2010

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This research was supported by the **Babson Faculty Research Fund**
Course Release / Spring 2008

BABSON
FACULTY RESEARCH FUND

THE ROLE OF COMPLEMENTARY RESOURCES IN THE DEVELOPMENT OF E-SUPPLY CHAINS AND THE FIRM'S PERFORMANCE: AN EXPLORATORY ANALYSIS OF SECONDARY DATA

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No. WP 1015 – CR s08

BFRF WORKING PAPER SERIES

This research was supported by the
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ABSTRACT

E-supply chains (e-SCs), which are Internet-enabled supply chains, are progressively being implemented in companies to improve their operational and financial performance. Several studies exist where the association between the development of an e-supply chain and the performance of a firm, has been investigated. However, there is a paucity of literature that describes how information technology (IT) resources interact with other complementary resources to e-supply chains to positively impact a firm's performance. This paper seeks to adopt a resource-based view of the firm (RBVF) and empirically tests a framework that identifies and validates the relationships among IT resources, complementary resources to e-supply chains, and performance of a firm. This study utilizes secondary data from two sources – data collected by the South Korean Ministry of Commerce, Industry and Energy (MOCIE) and financial data from the Korea Exchange. The data from a total of 170 firms representing 10 industries in South Korea were analyzed using a partial least-squares technique (PLS). The results of the analysis confirm that IT resources do not directly influence supply chain performance. However, when associated with a complementary resource, IT resources positively affect both supply chain operations and a firm's financial performance. The findings of this research support the current existing literature on the RBVF approach with regard to the domain of supply chain management, and can provide additional insights to industry practitioners on how to effectively utilize complementary resources in developing e-SCs to deliver improved performance.

Keywords: Resource-Based View (RBV), Supply Chain Management, Performance Measurement, Partial Least Squares, Secondary Data

INTRODUCTION

With escalated expectations of a firm's performance, and the emergence of globally dispersed supply chain networks, companies are presented with increased levels of complexity in the management of their supply chains. Both academia and practitioners have increasingly considered information technology (IT), and in particular, Internet, as one of the strategic resources that enables firms to reconfigure their supply chain capabilities to better manage the rising complexity of meeting consumer demand (e.g., Cagliano et al., 2005). As a result, firms have progressively developed e-supply chains with the assistance of Internet-based applications expecting an immediate improvement in both operational and financial performance. Numerous studies report potential performance improvement with e-supply chains (e-SCs) that are directly observed as cost reductions, increased responsiveness, and better financial performance (e.g., Croom, 2000; Frohlich and Westbrook, 2002; Dehning et al., 2007).

Nevertheless, not all firms appear to be leveraging the IT resources to the same extent in managing their supply chains. For example, Emiliani and Stec (2002) reported that 40% of the firms in the logistics service industry that implemented Internet-based applications to their supply chain activities, considered their operations to be either "very ineffective" or "somewhat ineffective." In their study of developing supply chain strategy taxonomy, McKone-Sweet and Lee (2008) reported a high level of Internet-based application use in managing supply chain does not explain the performance variances among firms.

The inconsistent conclusions drawn from these reports raise a general but important question: Why is it that only some companies have better operational and financial outcomes with e-supply chains? The resource-based view of the firm (RBVF) provides a framework for augmenting our understanding of these inconsistent results. In describing the inconsistent results, many RBVF scholars emphasize the role of complementary resources (CRs) in explaining the relationship between the implementation of IT and the performance improvement of a firm (Barney, 1991; Clemons and Row, 1991; Powell and Dent-Micallef, 1997).

This paper seeks to adopt the RBVF to explore how CRs are associated with IT resources in e-SCs to produce better performance. More specifically, this study investigates the main and mediating effects of CRs in shaping the relationship between IT resources and supply chain performance in e-SCs.

LITERATURE REVIEW

Resource-based View of the Firm (RBVF)

The focus on what causes firms to succeed has been shifted from the subject, who establishes and executes the strategies, to the environmental factors surrounding a firm, to the internal resources (Cho and Lee, 1998). A third perspective, known as the resource-based view of the firm (RBVF), has been considered extensively in additional research that explores the root cause of a firm's success. According to RBVF, the competitive advantage of a firm stems from its resources and its ability to bundle them in a unique way rather than from exogenous factors.

The literature on RBVF illustrates that firms hold heterogeneous resource-portfolios as a result of design, history, or luck, and that this heterogeneity is responsible for explaining the differences in the financial returns of firms (Barney, 1991). However, the above-normal return that yields a so-called 'competitive advantage' (Porter, 1991) tends to vanish when competitors can readily acquire resources from a factor market. Accordingly, one of the focal points of RBVF is how to increase the barriers to imitation, known as *'isolating mechanisms'* that produce a sustained competitive advantage. Rumelt (1984) proposed four different ways of realizing ‘isolating mechanism’: 1) time compression diseconomies; 2) historical uniqueness (first-mover advantages); 3) embeddedness of resources; and 4) causal ambiguity.

Among others, the third mechanism (embeddedness of resource) was further developed by Dierickx and Cool (1989) who suggested that firms need to develop firm-specific resource bundles, or “capabilities”, by combining resources in unique and inextricable ways. These resources that are inextricably combined into resource bundles, are known as complementary resources (CRs), and provide a way to achieve and sustain a competitive advantage (e.g., Black and Boal, 1994).

RBFV has been gaining recognition in SC domain, as it can substantiate the understanding of the relationship between supply chain management and the performance of a firm. Rungtusanatham et al., (2005) discussed supply chain linkages as a resource that can not only impact a firm’s operational performance but also assist in the acquisition of other resources that lead to better operational performance. Kim et al., (2005), through their investigations of when IT contributes to a firm’s performance, found that IT adoption was linked directly to market performance only when the partner firm also adopted IT to coordinate its operational activities. Most recently, Ordanini and Rubera (2008) examined the link between procurement capabilities, Internet resources, and performance in the textile and clothing industry. The results of the study also confirmed that Internet resources are linked to the performance of the firm but only through other CRs such as process efficiency and process integration in their study.

Complementary Resources

As a result of the explosive development of information technology (IT), researchers investigated the impact of IT investment on a firm’s financial performance. However, reported results of these studies remain inconsistent. While some articles demonstrated a positive relationship between IT investment and performance (e.g., Wiseman, 1985: Buday, 1986), others disputed the existence of such a relationship (e.g., Brynjolfsson and Hitt, 1998; Panko, 1991: Dent-Michallef, 1997). Drawing on RBVF, Clemons and Row (1991) proposed the resource-based 'strategic necessity hypothesis' to explain the inconsistent relationship between IT investment and performance. It suggests that IT *per se* does not create a competitive advantage, but IT can create a competitive advantage only when it leverages and exploits complementary resources (CRs).

A number of studies have emphasized the role of CRs to explain the relationship between IT implementation and a firm's performance (e.g., Clemons and Row, 1991; Powell and Dent-Micallef, 1997; Power, 2005). The results of these studies indicate that firms should consider not only the acquisition of IT resources but also the manner by which IT resources are combined with CRs to generate performance improvement.

Researchers have also identified various CRs that can be correlated to the implementation of new IT. For example, several case studies proposed that the utilization of qualitative organizational variables such as CEO commitment, culture of company, management vision and consensus for the implementation of new IT influence performance (e.g., Neo, 1988; Hansen and Wernerfelt, 1989; Powell, 1995). Some researchers suggest that firm-specific IT training programs, skills, and tacit knowledge of employees also serve as CRs that can leverage the value of new IT, while others discuss supplier relationships, business process design, IT planning, and the structure of organizations (e.g., Keen, 1993; Hammer and Champy, 1993). Powell and Dent-Micallef (1997), through their research on CR, place CRs into three buckets - human resources, business resources and technology resources.

Furthermore, the literature on supply chain management has shown an increasing acceptance by industry experts of various CRs to e-supply chains. In their in-depth case study of a paint firm, Lee at al., (2008) identified seventy-one CRs and reported on the degree to which certain types of CRs supported the successful implementation of Internet-based applications in a supply chain. The results of this study indicated that different CRs play a unique role in the development of e-supply chains. Ordanini and Rubera (2008) depict the complementary relationship of the ability to reduce costs and the ability to effectively incorporate procurement in the supply chain with Internet-based applications. The Ministry of Commerce, Industry and Energy (MOCIE) in the Republic of Korea, based on the Ser-M model (Cho & Lee, 1998), identified four CRs that have supported the implementation of Internet-based applications in managing various activities in supply chains since 2002. The four resources are environment, IT & infrastructure, process, and people.

The Development of E-Supply Chains and Performance

The distinct capabilities gained from developing e-supply chain, which is built upon Internet-based applications, substantively influence the way firms respond to demand. The reasons are three-fold. First, the universal protocol of Internet enables firms to synchronize the flow of information, which results in a more balanced demand across the entire supply chain. This synchronized information flow contributes to the countermeasures used in solving the typical problem of information distortion known as the 'bullwhip effect' (Lee et al, 1997). Second, the new way of delivering information allows firms to replace traditional labor-intensive interfaces including printed catalogs, showrooms, and certain retail stores with some products and services (Rao, 1999; Stenfansson, 2002). Finally, given the cost efficiency of the Internet, e-supply chains that can helps firms reduce the magnitude of the tradeoffs that result from reducing cost and improving responsiveness in supply chains management (Frohlich and Westbrook, 2002).

The numerous effects of implementing Internet-based applications to support supply chain processes are examined in several studies, including purchasing (Emiliani and Stec, 2002; Boer et al., 2002; Willcocks & Plant, 2003), production (e.g., Sarkis and Sundarraj, 2002), and distribution (Rao, 1999; Ellinger, et al., 2002). The expected supply chain performance benefits include reduced transaction costs in purchasing, reduced levels of inventory across a supply chain, shortened production planning horizons, and increased potential for optimal distributions (Robinson, et al., 2005). Contrary to these results, McKone-Sweet and Lee (2008) reported that a positive association between the use of Internet-based applications and supply chain performances does not exist.

Some studies explored the relationship between the implementation of IT in supply chains and financial performance. Byrd and Davidson, (2003) examined the impact of IT on supply chain, and the effect of these relationships on overall firm performance. However, the study used perceived financial performance rather than an actual measure. In the examination of the effect of the information sharing ability on buyer-supplier relationships and firm performance, Hsu et al., (2008) included three financial performance measures such as market share, return on assets, and average selling price. While previous studies recognize the need to further understand the relationship among complementary resources (CRs), e-supply chains, and other selected variables, little effort has been made to further explore the relationship among CRs, supply chain performance, and financial performance. This study develops a conceptual framework from the synthesis of prior research, and investigates the role of CRs within the proposed framework.

Conceptual Framework

This study examines data identified four resources that function to support the e-supply chains based on the Ser-M model (Cho and Lee, 1998). These resources are ‘IT and Infrastructure,’ ‘Environment,’ ‘People,’ and ‘Process.’ It also considers both operational and financial performance. In this section, we present our conceptual framework as shown in **Figure 1.** We consider the direct relationship between Environment, IT and Process resources and SC performance, the direct relationships between IT and People resources and Process resources, and the direct relationship between SC performance and financial performance. We describe each relationship below.

[Insert Figure 1 Approximately Here]

IT and supply chain performance. Upon review of the existing literature there is an abundance of papers that consider the relationship between IT and supply chain performance. While the role of IT varies, the most commonly reported view is that IT has a positive impact on the management of supply chains that result in higher performance (e.g., Lee et al, 1997; Stenfansson, 2002; Robinson, et al., 2005). The major functions of IT in supporting supply chains that have been identified include information visibility, coordination, and decision support (Auramo, et al., 2005). IT can share information across supply chains that enable a single point of contact for data. This enables the firm to make decisions based on more comprehensive supply chain information, and support the collaboration between supply chain partners (e.g., Frohlich and Westbrook, 2002). Therefore, the following hypothesis has been developed:

Hypothesis 1: IT and Infrastructure resources in the development of e-supply chains are positively associated to SC performance.

IT, Process, and Supply Chain Performance. On the contrary, there are some studies that report insignificant results between IT and supply chain performance (e.g., Emiliani and Stec, 2002; McKone-Sweet and Lee, 2008) indicating that there may exist an indirect relationship between IT and performance. Several studies describes how IT can influence various processes in supply chains (Emiliani and Stec, 2002; Boer et al., 2002; Sarkis and Sundarraj, 2002; Ellinger, et al., 2002; Lee, 2008). Since the supply chain encompasses various processes such as purchasing, production, delivering, and selling, one of the main foci of managing a supply chain is the integration and configuration of various processes that maximize the fulfillment of market demand. Therefore, we hypothesize that IT resources are positively associated with the process complementary resources (CRs) as below:

Hypothesis 2: IT& Infrastructure resources in the development of e-SCs are positively associated to process complementary resources to e-SCs.

In a study of investigating barriers of e-integration in the supply chain, Frohlich (2002) identified eight web-based processes under the construct of e-integration in supply chains and reported the positive relationship between those processes and performance. More recently, Ordanini and Rubera (2008) identified two key process capabilities in the procurement domain; the ability to reduce cost while maintaining relationships with external suppliers and internal activities, and the ability to effectively incorporate procurement in the entire supply chain to ultimately reduce the time-to-market and improve the with the response to market needs. Several studies discuss either the importance of business process changes to performance achievement or the mediating role of process between IT resources and performance (Favilla and Fearne 2005; Ravichandran and Lertwongsatien, 2005). Therefore, this study proposes a positive relationship between process CRs and supply chain performance as below:

Hypothesis3: Process complementary resources to e-SCs are positively associated to SC performance.

People and Supply Chain Performance. In our study, people CRs consider the support of the organization from various levels such as the CEO, senior executives, team members, and employees of the organization. Numerous studies highlight the importance of the organizational resources, such as top management involvement in IT implementation (e.g., Chatterjee et al., 2002; Jharkharia and Shankar, 2005), managers commitment (e.g., Powell and Dent-Micallef, 1997; Lai et al., 2008), and organizational support in general (Favilla and Fearne, 2005). Organizational resources are important in the development of the process CRs. Our study hypothesizes that the people CRs to e-SCs have a positive relationship with the development of process CRs. Therefore, our conceptual model shows that both people and IT resources influence the development of the process resources and are CRs. Thus, our study offers the following hypothesis:

Hypothesis 4: People complementary resources to e-SCs are positively associated to process complementary resources to e-SCs.

Environment and Supply Chain Performance. Environment CRs in our data represent the readiness of e-SCs from the perspectives of the supplier side, buyer side, and industry in general. The integration with upstream suppliers and downstream buyers is one of the main foci of supply chain research (Frohlich, 2002; Cagliano et al., 2003). Several studies describe the role of partner's "readiness" from upstream and downstream activities to achieve integration through information technology in supply chains (Hoogeweegen et al., 1998; Soliman and Janz, 2003). The environment in terms of network infrastructure and policy at the industry level are also considered as factors that affecting e-supply chain performance (Soliman and Janz, 2003). Because the level of e-SC environment readiness can directly affect the performance of the firm and its supply chain, they study hypothesizes a direct relationship between the supply chain readiness (environment) and supply chain performance. Therefore we consider the following hypothesis:

Hypothesis 5: Environment complementary resources to e-SCs are positively associated to SC performance.

Supply Chain Performance and Financial Performance. Frohlich (2002) proposed two different e-SC related performances. The first was conventional SC performances such as delivery lead-time, transaction cost, and inventory turns. The second was the transaction amount through e-SCs. Due to reduced inventory levels and lowered transaction costs, firms can realize the immediate cost-benefit of e-SCs (e.g., Malone et al., 1987; Lai et al., 2008). In addition, several studies suggest that the improved responsiveness of the firm due to the shortened lead-time increases the customer satisfaction levels which resulted in improved sales performance (e.g., Stank et al., 1999a; Hsu et al., 2008). Singhal and Hendricks (2005) showed that there a statistically significant relationship exists between the effect of both long-term stock price and equity risk. This study utilized both the perceptual and actual performance of a firm. For the perceptual performance, we incorporated into our analysis the established supply chain performance measures of the secondary data such as lead-time, cost, quality, and inventory reduction. We also used economic-goodwill as a financial performance measure as suggested by research in the domain of accounting (Ohlson, 1995; Feltham & Ohlson, 1995). Therefore, this study tests the following hypothesis:

Hypothesis 6: SC performance is positively associated to financial performance.

METHDOLOGY

Secondary Data Analysis

This study utilizes secondary data to test the proposed conceptual model described in the previous sections of this paper. We utilize two sources for the data – data collected by the South Korean Ministry of Commerce, Industry and Energy (MOCIE) and financial data from the Korea Exchange. Utilizing two sources - one for measuring the resources and another for measuring the financial data - ensures that there were no common reporter/method biases in the data.

The secondary data that were collected by the Ministry of Commerce, Industry and Energy (MOCIE), South Korea in 2002 was based on the Ser-M model (Cho & Lee, 1998). MOCIE identified four main resources that function to support the business transaction between supply chain partners for the purpose of measuring the degree of e-commerce utilization. Since 2002, MOCIE has continued its data collection efforts through a survey that is conducted on an annual basis from 11 industries such as Finance, Telecom, Electronics, Automobile, Petrochemical, Distribution, Construction, Transportation, Machinery, Steel and Textile/Apparel. The top 50 firms in terms of revenue for each industry are asked to participate in the survey and 500 firms responded in the survey of 2002. Since this survey is conducted by the South Korean government, survey participation is extremely high, with a response rate of 90.1 %.

As indicated in **Table 1**, the survey questions include four resource constructs such as environment, IT & Infrastructure, Process, and People, and one performance (or value) constructs. For each resource construct, multiple components are developed to better capture each construct. All variables were measured using Likert-type scales comprised of seven items with the total of 100 questions (Appendix A). The weights of components, which were acquired from a Delphi method, are assigned in order to develop index scores. The participants in the Delphi panel include scholars, Chief Information Officers, and statisticians.

[Insert Table 1 Approximately Here]

The research team also collected financial performance data from the Korea Exchange (KRX). Economic-goodwill was selected to measure financial performance. The equation for calculating economic-goodwill is like as follows:

Economic-goodwill = (Pit-BVit)/TAit-1

Pit = Price of i firm at the time of t

BVit = Book Value of i firm at the time of t

TAit-1 = Total Assets of i firm at the time of t-1

This research collected the financial data for those firms that were publically available from the Korean Exchange Data. The Finance industry, due to its unique structure of financial statement, was excluded from the analysis to maintain the homogeneity of the sample. When the research team merged the data from MOCIE and KRX, 170 firms had complete data. We used this subset of the data for our analysis.

A Preliminary Descriptive Analysis

The first column of **Table 2** shows the number of firms by industry. The petrochemical industry holds the largest portion of firms surveyed (16.5%) followed by the construction (15.3%) and steel industries (14.1%). The total scores in the last row of **Table 2** show that the environment resource has the highest average index score (60.41) followed by process (52.59), IT and Infrastructure (50.84), and human (50.81). As shown in **Table 2**, the results indicate the environment resource that represent the readiness of e-supply chains from both upstream and downstream, and from industry in general shows relatively higher score when compared to other resources.

[Insert Table 2 Approximately Here]

As show above, the acquired secondary raw data are Index data. This study transformed the index data into continuous variables dividing by 100 in order to reduce any variances. The integrity of the analysis was preserved.

Measurement Model

The measurement model was estimated using a structural equation model approach because the model was based on regression analysis with latent variables. The partial least squares (PLS) technique was used to demonstrate the predictive nature of this study and to avoid the multi-collinearity and measurement errors (Demirbag et al., 2007).

As Hulland (1999) suggested, the model was analyzed and interpreted in two steps: Step 1) factor loadings were utilized to assess of the reliability and validity of the measurement model; Step 2) structural paths were collected to assess the structural model. **Table 3** illustrates the measurement model.

[Insert Table 3 Approximately Here]

With regard to item reliability, Hair et al., (1998) suggested that loadings of indicators on latent constructs greater than 0.7 were sufficient to establish reliability. All of variables in the model exceeded the criteria set by Hair et al., and none were below the threshold value of less than 0.4-0.5, which resulted in good indicator reliability.

Convergent validity can be assessed by examining the composite reliability and the average variance extracted (AVE) measures (Hulland, 1999; Hair et al., 1998). The threshold of 0.7 for the composite reliability value and the threshold of 0.5 for the AVE value were considered to assess the consistency of the construct and convergent validity respectively. All constructs in the model met the requirement.

Discriminant validity was evaluated by comparing the AVE of each construct and the variance shared between such constructs and other constructs in the model. The correlation matrix is presented in **Table 4** below and the square root of the AVE value was calculated for each of the constructs along the diagonal. Because the square roots of AVE values were greater than the off-diagonal elements in the corresponding rows and columns, our analysis supports the discriminant validity (Hair et al., 1998; Hulland, 1999).

[Insert Table 4 Approximately Here]

The Analysis of Causal Paths

To test the proposed hypotheses, the structural model was fitted using the full sample as shown in **Figure 2**. As suggested by Chin (1998). the hypotheses for this study were either accepted or rejected, based on whether or not the t-value associated with each path exceeded the criterion of practical significance for the 0.05 significance level (t-value >1.96). **Figure 2** shows the path coefficient for the associated hypotheses and significance level in parenthesis.

As indicated by the path loadings, IT and Infrastructure do not have a significant relationship to perceptual SC performance (β = 0.017, t-value = 0.184). However, the path from IT and Infrastructure to process complementary resources (CRs) (β = 0.392, t-value = 4.033) and process CRs to perceptual SC performance are highly significant. This result confirms our theoretical expectation that IT alone does not provide a source of performance advantage. The results support for H1, H2, and H3 by demonstrating that process CRs mediates the relationship between IT and Infrastructure and perceptual SC performance. Environment CRs has significant direct influences on perceptual SC performance (β = 0.260, t-value = 3.549) and support H4. The paths from people CRs to process CRs (β = 0.511, t-value = 5.670) and from process CRs to perceptual SC performance (β = 0.017, t-value = 7.532) are significant. This result indicates that process CRs mediates the relationship between people CRs and perceptual SC performance. In turn, H5 and H3 are supported respectively. Finally, perceptual SC performance has both a positive and significant relationship to financial performance (β = 0.180, t-value = 2.346) supporting H6.

The results also present second-order constructs and their significant implications to the main constructs as shown in **Figure 2**. Each of these second-order constructs is significant ($p< 0.001$) with a high magnitude of beta value (ranged from β = 9.001 to β = 52.956). This supports the conceptualization of the dependent construct as a second-order structure in the survey conducted by MOCIE (Kelloway, 1998).

CONCLUSION

Managerial Implications

The role of complementary resources is tested based on the conceptual framework that this study developed based on prior literature. First, the outcomes of analysis suggest that the IT and

Infrastructure resources alone do not automatically lead to the positive effect on supply chain performance. This result supports the prior studies that report insignificant relationship between IT and performance. Nevertheless, IT and Infrastructure resources are indirectly related to performance through process complementary resources (CRs). The implementation of IT has often occurred without considering process changes assuming that the IT will directly support existing process (Sherer, 2005). However, our findings suggest that process CRs to e-SCs play a mediating role in shaping the relationship between IT and performance. Furthermore, our results find that people CRs, commensurate with IT and infrastructure resources, lead to high levels of process CRs. Managers need to understand and support the co-development of the CRs of IT, people and process.

Our research also shows what the relationships between both IT and infrastructure resources and people CRs with SC performance are mediated by process CRs. This provides further support that the co-development of these CRs leads to the development of process CRs and SC performance.

In our study, the environment construct capture the level of readiness from buyers and suppliers, and industry in general to develop e-SCs. Our results emphasize the importance of the SC environment to the overall SC performance. Managers need to consider the SC environment when developing e-SCs. It is only when suppliers, buyers and industry are ready and has the resources to consider supply chain coordination that a firm can get the most from its internal supply chain resources.

Finally, we find a positive and significant relationship between SC performance and financial performance. While there have been inconsistent reports on this relationship, this study shows that higher levels of supply chain performance are associated with higher levels of financial performance. If we assume that the ultimate goal of an enterprise is to maximize the firm's value and its ultimate measure is the stock price, the economic goodwill is a critical indicator of the value of a firm. This indicates that the supply chain performance is positively associated with the ultimate firm's value. These results are important to managers who are engaged in or who are trying to engage others in the development of supply chain CRs and the improvement of SC performance.

This study identifies the specific roles of CRs and explains how those resources are interconnected. This outcome can provide insights to practitioners in developing roadmap of e-SC implementation. Our analysis suggests that firms need to consider the balance between investments on resource acquisition and development and investments in IT resources.

Limitations and Indications for Future Research

The contributions of any research work must be considered in the light of limitations which will be the stimuli for future research (Ordanini and Rubera, 2008). The most significant limitation of this study was its narrow focus on Korean firms, thus precluding the generalization of findings to other emerging economies. Second, the CRs that we included in our study are selective rather than exhaustive. Due to the predetermined CR variables in the secondary data, this study includes only four resources in developing conceptual model and excludes other potential CRs that may affect the relationship in the model. Our analysis could not add control variables for example industry and size due to the small number of sample from each industry and because of the data availability of firm's size.

While there are numerous advantages of using secondary data, our research team experienced some difficulties in acquiring the raw data when the data is not publically available. It is suggested that researcher try to become involved with establishing the structure of the survey and data so that you can influence the type of data that is collected by secondary sources. It is also suggested that you provide your own confidentiality contract form promising that you will not reveal the raw data and will not use the data for purposes other than for academic research. Although our research team was only able to acquire the 2002 survey data when we conduct the current analysis, we now are in the process of acquiring the 2008 survey data. This additional data will allows us to better understand the evolving role of CRs. Future analysis needs to include how the role of CR changes as a firm grows in maturity relative to e-SC implementation.

TABLES

[Table 1] Score Card for the Index

Construct	Weight
Environment (15%)	Customer (30%) Supplier (30%) Industry (20%) Policy & etc. (20%)
IT Resource & Infra (20%)	Computing & Networking (18%) Security & Risk Mgt. (17%) DB & System Integration (19%) IT staff & policy (22%)
Process * (35%)	Buy side Operations Sell side Support
People (30%)	CEO (44%) Executives (23%) Team (18%) Organization (15%)
Value	The effects and values acquired by implementing ITs in supply chain

*The weight for the components of process construct is adjusted for each industry

[Table 2] Web-enabled Supply Chain Index Score

	No of Firms	E-supply chain Index Score				
		Env.	IT & Infra	Process	Human	Overall
Industry						
Apparel	17 (10%)	54.4	46.3	41.5	43.1	46.3
Petrochemical	28 (16.5%)	57.9	48.4	50.2	51.4	51.7
Steel	24 (14.1%)	52.2	46.3	48.3	39.8	46.6
Machinery	10 (5.8%)	63.4	50.8	53.9	50.4	54.6
Electronics	20 (11.8%)	69.3	54.1	54.5	55.1	58.2
Automobile	16 (9.4%)	70.3	49.2	54.4	52.0	56.5
Construction	26 (15.3%)	56.8	49.4	55.1	49.7	52.8
Distribution	12 (7.1%)	64.2	54.4	49.8	54.8	55.8
Transportation	11 (6.5%)	60.8	55.1	64.9	60.9	60.4
Telecommunication	6 (3.5%)	71.3	78.6	66.0	74.3	72.5
Total	**170**	**60.41**	**50.84**	**52.59**	**50.81**	**53.66**

[TABLE 3] The Measurement Model

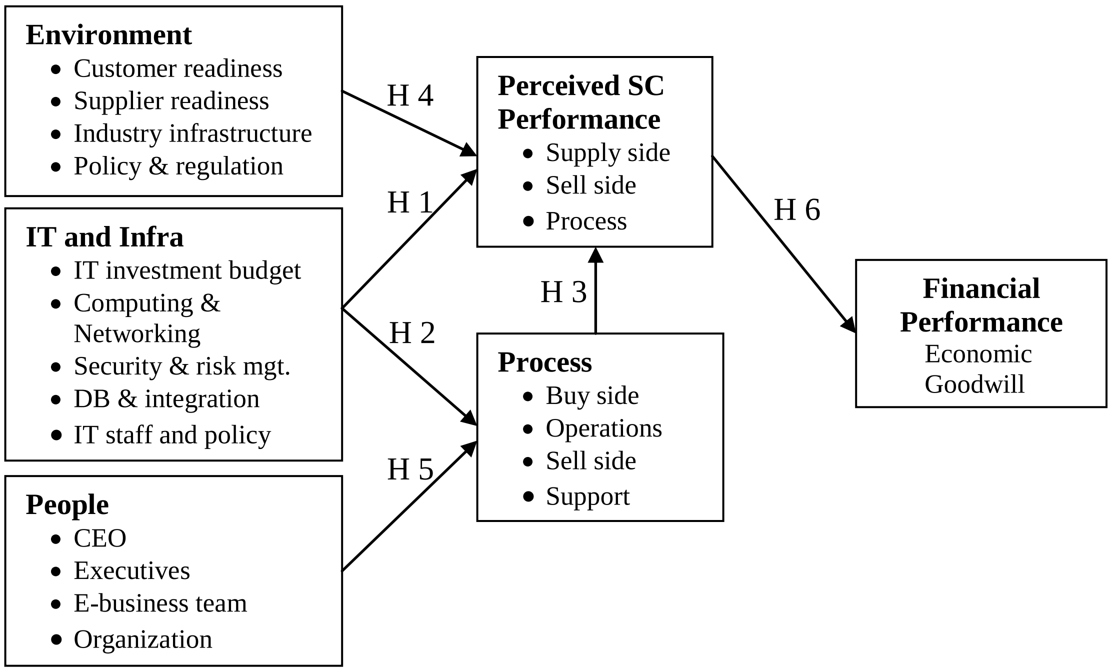
Factors & Items	*Standardized Loading*	*t-values*	*Composite Reliability*	*Average Variance Extracted*
Environment				
Customer	0.78	14.709	0.86647	0.61892
Supplier	0.79	18.114		
Industry	0.83	18.340		
Policy & etc.	0.75	11.724		
Human				
CEO	0.90	39.433	0.94493	0.081097
Executives	0.89	25.568		
Team	0.91	52.956		
Organization	0.90	47.456		
Process				
Buy side	0.81	20.027	0.90326	0.70040
Operations	0.80	17.153		
Sell side	0.87	32.920		
Support	0.87	37.800		
IT and Infra				
Computing & Network	0.66	9.001	0.87012	0.623881
Security & Risk Mgt.	0.86	30.692		
DB & Sys. Integration	0.87	38.060		
IT staff & policy	0.78	15.003		
SC Performance				
Supply side	0.71	9.589	0.83294	0.62389
Sell side	0.81	18.791		
Process	0.84	23.831		

[TABLE 4] Correlation between Latent Variables and Square Root of AVE

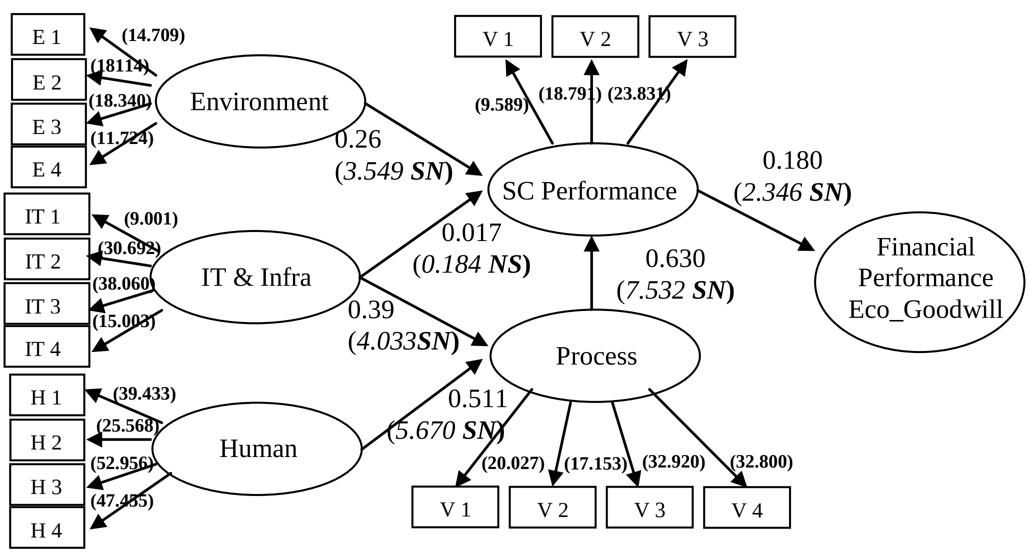
	Environment	Resource	Human	SC Perfo.	Process	Econonic Goodwill
Environment	0.786					
Resource	0.494***	0.793				
Human	0.560***	0.674***	0.901			
SC Perf.	0.599***	0.609***	0.704***	0.790		
Process	0.525***	0.736***	0.775***	0.779***	1.000	
Econo_Goodwill	0.152**	0.252***	0.704***	0.180**	0.537**	1.000

FIGURES

[Figure 1] Conceptual Model



[Figure 2] Results of Hypotheses Testing of the Structural Model



SN: Significant at 0.05 alpha level
NS: Non-significant at 0.05 alpha level

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APPENDIX A

Instrument

Company and Participants Information

Participant information: name, position, department, phone, e-mail,

Company information: B2B (%), B2C (%)

I. Environment
- a. Level of customer’s e-supply chain mind
- b. Level of customer’s e-supply chain infrastructure
- c. Level of supplier’s e-supply chain mind
- d. Level of supplier’s e-supply chain infrastructure
- e. Level of influence of industry related org. to your e-supply chain development
- f. Level of leading firm’s e-supply chain infrastructure within the industry
- g. Level of stakeholder’s influence to your e-supply chain development
- h. Level of state policy and support system influence to your e-supply chain development
- i. Level of legal system’s influence to e-supply chain development
- j. Level of domestic economic condition’s influence to e-supply chain development

II. IT & Infrastructure

1. Investment budget
    - a. Level of IT budget %
    - b. Level of IT budget average growth during the last three years
2. Computing and network environment
    - a. Level of new PC % over existing PCs
    - b. Level of high quality server system %
    - c. Level of mobile/wireless infrastructure
    - d. Level of using network solution (NMS) to effective management of your network system
3. Security and risk management
    - a. Level of system solution for security management
    - b. Level of third party security specialty consulting experience
    - c. Level of target-time management for system recovery
    - d. Level of back-up system for system crash or disaster
4. DB infrastructure and integration
    - a. DB capacity/required DB capacity %
    - b. Level of data standardization
    - c. Level of access to various information system with single ID
    - d. Level of web-based information system %
5. IT people and policy system
    - a. Ratio of IT people outsourcing (%)
    - b. Level of holding advanced IT related licenses (%)
    - c. Level of documenting IT system operation and policy
    - d. Level of structured plan for dealing with disaster or system obstruction

III. Process

1. Supply side process
    - a. Process using IS for purchasing standard information management
    - b. Process using IS for material resource planning
    - c. Process using IS for purchasing request
    - d. Process using online system for purchasing order and bidding
    - e. Process using of online payment system and link to accounting system
    - f. Process using online system for online inquiry for the material delivery schedule
    - g. Process using IS for quality inspection related data management
    - h. Process of using IS for supplier evaluation
    - i. Number of supplier making transaction through online (%)

j. Frequency of material purchased through online transaction (%)
k. Transaction amount through online (%)

2. Operation process
    a. R&D process supported by ISs
    b. Production planning through information system
    c. Managing production capacity through information system
    d. Managing workforces through information system
    e. Managing products information through information system
    f. Managing product quality through information system
    g. Managing productivity analysis through information system
    h. Managing production maintenance through information system
3. Sell side process
    a. Sales plan by using information system for sales plan
    b. Acquiring customer information and for proving company information through Internet
    c. E-mail marketing using Internet or e-mail
    d. Marketing campaign using information system
    e. Linkage between customer order and backend system
    f. Product customization through online
    g. Linkage between customer payment and accounting system
    h. Inquiry of delivery schedule through online
    i. Customer transaction information inquiry using information system
    j. Resolving customer complain using information system
    k. Managing customer information using information system
    l. Number of customer making transaction through online (%)
    m. Number of sales transaction through online (%)
    n. Amount of sales through online (%)
4. Supportive process
    a. Human resource management
        i. HR management using information system
        ii. Recruiting management using Internet or information system
        iii. Welfare management using intranet/internet
        iv. Salary and wages information using information system
    b. Financial management
        i. Managing accounting information using information system
        ii. Managing cost accounting system using information system
        iii. Budget plan and project planning using information system
        iv. Managing performance using information system
    c. Knowledge management
        i. Managing knowledge using information system
        ii. Capability of searching third party specialist using information system
        iii. Training and education using Internet
        iv. Supporting community activities for sharing knowledge using information system

IV. People

1. CEO
    a. Does he present the goal that the firm wants to achieve through e-supply chain?
    b. % of online approval (Internet or e-mail)
    c. How many messages that you received from CEO about promoting the need of e-supply chain?
    d. Level of CEO's involvement in e-supply chain related decision making process
2. Executives
    a. Level of CIO's responsibility
    b. Level of executives' participation to professional education program
    c. Level of executives' involvement in supply chain related decision making process

3. E-business team
    a. Level of exclusively responsible team for e-supply chain
    b. The highest level of position who is in charge of e-supply chain
    c. The capability level of team in managing e-supply chain related activities
    d. Level of training program for the e-supply chain related work forces
    e. Level of master plan for specific e-supply chain related project
4. Organization
    a. The frequency of e-supply chain related training program
    b. Evaluation system of people on the capability of using IT
    c. Incentive system to promote the level of participation to e-supply chain
    d. Level of activities related to execute training programs that are related to e-supply chain

V. Supply Chain Performance
    a. Level of e-supply chain performance evaluation
    b. Level of contribution of e-SC to sales
    c. Level of contribution of e-SC to cost reduction
    d. Level of contribution of e-SC to profit margin
    e. Level of contribution of e-SC to purchasing lead-time reduction
    f. Level of contribution of e-SC to inventory reduction
    g. Level of contribution of e-SC to purchasing cost
    h. Level of contribution of e-SC to production lead-time reduction
    i. Level of contribution of e-SC to production cost
    j. Level of contribution of e-SC to quality
    k. Level of contribution of e-SC to delivery lead-time
    l. Level of contribution of e-SC to sales cost
    m. Level of contribution of e-SC to customer satisfaction