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**Article**

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## Electronic Commerce, MCSs Change, and the Improvement of Supply-chain Performance

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### ABSTRACT

This paper aims to demonstrate the positive impact of the fit between the usage levels of business-to-business (B2B) electronic commerce (EC) and forms of management control systems (MCSs) on the supply-chain performance of a firm. This study analyses data taken from 114 manufacturing firms that are listed on the Korean stock market. We adopt the complementarity perspective to suggest the fit among research variables. To demonstrate the impact of the fit on the supply-chain performance of a firm, this study employs a cluster analysis that implies a systems approach of fit. This study also utilizes a subgroup analysis to show the moderating effects of top management support, resource capabilities, and suppliers' capabilities on the fit. The empirical results show that under high adoption degrees of EC, if both the use levels of non-financial performance measurement system (NPMS) are high and organic structures are employed, the supply-chain performance of a firm is more enhanced. However, the results also indicate that when EC is highly adopted, low usage levels of NPMS and mechanistic structures can reduce supply-chain performance. In the examination of the impact of supply-chain performance on a firm's overall performance, positive effects are demonstrated. From the results of a subgroup analysis, the facilitating roles of organizational resource capabilities, top management support, and suppliers' pressure and capabilities for the development of appropriate forms of MCSs under high EC adoption levels are partially confirmed. The designs of MCSs additionally include such components as reward systems and communication networks. In this study, only the core design variables of MCSs are considered.

*Keywords: Management control systems; Electronic commerce; Supply-chain performance; Non-financial performance measurements; Organic structures*

## 1. Introduction

Through the implementation and usage of EC, manufacturing firms can achieve diverse benefits such as reductions in inventories and transaction costs,

speedy delivery, enhanced cooperation with suppliers, and quick response to the market (Hartono, Li, Na, and Simpson, 2010). However, these advantages cannot be attained simply by the adoption of B2B EC alone. A number of studies have indicated that the adoption of EC must be accompanied by changes in internal business processes to realize the benefits enabled by EC (Chu and Smithson, 2007; Zeng, Ouyang, Zhou, and Hu, 2015). Some researchers have empirically demonstrated that both EC usage and concomitant organizational structural changes are

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required to improve business performance with the implementation of EC (Wang, Tai, and Wei, 2006; Paulraj, Lado, and Chen, 2008; Wang, Tai, and Grover, 2013).

With a case study, Kurnia and Johnston (2000) argued that the adoption of EC involves significant changes to organizations' culture, structure, and working practices over time and space. Paulraj et al. (2008) empirically showed that to achieve the improvements of both buyer and supplier performance through inter-organizational communication, the organic organizational structure in the buyer firm as well as a non-power-based relationship with the supplier must be prepared in advance. Wang et al. (2013) also found that the use of inter-organizational information systems (IS) requires flexible and organic management processes in the buyer and supplier firms to improve the levels of buyer's goal achievement. Although some prior studies have identified and confirmed the effects of inter-organizational IS or EC on internal organizational transformation in buyer firms, they usually have focused on the linear relationships among EC adoption, organizational structure or processes, and firm performance. The fit between EC and organizational structure or business processes and their interaction effects on organizational performance have not been empirically investigated. Most previous research has simply examined the impact of EC on some elements of organizational structure or management processes.

According to the complementarity theory, the adoption of EC demands complementary forms of organizational and management structures to achieve higher firm performance with EC (Milgrom and Roberts, 1995). The complementary organizational and management forms that are well fitted to the levels of EC adoption have to be identified and developed to successfully attain the targeted benefits of EC. Management control systems (MCSs) are mechanisms designed to increase the probability that organizational members will behave in ways that lead to the attainment of business strategic goals (Flamholtz, Das, and Tsui, 1985). Mechanisms that appear to directly influence individual or group

behavior towards the achievement of organizational goals include business processes and organizational structure. Since firms employ EC to attain strategic goals or benefits, the design of MCSs, which also affects the realization of strategic goals, must be matched with EC adoption. As varying forms of MCSs can influence the realization of EC advantages, the fit between MCSs design and EC tasks is extremely important.

Therefore, the current study empirically investigates and identifies the design types of MCSs that can be matched with EC implementation in manufacturing firms. Two broad categories of the B2B EC include EC with suppliers and EC with customers. To demonstrate and suggest the appropriate forms of MCSs under the condition of EC adoption, this study focuses on EC with suppliers, since information flows and cooperation through EC with suppliers are prerequisites for value creation in manufacturing firms (Iyer, Germain, and Claycomb, 2009). This study also empirically examines whether organizational performance is improved when design forms of MCSs are well fitted to the levels of EC adoption. Finally, this study investigates and confirms the effects of facilitating factors such as top management support for EC implementation, resource capabilities for EC adoption, and supplier's capabilities on the fit between MCSs design and EC. Thus, the results of this study can answer the following research questions: What are the ideal design types of MCSs under the adoption of EC for manufacturing firms? Do the impacts of EC usage on improvements in organizational performance differ according to the types of MCSs? Are there any facilitating factors to increase the degrees of fit between MCSs forms and EC adoption?

## II. Theoretical Background and Hypotheses

### A. B2B EC

Usually, the types of B2B EC that can be employed

by manufacturing firms are grouped into four kinds: electronic marketplace, electronic procurement, electronic partnerships, and electronic distribution (Chang and Wong, 2010). An electronic marketplace almost shows the characteristics of a traditional market such as short-term relationships and a minimum amount of information sharing (Overby and Mitra, 2014). The general features of an electronic procurement indicate that in trading relationships with suppliers, buyers take the initiative in executing transactions, and buyers can select their proper suppliers from the numerous vendors that contact the buyers' electronic procurement systems (Chang and Wong, 2010). In electronic procurement, only the supplier unilaterally chosen by the buyer firms can provide parts or materials that exactly meet the requirements of buyers.

Electronic partnerships represent that buyer firms usually contact and trade with a small number of suppliers that may have unique or rare capabilities, and so, their dependence on a few sellers in transactional relationships is absolutely high (Zhao and Xia, 2014). Through electronic partnerships, a buyer company can construct strategic partner relationships with its suppliers to exploit their complementary knowledge and capabilities in implementing cooperative projects such as joint new product development and R&D (Zhu, Zhao, Tang, and Zhang, 2015). Electronic distribution is characterized by suppliers' strong power as well as little necessity to share information between buyers and sellers. Buyer firms can choose an electronic distribution when the amount of information exchanged between buyers and their suppliers is small, since the degrees of environmental uncertainties are low, and supplier firms take the authority to sell and distribute the parts or materials demanded by buyers.

## B. Complementarity Theory and MCSs

The complementarity theory indicates that profitability is maximized when both EC and MCSs are clustered in ways that exploit potential complementarities

between them (Milgrom and Roberts, 1995). According to the theory, profitable firms develop high levels of fit between EC and MCSs design, and there exist synergies, which enhance profitability, in employing complementary forms of MCSs under the implementation of EC. The theory also points out that if inconsistent forms of MCSs are constructed under the adoption of EC, a firm's performance is negatively impacted. There are three principal theoretical models to explain the fit relationship between the adoption of information technology (IT) and organizational change. The first model is called the technological imperative. This perspective views technology as an exogenous force that determines organizational structures. The second model is called the organizational imperative, which regards technology as a matter of managerial choice to satisfy an organization's information needs. The third model involves the synergism between IT and organizational structure (Kurnia and Johnston, 2000; Choe, 2017). The synergism perspective suggests that on one hand, adoption of technology nurtures organizational changes and on the other hand, organizational changes foster the advancement of technology.

In the adoption and use of B2B EC, according to the complementarity theory, this study favors the synergism perspective. It is suggested that the strategic benefits of EC cannot be realized without concomitant organizational changes (e.g., processes and structures). MCSs are mechanisms to control the behavior of organizational members in order to achieve business strategic goals. When EC is utilized, MCSs, which include organizational structures and processes, must be transformed to realize the strategic benefits of EC. Flamholtz et al. (1985) articulated that the MCSs of an organization are composed of the core control system and organizational structure. The concept of the core control system presents an integrated structure of four basic organizational processes: planning, feedback, performance evaluation, and reward. However, in these four basic elements, performance measurement or evaluation is the most important, since planning can be linked to reward through performance measurement, which comprises prior and posterior controls as a linking medium

(Chenhall, 2003). Without performance evaluation, planning is meaningless, and reward cannot be implemented. Thus, this study considers organizational structures and performance measurement as primary design variables in MCSs.

### C. Changes of Organizational Structure and Changes in Performance Measurements

B2B EC can reduce the required slack resources of an organization through the speedy exchange of accurate business information and the close coordination and control of transaction activities between trading partners (Klein and Rai, 2009; Kurnia, Karnali, and Rahim, 2015). When slack resources in a firm decrease, buyer and supplier firms are more dependent on each other in the execution of their tasks. Thus, buyers and suppliers become more coupled and connected with their business partners. To quickly respond to more coupled tasks with suppliers, the decisional autonomy in the buyer firm has to be increased (Wang, Tai, and Wei, 2006; Huo, Zhang, and Zhao, 2015). Enhanced decentralization in a buyer firm supports speedy and strict transactions with suppliers through EC. If decentralization in a firm is not high, decision steps become long and complicated, and thus, the quick decision and response cannot be maintained in an organization.

B2B EC allows a firm to respond to rapidly changing environments through the exchange of business information and close collaboration with trading partners (Wong, Lai, and Cheng, 2012; Jean, Sinkovics, and Kim, 2014). Kurnia and Johnston (2000) asserted that to realize the benefits of quick responsiveness of a firm through EC, the organizational structure must also track environmental changes. Palma-Mendoza et al. (2014) suggested that the use of EC leads to corresponding changes in organizational structure that are compatible with business environments. Mahama (2006) empirically showed that under dynamic and complex environments, the adoption of EC requires very low levels of formalization, which is a key element of organizational structure. To ensure

flexibility in executions of transactional tasks and to adapt to uncertain business environments through EC, organizational procedures and rules in a firm must be loosely established. High decentralization and low formalization indicate characteristics of the organic forms of an organizational structure (Chenhall, 2003). Thus, it seems that under high levels of EC adoption, organic forms of an organizational structure are more preferred and utilized. Based on the above arguments, Hypothesis 1 can be proposed.

**H1.** When levels of EC adoption are high, forms of organizational structure become organic.

The ultimate strategic goals targeted with EC comprise process innovation, profit maximization through reduced inventory and transaction costs, enhanced cooperation with suppliers, and customer satisfaction by quick responses to market and new product launch (Chang and Wong, 2010; Qu, Pinsonneault, Tomiuk, Wang, and Liu, 2015). To attain these strategic objectives of EC, the goals related non-financial performance measures, which motivate and stimulate behaviors of employees leading to the achievement of strategic goals, must be employed in an organization (Chu and Smithson, 2007; Hall, 2011). For organization members to recognize and learn about EC strategic matters, these matters have to be communicated, discussed, measured, and evaluated among the members of an organization (Broadbent and Laughlin, 2009; Ferreira and Otley, 2009). Non-financial performance measurement system (NPMS), which includes strategic goals of EC, provides opportunities for and functions of the communications, discussion, measurement, and evaluations of diverse strategic topics among the members of a firm (Hall, 2011; Artz, Homburg, and Rajab, 2012).

NPMS, which comprises diverse measures across customers, profits, processes, and innovation, provides an important formal mechanism to collect or produce information that can be used to develop organizational learning (Chenhall, 2005; Hall, 2011; Ekawati and Yasa, 2018). The information provided by NPMS is prerequisite for organizational members' learning about the strategic targets of EC, the behavior patterns

for realizing them, and the ways to revise behavior patterns according to the actual outcomes (Henri, 2006). With a case study, Hass and Kleingeld (1999) showed that non-financial performance measurements cause strategic dialogues and interactions among the employees of a firm and as a results, the members' understanding of strategic targets is enhanced through organizational learning. Ittner et al. (2003) empirically found that NPMS that facilitates organizational learning can support organizational members' achievement of strategic objectives, and that this achievement can lead to the improvement of a firm's performance. Chenhall (2005) also demonstrated that NPMS has an indirect effect on manufacturing firms' strategic performance through organizational learning. Based on the above arguments and the prior studies, it is likely that when the adoption degrees of EC are high, the usage levels of NPMS are also high to facilitate the realization of strategic goals of EC. Thus, we can suggest the following Hypothesis 2.

**H2.** When levels of EC adoption are high, the usage degrees of NPMS are high.

#### D. MCSs, and Supply-chain and Organizational Performance

Many researchers have identified and demonstrated the strategic benefits in supply-chain performance, which are caused by the adoption of EC. Shi and Liao (2015) empirically showed that EC has a positive impact on the supply-chain performance of a firm, which is measured by on-time delivery, lead-time reduction, cost reduction, quality improvement, and quick response to market. Jean et al. (2014) demonstrated that the electronic collaboration between suppliers and buyers through inter-organizational IS can lead to improved supply-chain performance, such as enhanced learning, the creation of new products, and increased product quality and market share. Paulraj et al. (2008) also empirically found that inter-organizational communications between supply-chain partners through EC reduce transaction-related errors and delivery time, and thereby, enhance cost

savings, quality, and customer responsiveness.

Although EC itself positively affects the realization of supply-chain performance in a buyer firm, the supply-chain performance of a firm is further improved when complementary sets of MCSs are developed and prepared (Sim and Killough, 1998). According to the synergistic effects theory, higher levels of supply-chain performance can be attained through both the adoption of EC and suitable forms of MCSs than can be attained by using EC alone. Under the implementation of EC, complementary forms of MCSs show an organic organizational structure as well as high usage degrees of NPMS. Hence, when EC is highly employed in a buyer firm, it is likely that the supply-chain performance of a firm is more increased, if an organic organizational structure is adopted and the usage levels of NPMS are high. Based on these arguments, the following Hypotheses 3 and 4 are proposed.

**H3.** If levels of EC adoption are high, the degrees of supply-chain performance are higher when forms of organizational structure are organic than when forms of organizational structure are not organic.

**H4.** If levels of EC adoption are high, the degrees of supply-chain performance are higher when the usage degrees of NPMS are high than when the usage degrees of NPMS are not high.

The increased supply-chain performance of a firm, such as shortened lead and delivery times, reduced transaction and inventory costs, enhanced collaboration with suppliers, and quick launch of new products, naturally contributes to the improvement of organizational performance in a firm (Iyer, Germain, and Claycomb, 2009; Hartono, Li, Na, and Simpson, 2010). Iyer et al. (2009) empirically observed that the improved supply-chain performance, which is measured by speedy delivery, the prevention of inventory shortage and of production and transportation errors, and a high inventory return ratio, positively influences the financial and sales performance of a buyer firm. Klein and Rai (2009) also found that enhanced supply-chain relationships through strategic information flows between trading partners have positive effects on

the organizational performance of buyer and supplier firms.

Increased supply-chain performance and improved organizational performance can be explained with the knowledge-based view (Saraf, Langdon, and Gosain, 2007; Huo, Zhang, and Zhao, 2015). Collaborative information exchange between trading firms through EC has been considered as an effective mechanism to achieve new knowledge creation or sharing in inter-organizational relationships (Youn, Yang, Kim, and Hong, 2014). Inter-organizational knowledge sharing and integration can expand and supplement the supply of knowledge resources in an organization. Trading firms can utilize these expanded knowledge resources for the execution of transactional tasks to attain high levels of supply-chain performance, which lead to the enhancement of organizational competitiveness or performance. Inter-organizational information exchanges with B2B EC in buyer and supplier firms support the knowledge transfer, sharing, and acquisition that are vital to intensifying their competitive advantages, which contribute to the improvement of supply-chain and overall organizational performance (Cheng and Fu 2013; Yoo, 2016). Accordingly, Hypothesis 5 can be suggested.

- H5.** The degrees of supply-chain performance have a positive impact on the levels of organizational performance.

## E. The Effects of Facilitating Factors

Organizational resource capabilities for EC imply the acquisition levels of the financial and technical resources for EC adoption (Seddon, 2014). Technical abilities include general knowledge of information technology, internet-related techniques, and diverse kinds of expert knowledge. Since both EC adoption and the concomitant changes of MCSs are types of technical and managerial innovation, a company necessarily has to maintain the required resources for achieving successful innovations (Wong, Lai, and Cheng, 2012). Zhu and Kraemer (2005) empirically showed that when information technology infrastructure

and financial commitment for human resources and trainings are well developed and abundant, valuable kinds of EC are more heavily employed and utilized. In the perspective of new information technology diffusion, it was confirmed that organizational technical capabilities, the sophistication of existing information technology, and other technical resources have a positive impact on the development of appropriate clusters of EC and MCSs (Lin, 2006). Liu et al. (2008) also empirically observed positive effects of organizational capabilities for information technology on the realization of B2B virtualization. Thus, it is likely that resource capabilities for EC in a firm facilitate the adoption of EC and the accompanying modifications of MCSs. Thus, we can suggest the following Hypotheses 6 and 7 based on these arguments.

- H6.** Organizational resource capabilities for EC have a moderating impact on the relationship between levels of EC adoption and forms of organizational structure.
- H7.** Organizational resource capabilities for EC have a moderating impact on the relationship between levels of EC adoption and the usage degrees of NPMS.

Top management support for EC adoption points out personal interest, involvement, and concern for investment in the development and implementation of EC (Seddon, 2014). Top management support reflects, in many ways, the importance that the top executives place on B2B EC. Top management involvement can be measured by the level of funding for EC, and also includes the facilitation of successful EC implementation throughout the firm (Hartono, Li, Na, and Simpson, 2010). Prior studies (Lin, 2006; Kurnia, Karnali, and Rahim, 2015) reported that top management support involves the following functions: setting goals and appraising objectives, evaluating EC proposals, allocating resource, defining EC development and implementation requirements, and reviewing and adjusting EC adoption efforts. Through these functions, top management support affects the adoption of EC and the accompanying changes of MCSs for the successful achievement of EC strategic

goals. Byrd and Davidson (2003) also asserted that top management support contributes to the progressive and radical innovations of information technology (i.e., EC) and organizational processes (i.e., MCSs) for the improvement of a firm’s performance. In empirical research, Lin (2006) showed the positive effects of top management support on the alignment among business strategy, IS planning, and management processes. Thus, we can suggest the following Hypotheses 8 and 9.

**H8.** Top management support has a moderating impact on the relationship between levels of EC adoption and forms of organizational structure.

**H9.** Top management support has a moderating impact on the relationship between levels of EC adoption and the usage degrees of NPMS.

Competitive or external pressure such as suppliers’ strong demands for the use of EC is another important influence factor on the adoption of EC (Soliman and Janz, 2004). The adoption of EC, as a technological innovation, hinges on developing and implementing capabilities that are accessible to potential adopters. Thus, suppliers’ technical capabilities affect the efficient development and use of appropriate types of B2B EC (Liu, Sia, and Wei, 2008). External influence or pressure has been found to affect both intentions and actual behavior in the adoption of changed organizational forms and managerial innovations (Son and Benbasat, 2007). Since EC adoption involves

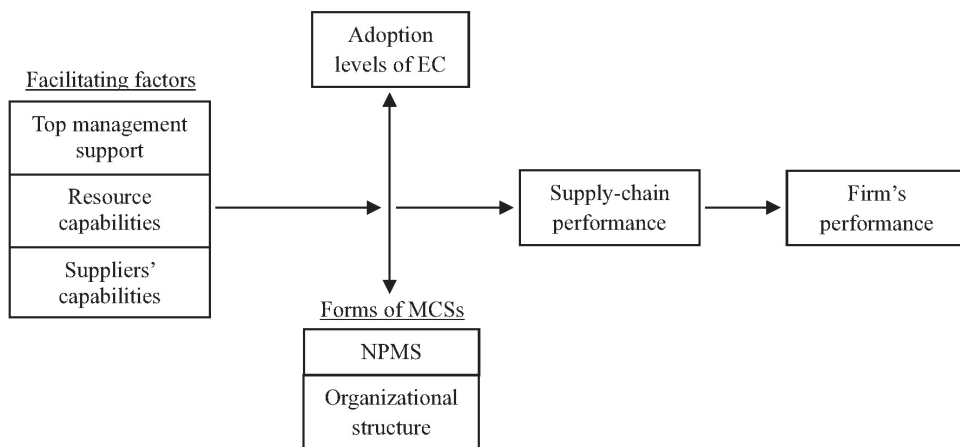
the redesign of MCSs (i.e., structures and performance measurement systems), suppliers’ (external) pressure should also play an important role in the intention and behavior formation for MCSs modifications (Liu, Sia, and Wei, 2008). Corporate EC initiatives and MCSs changes, which are kinds of technical and managerial innovations, are considered to provide a competitive weapon for coping with competitive pressure (Zhu and Kraemer, 2005). Thus, competitive or external pressure may necessarily cause MCSs modifications, which are accompanied with EC adoption and usage, to attain competitive advantages through EC. Based on these arguments, it seems that suppliers’ pressure and capabilities facilitate the changes of MCSs under high levels of EC adoption. Accordingly, we can suggest Hypotheses 10 and 11.

**H10.** Suppliers’ pressure and capabilities have a moderating impact on the relationship between levels of EC adoption and forms of organizational structure.

**H11.** Suppliers’ pressure and capabilities have a moderating impact on the relationship between levels of EC adoption and the usage degrees of NPMS.

**F. Research Model**

The research model used in this study, which



**Figure 1.** Research Model



describes the relationships among EC, MCSs, facilitators, supply-chain performance and organizational performance, is presented in Figure 1.

### III. Research Method

#### A. Study Sample

Data for this study were drawn from a survey of the current status of B2B EC used in Korean manufacturing firms. In total, 500 organizations were randomly selected from a population of about 1,000 firms that are listed on the Korean stock market. The manufacturing firms listed are medium to large in size and consequently, are likely to have more experience with B2B EC applications than smaller firms. First, the chief production managers or executives of the selected firms were contacted to ask for their participation in the research. At the beginning, 125 organizations responded to the request for information. However, during the survey, 11 firms withdrew from the survey, and as a result, 114 manufacturing firms were finally included in the research. In order to collect data, this study both administered questionnaires and conducted interviews with the participating firms. Only chief production managers or plant executives were selected as respondents. Before mailing the questionnaire, through an initial telephone interview with the respondent, the researcher of this study roughly asked him the firm's present conditions, such as its adoption degrees of B2B EC. The results of the first interview generally concurred with the results of the questionnaire response. A questionnaire with a cover letter was mailed to each respondent. After distributing the

questionnaire, through a second telephone interview, the contents of the questionnaire and the answering method were explained. The survey was conducted during the four-month period between January 2017 and April 2017. Table 1 summarizes the sample characteristics according to the industrial type of the firms.

#### B. Measurements

The levels of B2B EC adoption represent the usage degrees of the electronic marketplace, procurement, partnerships, and distribution for manufacturing firms to purchase parts or materials from their main suppliers. Based on the measures of Barua et al. (2001) and Dedrick et al. (2008), the usage degree in each kind of B2B EC was measured by the purchasing ratio of each type of B2B EC (i.e., purchasing volume of each kind of B2B EC for the year 2016 was divided by the total purchasing volume for the year 2016). Respondents provided the purchasing ratios for each types of EC. The degrees of B2B EC adoption in manufacturing firms were calculated by the summation of the purchasing ratios of the electronic marketplace, procurement, partnerships, and distribution.

To measure forms of organizational structure, organic or mechanistic structures were considered. Organic or mechanistic structures were measured with structural variables of decentralization and formalization (Chenhall, 2003). The degree of decentralization was measured by five questions, which represent the extent of authority delegation in the development of new products, hiring and firing, investments, budget allocation, and pricing decisions. Formalization was measured by four items that include job specification,

**Table 1.** Sample characteristics

Type of industry	Chemical industry	Machine industry	Auto-mobile	Electronic Industry	Textile	Food	Paper & pulp	Non-metal	Metal industry	Rubber	Total
No. of firms	24	18	21	15	5	4	4	8	12	3	114
No. of employees	Below 100		100 - 300	300 - 500	500 - 1,000		1,000 -		Total		
No. of firms	18		22	24	19		31		114		

employee's manual, level of operating decision, and managerial styles. Decentralization and formalization were measured on a seven-point Likert-type scale.

The usage degrees of NPMS were measured by the utilization levels of non-financial performance measures in performance evaluation (Chenhall, 2005). Thirteen question items developed by Hogue and James (2000) were employed to measure the usage degrees of NPMS. They were measured on a seven-point Likert-type scale that ranged from 'never used' to 'highly used'. The thirteen items include labor efficiency, material scrap loss, material efficiency, manufacturing lead time, good output to total output, new product launches, new patents, time to market new products, customer satisfaction, customer complaints, returned shipments due to poor quality, on-time delivery, and warranty repair costs.

Organizational resource capabilities for EC imply the acquisition levels of information technology, human resources, and financial support for EC development (Quaddus and Hofmeyer, 2007). Based on the measures of Son and Benbasat (2007) and Hartono et al. (2010), we constructed four question items that were measured on a seven-point Likert-type scale ranging from 'strongly disagree' to 'strongly agree'. The four items are sufficient information technology resource, skilled EC staff, sufficient financial resource, and knowledge necessary for EC development.

Top management support is defined as a top executive's understanding, interest, support, and recognition about EC development and implementation (Hartono, Li, Na, and Simpson, 2010). Using four question items developed by Soliman and Janz (2004), top management support was measured on a seven-point Likert-type scale, anchored by 'strongly disagree' and 'strongly agree'. The four items are: investing funds in EC, taking risks, considering strategic importance, and having an interest in adopting EC.

Suppliers' pressure and capabilities were measured by the four items, which were developed and validated in the study of Lin (2006). Respondents answered the extent to which they agree or disagree with each

item. A seven-point Likert-type scale was used to measure suppliers' pressure and capabilities. The four items are requesting and recommending implementation of EC, having knowledge about technical matters, and containing technical expertise.

Supply-chain performance implies the degrees of improvement or reduction in transaction tasks and costs through B2B EC. The four question items, which were developed by Hartono et al. (2010) and Youn et al. (2014), were utilized to measure it. The levels of supply-chain performance were measured on a seven-point Likert-type scale, anchored by 'strongly disagree' and 'strongly agree'. The four items include costs and time reductions, and improvements of transaction tasks and response capabilities.

We refer to organizational performance in terms of the overall financial performance relative to competitors. The five question items, developed by Saraf et al. (2007), captured the extent to which a respondent's firm performed better than its competitors in terms of sales growth, profits, overall financial performance, company reputation, and return on investment. Organizational performance was measured on a seven-point Likert-type scale, anchored by 'very low' and 'very high'. In this study, we also collected the financial performance measures of sample firms, such as return on assets (ROA; operating income/total assets), return on sales (ROS; net profit/total sales), and sales amount per employee (SAE), to prove the external validity of the subjective performance measurement. Accounting data used to compute the ROA, ROS and SAE were collected from the firm's balance sheets and income statements for 2016, which were provided in the Korean annual report of listed companies.

In this study, the organization size and age were considered as control variables since size and age may have significant effects on organizational performance. Size is the number of employees of a firm in the year 2016, and organizational age is measured by counting the years elapsed since the founding of a firm.

## IV. Data Analysis and Results

### A. Reliability and Validity Tests

Item analyses were performed with Cronbach's alpha coefficients for all multi-item scale measurements. All alpha coefficients were above 0.75, which is satisfactory for the reliability of a multi-item scale. Principal component analysis with a varimax rotation was used to verify the construct validities of the questionnaire items. Three separate joint factor analyses for organizational resource capabilities for EC, top management support and suppliers' pressure

and capabilities, NPMS, decentralization and formalization, and supply-chain performance and organizational performance were carried out to acquire a more stable solution by increasing the ratio of the sample size to the number of items. Using a 0.4 criterion for significant item loading on a factor, the results show that all items within each index, except for NPMS, are represented by a single factor. However, item 1 (development of new products) of decentralization and item 4 (manufacturing lead time) in NPMS were replicated with the items of other factors. Thus, item 1 in decentralization and item 4 in NPMS were removed. In the second factor

**Table 2.** Factor loadings of research variables (Varimax Rotation)

Variable	Factor			Variable	Factor					Variable	Factor	
	1	2	3		1	2	3	4	5		PER	1
ORC				DEC								
1	0.88			1					0.54	1		0.93
2	0.92			2					0.88	2		0.93
3	0.81			3					0.84	3		0.90
4	0.89			4					0.65	4		0.81
SPC		0.92		FOR						5		0.85
1		0.93		1			0.79			SCP		
2		0.82		2			0.82			1		0.89
3		0.77		3			0.74			2		0.91
4				4			0.64			3		0.93
TMS				NPMS						4		0.84
1			0.70	1	0.75							
2			0.79	2	0.76							
3			0.85	3	0.64							
4			0.88	4	0.76							
				5					0.78			
				6					0.83			
				7					0.65			
				8			0.84					
				9			0.65					
				10	0.54							
				11			0.68					
				12			0.62					
Eigen value	3.95	3.33	3.19	Eigen value	3.04	2.79	2.44	2.40	2.37	Eigen value	4.30	3.62
% of Variance	32.9	27.8	26.6	% of Variance	15.2	13.9	12.2	12.0	11.8	% of Variance	47.7	40.2

\* Factor loadings below 0.4 were not presented. ORC: Organizational resource capabilities, SPC: Suppliers' pressure & capabilities, TMS: Top management support, DEC: Decentralization, FOR: Formalization, NPMS: Non-financial performance measurements, PER: Organizational performance, SCP: Supply-chain performance

**Table 3.** Summary statistics of research variables

Variables	Mean	Standard deviation	Minimum	Maximum	Alpha coefficient
Adoption levels of EC	47.9%	39.1	0	100	-
Innovation measure	5.0	1.04	1.8	7.0	0.81
Customer satisfaction measure	4.8	1.09	1.0	7.0	0.77
Learning measure	3.8	1.39	1.0	7.0	0.82
Decentralization	3.5	1.06	1.0	6.7	0.75
Formalization	3.2	1.07	1.2	5.7	0.75
Top management support	3.7	1.51	1.0	6.6	0.95
Resource capabilities	4.0	1.45	1.0	7.0	0.95
Suppliers' pressure & capabilities	3.3	1.30	1.0	6.5	0.92
Supply-chain performance	3.7	1.48	1.0	7.0	0.95
Organizational performance	3.3	1.10	1.0	6.2	0.96
ROA	0.04	0.05	-0.14	0.21	-
ROS	0.004	0.18	-1.41	0.20	-
SAE *	2.195	6.194	0.055	45.81	-

\* Million \$

analysis, the items of each factor did not confound with the items in another factor.

In the case of NPMS, three factors with Eigen values greater than one were extracted. Factor 1 includes labor efficiency, material scrap loss, material efficiency, good output to total output, and returned shipments due to poor quality. Hence, Factor 1 is titled as 'innovation performance measure'. Factor 2 is composed of the questionnaire items regarding customer satisfaction (customer satisfaction, customer complaints, on-time delivery, and warranty repair costs). The title of Factor 2 is 'customer satisfaction performance measure'. Factor 3 comprises new product launches, new patents, and time to market new products. Thus, Factor 3 is named as 'learning performance measure'. The alpha coefficients of decentralization, innovation performance measure, customer satisfaction performance measure, and learning performance measure were 0.751, 0.807, 0.774 and 0.82, respectively. The results of this final factor analysis are presented in Table 2. Both the alpha coefficients and the values of the mean and standard deviation for the research variables were calculated and are summarized in Table 3.

## B. Levels of EC Adoption and Forms of MCSs

To empirically identify the forms of MCSs according to the levels of EC adoption, observations of the types of EC were divided into two groups with a median value being employed as a dividing point. In the adoption levels, high adoption (i.e., higher than the median) and low adoption (i.e., lower than the median) groups were classified. T-test was employed to demonstrate any differences in the forms of MCSs between the two groups. In Table 4, the results of t-test are presented. In terms of EC, there are significant differences between groups in the innovation performance measure and decentralization. The mean scores of both innovation performance measure and decentralization in the high adoption group are higher than those of the low adoption group.

However, in electronic market, there is no significant difference. For electronic distribution, there is significant difference between groups in formalization, and the mean score of formalization in the high group is lower than that of the low group. In the case of electronic procurement, significant differences are found in the innovation performance measure,

**Table 4.** Results of T-test between high adoption group and low adoption group

Variable	EC adoption			Electronic market adoption			Electronic distribution adoption		
	High	Low	T-value	High	Low	T-value	High	Low	T-value
INO	5.26	4.85	1.85 <sup>c</sup>	5.16	4.94	0.82	5.11	4.82	0.91
LEA	3.94	3.75	0.56	3.88	3.86	0.04	3.95	3.88	0.42
CSA	4.83	4.79	0.15	4.86	4.70	0.59	4.81	4.78	0.14
DEC	3.76	3.27	2.02 <sup>b</sup>	3.58	3.29	1.11	3.64	3.42	0.67
FOR	3.07	3.32	0.99	3.12	3.22	0.41	2.98	3.38	1.88 <sup>c</sup>
Variable	Electronic procurement adoption			Electronic partnerships adoption					
	High	Low	T-value	High	Low	T-value			
INO	5.24	4.72	1.95 <sup>c</sup>	5.13	4.94	0.73			
LEA	4.08	3.72	1.36	4.11	3.50	1.89 <sup>c</sup>			
CSA	4.81	4.78	0.08	5.01	4.54	1.84 <sup>c</sup>			
DEC	3.67	3.13	2.18 <sup>b</sup>	3.80	3.30	2.04 <sup>b</sup>			
FOR	2.88	3.35	1.90 <sup>c</sup>	3.06	3.32	1.03			

\* The numbers are mean values. INO: Innovation performance measure, LEA: Learning performance measure, CSA: Customer satisfaction performance measure, DEC: Decentralization, FOR: Formalization, b:  $p < 0.05$ , c:  $p < 0.1$ .

decentralization, and formalization. The mean values of innovation performance measure as well as decentralization in the high adoption group are also higher than those of the low group, and the mean score of formalization in the high group is lower than that of the low group. In terms of electronic partnerships, significant differences were showed in the learning and customer satisfaction performance measures and decentralization. The mean scores of the significant variables in the high adoption group are higher than those of the low adoption group. Thus, it is concluded that when the adoption levels of EC are high, organizational structure is decentralized and non-formalized, and NPMS is more utilized. These results support Hypotheses 1 and 2.

### C. Effects of Fit on Supply-chain Performance

Van de Ven and Drazin (1985) outlined three approaches to analyze data based on alternative definitions of fit. They include: selection, interaction, and systems. Researchers have been critical of the selection and interaction approaches, arguing that they

only provide partial depictions of the relationships between variables of interest and fail to consider the fit of the whole system. The systems approach takes a holistic view of fit by considering the internal consistency among multiple variables. In this study, a systems approach is employed because there are various combinations of levels of EC, the innovation, learning and customer satisfaction performance measures, and decentralization and formalization to enhance or decrease supply-chain performance. Many prior studies have suggested and adopted a range of cluster analysis methods as a more sophisticated means of operationalizing and realizing the systems approach. With a cluster analysis, this study classified the sample firms according to the values of the criterion variables (i.e., the levels of the types of EC, the innovation, learning and customer satisfaction performance measures, and decentralization and formalization). In the current study, cluster analysis provides groups of companies that are similar in terms of the scores of the criterion variables. In the cluster analysis, we used the hierarchical agglomerative method to form clusters because it generates non-overlapping clusters and it has been the dominant method. For the sorting or linkage rules, Ward's

method was chosen since this technique optimizes minimum variance within clusters. We also used the squared Euclidean distance as the proximity measure.

Based on the values of the levels of the types of EC, the innovation, learning and customer satisfaction performance measures, and decentralization and formalization, cluster analysis was performed to produce clusters of organizations. Additionally, supply-chain performance and organizational performance were calculated for each cluster. A critical issue in cluster analysis is to determine the optimal number of clusters. While there are formal decision rules to guide this process, heuristics are commonly used. A formal approach in determining the most appropriate number of clusters is to examine the distance coefficient. The distance coefficient is presented in Table 5. The points at which the distance coefficient suddenly jumps indicate suitable stages in the clustering sequence for analysis. In Table 5, the distance coefficient increases greatly at two points - between the seventh and eighth clusters, and the fourth and fifth clusters. This implies that the eight-cluster and five-cluster solutions may be

in the combination of the values of the criterion variables, the eight-cluster solution can be selected. The eight-cluster result provides suitable data to examine the variations in the levels of the types of EC, the innovation, learning and customer satisfaction performance measures, and decentralization and formalization. Therefore, the eight-cluster solution is used in the analysis.

The mean ranks of the variables within each cluster are presented in Table 6, along with Kruskal-Wallis tests ( $c^2$  values) for each clustering variable. The  $c^2$  values show that statistical differences exist for individual variables across clusters. In the case of C7, the level of EC adoption is relatively high (i.e., the ranking is second), and both the scores of NPMS and the values of organic structures are also high. Thus, C7 is solid in terms of supply-chain performance. The high scores of NPMS and organic structures mean that the innovation, learning and customer satisfaction performance measures are relatively more utilized, while organizational structure is decentralized and non-formalized. By contrast, in C6, though the level of EC is very high (i.e., the difference in the level

**Table 5.** Distance coefficients of cluster analysis

Stage	104	105	106	107	108	109	110	111	112	113
Coefficient	7,697	8,842	10,117	12,727	15,572	19,317	29,780	45,359	72,792	201,591
Increasing rate of coefficient	-	14.8%	14.4	25.7	22.3	24.0	54.1	52.3	60.4	176.9
No. of cluster	10	9	8	7	6	5	4	3	2	1

appropriate points for analysis. To show various cases of EC between C6 and C7 was examined using a

**Table 6.** Results of cluster analysis (Kruskal-Wallis test)

Items	C1 (n=19)	C2 (n=12)	C3 (n=9)	C4 (n=15)	C5 (n=31)	C6 (n=11)	C7 (n=9)	C8 (n=8)	$c^2$
EC	58.8(3)	31.0(7)	47.6(5)	39.5(6)	14.0(8)	68.9(1)	63.8(2)	53.6(4)	66.5 <sup>a</sup>
INO	37.8(4)	35.5(6)	39.6(2)	26.2(8)	41.0(1)	34.1(7)	38.0(3)	36.5(5)	11.7 <sup>c</sup>
LEA	41.8(3)	41.2(4)	38.6(5)	41.9(2)	33.5(6)	19.8(8)	49.0(1)	33.0(7)	6.69
CSA	40.7(2)	40.7(2)	36.7(5)	37.9(4)	35.9(6)	22.6(8)	47.6(1)	30.8(7)	11.3 <sup>c</sup>
DEC	41.8(5)	25.0(7)	54.0(1)	43.3(3)	33.0(6)	21.8(8)	45.1(3)	50.8(2)	12.9 <sup>c</sup>
FOR	43.9(1)	30.3(6)	39.3(3)	43.7(2)	34.8(5)	35.8(4)	29.8(7)	22.6(8)	5.29
SCP	46.6(3)	30.2(7)	33.8(6)	34.0(5)	24.4(8)	44.0(4)	51.5(2)	54.6(1)	17.89 <sup>b</sup>

\* The numbers are mean ranks, and the numbers in parentheses are rankings. INO: Innovation performance measure, LEA: Learning performance measure, CSA: Customer satisfaction performance measure, DEC: Decentralization, FOR: Formalization, SCP: Supply-chain performance, a:  $p < 0.01$ , b:  $p < 0.05$ , c:  $p < 0.1$ .

Mann-Whitney test and found to be insignificant), the values of NPMS and organic structures are considerably lower (i.e., ranked seventh or eighth). As a result, the supply-chain performance of C6 is middle ranking (i.e., the difference in supply-chain performance between C6 and C7 was examined with a Mann-Whitney test and found to be significant at the 10% level). The low scores of NPMS and organic structures imply that non-financial performance measures are underutilized, and the organizational structure is a somewhat mechanistic. These results confirm that at a high level of EC adoption, the firm's supply-chain performance is more increased when NPMS is highly utilized and the organizational structure is organic. Hence, Hypotheses 3 and 4 are supported.

In the case of C8, the level of EC adoption is middle (i.e., the difference in adoption level between C7 and C8 was examined using a Mann-Whitney test and found to be significant at the 5% level), while the learning and customer satisfaction performance measures are little utilized, and the organizational structure is highly organic. The supply-chain performance of C8 is the highest (i.e., the difference in performance between C7 and C8 was examined with a Mann-Whitney test and found to be insignificant). The high performance of C8 may be caused by both the level of EC adoption (i.e., a middle or rather high level) and the matched organic organizational structure. The case of C1 is similar to C8 because, in C1, the level of EC adoption is relatively high (i.e., the ranking is third) and the supply-chain performance of C1 is also a little high (i.e., also ranked third). In C1, the organizational structure is not organic, but the usage degrees of NPMS are rather high (i.e., ranked

second and third). Thus, a little high performance of C1 seems to be incurred by the relatively high adoption level of EC as well as the rather high usage degrees of NPMS.

In the cases of C2 and C5, the adoption levels of EC are the lowest, and except for customer satisfaction performance measure in C2 and innovation measure in C5, NPMS is not highly utilized and the forms of organizational structure are not organic. The levels of the supply-chain performance in C2 and C5 are also the lowest. In C3, the adoption level of EC is relatively low (i.e., ranked fifth), and the supply-chain performance of C3 is also low (i.e., the ranking is sixth). In C3, though the usage degree of innovation performance measure is high (i.e., ranked second) and organizational structure is decentralized, the high usage of innovation measure and the decentralized structure may not contribute to the improvement of supply-chain performance since they are not matched with a low adoption level of EC. The adoption level of EC in C4 is lower than middle rank, and the supply-chain performance of C4 is also low (i.e., ranked fifth). In C4, except for the learning performance measure, NPMS is not highly utilized and organizational structure is not organic. The results of C2, C3, C4, and C5 seem to show the notion that if both the adoption level of EC and the degrees of NPMS usage and organic structures are not high, the supply-chain performance of a firm cannot be improved.

#### D. Impact of Supply-chain Performance

To demonstrate the positive effects of supply-chain

**Table 7.** Results of multiple regression analysis (N=114)

Dependent variable	Independent variables	Supply-chain performance	Size	Age	R <sup>2</sup> (F)
		B coefficient (t-value)	B coefficient (t-value)	B coefficient (t-value)	
Organizational performance		0.58 (6.48 <sup>a</sup> )	0.00 (0.09)	0.20 (2.35 <sup>b</sup> )	0.37 (17.6 <sup>a</sup> )
ROA		0.18 (1.82 <sup>c</sup> )	-0.06 (-0.55)	0.02 (0.24)	0.10 (2.50 <sup>c</sup> )
ROS		-0.02 (-0.21)	0.05 (0.48)	-0.13 (-1.23)	0.02 (0.59)
SAE		0.31 (2.86 <sup>a</sup> )	-0.18 (-1.79 <sup>c</sup> )	-0.21 (-2.06 <sup>b</sup> )	0.24 (6.70 <sup>a</sup> )

a: p<0.01, b: p<0.05, c: p<0.1. The scores of VIF were below 1.2. Size and age: the organization size and age.

performance on the organizational performance of a firm, multiple regression analysis was employed. The results of regression analyses are presented in Table 7. The Results showed that supply-chain performance has a significant positive impact on organizational performance, return on assets, and sales per employee. Hence, it is indicated that the strategic benefits of EC adoption, such as decreased transaction and inventory costs, reduced delivery and reaction time, and quick response to market, contribute to the improvement of the firm's financial and sales-related organizational performance. From these results, Hypothesis 5 is fully supported

### E. The Moderating Impact of Facilitating Factors

The facilitating roles of organizational resource capabilities, top management support, and suppliers' pressure and capabilities were empirically investigated with a subgroup analysis. Subgroup analysis is a useful technique to confirm the moderating effects of facilitating factors (Sharma, Durand, and Gur-arie, 1981). For subgroup analysis, observations of the facilitators were divided into two groups with the median value being employed as a dividing point. In each group, Pearson correlation analysis was performed. The correlations between levels of EC adoption and forms of MCSs are represented in Table 8. In Table 8, correlation coefficients were compared between groups. In high top management support, the correlations between types of EC and the performance and decentralization measures are positive, while in low top management support, they are negative. In formalization, the signs of the correlation coefficients are reversed. However, whether the difference in correlation coefficients between groups is significant or not cannot be decided by simple comparison. Fisher Z statistics can be used to determine the significance of the difference in correlation coefficients between groups. In the cases of EC and electronic partnerships, the values of standard Z for the innovation and customer satisfaction measures and organizational

structures were significant at the 1%, 5%, and 10% levels. For electronic procurement, the coefficients of standard Z for innovation measure and formalization were significant at the 1% and 10% levels. In the cases of electronic market and distribution, the scores of standard Z for innovation measure and decentralization were significant.

In terms of organizational resource capabilities, when the degrees of organizational resource capabilities are high, except for formalization, the correlation coefficients between type of EC and the performance and decentralization measures are positive, while under low resource capabilities, they are negative in the innovation and learning performance measures. In the types of EC, some coefficients of standard Z for performance measures were significant at the 1%, 5%, and 10% levels. The values of standard Z for organizational structures were significant in the electronic distribution, procurement and partnerships at the 5% and 10% levels. In the case of suppliers' pressure and capabilities, under high pressure and capabilities, the correlation coefficients between types of EC and performance measures are positive. Some values of standard Z for performance measures were significant at the 1%, 5% and 10% levels. From these research findings, it is partially accepted that top management support, organizational resource capabilities, and suppliers' pressure and capabilities have a moderating impact on the relationships between levels of EC adoption and forms of MCSs. Thus, it is concluded that they can facilitate the development of the appropriate forms of MCSs according to the adoption levels of EC. Accordingly, Hypotheses 6, 7, 8, 9, 10, and 11 are partially supported.

## V. Conclusion and Discussion

### A. Implications for Practice

This study adopted the complementarity perspective to demonstrate the positive impact of the fit between



**Table 8.** Comparisons of correlation coefficients between groups (Subgroup analysis)

Variables	High top management support (N=55)					Low top management support (N=56)				
	EC1	EC2	EC3	EC4	EC	EC1	EC2	EC3	EC4	EC
INO	0.24 <sup>c</sup> (3.08 <sup>a</sup> )	0.13 (1.26)	0.05 (1.59 <sup>c</sup> )	0.27 <sup>b</sup> (3.79 <sup>a</sup> )	0.18 (3.76 <sup>a</sup> )	-0.33 <sup>b</sup>	-0.11	-0.25 <sup>c</sup>	-0.42 <sup>a</sup>	-0.49 <sup>a</sup>
LEA	0.02 (0.00)	0.05 (0.67)	0.00 (0.00)	0.01 (0.26)	0.01 (0.21)	0.02	-0.08	0.03	-0.04	-0.03
CSA	0.18 (1.21)	0.17 (0.89)	0.11 (0.93)	0.17 (2.23 <sup>b</sup> )	0.28 <sup>b</sup> (2.73 <sup>a</sup> )	-0.05	-0.00	-0.07	-0.25 <sup>c</sup>	-0.23 <sup>c</sup>
DEC	0.25 <sup>c</sup> (1.23)	0.27 <sup>b</sup> (2.24 <sup>b</sup> )	0.33 <sup>b</sup> (1.20)	0.23 <sup>c</sup> (1.59 <sup>c</sup> )	0.38 <sup>a</sup> (2.35 <sup>a</sup> )	0.02	-0.15	0.11	-0.07	-0.05
FOR	0.05 (0.36)	-0.09 (1.05)	-0.27 <sup>b</sup> (2.89 <sup>a</sup> )	-0.27 <sup>b</sup> (2.95 <sup>a</sup> )	-0.17 (2.57 <sup>a</sup> )	0.12	0.11	0.26 <sup>c</sup>	0.28 <sup>b</sup>	0.31 <sup>b</sup>
Variables	High resource capabilities (N=55)					Low resource capabilities (N=56)				
	EC1	EC2	EC3	EC4	EC	EC1	EC2	EC3	EC4	EC
INO	0.29 <sup>b</sup> (2.73 <sup>a</sup> )	0.08 (1.05)	0.06 (1.70 <sup>b</sup> )	0.08 (0.79)	0.16 (1.63 <sup>c</sup> )	-0.22 <sup>c</sup>	-0.12	-0.26 <sup>c</sup>	-0.07	-0.15
LEA	0.00 (0.26)	0.11 (0.21)	0.01 (0.15)	0.25 <sup>c</sup> (2.56 <sup>a</sup> )	0.18 (1.79 <sup>b</sup> )	0.05	0.07	0.04	-0.23 <sup>c</sup>	-0.16
CSA	0.00 (1.33 <sup>c</sup> )	0.05 (0.73)	0.06 (0.10)	0.26 <sup>c</sup> (0.91)	0.17 (0.26)	0.25 <sup>c</sup>	-0.09	0.04	0.09	0.12
DEC	0.07 (0.00)	0.24 <sup>c</sup> (1.87 <sup>b</sup> )	0.25 <sup>c</sup> (0.11)	0.24 <sup>c</sup> (1.23)	0.24 <sup>c</sup> (0.49)	0.07	-0.11	0.23 <sup>c</sup>	0.01	0.15
FOR	0.14 (0.00)	-0.18 (1.75 <sup>b</sup> )	-0.15 (2.18 <sup>b</sup> )	-0.02 (1.38 <sup>c</sup> )	-0.00 (1.22)	0.14	0.15	0.26 <sup>c</sup>	0.24 <sup>c</sup>	0.23 <sup>c</sup>
Variables	High suppliers' pressure and capabilities (N=56)					Low suppliers' pressure and capabilities (N=56)				
	EC1	EC2	EC3	EC4	EC	EC1	EC2	EC3	EC4	EC
INO	0.07 (1.80 <sup>b</sup> )	0.09 (1.94 <sup>b</sup> )	0.00 (1.12)	0.05 (0.68)	0.04 (1.42 <sup>c</sup> )	-0.27 <sup>b</sup>	-0.22 <sup>c</sup>	-0.21 <sup>c</sup>	-0.08	-0.23 <sup>c</sup>
LEA	0.03 (0.15)	0.13 (0.69)	0.08 (0.79)	0.07 (0.74)	0.15 (1.56 <sup>c</sup> )	0.06	0.00	-0.07	-0.07	-0.15
CSA	0.24 <sup>c</sup> (2.54 <sup>a</sup> )	0.18 (1.28)	0.21 <sup>c</sup> (1.36 <sup>c</sup> )	0.06 (1.33 <sup>c</sup> )	0.25 <sup>c</sup> (2.65 <sup>a</sup> )	-0.24 <sup>c</sup>	-0.06	-0.05	-0.19 <sup>c</sup>	-0.25 <sup>c</sup>
DEC	0.05 (0.32)	0.21 <sup>c</sup> (0.21)	0.25 <sup>c</sup> (0.17)	0.00 (1.29 <sup>c</sup> )	0.23 <sup>c</sup> (0.22)	0.11	0.17	0.28 <sup>b</sup>	0.24 <sup>c</sup>	0.27 <sup>b</sup>
FOR	0.05 (1.20)	-0.08 (1.55 <sup>c</sup> )	-0.23 <sup>c</sup> (0.60)	-0.11 (0.63)	-0.21 <sup>c</sup> (0.96)	0.27 <sup>b</sup>	0.21 <sup>c</sup>	-0.12	0.01	-0.03

\* The numbers in parentheses are Fisher Z statistics. EC1: Electronic market, EC2: Electronic distribution, EC3: Electronic procurement, EC4: Electronic partnerships, INO: Innovation performance measure, LEA: Learning performance measure, CSA: Customer satisfaction performance measure, DEC: Decentralization, FOR: Formalization, a:  $p < 0.01$ , b:  $p < 0.05$ , c:  $p < 0.1$ .

the usage levels of EC and forms of MCSs on the supply-chain performance of a firm. First, we investigated any differences in the forms of MCSs between the high EC adoption group and the low EC adoption group. The results showed that when

EC is highly adopted, NPMS is more heavily utilized and organizational structures become organic. Since under high EC adoption levels, targeted goals of EC are very diverse and non-financial (e.g., customer satisfaction, delivery time, quality, and market

response), the use of NPMS is more demanded to promote and evaluate the achievement of strategic goals of EC. When the adoption levels of EC are high, various kinds of information are frequently and rapidly exchanged between traders, and transaction tasks with trading partners are executed and coordinated in a real time. Thus, to adapt to speedy execution of tasks, organic (i.e., decentralized and non-formalized) structures are necessarily required.

The empirical results of the cluster analysis showed that under high adoption degrees of EC, if both the use levels of NPMS are high and organic structures are employed, the supply-chain performance of a firm is further enhanced. However, the results also indicated that when EC is highly adopted, low usage levels of NPMS and mechanistic structures may decrease supply-chain performance. Low adoption degrees of NPMS as well as mechanistic structures cannot support the speedy execution of transaction tasks and the achievement of strategic goals through EC. According to the results, it was also suggested that although the adoption levels of EC are low, under low usage degrees of NPMS and mechanistic structures, supply-chain performance is not improved. Hence, when the three conditions (i.e., high adoption levels of EC, high usage degrees of NPMS, and organic structures) are well satisfied, the supply-chain performance of a firm can be greatly increased.

In the examination of the impact of supply-chain performance on a firm's overall performance, positive effects were demonstrated. Thus, it is concluded that increased supply-chain performance is directly linked to improved overall organizational performance. From the results of the subgroup analysis, the facilitating roles of organizational resource capabilities, top management support, and suppliers' pressure and capabilities for the development of appropriate forms of MCSs under high adoption levels of EC were partially confirmed. When the levels of EC adoption are high, through high top management support, abundant organizational resources, and strong suppliers' pressure and capabilities, high usage degrees of NPMS and organic organizational structures can be properly obtained. Top management support and

organizational resources are necessary internal conditions for the adoption of EC and the concomitant changes in MCSs. Suppliers' pressure and capabilities are also required external factors that facilitate the use of EC and the accompanying modifications of MCSs.

## B. Limitations and Future Research Efforts

The designs of MCSs additionally include such components as communication networks, reward systems, and organizational integration (Flamholtz, Das, and Tsui, 1985). In this study, only the core design variables (i.e., performance measurement and organizational structures) of MCSs were considered. Research questions about how other design variables must be changed and constructed under the high usage degrees of EC were not answered. There exist interrelationships among the design components of MCSs. NPMS may affect the types of reward systems employed, and organizational structures and integration can influence the modes of communication network developed. In future research, various other elements of MCSs can be totally included considering their interrelationships in investigating the complementary forms of MCSs under the high adoption levels of EC.

This study classified the kinds of EC into four types: electronic market, electronic procurement, electronic partnerships, and electronic distribution. In demonstrating the effects of the fit between the adoption levels of EC and forms of MCSs on supply-chain performance, types of EC were not taken into account. Only the usage degrees of EC were considered. However, according to the kinds of EC, degrees of collaborations, amount of information exchanged, and the speed of transaction execution between trading partners are different. Usually, electronic partnerships demand higher cooperation, and more speedy and frequent information exchange between traders. Thus, it seems that the types of EC also affect the modifications of MCSs. Future research can investigate diverse forms of MCSs according to the kinds of EC. In this study, due

to the small sample size, the whole research model could not be tested and analyzed with structural equation modeling. If the whole model could be analyzed simultaneously, the cause and effect relationships among the research variables could be examined and proposed.

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