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Information technology and firm performance: the role of supply chain integration

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Abstract This study analyzes the correlation among integrative information technology (IT), supply chain integration (SCI), and firm performance. The results show that integrative IT is positively associated with firm performance through SCI. However, the results of this study show that integrative IT does not have a positive correlation directly with firm performance. It is considered that in the relationship between integrative IT and firm performance, a new approach such as business process-oriented view arguing that performance is yielded through the primary influence of IT is necessary rather than a traditional view that sets up their direct correlations. The findings have the following implications. First, this study presents an endeavor to investigate the consequences of integrative supply chain strategy. Second, this study provides implications in decision making so that supply chain managers can use IT in an effective way.

Keywords Information technology · Firm performance · Supply chain strategy · Supply chain integration

1 Introduction

Supply chain integration (SCI) is defined as the strategic collaboration of the manufacturer with its supply chain partners and the degree of collaborative management in both intra-organizational (i.e., among departments) and inter-organizational (i.e., among suppliers and customers) processes (Flynn et al. 2010; Zhao et al. 2011). Most previous studies on the relationship among information technology (IT), SCI, and firm performance have been constantly increasing. Most of the previous studies argued that the correlation between IT and firm performance (Albadvi et al. 2007; Carr and Kaynak 2007; Liang et al. 2010), and that between SCI and firm performance (Boyer and Lewis 2002; Prajogo and Olhager 2012; Cao and Zhang 2011; Khanchanapong et al. 2014) were positive. Also, there exist multiple studies, which argued that IT played a role of an enabler of SCI (Fawcett et al. 2011; Wu et al. 2014).

Nevertheless, there remain many research areas that previous studies could not address satisfactorily. First, while many previous studies dealt with the business utilizing IT in managing supply chain, in-depth studies on the relationship between the use of IT and firm performance from the process-oriented perspective in the area of supply chain management are rare (Tippins and Sohi 2003; Wu et al. 2006; Vijayasarathy 2010; Qrunfleh and Tarafdar 2014; Pavlou and El Sawy 2011; Wang et al. 2012). Therefore, studies on what process IT as an important resource of a company takes to improve firm performance need to be consistently made (Tippins and Sohi 2003; Melville et al. 2004; Wang et al. 2012).

Second, although previous studies managed to show that integrative information technology (IT) has a positive impact on SCI, what could be the consequences of integrative supply chain strategy has not been clearly described yet. An integrative supply chain strategy is defined as a business process that creates values by integrating not only firms but also suppliers and customers (Stevens 1989; Tan et al. 1998; Vickery et al. 2003). Integrative IT and SCI are the core constituents of an integrative supply chain strategy. Integrative IT is defined as technology that facilitates the collection of vital information concerning key business processes and the sharing of such

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information across functional areas and across firm boundaries. In other words, integrative IT means IT that enable the achievement of integration both internally and externally. Therefore, this study is aimed at contributing to the achievements of previous studies on the integrative supply chain strategy (Vickery et al. 2003; Prajogo and Olhager 2012) by examining the impact of integrative IT on firm performance.

This paper is structured as follows: Section 1 explores the research purpose and need; Section 2 reviews recent literature on theoretical background, integrative supply chain strategy, supply chain integration, and firm performance, and suggests hypotheses; Section 3 explains the research sample and measures; Section 4 presents the results of analysis; and Section 5 summarizes the findings and discusses the research implications.

2 Literature review and hypotheses development

2.1 Theoretical background

This study is largely based upon three strategic theories, which are resource-based view, relational view, and extended resource-based view. The resource-based view maintains that firms have a sustained competitive advantage because their resources have heterogeneous and immobile qualities (Hunt and Lambe 2000). Firm-specific resources include the total assets, capabilities, organizational processes, firm attributes, information, and knowledge that organizations manage in order to improve their effectiveness and efficiency. If all companies had homogeneous resources that could be duplicated, then those companies would apply the same strategies and fail to achieve competitiveness. According to resource-based view, firms must develop new products and new technologies and build internal capability through training and communications for sustained competitive advantage. In other words, resource-based view emphasizes internal integration (Leuschner et al. 2013).

Relational view asserts that resources important to an organization can be expanded beyond organizational perimeters because they are embedded in the relationship between organizations (Dyer and Singh 1998). According to relational theorists, an organization's sustained competitive advantage depends on its relationship with other organizations. Therefore, organizations must cooperate with suppliers and customers in their network. Relational theorists propose that competitive advantage stems from relationship-specific assets, complementary resources and capabilities, and effective governance. Relationship-specific assets are embedded in the relationship between an organization and its corporate partner (Teece et al. 1997), and comprise site specificity, physical asset specificity, human asset specificity, and dedicated asset specificity. Complementary resources and capabilities refer to generating a synergy effect, potentially greater than the sum of its parts, from inter-organizational exchange of resources. They have been highlighted as the main benefits of corporate partnerships. Lastly, effective governance refers to a governance structure that minimizes transaction costs and improves efficiency between companies. For sustainable advantage, relational view emphasizes building a network with suppliers and customers. In short, relational view emphasizes supplier integration and customer integration.

Meanwhile, Lavie (2006) proposed an extended resource-based view that represents a compromise between resource-based view and relational view. Whereas resource-based view conventionally argues that an organization must own or have complete control over its value-creating resources, extended resource-based view argues that access to resources, rights to use the resources, authority to enjoy the benefits associated with resources, and so forth comprise an organization's sustained competitive advantage (Hunt and Davis 2012). According to extended resource-based view, organizations can create a sustainable competitive advantage not only through internal integration but also through supplier integration and customer integration. In other words, extended resource-based view contends that organizations should extend their resources by tapping into those of their suppliers and customers.

2.2 Integrative supply chain strategy and firm performance

An integrative supply chain strategy as a business process integrates suppliers and customers as well as firms, and thereby creates values (Stevens 1989; Tan et al. 1998; Vickery et al. 2003). Integrative IT and SCI are the core constituents of an integrative supply chain strategy. Integrative IT is divided into IT capabilities and information sharing, both of which had significant effects on logistics integration (Prajogo and Olhager 2012). Integrative IT plays a crucial role in supply chain management. Wu et al. (2006) argued that IT could not enhance firm performance on its own, and information would need to be shared with suppliers and customers outside of the firm after firm-specific IT capabilities have been in place based on the resource-based view. Sharing of accurate information saves costs attributable to excessive inventories and shortages (Lee et al. 2000; Liu et al. 2013). Kulp et al. (2004) found that information sharing may have given companies a competitive advantage, which constituted a first step in supply chain integration. Li et al. (2009) revealed that IT did not directly affect firm performance, but the supply chain integration of the logistics system.

In addition, various researchers investigated the impact of the integrative IT on the performance of companies. A considerable number of studies argued that integrative IT has vast potential for improving a firm's financial performance

(Hendricks and Singhal 2003). Bharadwaj (2000) emphasized that the integrative IT was important in estimating the improved firm performance. Sanders and Premus (2005) verified empirically that integrative IT influenced the internal and external cooperation of a company, and had a direct and indirect impact on firm performance, and thereby emphasized the importance of the information technology. Vijayasarathy (2010) elucidated the direct effect of information technology on firm performance by performing a comparative analysis of the direct effect and mediating factors of information technology on supply chain and firm performance. In addition, some researchers presented the results of the empirical analysis suggesting that the relationship between the integrative IT and firm performance was not direct but indirect based upon the logic of process-oriented perspective (Tippins and Sohi 2003; Kim et al. 2011). Based on these studies, this study proposes the following hypotheses.

H1: Integrative information technology has a positive correlation with supply chain integration.
H2: Integrative information technology has a positive correlation with firm performance.

2.3 Supply chain integration and firm performance

Companies are realizing that they can secure competitive advantage through a mutual integration of partner companies within the supply chain (Horn et al. 2014). Supply chain integration (SCI) is defined as the strategic collaboration of the manufacturer with its supply chain partners and the degree of collaborative management in both intra-organizational and inter-organizational processes (Flynn et al. 2010; Zhao et al. 2011).

Despite a consensus among many contemporary scholars that supply chain integration consists of multiple dimensions, earlier studies offered a wide range of suggestions for how supply chain integration is constructed. Previous research has classified supply chain integration using a single dimension (Rosenzweig et al. 2003; Marquez et al. 2004), two dimensions (i.e., internal integration and external integration) (Stanley and Wisner 2001; Pagell 2004; Petersen et al. 2005), or multiple dimensions (e.g., supplier integration, internal integration, and customer integration) (Narasimhan and Kim 2002; Droge et al. 2004; Campbell and Sankaran 2005; Koufteros et al. 2007; Vickery et al. 2003). SCI is mainly divided into supplier integration, internal integration, and customer integration (Narasimhan and Kim 2002; Flynn et al. 2010; Zhao et al. 2011). Supplier integration represents strategic collaborations between an organization and its supplier through information sharing and strategic alliance (Lai et al. 2008), enabling costs reduction and profit sharing (Koufteros et al. 2007). Internal integration represents the collaborative and cooperative intra-organizational efforts to satisfy customer needs and maintain low costs in product design, procurement, production, distribution, and sales. Additionally, customer integration is a strategic action that improves visibility and makes possible joint planning by sharing company information and collaborating with customers (Fisher et al. 1994).

Many existing studies have explored the relationship between SCI and firm performance (Handfield et al. 2009; Vachon et al. 2009; Wagner and Krause 2009). Most SCM literature argued that supply chain performance improves in more integrated chains. Through integration, individual organizations within the supply chain system improve their robustness and agility, on the one hand, they exchange information and knowledge that should minimize the probability of disruption and, on the other hand, overall impacts should be minimized because information will flow quickly thus enabling faster and more meaningful reactions (Gualandris and Kalchschmidt 2014, 2015).

Study results vary depending on how supply chain integration dimensions and components and firm performance components are treated. For example, Shin et al. (2000) took a single-dimensional approach. They proposed the concept of supply management orientation, identified as long-term supplier–buyer relationships, supplier-involved product development, quality focus in selecting suppliers, and reduced supplier base. Their results showed that supplier management orientation significantly affects supplier and customer performance. Among the performance indicators, delivery and quality performance have a more significant effect than do cost and flexibility outcomes.

Next, Das et al. (2006) divided supplier integration into two dimensions: internal and external. The authors argued that optimal configuration in each dimension can maximize firm performance. This study examined both the positive and negative effects of supplier integration. Supplier integration lowers transaction costs in developing, negotiating, and monitoring and achieves economies of scale and economies of scope to improve firm performance. On the other hand, supplier integration can also reduce performance because of decreased flexibility and costs generated from coordination and compromise. As a result, the study revealed a non-linear relationship in which performance gradually drops as supplier integration efforts move farther away from the optimal point.

Lastly, some studies have divided supply chain integration into three dimensions and explored their relationship with firm performance. Lee et al. (2007) distinguished supply chain integration as supplier integration, internal integration, and customer integration. They empirically showed that all three integrations positively affect supply chain performance. The study revealed that internal integration has the largest impact on organizational costs containment, and that supplier integration is the best strategy for achieving reliable performance. Similarly to Lee et al. (2007), Flynn et al. (2010) divided

supply chain integration into supplier integration, internal integration, and customer integration. Further, they divided performance into operational and business, wherein operational performance includes process efficiency and logistics service performance and business performance includes financial performance and market share. Study results showed that internal integration had a significantly positive effect on both operational and business performances. While customer integration strengthened operational performance, it had no significant effect on business performance. On the other hand, although supplier integration had no significant effect on any of the performance measures, the interaction between supplier integration and customer integration had a significant effect on operational performance.

Based on the studies above, this study proposes the following hypothesis.

> H3: Supply chain integration has a positive correlation with firm performance.

3 Methodology

3.1 Research sample

An online survey company was contracted to compile surveys from manufacturing organizations in Korea. The target respondents were supply chain managers or production managers who understands the overall process of the firm well. Through this, it can be considered that all the respondents are in the position to answer the questionnaire. The contracted company sent out an email detailing the purpose of the study along with a survey URL to 2,000 participants on August 2016. Thirty five percent of the email recipients clicked on the URL. Upon two follow-up emails, 161 respondents replied, which accounted for 21.5%. Since it was an online survey, there were no missing data. The responses to the survey were made from the position of the focal firm that is the responding company, not the entire supply chain.

Table 1 presents the profile of respondents.

Table 1 Profile of respondents

Industry	Frequency
Food/grocery manufacturer	5
Semiconductor/electronic manufacturer	12
Chemicals/oil/rubber/plastic products	9
Apparel/textile/leather products	24
Machinery products	11
Automotive products	37
Mineral products	4
Furniture/fixtures products	20
Computer/communication equipment products	25
Other sectors	14

3.2 Measures

All the measurements were developed via the following stages in order to ensure the content validity: literature review to identify previously validated measures, development of a draft version, review of draft by invited academics and practitioners, pre-testing, and refinements to the questionnaire. Each question item except firm performance was scored using a five-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Similarly a five-point scale, ranging from 1 (strongly worse) to 5 (strongly better) was deployed to each question item for firm performance.

3.2.1 Integrative IT

Integrative IT is defined as technology that facilitates the collection of vital information concerning key business processes and the sharing of such information across functional areas and across firm boundaries. In other words, integrative IT means IT that enable the achievement of integration both internally and externally. This study measured integrative IT on a three-item scale adapted from Vickery et al. (2003).

3.2.2 Supply chain integration

Supply chain integration (SCI) is defined as the strategic collaboration of the manufacturer with its supply chain partners and the degree of collaborative management in both intra-organizational (i.e., among departments) and inter-organizational (i.e., among buyers, suppliers, and customers) processes (Flynn et al. 2010; Zhao et al. 2011). It was measured on a five-item scale based on Li et al. (2009).

3.2.3 Firm performance

In order to measure firm performance, this study used eight items adapted from Boyer and Lewis (2002), and Khanchanapong et al. (2014). These items included product quality, lead-time, flexibility, and cost.

3.2.4 Control variables

This study considered five control variables, namely, firm size, the industry, and alternative explanations (demand and supply uncertainty, supply chain complexity, and environmental and

social pressure). Specially, the firm size may be crucial to a firm's ability and firm performance (Zhou and Li 2010), so this study treated firm size as the control variable and measured it by the number of employees based on Koufteros et al. (2007). In addition, the industry may have significant effects on management (Frohlich and Westbrook 2001). Therefore, this study treated industry type as the control variable based on Golicic and Smith (2013). Finally, given that this study focuses on integrative IT, other drivers/antecedents such as demand and supply uncertainty (Lee 2002), supply chain complexity (Christopher et al. 2011), and environmental and social pressure (Gualandris and Kalchschmidt 2016) may affect the integrative IT. Therefore, this study controlled for these alternative explanations. Demand and supply uncertainty were measured with a two-item scale excerpted from Lee (2002). Demand and supply uncertainty increases as product life cycles are becoming shorter and product diversity greater. Supply chain complexity was measured with a six-item scale excerpted from Bozarth et al. (2009). They measured supply chain complexity by the number of suppliers and customers, product diversity, and so on. Environmental and social pressure was measured with a three-item scale excerpted from Gualandris and Kalchschmidt (2016). They proposed environment-related regulations that corresponds to environmental and social pressure.

4 Results

4.1 Measurement model reliability and validity

In order to evaluate the measurement model prior to testing the research model, Amos 18.0 was used to run a confirmatory factor analysis (CFA). This study broadly investigated previous studies and identified each construct with proven reliability and validity. Furthermore, a CFA was used to test whether the measured items, which are observed variables, appropriately constitute the latent variables. Tables 2 presents measurement model reliability and validity. The measurement model is supported by a number of goodness-of-fit indices ($\chi 2/df = 1.475$; CFI = 0.952; TLI = 0.964; RMSEA = 0.051) which satisfy the recommended cut-off values.

To test for reliability, Cronbach's α, CR, and AVE must be examined. Cronbach's α value must be above 0.7 (Hair et al. 2010). Analysis results show that all the constructs have a Cronbach's α value greater than 0.7. Furthermore, CR must be above 0.7 and AVE must be above 0.5 to confirm construct reliability (Bagozzi and Yi 1988). Analysis results show that all the constructs meet this requirement.

In addition, convergent validity and discriminant validity must be determined in order to evaluate construct validity.

Table 2 Measurement model

Construct (Source)	Loading	Reliability and validity
Integrative information technology (Vickery et al. 2003)		$\alpha = 0.925$; CR = 0.859; AVE = 0.713
Using integrative electronic data interchange (i.e. integration of paper-less (electronic) documents into business systems with no manual intervention)	0.81	
Using integrative information systems (i.e. use of information technology that enables all functional areas to access and transmit information from one to another)	0.91	
Using computerized production systems (i.e. use of computer systems (such as MRP or MRP II) for planning, tracking, and ordering components and products throughout the manufacturing operations)	0.87	
Supply chain integration (Li et al. 2009)		$\alpha = 0.897$; CR = 0.824; AVE = 0.683
Understanding of market trends and accuracy of demand forecasting	0.84	
Accuracy and adaptability of SCM planning	0.87	
Control and tracking of inventory: accuracy and visibility	0.78	
Process standardization and visibility	0.75	
Strategies for optimizing logistics system resources based on design for logistics	0.89	
Firm performance (Boyer and Lewis 2002; Khanchanapong et al. 2014)		
Product durability	0.77	$\alpha = 0.854$; CR = 0.782; AVE = 0.632
Conformance to specifications	0.84	
Procurement lead time	0.78	
Delivery speed	0.83	
Easily change the production volume of a manufacturing process	0.85	
Easily modify products to a specific customer need	0.74	
Production cost	0.91	
Inventory turnover	0.82	

Convergent validity is related to indicators that show the extent of correspondence or convergence among variables that measure the same or similar constructs (Anderson and Gerbing 1988). Discriminant validity is related to indicators that show dissimilarity among variables that measure unrelated constructs. Generally, a construct reliability (CR) value greater than 0.7 and average variance extracted (AVE) value greater than 0.5 establish convergent validity (Bagozzi et al. 1991). Analysis results show that the CR was higher than 0.7 and AVE was higher than 0.5, thus indicating convergent validity. Discriminant validity is assessed by examining whether a square root of the AVE is higher than the correlation coefficient between the constructs (Hair et al. 2010). Analysis results showed that all square roots of the AVE were higher than the correlation coefficient between the constructs, thus confirming discriminant validity of the constructs (Table 3).

4.2 Common method variance

Common method bias is possible when the data for both predictor and criterion variables were obtained from one single person in the same measurement context. It may exert great influence on measurement validity, thus distorting research results by increasing or decreasing the correlation between variables (Podsakoff et al. 2003). Harman's single-factor test is the representative technique to account for common method bias. The results of Harman's single-factor test conducted in this study showed that the largest factor explained 29% of the covariance, which indicates that there is no significant evidence of severe common method bias (Flynn et al. 2010).

4.3 Hypotheses testing

In examining the fit indices of the structural model, it was shown that $\chi 2/df = 1.628$, CFI = 0.929, TLI = 0.931, RMSEA = 0.057 indicating a fitting model that satisfies the criteria for each index.

Next, the hypotheses were verified by examining the standardized path coefficients of the model. H1 proposed a positive correlation between integrative IT and SCI, and this hypothesis was supported by a standardized path coefficient of 0.37 (t = 3.065, p < 0.01). H2 proposed a positive correlation between integrative IT and firm performance. H2 was not supported given a standardized path coefficient of 0.15 (t = 1.182, $p > 0.05$). Moreover, H3 stated that there was a positive correlation between SCI and firm performance. Since the standardized path coefficient was 0.43 (t = 3.927, p < 0.01), this hypothesis was supported. This result means that SCI improves firm performance. Additionally, this study uses a sobel test to attest that the overall indirect effect of integrative IT on firm performance through SCI is statistically significant (Baron and Kenny 1986; Gualandris and Kalchschmidt 2016). The independent variable is integrative IT, the mediating variable is SCI, and the dependent variable is firm performance. Result of the sobel test suggests that the indirect effect of integrative IT on firm performance via SCI is significantly different from zero (F = 29.84, $p < 0.01$). Taken overall, findings suggest that for manufacturers, integrative IT and SCI lead to enhanced firm performance.

Table 3 Correlation of constructs

	Mean	Standard deviation	IIT	FP	SCI
IIT	3.25	0.76	0.713		
FP	3.71	0.82	0.398**	0.632	
SCI	3.80	0.59	0.450**	0.427**	0.683

AVE is on the diagonal

IIT Integrative information technology, *FP* Firm performance, *SCI* Supply chain integration

** $p < 0.01$

4.4 Comparison between research model and alternative structural model

To enhance the adequacy and validity, this study investigated not only the model proposed but also alternative structural model. Table 4 shows the comparison between the research

Table 4 Comparison of research model and alternative model

	Model 1	Model 2
Structural paths		
IIT → SCI	0.37**	0.37**
IIT → FP	0.15	
SCI → FP	0.43**	0.41*
Model fit indices		
χ^2/df	1.719	2.965
CFI	0.925	0.874
TLI	0.924	0.855
RMSEA	0.061	0.073
PNFI	0.704	0.657
AIC	152.425	173.509
CAIC	263.857	282.635
Variance explained (R^2)		
FP	0.149	0.152

IIT Integrative information technology, *SCI* Supply chain integration, *FP* Firm performance, *CFI* Comparative fit index, *TLI* Tucker-Lewis Index, *RMSEA* Root Mean Square Error of Approximation, *PNFI* Parasimonious Normed Fit Index, *AIC* Akaike's Information Criterion, *CAIC* Consistent Akaike's Information Criterion

** $p < 0.01$, *$p < 0.05$

model and alternative structural model according to the criteria proposed by previous studies (Morgan and Hunt 1994; Paulraj et al. 2008), and subsequently found that our proposed model was the more adequate.

5 Conclusions

This study analyzes the correlation among integrative IT, SCI, and firm performance. The findings of this research are summarized as follows. The results show that integrative IT is positively associated with firm performance through SCI (H1 and H3). This suggests that firm performance is engendered by integrative supply chain strategy (integrative IT and SCI). This result is consistent with that of the study by Vickery et al. (2003), which emphasized the importance of integrative supply chain strategy. However, the results of this study show that integrative IT does not have a positive correlation directly with firm performance (H2). Such a result is in agreement with the study by Tippins and Sohi (2003), Kim et al. (2011), but not with that of Sanders and Premus (2005). If this is interpreted on the basis of the results of the study by Vijayasarathy (2010), it can be seen that the use of IT has different impacts on performance depending on the extent of partnership on the supply chain. Thus, it is considered that in the relationship between IT and firm performance, a new approach such as business process-oriented view arguing that performance is yielded through the primary influence of IT is necessary rather than a traditional view that sets up their direct correlations.

The findings of this study have the following academic and practical implications. First, this study presents an endeavor to investigate the consequences of integrative supply chain strategy. This study contributes to research related integrative supply chain strategy by examining the relationship between integrative IT and firm performance through SCI and expands the scope of available research. The result of this study supports previous researches which concluded that integrative IT within supply chain networks leads to higher level of SCI (Zhang et al. 2005; Koh and Saad 2006; Prajogo and Olhager 2012). Prajogo and Olhager (2012) highlighted that information integration is important for SCI, having significant effects on firm performance. Second, this study provides practical implications in decision making so that supply chain managers can use IT in an effective way. Supply chain managers of today know that IT is important, but often do not succeed in using it in an effective way (Gunasekaran and Ngai 2004). And it is not because companies have these IT systems that they outperform. There are also a lot of failures in this respect. The results of this study show that integrative IT was found to have positive correlations with firm performance through SCI. This suggests the direction and order in building an information system. When companies conduct supply chain management using IT, they first need to establish a system for information integration within a focal firm, and possess the integrative IT. Subsequently, they have to seek information integration with partners in the supply chain (Narasimhan and Kim 2001).

This study has a few limitations, and the direction of future studies to overcome these are as follows. First, this study has a limitation that only a mediating variable SCI was taken into consideration. It is expected to better understand the impact of integrative IT on firm performance by measuring more diverse mediating variables in future studies. Second, this study did not closely examine the integrative supply chain strategy since a cross-sectional survey was conducted. In future studies, a longitudinal survey can lead to more in-depth investigation. Finally, the survey based on the perception of respondents was performed in this study. Although Murphy and Callaway (2004) revealed that subjective measures based on perception of respondents were highly correlated with objective measures, higher reliability is expected if firm performance is measured using the secondary data in future studies.

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