results of all the main, mediating, and moderating effects within one PLS-SEM model. This is more accurate and convenient than the traditional way (i.e., Baron & Kenny, 1986) in which mediating and moderating effects need to be tested separately. Notably, SmartPLS can also conduct bootstrapping to determine the p-values of coefficients, which is considered as a stronger approach to testing both mediation and moderation (Bahli & Rivard, 2013).

Construct Validity and Reliability

Table 1 summarizes the descriptive statistics. We ran SmartPLS 3.0 for the measurement model and found all item loadings are higher than 0.5, and all crossing loadings are lower than 0.5. The construct average variance extracted (AVE) values (in the diagonal cells) are also higher than the threshold of 0.5 (Fornell & Larcker, 1981), which indicates that convergent validity is established. Discriminant validity is also established, because the AVE of each construct is higher than the covariance between this construct and the others (the values in the off-diagonal cells). Composite reliability (CR) was calculated for each construct because it is a more accurate measurement of reliability than Cronbach's α (Lowry & Gaskin, 2014). All of the CRs were above 0.8, indicating that the measurement is highly reliable.

Almost all data were collected from different people in each organization, which helped reduce CMB. We further used the Harman one-factor test and found that the first un-rotated single factor only explains 23.62% of total variance (Harman, 1976). We also run a common latent factor analysis and the difference between standardized and unstandardized weights are all below 0.2, further confirming no CMB in the measurement. Finally, we tested the multicollinearity and found all values of the variance inflation factor (VIF) are below 1.6, indicating no multicollinearity in the data. The Fleiss' Kappa values of ES-enabled competence, innovation uniqueness, and continuous improvement are 0.447, 0.664, and 0.509 respectively, indicating a good level of inter-rater agreement.

Table 1 - Measurement Model Statistics

Construct	*CR*	*Mean*	*SD*	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
1. CI	.860	5.71	.48	**.554**						
2. Innovation uniqueness	.826	4.50	.77	.110	**.673**					
3. NPD applicability	.870	5.16	.85	.001	.008	**.626**				
4. NPD dependability	.884	4.84	.85	.008	.018	.317	**.657**			
5. NPD flexibility	.843	4.97	.99	.028	.003	.147	.134	**.729**		
6. ES-enabled competence	.826	3.20	.67	.102	.073	.043	.053	.065	**.613**	
7. ES integration	---	.370	.22	.013	.039	.002	.036	.031	.098	---

Model and Hypothesis Testing

We tested the research model by using SmartPLS 3.0. After setting the measures of all first-order constructs, we set NPD performance, the second-order construct, containing all indicators and predicting its three sub-first-order-constructs. Then, we linked the hypothesized paths in the PLS model. The effects can be examined by path coefficients and p-values generated by bootstrapping. We chose the standardized solution to avoid multicollinearity and generated a bootstrapping procedure with 5000 re-samples. The results are shown in Figure 2.

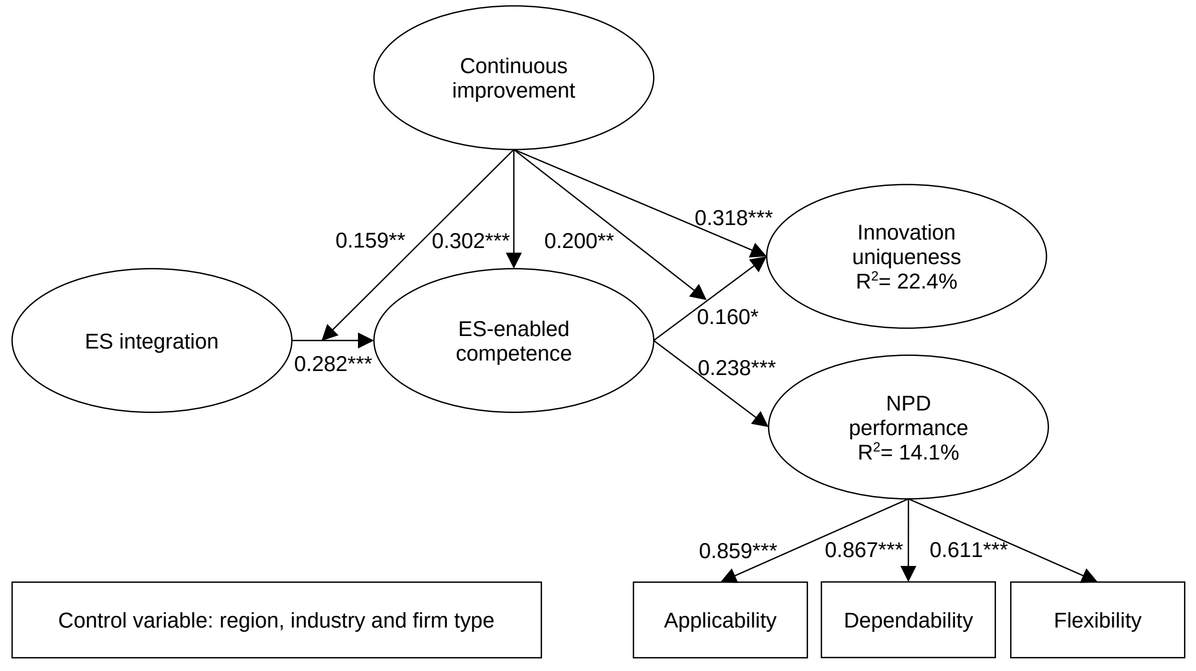

Figure 2 - The Results of the Proposed Model

The path coefficients between NPD performance and its three sub-constructs are all above 0.6 with p = 0.000, indicating the validity of the second-order construct structure. The R-square values of NPD performance and innovation uniqueness are 14.1% and 22.4% that are not low for firm-level studies, indicating explanation power of the research model. The effect of ES integration on ES-enabled competence is positive and significant (β = 0.282, p = 0.000), indicating H1 is supported. ES-enabled competence has positive and significant effects on NPD performance (β = 0.238, p = 0.001) and innovation uniqueness (β = 0.160, p = 0.019), indicating H2a and H2b are supported. The indirect effect of ES integration on NPD performance through ES-enabled competence is significant (β = 0.067, p = 0.007) while its direct effect is insignificant (β = 0.119, p = 0.111), indicating that ES-enabled competence fully mediates ES integration on NPD performance. Thus, H3a is supported. Similarly, the indirect effect of ES integration on innovation uniqueness through ES-enabled competence is significant (β = 0.045, p = 0.036) while its direct effect is insignificant (β = 0.063, p = 0.300), indicating that ES-enabled competence fully mediates ES integration on innovation uniqueness. Thus, H3b is also supported.

Continuous improvement has shown significant effect on ES-enabled competence (β = 0.302, p = 0.000). It also has significant moderating effect between ES integration and ES-enabled competence (β = 0.159, p = 0.002). Therefore, H4a and H4b are supported. However, continuous improvement does not show significant main effect (β = 0.016, p = 0.835) or moderating effect (β = 0.014, p = 0.847) on the operational innovation performance variable, NPD performance. Therefore, H5a and H5b are not supported. On the other hand, continuous improvement does show significant effects on the strategic innovation performance variable, innovation uniqueness. The main effect (β = 0.318, p = 0.000) and the moderating effect (β = 0.200, p = 0.000) support H6a and H6b.

Robustness Check

To further test results, we ran a robustness check by using an SPSS macro called PROCESS, introduced by (Hayes, 2013). To get values of the latent variables to be used in PROCESS, we calculated the mean of the items for each variable as its value. To avoid multicollinearity, we centered the values of all main variables. We then tested for multicollinearity among all variables in the model. All VIFs are lower than 1.5, indicating no serious multicollinearity.

The test was run with PROCESS version 2.15 in SPSS 22. We chose n = 5000, and 95% confidence level. According to the structure of our research model in which one moderator is hypothesized to moderate both mediation paths, we chose Model 58 among the model types provided by PROCESS (see the Appendix B for Model 58). However, our research model has two dependent variables, NPD performance and innovation uniqueness. We thus ran the model for each dependent variable separately (see Appendix C). In the model of NPD performance, we received two sub-models. The first one is the mediation model for ES-enabled competence. We found that ES integration has a significant effect on ES-enabled competence (β = 0. 945, p = 0.000), which supports H1. In addition, continuous improvement has a significant influence on ES-enabled competence (β = 0.458, p = 0.000), supporting H4a. The interaction of ES integration and continuous improvement is significantly associated with ES-enabled competence (β = 0.869, p = 0.031), thus supporting H4b.

The second one is the model for NPD performance, and we found that ES integration has no significant direct effect on NPD performance (β = 0.339, p = 0.123). ES-enabled competence has significant direct effect on NPD performance (β = 0.267, p = 0.000), which supports H2a and H3a. However, continuous improvement has not been found to have significant effect on NPD performance (β = 0.054, p = 0.593), which is consistent with the result of PLS analysis. Thus, H5a and H5b are not supported.

In the model of innovation uniqueness, we ran the same test by only changing the dependent variable as the innovation uniqueness. Thus, we obtained the same first sub-model but different second sub-model. The second sub-model on the innovation uniqueness indicates that ES integration has no significant direct effect on innovation uniqueness. The effect of ES-enabled competence is not as large as expected (β = 0.130, p = 0.107), which may be due to PROCESS's limited capability to deal with latent variables versus structure equation modeling. However, the p-value is still very near to 0.1. Thus, we believe that the robustness check of H2b and H3b passes. continuous improvement was found to have a significant effect on innovation uniqueness (β = 0.526, p = 0.000). The interaction of ES-enabled competence and continuous improvement has a significant effect on innovation uniqueness (β = 0.426, p = 0.005). Therefore, H6a and H6b are confirmed. We summarized the hypotheses testing and robustness check results in Table 2.

Table 2 - Hypotheses Testing Results and Robustness Check

Hypothesis	*Results*	*Robustness check*
H1. ES integration → ES-enabled competence	Supported	Pass
H2a. ES-enabled competence → NPD performance	Supported	Pass
H2b. ES-enabled competence → innovation uniqueness	Supported	Pass
H3a. ES-enabled competence mediates the effect of ES integration on NPD performance.	Supported	Pass
H3b. ES-enabled competence mediates the effect of ES integration on innovation uniqueness.	Supported	Pass
H4a. CI → ES-enabled competence	Supported	Pass
H4b. CI moderates the effect of ES integration on ES-enabled competence.	Supported	Pass
H5a. CI →NPD performance	Not supported	Pass
H5b. CI moderates the effect of ES-enabled competence on NPD performance.	Not supported	Pass
H6a. CI →innovation uniqueness	Supported	Pass
H6b. CI moderates the effect of ES-enabled competence on innovation uniqueness.	Supported	Pass

The Moderated Mediation Effect

We also examined the moderated mediation effects in the PROCESS model. Moderated mediation effect refers to the moderating effect on the mediating effect. Namely, the mediating (indirect) effect may be different when the value of the moderator changes. Having a moderating effect on one of the mediation paths does not necessarily mean having moderated effects on the mediation effect (Hayes, 2015). Model 58 provided by PROCESS with the same moderator on two mediation paths only provides the index of moderated mediation when the moderator is dichotomous (the effect is nonlinear for a continuous moderator). To obtain the index, we prepared our data by categorizing the cases into high-continuous improvement companies with their continuous improvement values above average and low-continuous improvement companies with their continuous improvement values below average. We then reran the PROCESS models with the two types of continuous improvement as the moderator. The moderated mediation effect of continuous improvement types on ES integration and NPD performance was insignificant (β = 0.126, 95% confidence interval [-0.185, 0.464]). The moderated mediation effect on innovation uniqueness was significant at $p=0.1$ level (β = 0.269, 90% confidence interval [0.030, 0.584]). The mediation effect coefficient of the low-continuous improvement firms is 0.087 ($p > 0.1$), while that of the high-continuous improvement firm is 0.356 ($p < 0.05$). A marginal moderated effect of continuous improvement thus exists on the mediating effect between ES integration, ES-enabled competence, and innovation uniqueness.

Discussion

As indicated in Table 2, the empirical data confirmed all the hypotheses, except H5a and H5b. We first confirmed that continuous improvement plays a key role in the transition from ES integration to ES-enabled competence and then to innovation uniqueness. Continuous improvement moderates the relationship not only between ES integration and ES-enabled competence, but also between ES-enabled competence and innovation uniqueness, the strategic innovation performance. In addition, continuous improvement moderates the mediation effect: firms with high continuous improvement have a positive mediation effect along the line, whereas firms with low continuous improvement have no significant mediation effect. This finding may explain the phenomenon that despite having fully implemented ES, some companies still cannot achieve a real break-through in innovation performance: They are crippled by their low continuous improvement levels. If it is true, the lack of continuous improvement is anathema to innovation and undermines the benefit of highly integrated ES.

However, this moderating effect of continuous improvement does not work for the transition to NPD performance. The reason may be that NPD performance is mainly assessed from the operational perspective. Continuous improvement has a significant direct effect on strategic innovation, which is consistent with the pattern of organizational learning (Berghman et al., 2013). However, its effects on operational innovation performance may be indirect. We further checked the indirect effect between continuous improvement and NPD performance through ES-enabled competence and found it was significant (0.072, $p = 0.007$), indicating ES-enabled competence fully mediates the relationship between them. From the research findings, we conclude that while continuous improvement affects strategic innovation directly, it may need IT-enabled capability to enhance operational performance. Thus, continuous improvement and ES-enabled competence are likely complementary.

As hypothesized, ES-enabled competence mediates the relationship between ES integration and innovation outcomes, especially NPD performance. Further, our results indicate that ES-enabled competence serves as a mediator from continuous improvement to NPD performance. This finding implies that ES-enabled competence played an important role in ES-enabled innovation at the operational level. In addition, a comparison of the direct effects of ES-enabled competence on innovation uniqueness (β = 0.160, $p = 0.019$) and on NPD performance

($\beta = 0.238$, $p = 0.001$) indicates ES-enabled competence may have the greater effect on NPD performance than on innovation uniqueness. We then extracted the samples of the two coefficients from bootstrapping results and ran a paired t-test after checking their normality and equality of variance. The result shows a significant difference between the means of the two coefficients ($p < 0.000$), indicating that ES-enabled competence has a greater effect on the NPD performance than on innovation uniqueness. Therefore, increasing ES-enabled competence is more effective in operational innovation performance than in strategic innovation performance.

To investigate which factor had a larger effect on strategic innovation performance, we then compared the direct effects of continuous improvement and ES-enabled competence on innovation uniqueness. Using paired t-test for the samples of the two coefficients from the bootstrapping, we found that continuous improvement has a greater direct effect on innovation uniqueness than ES-enabled competence does ($p < 0.000$). In fact, continuous improvement also has an indirect effect on innovation uniqueness by its moderating effect. Based on the post-hoc analysis, we find that although both continuous improvement and ES-enabled competence are important, they play different roles in terms of innovation: continuous improvement plays a more direct role in the strategic aspect and ES-enabled competence is necessary for the operational aspect.

Theoretical Implications

This study has implications for the research on ES-enabled innovation by proposing a capability-based framework. First, ES-enabled capability building is found to be a step towards a theoretical foundation of ES-enabled innovation. With ES extensively implemented in contemporary companies, not all companies can leverage ES to enhance their innovation in the competition without revolutionizing existing practices and introducing new ones (Karimi et al., 2007). The capability-based framework contributes to explaining inter-firm heterogeneity in creating and appropriating value by implementing ES. This study introduces the concept of ES-enabled competence and empirically tests its critical role in translating ES value into innovation performance. This finding provides the key to solve the ES-related rigidity-innovation paradox (Davenport, 2000). Further, the findings of this research uncover the micro-foundation underlying ES-enabled innovation.

This study also deepens the understanding of role of continuous improvement played in enhancing innovation. Continuous improvement is found to moderate the relationships between ES-enabled competence and innovation. Although prior research conceptually proposes continuous improvement as a dynamic capability (Anand et al., 2009), few studies empirically examine its impacts on influencing IT-enabled innovation. Beyond the conventional focus on operational implications of continuous improvement, this study looks at continuous improvement at the intersection between organizational capability system and operations functional area. The nature of continuous improvement is highlighted and provides a foundation for theorizing continuous improvement as a dynamic capability that systematically changes firm ordinary capabilities for improvement. This study also responds to prior literature's call for examining the moderating effects of dynamic capabilities (Laaksonen & Peltoniemi, 2018). The findings of the moderating effects of continuous improvement on ES-enabled competence and innovation enlighten the understanding of the strategic implications of continuous improvement within companies.

Moreover, this study classifies the innovation outcomes in the competitive environment into operational and strategic levels, which contributes to the literature in the innovation field. Previous studies on innovation usually adopt one type of innovation outcome or classify innovation based on its extent (such as incremental and radical innovation). Little has differentiated the innovation outcomes on different levels and considered the competitiveness. We not only investigate the innovation outcomes from different levels (namely, innovation

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uniqueness at the strategic level and NPD performance at the operational level), but also defined them from a competitive perspective. We found that the results are different on these two levels. Continuous improvement has significant main and moderating effects on innovation uniqueness but no effects on NPD performance, which indicates that our classification is valid and it is necessary to examine innovation from different levels and perspectives.

Practical Implications

Although the previous research on ES is fairly matured, new challenges appear nowadays. As we have mentioned, the superiority of ES has been faded away as the application of IT in business becomes increasingly wide. The research results can provide insights for managers to make better decisions.

First, our results indicate that developing ES-enabled competence is necessary for innovation after ES infrastructure and integration are established. The existing literature has focused on the role of ES as one type of resource; however, ES integration cannot successfully produce innovative improvement if it is not transformed into organizational capability. Organizations progress in innovation only when they form a core competence (managerial, technical, and organizational skills and expertise) that is difficult to imitate. Therefore, organizations should not assume that the initial implementation of their ES is sufficient (Lokuge & Sedera, 2014). In fact, ES project cycle includes several crucial stages after ES adoption, including adaptation, acceptance, routinization, and infusion (Law et al., 2010). ES-enabled competence is created along these stages with the basis of inimitable routines (Peng et al., 2008), so that innovation can be conducted iteratively throughout ES lifecycle (Lokuge & Sedera, 2014). Therefore, it is necessary for organizations to dedicate to transforming their ES into capabilities that trigger both the innovation process and outcomes, leading to more innovative ideas and solutions and even helping to build an innovation ecosystem with partners in the supply chain (Nambisan, 2013).

Second, the research findings suggest that continuous improvement plays an important role in the transition from the IT-factor, ES, to innovation in a competitive environment. The moderated mediation mechanism identified may explain why, despite having built their ES, some companies cannot transform them into a capability for real innovation performance. Such organizations may have a very low continuous improvement level, which cannot enhance the transition from ES integration to ES-enabled competence and then eventually to innovation. Therefore, organizations must increase their continuous improvement to above average to experience the mediating effect that leads to successful innovation. Participating in benchmarking projects can help organizations obtain information about their continuous improvement level and direct their innovation accordingly. They are encouraged to benchmark their continuous improvement level against best performers to generate a competitive advantage through ES. Organizations should pursue high continuous improvement to achieve both incremental and radical innovation as well. Therefore, organizations must emphasize their learning and improving culture to ensure continuous success.

Third, this study indicates that both IT-factors (e.g., ES integration and competence) and non-IT-factors (e.g., continuous improvement) are important for innovation. IT- and non-IT-factors are actually complementary with each other and their interaction and synergy can benefit the organizations eventually. Therefore, managers in organizations should emphasize both aspects without overlooking any of them.

In addition to the competitive environment, organizations are facing different emerging digital technologies (such as cloud computing, big data, and mobile technologies) that are embedded with ES increasingly. For example, cloud-based ES outperforms traditional ES because of the benefits of reduced cost, less staff, greater mobility, more flexibility, and scalability (Lenart, 2012; Raihana, 2012). Cloud-based ES accumulated more structured and unstructured data from different sources than ever before. These data are valuable for developing innovative products or services. Thus, big data analytics is also needed to accelerate and provide insight for innovation (Grover et al., 2018). Thus, IT practitioners need to reconsider the nature and roles of ES, especially the relationship between ES and innovation. The finding of ES-enabled innovation provides confidence for viewing ES as a strategic resource for innovation-based competitive advantages.

Limitations and Future Research

This study has several limitations that can be improved upon in future research. Although we have a rigorous data collection procedure for a high-quality dataset and the multi-national data allow for the generalizability of our results, the most significant limitation of the data is the cross-sectional nature. The time lag associated with ES may be one reason for the IT productivity paradox; that is, an IT system's benefit lags behind its implementation by years (Bui et al., 2018). Therefore, we will use longitudinal data to examine the effects of ES to avoid obfuscation of the results by the IT productivity paradox and to obtain a more precise prediction of innovation performance in the future.

Another limitation lies in the small sample size of each region or country, which limits the comparison of the research findings across different regions or countries. The same model may yield different results due to different cultures. For example, researchers have found that innovation assimilation is different in different countries (Zhu et al., 2006). In addition, with late-mover advantage in embracing large-scale ES, developing countries may show different patterns from developed countries (Niebel, 2018). They perform a technological leapfrog by adopting the most updated ES that may strongly enhance strategic innovation performance. Therefore, the future study will be performed by collecting more data from different countries and compare the mechanism between ES-factors, continuous improvement, and innovation performance across countries. Future studies could also consider the management support and the other IT resources in the development of innovation.

Conclusion

Our study challenges the widely held view that ES is an important operational but nonstrategic organizational asset, and it contributes to understanding how ES integration can positively influence innovation. We confirm the roles of ES as a resource and a capability and the effects of these roles on innovation—including the operational outcome, NPD performance, and the strategic one, innovation uniqueness. We demonstrate that continuous improvement moderates the mediation paths, namely "ES integration – ES-enabled competence – innovation performance". The moderated mediation effect exists among continuous improvement, ES integration, ES-enabled competence, and innovation uniqueness. The study further links information systems research to the innovation field and makes a theoretical contribution by applying the resource-based theory and capability building theory. It also has practical implications for achieving competitive advantages by making the best use of ES.

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Appendix A. Measurement details

Table A - Measurement Details and Notes

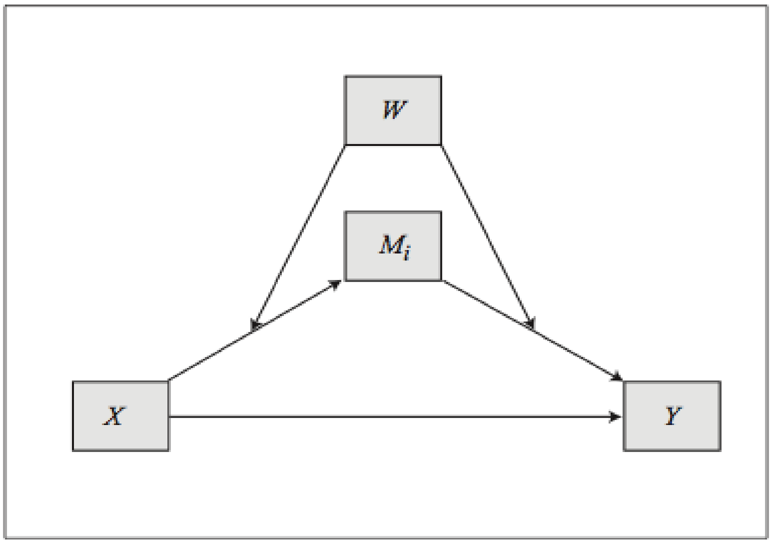
Construct	*Subconstruct*	*Prompt / Items*	**Notes**
ES integration		Prompt: Please check whether each application area supported by software is integrated with each other at the company.	Respondents: IS managers
	Basic models of MRPII (12 items)	Master production schedule	Developed based on Gattiker and Goodhue (2005); Saraf et al. (2013).
		Rough cut capacity planning	
		Material requirements planning	
		Capacity requirements planning	
		Finite capacity scheduling	
		Shop floor control	
		Inventory management	
		Purchasing	
		Forecasting	
		Demand planning	
		Order management	
		Simulation and optimization of production and logistics planning	
	SCM system (CRM + DRP) (4 items)	Catalog and price management	
		Service management (after the sale)	
		Distribution management	
		Transportation management	
	CIMS + TQM (6 items)	Product configuration	
		Design (CAD, CAE)	
		Product data management	
		Maintenance management	
		Quality documentation management	
		Quality control and improvement	
	Accounting system (4 items)	General accounting	
		Cost accounting	
		Budgeting	
		Performance measurement system	
	Human resource & others (5 items)	Human resource management	
		Workflow management	
		Business intelligence (query & report, OLAP, data mining)	
		Project management	
		Groupware tools (e.g., Lotus Notes)	

ES-enabled competence	n/a	From a product management perspective, please indicate your opinion about the ES competence in your company compared to that of the competitors in your industry. From a quality management perspective, please indicate your opinion about the ES competence in your company compared to that of the competitors in your industry. From an overall perspective, please indicate your opinion about the ES competence in your company compared to that of the competitors in your industry.	Respondents: triangulated by General managers, quality managers, and superintendents Developed based on the concept from Peppard and Ward (2004)
NPD performance		Prompt: Please compare a typical new product to similar products manufactured and sold by your competitors.	Respondents: product development team Developed based on Durmuşoğlu and Barczak (2011)
	NPD applicability	Performance (functionality) Features Aesthetic appeal of this product Customers' perception of this product	
	NPD dependability	Durability (life expectancy) Reliability (time between failures) Conformance quality Ease of servicing this product	
	NPD flexibility	Our ability to customize the product Our ability to rapidly deliver	
Innovation uniqueness	n/a	We are known for developing innovative new practices. Our practices are unique and cannot be easily copied by others. We gain a competitive advantage from our unique practices.	Respondents: triangulated by process engineers, supervisors, and superintendents. Adapted from Hallin et al. (2011), extended.
Continuous improvement	n/a	We strive to improve all aspects of products and processes continually rather than taking a static approach. Continuous improvement makes our performance a moving target for competitors to imitate. We believe that the improvement of a process is never complete and there is always room for more incremental improvement. Our organization is not a static entity but engages in dynamically changing itself to serve its customers better.	Respondents: triangulated by direct laborers, quality managers, and supervisors Adapted from Huang et al. (2011)

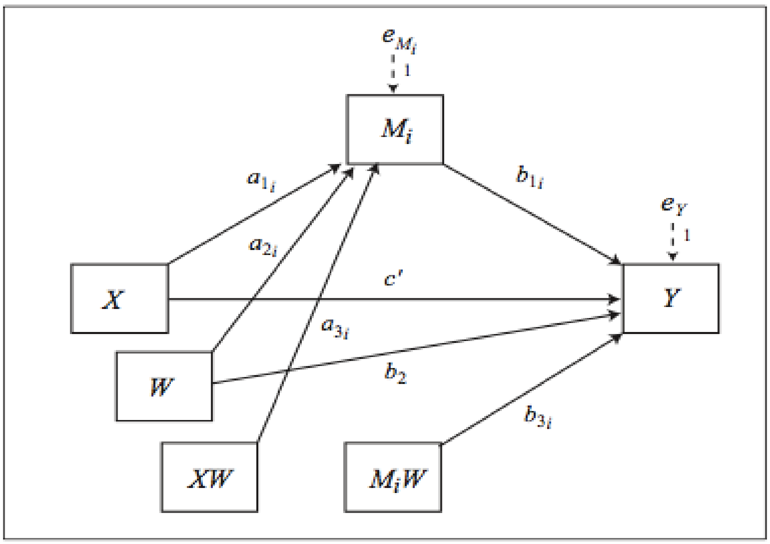
Note: All items were measured with 5- or 7-point scales except for the ES integration items, which were answered with "yes" or "no."

Appendix B. The structure of model 58

Conceptual Diagram



Statistical Diagram



Conditional indirect effect of X on Y through $M_i = (a_{1i} + a_{3i}W)(b_{1i} + b_{3i}W)$

Direct effect of X on $Y = c'$

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Appendix C. Robustness check tables

Table C1 - Mediation Model for ES-enabled Competence

R^2	*MSE*	*F-value*	*df1*	*df2*	*p-value*
0.2411	0.3496	8.8956	8	224	0.0000
Item	*Coefficient*	*SE*	*t-statistic*	*p-value*	*95% C.I.*
Constant	-0.1312	0.1006	-1.3041	0.1936	[-0.3296, 0.0671]
Region1	-0.0648	0.0921	5.047	0.4821	[-0.2462, 0.1166]
Region2	-0.3009 †	0.166	5.4084	0.0711	[-0.6279, 0.0261]
Industry1	0.1947*	0.0988	2.1767	0.0499	[0.0001, 0.3893]
Industry2	0.234*	0.0941	-0.7041	0.0136	[0.0485, 0.4194]
Type	0.1293	0.0866	-1.8131	0.1371	[-0.0415, 0.3000]
ES integration	0.9453***	0.1873	1.9716	0.000	[0.5762, 1.3145]
Continuous improvement	0.4583***	0.0847	2.4865	0.000	[0.2913, 0.6253]
ES integration X Continuous improvement	0.869*	0.3992	1.4921	0.0305	[0.0823, 1.6557]

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C2 - Dependent Variable Model for NPD Performance

R^2	*MSE*	*F-value*	*df1*	*df2*	*p-value*
0.1241	0.4569	3.5108	9	223	0.0004
Item	*Coefficient*	*SE*	*t-statistic*	*p-value*	*95% C.I.*
Constant	-0.0601	0.1169	-0.5145	0.6074	[-0.2905, 0.1702]
Region1	0.0526	0.1058	0.4978	0.6191	[-0.1558, 0.2611]
Region2	0.2602	0.1918	1.3565	0.1763	[-0.1178, 0.6382]
Industry1	0.0835	0.1135	0.7364	0.4623	[-0.1400, 0.3071]
Industry2	0.0721	0.1092	0.6602	0.5098	[-0.1431, 0.2874]
Type	-0.1345	0.0996	-1.3505	0.1782	[-0.3307, 0.0617]
ES integration	0.3388	0.2246	1.5088	0.1328	[-0.1037, 0.7813]
Continuous improvement	0.2665***	0.0771	3.4553	0.0007	[0.1145, 0.4185]
ES integration X Continuous improvement	0.0542	0.1011	0.5356	0.5927	[-0.1451, 0.2534]
Direct Effect of ES Integration on NPD Performance					
	Coefficient	SE	*t*-statistic	*p*-value	95% C.I.
	0.3388	0.2246	1.5088	0.1228	[-0.1037, 0.7813]
Conditional Indirect Effect at Specific Value(s) of the Moderator(s)					
Continuous improvement Value	Indirect Effect		Bootstrapping SE		Bootstrap 95% C.I.
-0.4798	0.1147		0.0788		[0.0050, 0.3246]
0.0000	0.2520		0.0927		[0.1026, 0.4721]
0.4798	0.4304		0.1635		[0.1618, 0.8056]

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table C3 - Dependent Variable Model for Innovation Uniqueness

R^2	*MSE*	*F-value*	*df1*	*df2*	*p-value*
0.2007	0.4923	6.2204	9	223	0.0000
Item	*Coefficient*	*SE*	*t-statistic*	*p-value*	*95% C.I.*
Constant	0.0973	0.1213	0.8016	0.4237	[-0.1032, 0.2977]
Region1	-0.2581	0.1098	-2.3514	0.0196	[-0.4395, -0.0768]
Region2	-0.1881	0.1991	-0.9448	0.3458	[-0.5170, 0.1407]
Industry1	-0.0280	0.1178	-0.2381	0.8120	[-0.2225, 0.1665]
Industry2	0.0841	0.1134	0.7413	0.4593	[-0.1032, 0.2713]
Type	0.0302	0.1033	0.2918	0.7707	[-0.1405, 0.2008]
ES integration	0.2608	0.2331	1.1188	0.2644	[-0.1242, 0.6458]
Continuous improvement	0.1297	0.0801	1.6200	0.1066	[-0.0025, 0.2620]
ES integration X Continuous improvement	0.5258	0.1049	5.0106	0.0000	[0.3525, 0.6992]
Direct Effect of ES Integration on NPD Performance					
	Coefficient	SE	*t*-statistic	*p*-value	95% C.I.
	0.2608	0.2331	0.1166	0.2644	[-0.1242,0.6458]
Conditional Indirect Effect at Specific Value(s) of the Moderator(s)					
Continuous improvement Value	Indirect Effect		Bootstrapping SE		Bootstrap 95% C.I.
-0.4798	-0.0395		0.0616		[-0.1695, 0.0329]
0.0000	0.1226		0.0747		[0.0158, 0.2661]
0.4798	0.4551		0.1679		[0.2114, 0.7637]

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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