

The Effect of Alignment between E-Commerce Adoption and Supply Chain Structure on Performance

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Abstract

This paper discloses the dynamic relationships among E-commerce adoption, supply chain structure, performance, and identify the moderate effect of the characteristics of traded products and buyer-supplier relationship on the above relationship. From the results of empirical test on the proposed structural equation model and set correlation model, this study suggests a conceptual framework to develop an advisable set of E-commerce adoption strategies for the efficiency improvement of overall supply chain management. The model proposed as a result of this research can be used to begin to establish the integration strategy of supply chain.

I. Introduction

During the last decade, buying company has emphasized gradually the importance of strategic cooperation and supply-network construction with suppliers, and systematic supply chain management as a critical success factor for

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sustainable competitive advantage. In particular, recently, due to the development of computer and telecommunication technology, firms attempt to improve the efficiency of transaction between buyer and supplier by information sharing and communication through electronic commerce, and electronic commerce (EC) is recognized as a way that buying companies can manage more efficiently their supply chain. In the light of such current change and trend, electronic commerce between buyer and supplier is highlighted as not only a fresh opportunity to obtain competitive strategy, but also a facing task both buyer and supplier should challenge and overcome together.

The cutting edge for business today is electronic commerce. In the face of strong market forces created by electronic commerce and mounting competition, firms can no longer plod along historical tracks or seek the preservation of the status quo (Kalakota and Whinston 1997). Commonly defined, electronic commerce is associated with the buying and selling of information, products and services via computer networks today and in the future via any one of the myriad of networks that make up the information superhighway (Kalakota and Whinston 1996). The Automotive Industry Action Group in North America defines it as the enablement of a business vision supported by advanced information technology to increase the effectiveness of the business relationships between trading partners (Kim 1999)

Electronic commerce is becoming critical in three interrelated dimensions: Customer-to-Business interactions; Intra-business interactions; and Business-to-Business interactions. In particular, from the Business-to-Business or interorganizational perspective, electronic commerce facilitates changes in many business applications such as supplier management, channel management, payment management and so on (Kalakota and Whinston 1997). In the face of these changes, and in order to survive and be successful, management has to cope with the changes taking place in the various market spaces (Kim 1999).

The expansion of business-to-business electronic commerce changes the existing shape of transaction relationship between companies. This is because the

introduction of B-to-B EC enables the construction of new business model, which was unavailable under the existing private network or customer-to-business electronic commerce. In other words, the rapid expansion of the electronic commerce has huge potential for enabling companies, large and small, to gain new marketplaces globally at low cost, or to be disintermediated by others doing so. A totally new competitive environment opening up new opportunities is upon us. As a result, the electronic commerce is growing quickly and the importance of electronic marketplace is emphasized.

The utilization of information technologies and systems in supply chain management has mainly focused on supply chain integration. Through the utilization of such information systems, companies have been able to attempt the integration of various functions spread over different areas within a company and with external suppliers and customers as well as curtail unnecessary activities, thus enhancing their capability to cope with sophisticated needs of customers and meet the quality standards of products (Bardi *et al.* 1994, Carter and Narasimhan 1995). However, from the supply chain management point of view, applying the business-to-business electronic commerce to the relationship between firms may be expected to make major changes. That is, Web-based electronic commerce which has totally different characteristics with the existing information technologies and systems, may reduce the excessive dependence on supply chain integration with few key suppliers by deriving complete competition in electronic market among numerous suppliers. This also means that the optimal points of supply chain structural issues related to and focused on just the establishment of supply chain integration may be changed by the level of E-commerce utilization. Of course, such expectation can be different depending on the characteristics of traded products, the strength of buyer-supplier relationship, and company's practical capability. Accordingly, this trend motivates that future research should first focus on the influence of B-to-B EC on the alignment between supply chain integration and other SC strategic/structural issues under new business model prior to the discussion on the role and function

of B-to-B EC for the efficient construction of supply chain integration.

Also, the research on E-commerce technology itself too much focusing on the indiscreet introduction of information system such as EDI and ERP should be changed. Numerous companies, under the obscure expectation that E-commerce can fulfill all of company's needs, have made unconditionally immense investments on the introduction of E-commerce technology without any consideration on product characteristics, environmental factors, business strategy, and current supply chain structure. However, in spite of such indiscreet introduction, many companies do not have big benefits as expected. Even though E-technology has considerable influences on entire operations and decision-making procedure of a company in small or medium companies as well as large companies, top managers are not being able to come out appropriate policy directions or problem solutions due to the insufficiency of technical and administrative recognition on E-technology. This is because researches on E-commerce adoption in terms of the effective implementation of E-technology for sustainable competitiveness are insufficient relative to those on E-commerce technology itself. In other words, past researches on E-commerce technology has mainly focused on the availability and significance of E-technology itself. The assertion of Keen (1993) that the difference in competitive and economic benefits which firms can obtain from E-commerce technology is dependent on not the difference in technology itself, but the difference in managerial capability, emphasizes the importance of research on E-commerce adoption in supply chain management.

Conclusively, the systematic design of supply chain structure, the appropriate application of information technologies, and the establishment of proper relationships among supply chain members, are the most important key strategic factors for acquiring sustainable competitive advantage. Viewed in this perspective, strategic alignment between key SCM strategic and structural issues, and between such strategic/structural issues and E-technology adoption, should be regarded as the most significant and urgent research theme for the construction of a competitive future SCM strategy.

The purpose of this study is to disclose the dynamic relationships among supply chain management strategy, structure, performance, and the effect of E-commerce adoption on the relationships. For this, this paper attempts to test empirically integrated research framework, which combines the general research flow of 'strategy → structure → performance' Chandler (1962) and Child (1972) assert with the type of E-commerce technology adoption. On the basis of the results, this study suggests a conceptual framework to develop the utilization strategy of e-commerce technology for strategic supply chain management. The model proposed as a result of this research can be used not only to establish supply chain network-system with suppliers, customers, and internal functions within a firm in an operational perspective, but also to construct company-level alignment strategy between supply management and manufacturing for the innovation of traditional product-process structure in a strategic perspective.

II. Literature Review

2.1 The Effect of E-Adoption on the Alignment among Supply Chain Strategy and Structure

Even though supply chain needs to be evaluated and managed as a unit, few researches have analyzed supply chain as a unit. Most researches have focused on one part or several parts out of overall supply chain functions, such as forecasting, planning, production control, inventory control, scheduling, etc., and just a small number of researches have investigated the relevance among such parts (Hoekstra and Romme 1991; Towill et al. 1992). That is, even though the necessity of integrated supply chain management has consistently been emphasized, the research on the overall structure of supply chain, which is the starting point for supply chain management, is almost beginning stage (Hoekstra and Romme 1991; Towill et al. 1992). Generally, previous researches show general agreement in that the level of supply chain diversification, the level of supply chain integration, lead time of supply chain, the response point of supply chain, and the level of safety

stock, can be the most representative key issues for the design of supply chain structure (Bucklin 1973: Hoekstra and Romme 1991: Christopher 1992: Lagodimos 1992: Lassar and Kerr 1996: Towill 1996: Disney et al. 1997: Jones et al. 1997). The discussion on the effect of these supply chain structural issues on performance is started from theoretical relevance with supply chain strategic issues.

The most important strategic issue, which should be considered in the design of such supply chain structure, is the characteristics and strategy of traded products (Fisher 1997). Fisher (1997) asserted that traded products can be classified into efficient product and innovative product, and supply chain appropriate for each product category should be designed. Lassar and Kerr (1996) examined the relationship between a company's supply chain structure and primary product strategy such as differentiation, cost leader, and focused strategies (Porter 1980). Fisher (1997) emphasized the length and thickness of supply chain in the design of supply chain, while Lassar and Kerr (1996) considered mainly the partnership between manufacturer and distributor and the regional intensity of distribution. Bensaou and Venkatraman (1996) showed that the characteristics/strategy of traded product can be closely related to the strength of buyer-supplier relationship, through the suggestion of the portfolio of inter-firm transaction relationship by the level of investment on the transaction-specific asset of buyer or supplier. That is, they suggested that the type of market exchange relations in which the technical and economical dependence of both buyer and supplier on each other is relatively low, is appropriate for highly standardized products, while the type of strategic partnership in which buyer-supplier relationship is strongly connected by considerable transaction-specific assets of both buyer and supplier, is significantly correlated with highly customized products. When considering the relationship between a company's supply chain structure and product strategy Fisher and Lassar/Kerr identified, such matching of product characteristics/strategy and buyer-supplier relationship implies that the strength of buyer-supplier relationship also can be the key strategic issue for constructing

efficiently supply chain structure. In fact, Anderson, Hakansson, and Johanson (1994) commented that depending on the position and level of negotiation power between buyer and supplier, the overall design and type of supply chain structure can be different, thus supporting the above argument.

The level of supply chain diversification in horizontal perspective, which is one of structural issues, means the length of supply chain, that is, the number of participants included in a supply chain from procuring raw materials to delivering finished products (Hoekstra and Romme 1991; Jones et al. 1997). Forrester (1961) suggested five stages such as raw material supplier, manufacturer, factory warehouse, distributors, and retailers, as typical supply chain path, and on the basis of such five supply chain paths, numerous subsequent researches have been consistently implemented by mainly using normative modeling methods such as simulation and heuristics. Also, with horizontal supply chain diversification, the interest on the effect of supply chain diversification in the vertical perspective, has increased. Vertical supply chain diversification means the width of supply chain identifying additional supply chains where a firm can establish a presence, and extending a firm's supply chain to include members beyond immediate suppliers and customers (Bakos 1991). This has the same logic with the diversification of transaction line and the expansion of distribution network (Anderson and Coughlan 1987; Cespedes 1988; Rosenbloom 1995; Lassar and Kerr 1996). The reason that the significance of supply chain diversification is increasingly brought out, is because bullwhip effect or demand amplification among various reasons for imbalance between demand and supply is particularly influenced by the number of participants in a supply chain and the diversification of transaction line (Wikner et al. 1991; Towill et al. 1992; Towill 1996; Disney et al. 1997; Jones et al. 1997). Previous researches on the relevance between the length of supply chain and strategic issues (Anderson and Gatignon 1986; Miller 1988; Eisenhardt 1989; Lassar and Kerr 1996) have agreed that in case of standardized/cost leader focused product appropriate for market exchange relations structure, the necessity of controlling the number of participants in a

supply chain is relatively low due to the low weights of monitoring and cooperation on supply chain, while in case of customized/differentiation focused product, systematic monitoring and cooperation on supply chain is more emphasized in order to support various types of services to customers. Thus, in case of customized/differentiation focused product connected to strategic partnership structure, the possibility that a firm attempts to reduce intermediate supply chain participants, and increase monitoring and trust among supply chain members is higher. Also, Bakos (1991) suggests a meaningful argument on the relevance between the width of supply chain and strategic issues. That is, in terms of buyers, in case of standardized/cost leader focused product appropriate for market exchange relations structure, the number of transaction-available supplier is expected to increase because the change of supply line is relatively easy due to the low level of dependence on supplier, transaction-specific asset, and changeover cost. Meanwhile, in case of customized/differentiation focused product connected to strategic partnership structure, the meaning of increasing the number of supplier may be reduced, because the incentives for improving non-contractible factors except price is more strongly required.

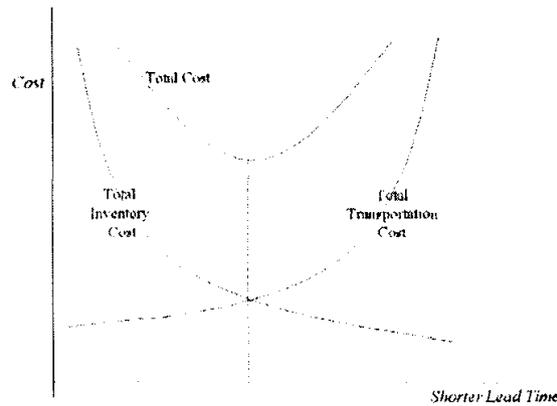
However, the introduction of E-commerce may somewhat change the type of relevance between the width of supply chain and strategic issues which Bakos (1991) argues. That is, like the argument of Malone et al. (1987) that the ratio of electronic market structure to inter-firm relationship will be increased according to the development of telecommunication technology, it is predicted that Web-based E-commerce adoption may increase the number of supplier within a limited scope, even in strategically important customized products. Therefore, we can expect that even though the effort for maintaining cooperative relationship on strategically important customized products by reducing the number of supplier will be continued, the intensity will be weakened according to the introduction of Web-based E-commerce. Such kind of change also may be indicated in the relationship between the length of supply chain and strategic

issues. That is, in case of customized/differentiation focused product emphasizing more systematic monitoring and cooperation on supply chain by strategic hierarchical partnership structure in order to support various types of services to customers, the likelihood that a firm attempts to reduce intermediate supply chain participants is higher. However, E-commerce adoption may decrease the necessity of reducing intermediate participants compulsorily with enduring the burden of related costs by reducing the level of dependence on physically contacted-monitoring and increasing the capability of real-time information sharing. Consequently, the introduction of Internet or Web-based E-commerce enables buyers to pursue the moderate electronic market structure even on strategically important customized products and maintain the proper number of intermediate supply chain participants.

Such introduction of E-commerce also may have an influence on the relevance between the level of supply chain integration and strategic issues. Supply chain integration can be related with some problems on the independence of supply chain participants: should raw material suppliers or distributors be internalized in the design of supply chain structure? Should finished products be sold directly to customers, or are intermediate distributors necessary? How should managerial independence be established in the relationships among supply chain members? Generally, it has been recognized that such independence of supply chain participants may be the direct reason of imbalance between demand and supply (Lee and Billiton 1992; Lee et al. 1996). Particularly, Lee et al. (1996), in the explanation on bullwhip effect, assert the necessity of avoiding excessive managerial independence and integrating various supply chain functions, because independent forecasting of each of supply chain participants and gaming among participants may lead to the imbalance of demand and supply, that is, the creation of excessive supply chain inventory. This has the same context with demand amplification in industrial dynamics Forrester (1961) and Burbidge (1961) advocated. Wikner et al. (1991) also support the above argument. However, the necessity of supply chain integration described above can be

different depending on the type of product strategy and buyer-supplier relationship, similarly with the case of supply chain diversification. That is, in case of standardized/cost leader focused product suitable for market exchange relations structure, managerial independence may be guaranteed, because it is expected that result-based contract among supply chain members is emphasized and the necessity of monitoring/promotion on supply chain members is low (Lassar and Kerr 1996). Meanwhile, in case of customized/differentiation focused product aligned with strategic partnership structure, product life cycle is relatively short and various kinds of competitive factors (technology, design, service) except product price should be supported. Also, the demand of finished product is considerably unstable. Accordingly, buyer should support various types of promotion activities (Winter 1993; Lassar and Kerr 1996), and accomplish high level of cooperation or integration with other supply chain members by providing high margin (Porter 1980; Anderson and Gatignon 1986; Miller 1987, 1988; Anderson and Schmittlein 1994; Lassar and Kerr 1996). Also, systematic training for differentiated product/service, and buying firm's monitoring on distributor are more strongly required, because there are a large amount of information which should be processed (Galbraith 1973) and a high possibility of decision-making's delay (Govindarajan 1985). Therefore, the possibility of behavior-based contract among supply chain members is very high (Lassar and Kerr 1996). In other words, the likelihood that buyer pursues high level of cooperation and integration with external supply chain members with enduring high burden of integration costs and political conflicts is very strong. However, E-commerce adoption may make it possible for buying firms to obtain the effects of integration simultaneously with guaranteeing somewhat the managerial independence of other chain members, by supporting the capability of continuous and consistent remote monitoring/ promotion on supply chain members. Therefore, it can be foreseen that buying firms with high level of E-commerce adoption do not need to pursue excessive supply chain integration even on customized/differentiation focused product.

Figure 1: Traditional Trade-off Relationship between Inventory and Transportation Costs

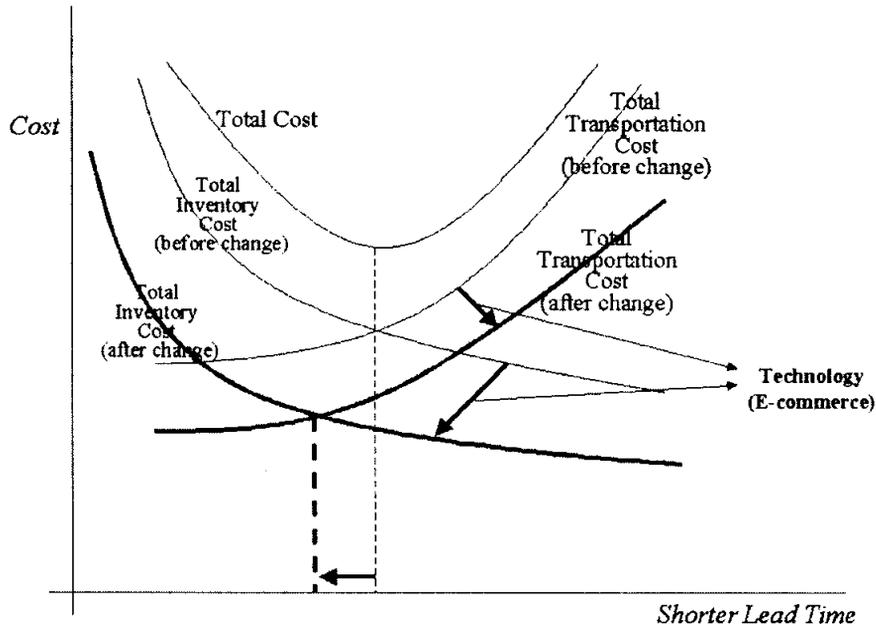


The lead time of supply chain means the time taken from the orders of final customers to the delivery of finished products or services (Christopher 1992; Krajewski and Ritzman 2000). Many previous researchers asserts that the reduction of lead time has the role of time competitiveness as the creation of value added, and thus the reduction of lead time should be preceded for obtaining sustainable competitiveness (Stalk and Hout 1990; Christopher 1992; Krajewski and Ritzman 2000). However, the lead time of supply chain may also have influences on other kinds of supply chain related activities. That is, the reduction of supply chain lead time can lead to the reduction of safety stock, order frequency, and order batch size. But, transportation cost increases. In other words, if lead time is reduced and distribution time is frequent, overall inventory level is decreased, while transportation is increased. Like this, the reduction of supply chain lead time may induce trade-off relationships among various supply chain variables (Figure 1) (Magee et al. 1985). The reduction of lead time in this respective does not have a significant effect on the reduction of total cost. Therefore, the approaches for minimizing total costs should be considered in managing supply chain lead time (Bowersox and Closs 1996). In case of customized/differentiation focused product and strategic partnership structure, the type of supplying immediately products when necessary may be preferred to

that of placing a large amount of inventories on distributors or retailers, because margin rate and value added are high. Thus, in order to pursue high customer service with low inventory level, quick response logistics system should be constructed. Also, in case of customized/differentiation focused product, a wide range of product lines should be completed and the necessity of consistent product innovation and R&D is high. Because of such characteristics of product variety, it is very difficult for distributors or retailers to hold and control properly the inventories of various kinds of products in their warehouses or sales shops (Fisher 1997). Accordingly, in this case, it is advisable to reduce supply chain lead time in order to deal with effectively immediate demand. However, in case of standardized/cost leader focused product suitable for market exchange relations structure, it is expected that most orders are made by the type of batch, because the responsibility of demand uncertainty may be shifted onto other supply chain members through result-based contract among supply chain members as mentioned previously. Accordingly, in case of such order with batch type, supply chain lead time may be relatively long.

However, the development of E-commerce technology requires the change of concept on trade-off relationships among various supply chain variables, which has been accepted traditionally. That is, the development of E-commerce technology can lead to the consecutive reductions of total transportation cost and total inventory cost by grafting advanced information technology onto logistics and inventory processing activities. Such consecutive reductions should shift the minimum point of total cost into left and down side (Figure 2). Therefore, the development of E-commerce may enable buying firms to accept a little longer lead time relative to the existing lead time which has been recognized guaranteeing maximum total cost. According to this logic, it can be anticipated that if the level of E-commerce adoption is relatively high, the significance of reducing the lead time of supply chain will be less even in customized/ differentiation focused product and strategic partnership structure.

Figure 2: The Effect of E-commerce on Inventory and Transportation costs



The response point of supply chain, which is defined as order penetration point by Christopher (1992), is the point of starting physical response to orders from customers, in which push by demand forecast and pull by customer order come across (Hoekstra and Romme 1991; Jones et al. 1997). The discussion on the response point of supply chain has consistently continued, and recognized as a key manufacturing strategy with defining as positioning strategy (Krajewski and Ritzman 2000). Krajewski and Ritzman (2000) classified positioning strategy into make-to-stock strategy, assemble-to-order strategy, and make-to-order strategy. Meanwhile, Hoekstra and Romme (1991) classified more specifically decoupling points into make and ship-to-stock, make-to-stock, assemble-to-order, make-to-order, and purchase and make-to-order. Such response point should be designed by manufacturer, and manufacturer should establish an optimal response point by considering the characteristics of traded products, product strategy, and related environmental factors (Hoekstra and Romme 1991; Macbeth and Ferguson 1994; Jones et al. 1997). In case of standardized/cost

leader focused product, the level of product variety is not high (Hambrick 1983), demand is stable (Miller 1988), and demand area is generally wide (Porter 1980; Miller 1987). Also, the strength of buyer-supplier relationship may be relatively weak because market governance structure is expected to appear dominantly as mentioned previously. Thus, the likelihood that response point is built in the upstream of supply chain is high. Meanwhile, in case of customized/ differentiation focused product, the level of product variety is high (Porter 1980; Miller 1987), demand is unstable (Miller 1988). Also, the level of support and cooperation among supply chain members for dealing with effectively demand uncertainty is relatively high (Anderson and Gatignon 1986; Miller and Friesen 1986; Ward et al. 1996; Lassar and Kerr 1996), because it is expected that hierarchical governance structure by strategic partnership between buyer and supplier and behavior-based contract among supply chain members are mainly shaped (Eisenhardt 1985; Lassar and Kerr 1996). According to these characteristics, firms with customized/differentiation focused product would try to obtain information on final demand more quickly than firms with standardized/cost leader focused product. Thus, the likelihood that response point is established in the downstream of supply chain is strong. The decision for such supply chain lead time can be related to the pursuit of geographic proximity to supplier and customer. However, the utilization of E-commerce may change such traditional perspectives on the response point of supply chain. That is, Internet or Web-based E-commerce adoption can improve the capability of remote monitoring and precise prediction on demand information, product variety, and market situation. Accordingly, it is expected that even firms with customized/ differentiation focused product may pursue the shift of response point into more upstream level of supply chain through the utilization of E-commerce. This makes it possible for manufacturing firms to accomplish the proper balance between the shift of order penetration point into upstream for quick switch to new product for dealing with effectively demand uncertainty and the maintenance of quick response capability on customers, which Berry et al. (1994) emphasizes.

Such argument on the relationship between E-commerce adoption and the response point of supply chain also can explain the effect of E-commerce on the relationship between safety stock and the characteristics of traded product or buyer-supplier relationship. That is, In case of standardized/cost leader focused product, the characteristics of demand stability and the availability of multi-suppliers by taking market governance structure can induce the reduction of safety stock. Meanwhile, in case of customized/differentiation focused product, safety stock may be maintained consistently as high level, because high customer service is pursued, demand uncertainty is inherent, and the unexpected accident of key supplier can lead to the difficulty of immediate response to customer orders when pursuing excessively strategic partnership with key supplier. If order penetration point is shifted to upstream by E-commerce adoption as mentioned previously, overall inventory in a supply chain is expected to reduce, but average safety stock in a supply chain may increase in order to establish quick-response logistics system. This is because the weight of push-type management will be decreased, while the weight of pull-type management is anticipated to increase (Hoecstra and Romme 1991; Jones et al. 1997). However, if both the shift of response point into more upstream level and the construction of automatic quick-response logistics system can be accomplished successfully through the utilization of Internet or Web-based E-commerce as mentioned previously, even firms with customized/ differentiation focused product may expect the benefits from the reduction of safety stock. This means that traditional perspectives on the relationship between safety stock and strategic issues also can be changed depending on the level of E-commerce adoption. Of course, in order to derive the above argument, the analysis by using approaches for minimizing total costs on trade-off relationship between additional costs and improved benefits induced by the change of response point and the reduction of safety stock should be preceded (Bowersox and Closs 1996). Generally, it is predicted that under total cost minimum approaches, improved benefits are superior to additional costs.

2.2 E-Commerce Initiatives for Supply Chain Management

As discussed above, the key issues for the design of supply chain structure may be influenced by the characteristics/strategy of traded products and buyer-supplier relationship. In other words, depending on which type of product strategy and buyer-supplier relationship are combined with supply chain structural issues, the direction itself for designing supply chain structure can be totally different, and further the effect of supply chain structure on performance can be also diverse. Also, the introduction of B to B E-commerce can contribute to the efficiency improvement of supply chain structure, because it can provide product information, inventory level, shipping information, and the information on customer requirement, on a real-time basis (Radstaak and Ketelaar 1998). Particularly, because buying company can establish cooperative planning on demand forecasting and production schedule with supplying company through information sharing by E-commerce, the potential of E-commerce for the efficient design of supply chain structure is tremendous (Karoway 1997). Additionally, E-commerce makes 'pull' supply chain management possible by linking effectively each function in a supply chain and customer's demand information (Kalakota and Whinston 1997). However, in spite of such significance of E-commerce for the consideration on the efficiency of supply chain management, to my knowledge, there is no previous paper to introduce systematically and specifically which kinds of E-commerce adoption initiatives can be considered for efficient supply chain management. The value of such kind of research is substantial.

The first initiative of E-commerce adoption, which can be considered in terms of supply chain management, is the utilization level of EDI. This initiative can be related to the problem on the type of purchasing related EDI or inter-organizational telecommunication network. The type of EDI can be classified into intra-EDI, VAN-EDI, Internet-EDI, and Web-based EDI, depending on which type of inter-organizational telecommunication network among private network, value-added network, and open network is selected (Kalakota and Whinston 1996, 1997; Kim 1999). Intra-EDI using closed private network is the method

connecting directly each node within a supply chain through a rental exclusive line. Meanwhile, VAN-EDI using value-added network is the method attempting the connection with suppliers by way of a third value-added telecommunication network such as GEIS, IBM, or AT&T. Open network is classified into Internet-EDI and Web-based EDI. Internet EDI is the method exchanging reciprocally electronic data between buyer and supplier through the standardization of communication protocol, without the construction of separate telecommunication network, while Web-based EDI is the method exchanging reciprocally electronic data between buyer and supplier through the direct connection to procurement homepage of buyer, in case that suppliers does not have a capability and environment of receiving and processing directly electronic data file because of weak internal basic communication system and infrastructure. Kim (1999) and Klein (1995) suggests three types of linkage between the type of inter-organizational telecommunication network and the pattern of buyer-supplier relationship in the perspectives of links between technological and organizational developments: *Hierarchical strategic partnership structure-Private network, Intermediary network structure-Value-added network, Market exchange relations structure-Open network*. When considering that buyer-supplier relationship can be directly related to the characteristics of traded products and issues for the design of supply chain structure, the argument of Kim (1999) implies that the type of EDI or inter-organizational telecommunication network can have a direct influence on the efficient linkage of supply chain strategy and structure.

Second initiative of E-commerce adoption is the level of integration with the information systems of various functions within a buying company including purchasing, sales, and manufacturing. Daugherty (1994) argues that EDI provides the basis for establishing strategic linkages, but its technical aspects alone are not sufficient to achieve strategic linkage along the supply chain. Accordingly, she emphasizes that the integration with functional IS within a firm beyond the development of EDI itself is necessary to achieve strategic linkage among supply chain members and ultimately create differential competitive

advantages. Bowersox (1989) asserts that the process of supply chain integration should progress from the integration of internal logistics processes to external integration with suppliers and customers, and such internal and external integration can be accomplished by the continuous automation and standardization of each internal logistics function and by efficient information sharing and strategic linkage with suppliers and customers. This notion implies that IS utilization may play an important role in the efficient accomplishment of supply chain integration, which is one of supply chain structural issues, and further the role of IS as a mechanism for the efficient linkage among supply chain members should be gradually emphasized. All the above arguments show that EDI's level of integration with functional IS can become a key initiative of E-commerce adoption for supply chain management.

E-auction also can have a role as an initiative of E-commerce adoption for supply chain management. In traditional auction, the number of suppliers participating in auction is limited, the process is unhurried, and a single closed bid from each supplier does not make true competition. Meanwhile, E-auctions enable a large number of suppliers to offer bids freely. Competition is expanded by exhibiting prices for every participant to observe and by permitting multiple bids from suppliers. Suppliers compete in real-time, offering lower bids (Hartley et al. 2001). Henke (2000) argues that E-auctions are supported for standard materials or services with many suppliers with similar capabilities, and in these situations, close strategic partnership with suppliers are not correlated with performance. Such argument indicates that E-auction may have a significant effect on the level of supply chain diversification, thus implying the relevance to the efficiency improvement of supply chain structure. The establishment of EC agent can activate more strongly open-bidding by Internet abovementioned. That is, EC agent is selected through open-bidding on unspecified multiple companies, and selected EC agent choose competitive suppliers through Internet open-bidding after the acquisition of information on required item, stock point, and amount from buyers. Also, EC agent directly contracts with suppliers, and

implements price decision and delivery command on related item. Then, EC agent supplies raw materials from suppliers to the purchasing department of buyer, and requests the payment of charge.

The importance of online electronic exchange has also been increased gradually for successful supply chain management. Freemarkets conducts online competitive bidding events in which potential suppliers of industrial products conduct live Internet bidding in order to secure orders from industrial buyers for manufactured parts and components. To be successful, industrial buyers must be willing to adopt the idea of auctioning off their supply contracts and potential suppliers must be willing to adopt the competitive buying process (Plouffe et al. 2000). For accomplishing this purpose, many companies have launched or are experimenting with new forms of electronic payment like direct-debit and smart cards. These systems are designed to simplify cash management and reduce transaction costs (Allen 1996). Conclusively, new payment system by electronic exchange can be a very different pattern of important driver for creating new type of auction and further new type of buyer-supplier relationship.

The level of linkage with JIT delivery can be also recognized as an important E-supply chain initiative. The theoretical validity of such argument can be identified from the triangular supplementary relationship among supply chain integration, JIT, and electronic linkage with suppliers. Like JIT manufacturing, quick response has become the watchword of a new era of time-based competition in the retail industry. Quick response is based on reducing development, production, order processing, and delivery cycle times. It requires integration of supply chains and necessitates that distribution channels carry up-to-the-moment market information as well as physical products. This method accelerates the flow of information and products, capturing relevant information at the point of sale and passing it immediately on to manufacturers and suppliers of raw materials to generate replenishment orders (Forrest 1994; Pedler 1994; Magretta 1998). Similarly, supply chain integration concepts already are manifest in numerous initiatives for JIT manufacturing, continuous replenishment, and

vendor-managed inventory. However, a successful supply chain integration strategy depends in large part on the information system that supports it. As mentioned previously, one of the most common information technologies to integrate a company with its business partners is to establish electronic commerce, including electronic data interchange (EDI) system and the Internet (Earl 2000; Arora 2000; Borck 2000; Morgan 2000; Arnum 2000; Gourley 1998; Hill 1995; Gregory 1995; Hammant 1995). Such integration with suppliers through E-commerce has great potential to increase logistics productivity, provide customers with high level services, and further accomplish key steps to logistics success, thus accelerating inter-organizational integration with customers (Chiu 1995; Lawrence 1997).

The level of documentation on various supply chain activities and auditing/monitoring on supply chain members is also a significant measure for the effect of E-commerce. Electronic Document Management System (EDMS) is the most representative system implementing the functions of documentation. EDMS controls all of processes from the creation to the cleanup of documentation file, and this covers files made in all applications including word-process, spreadsheet, multi-media, image-file, and electronic mail. EDMS consists of electronic data management (EDM), imaging system, workflow, COLD, FTR, Viewer, and OCR, and among them, EDM and imaging system is the most significant. Also, EDMS manages comprehensively numerous business documents on administration: partner, product, and service review; product introduction; order management; inventory management; marketing information management; service and support; and manufacturing. E-auditing implements the auditing on the type and the level of fit with standards of documents communicated among supply chain members. Also, E-auditing function monitors the difference in ordered price and volume between buyer and supplier, and can take error treatment and the prohibition of transmission on inconsistent file. This function can be applied to all of supply chain members.

The establishment of buyer-oriented E-server should be additionally considered.

As the representative type of buyer-oriented E-server construction, we can think the establishments of buyer-focused directory and comparing shopping by buyer's E-cart. Supplier-focused directory is not easy to use in terms of buyer. Accordingly, buyer can feel the need for making buyer-focused directory, and this directory can be managed by software agent. Also, in supplier-focused market, shopping cart is stored to supplier's server. But, in order for buyer to procure effectively materials from various suppliers, materials should be stored temporarily to buyer's cart, and then buying company should decide procurement after comparing accurately the stored materials. Such buyer-oriented E-server construction can create totally different perspectives on the dynamic relationship between buyer-supplier relationship and supply chain structure.

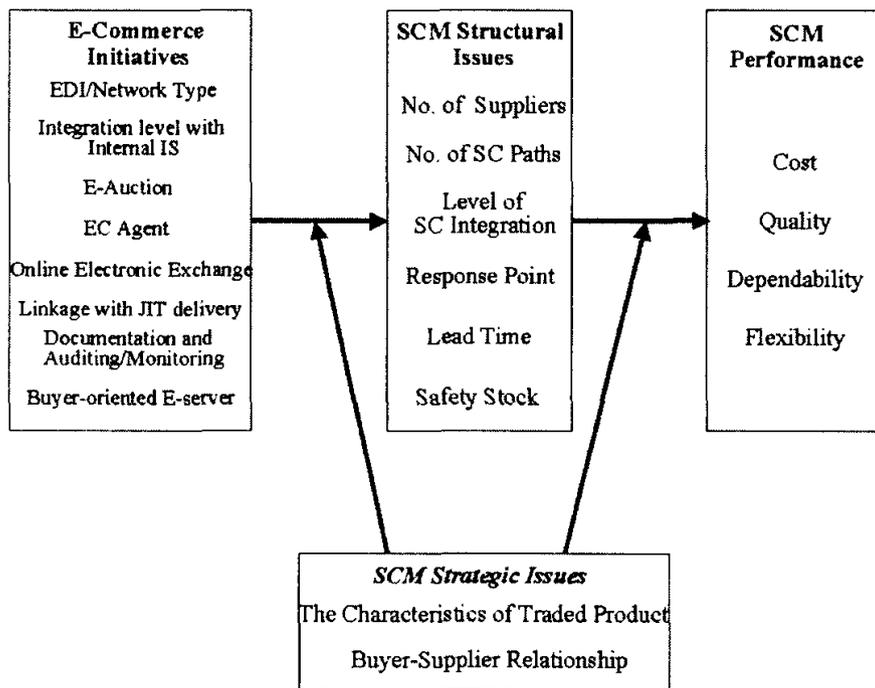
III. Research Design

As mentioned previously, the purpose of this study is to disclose the dynamic relationships among E-commerce adoption, supply chain structure, performance, and the moderate effect of supply chain strategic issues on the relationships. For this, this paper defines *number of suppliers, number of SC paths, the level of SC integration, order penetration point, lead time, and safety stock* as supply chain structural issues, and sets *the type of EDI/network, integration level with internal IS, the utilization level of E-auction, the utilization level of EC agent, the utilization level of online electronic exchange, the level of linkage with JIT delivery, the level of E-documentation and E-auditing, the level of buyer-focused E-server* as E-commerce initiatives. Also, *the characteristics of traded products and buyer-supplier relationship* are designed as moderate variables.

This paper suggests two research models. First model is to analyze the structural relationship among E-commerce initiatives, supply chain structural issues, and performance, and to identify the moderate effect of the characteristics of traded products and buyer-supplier relationship on the above relationship. For this, first, the groupings on sample firms are implemented according to strategic

significance and customized level of traded products or depending on the difference in investment level on transaction-specific assets between buyer and supplier. After classifying groups, the test on the designed structural equation model is implemented by the group, and multi-group equality test between groups for identifying the difference of significance in relation path is followed. Figure 3 represents the first model.

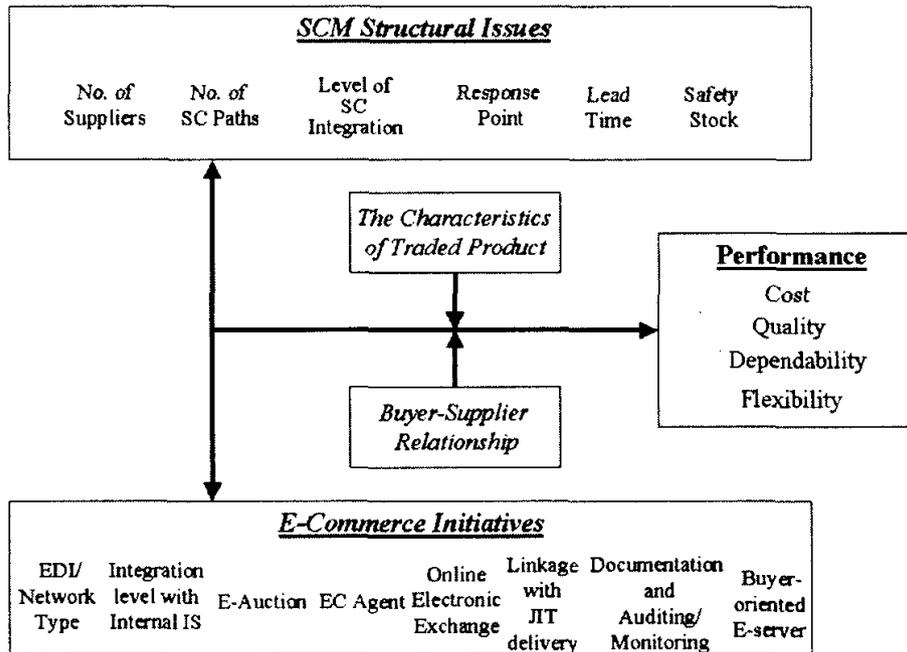
Figure 3: Research Model (1)



The fundamental intention of this study is not to simply confirm the causal relationships among theoretical variables indicated in Figure 3, but to suggest specifically a set of advisable utilization strategies of E-commerce for the efficiency improvement of overall supply chain management. The purpose of second model is to suggest the specific utilization strategies of E-commerce for the design of efficient supply chain structure, and to identify the type of supply chain strategy and structure appropriate for the implementation of such

E-commerce adoption strategy in terms of the cumulative improvement of four performance measures. For this, set correlation analysis was performed to analyze the association between the set of 6 SCM structural issues and 8 E-commerce initiatives described above (Figure 4). Of course, similarly with structural equation model in Figure 3, the characteristics of traded product and buyer-supplier relationship are included into the model as moderate variables. The goal was to form linear combinations of the initiatives in the two sets that have maximum correlation. Simply stated, we want to estimate coefficients so that the linear combination of SCM structural issues correlates as highly as possible with the linear combination of E-commerce initiatives.

Figure 4: Research Model (2)



IV. Expected Results and Contributions

4.1 Comparison with Previous Literatures

This study can be discriminated from previous researches in the following several theoretical and methodological points.

First, to my knowledge, this study is the first attempt to graft E-commerce adoption onto supply chain structural issues. Even though the necessity of integrated supply chain management has consistently been emphasized in the literature, the research on the overall structure of supply chain, which is the starting point for supply chain management, is almost beginning stage (Hoekstra and Romme 1991; Towill et al. 1992). This study suggests specifically an advisable set of E-commerce adoption strategies for supply chain management in SC structural perspectives as well as in strategic perspectives.

Second, past researches on E-commerce technology has mainly focused on the availability and significance of E-technology itself. This paper shifts the focus of research on E-commerce from E-technology itself to the efficiency of E-commerce adoption in supply chain management, by redesigning and measuring both technological and managerial E-commerce adoption initiatives in the perspective of suggesting mechanisms for the improvement of overall SCM efficiency, and by analyzing dynamic relationship between the designed E-commerce initiatives and various SCM initiatives.

Third, any of previous literatures has not considered process strategy as a strategic issue for the design of supply chain structure. This study, by inserting product-process matrix paradigm into the settings of variables for identifying the characteristics of traded product, tests empirically the possibility that the systematic design of supply chain structure and the appropriate utilization of E-commerce technology drives new type of manufacturing strategy framework.

Fourth, this paper considers simultaneously both the independent main effect and the interaction effect of E-commerce adoption on the design of supply chain structure and the establishment of supply chain strategy, by suggesting two

different models such as structural equation model and set correlation model for analyzing the structural relationship between the proposed E-commerce initiatives and SCM initiatives and suggesting the specific utilization strategies of E-commerce for efficient supply chain management.

4.2 Expected Major Contributions

From the empirical test of research model, this paper expects the following major suggestive contributions.

First, this study suggests specifically an advisable set of E-commerce adoption strategies for supply chain management in SC structural perspectives as well as in strategic perspectives. The identification of both the independent main effect and the interaction effect of E-commerce adoption on the design of supply chain structure and the establishment of supply chain strategy by testing empirically two different models such as structural equation model and set correlation model described previously, will enable us to accomplish the main purpose of this paper.

Second, this study can construct E-supply chain progression paradigm. Traditionally, it has been generally accepted that the developmental stage of E-network would shift from private network through value-added network to open network. The level of network development, which is one of this paper's E-commerce adoption variables, represents this shift. Accordingly, if connecting SC strategic and structural types suitable for each network type to the shift of (Private network → Value-added network → Open network), the construction of E-supply chain progression paradigm is possible.

Third, this study can identify the existence possibility of new type of supply chain structure. Fisher (1997) argues that typically, according to the characteristics of traded products, supply chain can be classified into physically efficient supply chain and market-responsive supply chain. This paper, by considering buyer-supplier relationship and the effect of E-commerce adoption other than the characteristics of traded product, investigates the validity of Fisher's argument and further gropes for the likelihood of creating new type of supply chain

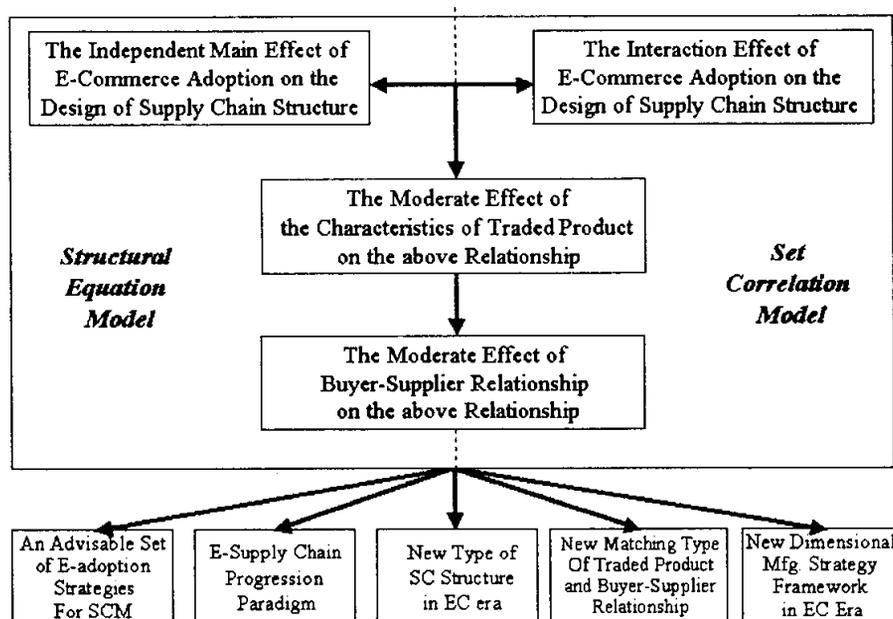
structure suitable for supply chain management in E-commerce era.

Fourth, this study can identify the most compatible sets of the characteristics of traded products and buyer-supplier relationship for the abovementioned E-supply chain progression. Bensaou and Venkatraman (1996) showed that the type of market exchange relations is appropriate for highly standardized products, while the type of strategic partnership is significantly correlated with highly customized products. Previous literatures have analyzed the relevance between strategic issues and structural issues in supply chain management, under the general agreement on the above combination type Bensaou and Venkatraman (1996) suggest. Through the analysis on the relationship between E-commerce adoption and interaction effect of the characteristics of traded products and buyer-supplier relationship, this study investigates the possibility that the matching type of product strategy and buyer-supplier relationship suitable for E-commerce era can be totally different.

Fifth, this paper can suggest new dimensional manufacturing strategy framework in E-commerce era. Grover and Malhotra (1999) comment that the trade-offs between achieving mass production and mass customization (Pine et al. 1993) need not be made as rigorously as in the past. Further, they suggest that the utopian goal of efficient mass customization with line flow strategies can be accomplished, and advanced information and process technology can lead such transition from traditional product-process matrix. This study, by inserting product-process matrix paradigm into the settings of variables for identifying the characteristics of traded product, tests empirically the possibility that the systematic design of supply chain structure and the appropriate utilization of E-commerce technology actualize the utopian goal.

Figure 5 shows the linkage between the research design of this paper and the abovementioned expected contributions.

Figure 5: Research Design and Expected Contributions



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