TOC 이론을 기반으로 한 전략적 관점에서의 공급사슬관리

(Supply Chain Management from the Strategic Perspective through the Theory of Constraints)

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Abstract As the information technology including Internet not only opened the cyber world but also has evolved as a platform that enables a new generation of businesses and remolds the shape of thinking and the rules of supply chain management (SCM). By using the Theory of Constraints, which seems simple but robust to review the traditional SCM context, the paper proposes a conceptual framework to handle the SCM issues. From the strategic perspective, this paper focuses on three policy constraints: supplier-manufacturer oriented constraints, manufacturer-distributor oriented constraints, and supply chain oriented constraints. To optimize the throughput and sustain the competitiveness of supply chain members in the dynamic business environment, the companies should utilize the potential competency of information technology and consistently perform the activities of removing and/or reinforcing the constraints.

1. Introduction

The Internet is changing the world. The Internet is creating the opportunity to implement entirely new ways of conducting business. Innovative information technology like the Internet is constantly reshaping the business processes and organizational performance in terms of reducing costs, lowering cycle times, enhancing customer service, and improving product quality [1]. Consequently, electronic commerce is receiving considerable attention. Kalakota and Whinston [2] define electronic commerce as 'a modern business methodology that addresses the needs of organizations, merchants, and consumers to cut costs while improving the quality of goods and services and increasing the speed of service delivery' .

Compared to Amazon.com, the Barnes and Noble Booksellers had a policy constraint in the distribution strategy. According to the Theory of Constraints, every business has at least a constraint or a weakest link that is preventing the firm from making infinite profits. Scott and Westbrook [3], and Turner [4] suggested that the supply chain links each element of the processes from raw materials through to the end user. As a result, each supply chain has a weak link or a constraint, which determines the performance limits of the supply chain mechanism. To improve the performance of the supply chain, the bottleneck should be resolved, in other words, a weak link or a constraint should be reinforced, replaced or reorganized.

The purpose of this paper is to furnish a conceptual model of applying the Theory of Constraints on the supply chain context to handle the SCM issues based on the information technology background. In order to achieve the research goal, we review the constraints of supply chain management and then classify and exploit those constraints.

As long as the level of supply chain management

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is concerned, Stevens [5] proposed three perspectives; strategic, tactical, and operational. This paper focuses on a competitive strategic perspective rather than individual firm-focused tactical and operational perspectives. Research on a strategic perspective includes developing objectives and policies for the supply chain, determining the shape of the supply chain in terms of process design, discussing how supply chain management can enhance the competitiveness of firms. Accordingly manufacturers or assemblers' perspectives will be discussed because they still play a major role in the supply chain.

First, we will review the SCM concept, especially its design and integrated processes. Second, the Theory of Constraints will be explored regarding definitions, performance measure, significance and types of the constraints. Then the conceptual model will be suggested to explain the constraints of SCM in order to improve the chain performance. Finally, limits and future research will be discussed.

2. Literature Review

2.1 Supply Chain Management

2.1.1 Definition

The concept of supply chain management (SCM) originated in the logistics literature and logistics has continued to have a significant impact on the concept. According to Bechtel and Jayaram [6], there are four supply chain schools of thought in terms of their definitions of SCM; chain awareness school, linkage school, information school, and integration school. From the linkage school' s perspective, Scott and Westbrook [3] referred the supply chain as the chain linking each element of the production and supply processes from materials through to the end customer. Also Turner [4] defined it as a technique that looks at all the links in the chain from raw materials suppliers through various levels of manufacturing to warehousing and distribution to the final customer.

While the integration school focuses on integrated processes between the chain members in order to add value. Cooke [7] defined SCM as successful coordination and integration of all the activities associated with moving goods from the raw materials stage through to the end user for sustainable competitive advantages. Those activities include systems management, sourcing and procurement, production scheduling, order processing, inventory management, transportation, warehousing, and customer service. Members of The International Center for Competitive Excellence in 1994 and Cooper *et al.* [8] defined SCM as the integration of business processes from end users through original suppliers that provides products, services and information that add value for customers.

Whereas the linkage school emphasizes on how linkages among the functional areas in a sequence can be exploited to reduce firm' s costs, the integration school focuses on customer satisfaction regardless of the configuration of the functional areas in the supply chain. By combining together, we define SCM as management of a linkage of processes from end users through original suppliers that provides products, services and information that increases throughputs for the chain members.

2.1.2 Objective

At the beginning of supply chain management, it was significant how to gain competitive advantage through suppliers' processes, technology, and capability. As a result, some researchers have focused on cost reduction like lowering inventory costs through SCM. Jones and Riley [9] stated that the objective of integrating the supply chain is to lower the total amount of resources required to provide the necessary level of customer service to a specific segment. Stevens [5] said that the objective of SCM is to synchronize the requirements of the customer with the flow of materials from suppliers in order to effect a balance between what are often seen as the conflicting goals of high customer service, low inventory investment and low unit cost. Also Tan *et al.* [10] suggested that the short-term objective of SCM is primarily to increase productivity and reduce costs, inventory and cycle time while the long-term goal is to increase customer satisfaction, market share

and profits for all members of the supply chain.

In our model, the objective of integrated supply chain management is to increase the business performance measured by a new perspective, *throughput* that is defined as money generated through sales, not through production in that customer satisfaction, market share, and cost reduction cannot always enhance firm' s profitability.

2.1.3 Characteristics

SCM takes several basic characteristics that are very different from the traditional ones in manufacturing environment. First, SCM involves a long-term relationship. Second, the total number of suppliers has been reduced [11]. Third, channel leadership is needed for channel coordination [8]. Fourth, information flows are bilateral and compatible. Fifth, channel members cooperate to reduce total channel cost to gain win-win strategy. Finally such a supply chain will typically extend to several organizational boundaries [3].

Since the need for mass customization and flexibility is growing, many organizations have recognized the benefits and competitive advantages associated with integrated processes within the organizations. For example, integrating purchasing and supply management into strategic planning allows organizations to deliver products and services to customers more timely and effectively. To further exploit the competitive advantages associated with integrated processes, organizations need some level of coordination and cooperation across organizational boundaries [8]. Thus, organizations should integrate processes and functions at the enterprise level within the organization on the beginning stage of SCM implementation, and then integrate them across the supply chain.

As long as the functions and activities to be integrated across the supply chain are concerned, the SCM literatures have included information systems integration, strategic planning and control activities, marketing research, promotion, sales and information gathering, R&D, and product design/development [9, 12]. Thus, supply chain relationship involves more processes and functions than integrated logistics relationships.

2.1.4 Performance measure

When all of the members in a supply chain are integrated and act as a single entity, performance is enhanced throughout the chain. The SCM literatures address the performance measurement areas such as service levels, cost, productivity/asset utilization, and time [13; 14; 15; 16]. However, those measurement systems have the weaknesses that no measures can explain the effective combination of integrated and nonintegrated measures and incorporate processes across firms. The integrated measures that include the measurement of an entire process or a series of processes across functional areas are very important because they help to avoid optimization at one point in the supply chain without considering the problems that may occur at other points. Also they are incentives to work with other members to increase performance on these measures [6]. To surmount those problems on the measurement system in SCM, throughput that is "the rate at which the system generates money through sales, not through production" is suggested. Each chain member has its throughput. If a chain member faces its decreasing throughput, it implies that there are problems in an entire process or a series of processes across functional areas in the supply chain. To gain a win-win strategy, a supply chain leader(s) should try to find out the alternative(s) to enhance each member' s throughput. Furthermore, a next interesting issue is following: who will control each member' s throughput?

2.1.5 Structure of the Supply Chain

The supply chain structure means the configuration of companies within the supply chain [8]. Channels of distribution have played a major role in shaping the supply chain systems because of their great impact on logistics systems during the 1980s and into the 1990s [17]. The theory of channel structure developed by Bucklin [18] can provide great insight into supply chain design.

Even though there is no best channel structure for all firms producing similar products, the channel (or

supply chain) structure depends to a large extent on the complexity of the product, the number of available suppliers, the availability of raw materials, and the firm' s target market. A manufacturer should consider *outsourcing*, *customers' buying behaviors*, types of distribution, control, product characteristics, and customer satisfaction in its supply design and evaluation of existing channel. In addition, making decisions on supply chain configuration is very important in new product development and market development [19].

Also the structure of supply chain is affected by the factors such as the size of the firm, sourcing and partnerships. Bhattacharya *et al.* [20] asserted that the sourcing structure in the auto industry are moving towards single sourcing because new product technology and product uniqueness are becoming critical to gain and maintain a competitive edge. This trend is related to the size of the firm. Whereas the car assemblers producing relatively low market volume in the European countries have first tier suppliers who provide their products with multiple customers, the large Japanese auto manufacturers maintain the *keiretsu* structure that is very similar to the vertical integration. As a result, it is very significant for the manufacturers to choose the level of relationship appropriate with their suppliers for particular supply chain links because there are no needs to be closely coordinated and integrated throughout the supply chain.

2.2 Theory of Constraints

2.2.1 Definition

Since Eliyahu Goldratt, an Israeli physicist introduced the Theory of Constraints as a manufacturing philosophy in the mid-1980s, it has been applied to cost accounting, financial banking system, reengineering, as well as manufacturing [21, 22]. The key idea is that every business has at least a constraint or a weakest link that is preventing it from making infinite level of specific goals such as profits. If a company has no constraints, it is able to achieve an unlimited level of performance. However, no company is perpetually making profit, which indicates every business must have at least one constraint. For example, demand is a constraint when firm' s capacity is greater than market demand. Therefore, the weakest link should be replaced, reinforced, or reorganized in order to improve the fir m' s performance.

The Theory of Constraints is one of frameworks for analyzing work processes and resource flows in an organization or a sales channel. Srikanth and Umble [23] define the concept of constraint as any specific area, aspect, or process that limits the business' performance from a specific viewpoint such as customer, competitive, or profit. Both articles imply that any process in a system like a supply chain that limits the system' s performance is a constraint. Constraints are any internal or external limit imposed on the system, and can come from either inside or outside of the system.

There are three major categories of constraints that exist in any given system at any given time, and are related to one another [24]. First, *physical constraints* are physical and tangible in nature and are easy to recognize as a constraint. The examples include machine capacity and capability, staff availability and capability, material availability and quality, space availability. However, every constraint does not come from a tangible or physical entity such as a bottleneck machine. Constraints can come from the rules and procedures that govern the organization. *Policy constraints* are those rules and measures that inhibit the system' s ability from continuing to improve. Poor pricing decisions, poorly designed sales territories are typical examples. The final category is *market constraints*. This constraint exists when the demand for the company' s products and services is less than or equal to the capacity of the organization, or in some other way limits the bottom-line performance of the company.

According to Tanner and Honeycutt [22], there are two methods to find and eliminate or elevate a constraint. One is a *scientific method* that understands the constraints, hypothesizes causes and examines potential and actual effect of those causes. The other is *evaporating clouds*, a technique of identifying solutions for core problems by changing incorrect assumptions. Constraints should be continuously

managed because the constraints are changing over time whereas non-constraints need not be managed because the performance of organization is limited by the constraints.

2.2.2 Significance

Since customers typically demand shorter lead times, it is important for the firm to launch a new product faster than its competitors in the market. The Theory of Constraints recognizes the value of time. In the case of developing a new product, the constraint is the critical path [25]. The critical path determines the minimum time needed to complete the new product development project. Reduction of the time from the concept stage to the scale-up stage in new product development with the Theory of Constraints can be translated into higher revenues.

Since a business organization is a dynamic system, the constraints are likely to change over time. It is very significant for managers to focus on the constraints that limit the performance of the system over time. Srikanth and Umble [23] state that failure to properly manage constraints causes the performance of the organization to be lower than the limit set by the constraints, and the organization would perform below its capability. Thus, recognizing the organizatio n' s constraints and then managing and controlling them properly determine the profitability of the firm.

2.2.3 Performance Measure

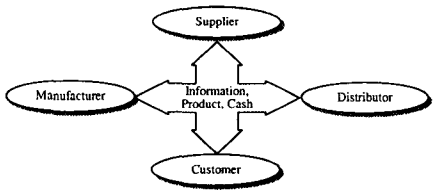
Theory of Constraints focuses not on input or output but on throughput. Scheinkopf [26] defines throughput as the rate at which the system generates money through sales, not through production, emphasizing on not units produced, but only sales. The reason is that inventories do not generate revenues for the firm until they are sold because finished goods can be sold at distressed prices or simply become obsolete. Thus, when the goal of the organization is to steadily increase its profitability, the increase of throughput that is the term used to describe "value added" can measure the improvement of the firm' s performance.

3. Conceptual Model and Constraints of SCM: Strategic Perspective

3.1 Conceptual Model

We referred SCM as management of a linkage of processes from end users through original suppliers that provides products, services and information that increases throughputs for the chain members. While the Theory of Constraints explains that every business has at least a constraint or a weakest link against infinite achievements. Thus, we can apply the concept to identify the problems in the supply chain and then improve each supply chain member' s throughput.

<Figure 1> indicates that supply chain management is based upon the integration of basic processes such as product, information, and cash [17]. The Theory of Constraints attempts to explain a constraint or a weakest link within an organization. Even though the boundary of supply chain relationship is beyond an organization, the supply chain that consists of channel members acts as a single entity [5]. As a result, each supply chain has a weak link or a constraint among supply chain members, which determines the performance limits of the supply chain. To improve the performance of the supply chain, a weak link or a constraint should be reinforced, replaced or reorganized.



<Figure 1> Integration of Supply Chain Processes

The categorization of three major constraints (physical, market and policy) is appropriate for a single organization. Market constraints and physical constraints can be common for most of the supply chain members, whereas policy constraints are somewhat different issues among supply chain

members. Even though the supply chain members behave like a single entity, in fact each member has its policies. As focusing on policy constraints, we propose a conceptual model shown as <Figure 2>. Also we will review and discuss three major categories of constraints in the supply chain context: (1) supplier-manufacturer oriented constraints, (2) manufacturer-distributor oriented constraints, and (3) supply chain oriented constraints. To improve each supply chain member' s throughput, those constraints should be identified and resolved, and information technology should be utilized to play a strategic role in a successful implementation of SCM. Specific explanations and discussions will be furnished in the next section.

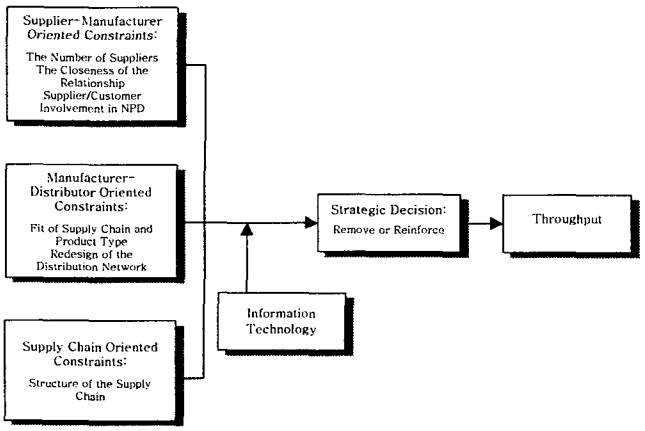
3.2 Supplier-Manufacturer Oriented Constraints

Based on the previous research on the internal constraints that may influence on the development of SCM strategy, constraints associated with the relationship between manufacturers and suppliers have been identified as critical factors that can limit either and/or both parties' throughput(s). Those factors include the number of suppliers, the closeness of the relationship between suppliers and manufacturers, and supplier involvement in new product development.

3.2.1 Number of Suppliers

How many suppliers are appropriate to increase manufacturer' s throughput? The number of suppliers is a typical policy constraint oriented from supplier-manufacturer relationships. Although firms usually do not like to depend on a small set of suppliers due to the supplier' s opportunistic behavior, this trend has changed [27]. Leading companies such as Xerox, Motorola, General Motor, and Texas Instrument reduced the number of suppliers because maintaining a large number of suppliers represents high transaction costs (B1, Wall Street Journal, Aug. 16, 1991). This trend resulted in better services and prices. In addition, locking in good suppliers can reinforce the entry barrier by reducing the intensity of competition from existing rivals and new entrants through tightly-coupled and limited number of suppliers.

However, the Internet-based B2B e-procurement system provides efficient and global management capability regarding on much more suppliers. Therefore, the weight of number of supplier itself in this constraint is relatively lighter than before. Rather the next two factors have gained more importance in the SCM.

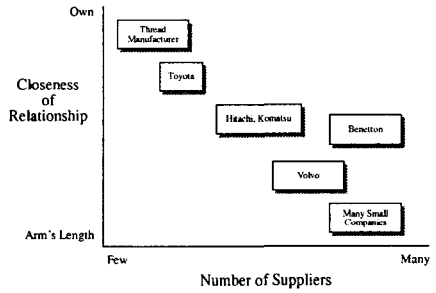


<Figure 2> Conceptual Model

3.2.2 Closeness of the Relationship between Suppliers and Manufacturers

Compared to the number of suppliers, the closeness of the relationship between suppliers and manufacturers is a higher level of decision-making. Improper relationship between suppliers and manufacturers is a typical policy constraint. As you can see in the <Figure 3>, supplier-manufacturer relationship indicates the firm' s strategic positions in terms of the number of suppliers and the closeness of the relationship between suppliers and manufacturers. Whereas good suppliers in the traditional approach are switched frequently for the lowest quote at arm' s length, good suppliers in the supply chain approach are trustworthy, innovative, and committed to long-term and quality.

Companies trying to gain more control over their supply chains tend to seek for moving to the *top left* on a grid in <Figure 3>. In order to move their position on the grid, companies should consider the following factors; extent of dependence on the chain, longevity of the relationship, technological or process links, the existence of legal ties, and the length and complexity of supply chain [3].



<Figure 3> Supplier-Manufacturer Relationship

Source: C. Scott and R. Westbrook, "New Strategic Tools for Supply Chain Management," International Journal of Physical Distribution and Logistics Management, Vol. 21, No. 1 (1991), pp. 23-33.

3.2.3 Supplier/Customer Involvement in New Product Development

"*Faster, Cheaper, and Better*" epitomizes the challenges facing on new product development (NPD) [28]. NPD teams have made great efforts to find the means for reducing new product development cost, enhancing product quality, and speeding up product development time [29]. In a competitive environment, effective integration of suppliers into new product development can furnish a competitive advantage [27, 30]. It yields such benefits as reduced costs and reduced product development time resulted from concurrent engineering [31] as well as improved quality. As the concept of SCM develops and adapts very rapidly to the industry, not only suppliers' roles in the supply chain but also new product development become more important than ever in the past.

A number of researches have discussed successful cases for integrating suppliers into new product development [30; 32; 33; 34]. North American automakers are shifting more design and engineering responsibilities to suppliers in an effort to cut costs and reduce new product development time [33, 35]. Japanese firms that adopted high levels of intensive supplier involvement in NPD suggest a significant advantage in lead-time and cost [32]. Early supplier involvement and early supplier selection offers performance benefits in design [36; 37; 38]. Bonaccorsi and Lipparini [39] suggest that partnering with suppliers in the new product development process provides a shorter product cycle, leads to better products, and increases firm' s ability to compete. Those studies suggest that early supplier involvement in NPD lead to a competitive edge. As a result, early supplier involvement in NPD can improve developer' s throughput. Therefore, disregarding early supplier involvement in NPD is a policy constraint.

Product life-cycle management (PLM) solution, an extended ERP solution provides a variety of possible functions to resolve this constraint in that companies have understood that using product definition information throughout the product life-cycle is critical to their success. Also integration of PLM with customer relationship management (CRM) is enabling incorporation of customer feedback and requests into product changes and corrections. For example, requirements management within PLM is integrated with CRM to gather and ensure incorporation of customer desired features and functions, and therefore

reorganize the business processes and shift the constraint up.

3.3 Manufacturer-Distributor Oriented Constraints

3.3.1 Fit of Supply Chain and Product Type

Poor coordination among supply chain partners in the U.S. food industry wastes $30 billion annually. One of the reasons is that managers lack a framework for deciding which supply chain is optimal for their products without considering the nature of demand for the products. Fisher [40] suggested that functional products that are characterized as stable, predictable demand and long life cycle require a physically efficient supply chain, whereas innovative products that are characterized as unstable, unpredictable demand and short life cycles require a market-responsive supply chain. The primary purpose of a market-responsive supply chain is to response quickly to unpredictable demand in order to minimize stock-outs, forced markdowns, and obsolete inventory, while the primary purpose of a physically efficient supply chain is to supply predictable demand efficiently at the lowest possible cost. Accordingly, mismatching supply chains with products can lead to decrease of manufacturers and distributors' throughputs. Thus, mismatching supply chains with products can be a policy constraint. As you can see in <Figure 4>, managers should use the four cells of the matrix in order to check whether their supply chains are well matched to the product types, considering the nature of demand for the products.

Efficient Supply Chain	match	mismatch
Responsive Supply Chain	mismatch	match
	Functional Products	*Innovative* Products

<Figure 4> Fit of Supply Chain and Product Type

Source: M. L. Fisher, "What is the Right Supply Chain for Your Product?" Harvard Business Review, Vol.75, Iss. 2 (March-April 1997), pp. 105-116.

3.3.2 Redesign of Distribution Network

Unlike industries such as food, consumer- packaged goods, automobiles, and fashion apparel, the PC industry is not as mature as other industries [41]. As e-Commerce enables buyers and sellers to exchange information about prices and product offerings at low costs [1], the PC supply chain structure has been changed a lot. The traditional model in the PC industry was a value chain with arms-length transactions from suppliers to a manufacturer to distribution channels to customers, whereas the direct model like the Dell Computer eliminates the intermediaries between the manufacturer and the end-user [42]. The direct model can reduce more inventories that can be a massive risk because the cost of materials goes down very fast in the PC industry. Accordingly an existing distribution network can limit manufacturer or assembler' s throughput. Thus, a poorly organized distribution network can be a policy constraint.

In reconfiguring an existing distribution network, it is needed for supply chain decision makers to consider the following factors; customer satisfaction, market share, distribution costs, profits, efficient performance of the redesigned network, and warehouse and distribution center locations [43]. Actually, success of business process reengineering (BPR) in distribution network redesign heavily depends on understanding and implementation. Since we have observed a significant transformation in the role definitions for information technology within management for last decade, IT as a strategic resource is well understood as the results of convergence of two concurrent forces; technology push and competitive pull.

3.4 Supply Chain Oriented Constraints

3.4.1 Structure of the Supply Chain

Determining the shape of the supply chain in terms of design is very important strategy because it impacts on manufacturer' s throughput. As mentioned earlier, a poorly designed supply chain is a policy constraint over an entire supply chain. However, according to Austin and Lee [41], multi-tier

manufacturers cannot immediately switch to a new distribution structure because it causes their strong channel relationships and their business to be at considerable risk. Thus, supply chain managers should analyze the factors that can affect the shape of the supply chain in terms of design. The structure of the supply chain is composed of upstream and downstream structure from a manufacturer. Since the previous section dealt with those factors, the following factors are additional ones across two streams.

- Technology Change: Technology development such as state-of-the-art applications and networks enables firms to select their optimal distributors and suppliers.
- Control and Leadership: The level of control and leadership across the supply chain will affect its structure. Controlling the supply chain can be achieved by vertical integration, but this is rarely the most cost-efficient method of organizing distribution [44]. Control without ownership or some other legal means such as franchising can only be achieved through cooperation among supply chain members. There are usually one or two strong leaders among the supply chain members.
- New Product Development: As technology develops, the number of components in a product tends to decrease [43]. This means fewer suppliers and service parts. Therefore, new product development will impact on the supply chain configuration.
- The Bullwhip Effect: The bullwhip effect is the phenomenon that the demand order variability in the supply chain is amplified as they moved up the supply chain. The effect leads to excessive inventory, poor customer service due to unavailable products or long backlogs, lost revenues, insufficient or excessive capacities. Lee *et al.* [45] identified four major causes of the bullwhip effect; Demand forecast updating, order batching, price fluctuation, and rationing and shortage gaming. Thus, supply chain managers should consider the bullwhip effect to configure the supply chain.
- Delivery, Quality, Trust, Cooperation as well as Price: In the past contracts between suppliers and manufacturer were short term, suppliers are numerous, competition is almost only based on price, whereas nowadays single sourcing is becoming more common, and competition is based on quality, delivery, trust, cooperation as well as price [33, 46]. Accordingly, manufacturers should analyze those factors in order to select the best suppliers.

4. Contribution and Limit for Future Research

There seems an apparent limitation with Theory of Constraints; only when a problem arises, the theory can be applied to fix a problem [22]. If a problem does not occur, the Theory of Constraints cannot provide improvement. However, checking the most potential constraints before making strategic decisions is a way of preventing problems from limiting firm's throughput. Thus the conceptual model that we propose in this paper can be utilized as a checklist to improve supply chain members' throughput from a strategic perspective.

In fact, it is very difficult for supply chain managers to recognize intangible problems like policy constraints across the supply chain. Even though senior supply chain managers recognize policy constraints due to other members in the chain, how can they handle the problem? Accordingly, how to recognize and handle policy constraints in the supply chain is a crucial issue especially in adoption and utilization of information technology.

The supply chain members are interdependent; if one member fails, the chain is apt to be disrupted, creating poor performance and establishing the workload in other areas, thereby jeopardizing the effectiveness of the supply chain [5]. It is necessary to think the constraints in terms of a single integrated chain rather than narrow functional areas. Every supply chain member should consider other member's constraints, when removing or reinforcing its constraints. The worst constraint across the supply chain should be removed or reinforced. As a result, a supply chain leader and cooperation are necessary to settle down those problems.

As mentioned earlier, this paper focuses on the constraints of supply chain management from a strategic perspective. Strategic decisions are made for monthly, annually, or multi-year planning to achieve

the goal(s) of firms. In addition to a strategic perspective, tactical and operational perspectives are also significant to successfully implement strategic decisions. Therefore, we need to further research the constraints of supply chain management from tactical and operational perspectives.

As organizations should integrate processes and functions within the organization at first and then make an attempt to integrate them across the supply chain, externally related constraints should be removed or reinforced after internally related constraints did. Each supply chain member has different internal constraints. What are the internal constraints of suppliers, manufacturers, and distributors? What is the relationship between internal and external constraints? Those are interesting issues.

This paper does not provide empirical evidence to prove how to remove or reinforce the constraints to improve the firm' s throughput. However, it would be a good alternative to conduct simulation in terms of the changes of the supply chain structure based on a variety of the variables. By using the simulation method, an optimal chain structure can be developed. Therefore, the final research issue will be to investigate the sensitivity of decision variables affecting the configuration of the supply chain.

REFERENCES

[1] R. Nath, M. Akmanligil, K. Hjelm, T. Sakaguchi, and M. Schultz, "Electronic Commerce and the Internet: Issues, Problems, and Perspectives," International Journal of Information Management, Vol. 18, No. 2 (1998), pp. 91-101.

[2] Kalakota, R. and A. B. Whinston, Frontiers of Electronic Commerce. Addison-Wesley: Readings, MA, 1996.

[3] C. Scott and R. Westbrook, "New Strategic Tools for Supply Chain Management," International Journal of Physical Distribution and Materials Management," Vol. 21, No. 1 (1991), pp. 23-33.

[4] J. R. Turner, "Integrated Supply Chain Management: What' s Wrong with This Picture?" Industrial Engineering, Vol. 25, No. 12 (1993), pp. 52-55.

[5] G. C. Stevens, "Successful Supply Chain Management," Management Decision, Vol. 28, No. 1 (1992), pp. 25-30.

[6] C. Bechtel and J. Jayaram, "Supply Chain Management: A Strategic Perspective," The International Journal of Logistics Management, Vol. 8, No.1 (1997), pp. 15-34.

[7] J. A. Cooke, "In This Issue," Supply Chain Management Review, Vol. 1, No.1 (Spring 1998), p. 3.

[8] M. C. Cooper, D. M. Lambert, and L. D. Pagh, "Supply Chain Management: More Than a New Name for Logistics," The International Journal of Logistics Management, Vol. 8, No.1 (1997), pp. 1-13.

[9] T. C. Jones and D. W. Riley, "Using Inventory for Competitive Advantage Through Supply Chain Management," International Journal of Physical Distribution and Materials Management," Vol. 15, No. 5 (1985), pp. 16-26.

[10] K. C. Tan, V. R. Kannan, and R. B. Handfield, "Supply Chain Management: Supplier Performance and Firm Performance," International Journal of Purchasing and Materials Management, Vol. 34 (Summer 1998), pp. 2-9.

[11] M. Abrahamsson and S. Brege, "Structural Changes in the Supply Chain," The International Journal of Logistics Management, Vol. 8, No.1 (1997), pp. 35-44.

[12] J. L. Cavinato, "A Total Cost/Value Model For Supply Chain Competitiveness," Journal of Business Logistics, Vol. 13, No. 2 (1992), pp. 285-301.

[13] Camp, R. C., Business Process Benchmarking. ASQC Quality Press: Milwaukee, WI, 1995.

[14] E. Raia, "Synchronizing the Supply Chain," Purchasing, Vol. 117, No. 3 (September 8, 1994), pp. 38-43.

[15] F. Hewitt, "Supply Chain Integration," Annual Conference Proceedings; Oak Book, IL; Council of Logistics Management, (1992), pp. 334-341.

[16] T. Davis, "Effective Supply Chain Management," Sloan Management Review, Vol. 34, No. 4 (1993), pp. 35-46.

[17] Coyle, J. J., E. J. Bardi, and C. J. Langley, Jr., The Management of Business. Logistics. West Publishing Company: New York, 1996.

[18] Bucklin, L. P., A Theory of Distribution Channel Structure. IBER, University of California, Berkeley:

Berkeley, CA, 1966.

[19] Lambert, D. M., J. R. Stock, and L. M. Ellram, Fundamentals of Logistics Management, Irwin/McGraw-Hill: New York, 1998.

[20] A. K. Bhattacharya, J. L. Coleman, G. Brace, and P. J. Kelly, "The Structure Conundrum in Supply Chain Management," The International Journal of Logistics Management, Vol. 7, No. 1 (1996), pp. 39-48.

[21] S. C. Gardiner and J. H. Blackstone, Jr., "The Theory of Constraints and the Make-or-Buy Decision," International Journal of Purchasing and Materials Management, Vol. 27 (Summer 1991), pp. 38-43.

[22] J. F. Tanner, Jr. and E. D. Honeycutt, Jr., "Reengineering Using the Theory of Constraints," Industrial Marketing Management, Vol. 25 (1996), pp. 311-319.

[23] Srikanth, M. L. and Umble, M. Michael, Synchronous Management: Profit-Based Manufacturing for the 21st Century. The Spectrum Publishing Company: Guilford, Connecticut, 1997.

[24] Goldratt, E. M., Theory of Constraints. North River Press: Great Barrington, MA, 1990.

[25] J. Elton and J. Roe, "Bringing Discipline to Project Management," Harvard Business Review, (March-April, 1998), pp. 153-159.

[26] Scheinkopf, L. J., Thinking for a Change: Putting the TOC Thinking Processes to Use. The St. Lucie Press: New York, 1999.

[27] J. N. Sheth and A. Sharma, "Supplier Relationships," Industrial Marketing Management, Vol. 26 (1997), pp. 91-100.

[28] E. G. Mendez and J. N. Pearson, "Purchasing' s Role in Product Development: The Case for Time-Based Strategies," International Journal of Purchasing and Materials Management, Vol. 30 (Winter 1994), pp. 3-12.

[29] Wheelwright, S. C. and Clark, K. B. Clark (1992), Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality, The Free Press: New York, 1992.

[30] L. M. Birou and S. E. Fawcett, "Supplier Involvement in Integrated Product Development: A Comparison of U.S. and European Practices," International Journal of Physical Distribution and Logistics Management, Vol. 24, No. 5 (1994), pp. 4-14.

[31] C. O' Neal, "Concurrent Engineering with Early Supplier Involvement: A Cross Functional Challenge," International Journal of Purchasing and Materials Management, Vol. 29 (Spring 1993), pp. 3-9.

[32] K. B. Clark, "Scope and project Performance: The Effect of Parts Strategy and Supplier Involvement on Product Development," Management Science, Vol. 35 (1989), pp. 1247-1263.

[33] S. Helper, "How Much Has Really Changed between U.S. Automakers and Their Suppliers?," Sloan Management Review, Vol. 32, No. 4 (Summer 1991), pp. 5-28.

[34] A. Lipparini and M. Sobrero, "The Glue and The Pieces: Entrepreneurship and Innovation in Small-Firm Networks," Journal of Business Venturing, Vol.9 (1994), pp. 125-140.

[35] R. G. Newman and K. A. Rhee, "A Case Study of NUMMI and Its Suppliers," International Journal of Purchasing and Material Management, Vol. 26 (Fall 1990), pp. 15-20.

[36] R. L. Cutts, "Capitalism in Japan: Cartels and Keiretsu," Harvard Business Review, Vol. 70, Iss. 4 (July-August 1992), pp. 48-55.

[37] R. Landeros, R. Reck, and R. E. Plank, "Maintaining Buyer-Supplier Partnerships," International Journal of Purchasing and Materials Management, Vol. 31 (Summer 1995), pp. 3-11.

[38] S. N. Wasti and J. K. Liker, "Risky Business or Competitive Power? Supplier Involvement in Japanese Product Design," Journal of Product Innovation Management, Vol. 14 (1997), pp. 337-355.

[39] A. Bonaccorsi and A. Lipparini, "Strategic Partnerships in New Product Development: an Italian Case Study," Journal of Product Innovation Management, Vol. 11 (1994), pp. 134-135.

[40] M. L. Fisher, "What is the Right Supply Chain for Your product?" Harvard Business Review, Vol. 75, Iss. 2 (March-April 1997), pp. 105-116.

[41] T. A. Austin and H. L. Lee, "Unlocking the Supply Chain' s Hidden Value: A Lesson from the PC Industry," Supply Chain Management Review (Summer 1998), pp. 24-34.

[42] M. Dell and J. Magretta, "The Power of Virtual Integration: An Interview with Dell Computer' s Michael Dell," Harvard Business Review, Vol. 76, Iss. 2

(March-April 1998), pp. 73-84.

[43] V. Mabert and M. A. Venkatraman, "Special Research Focus on Supply Chain Linkages: Challenges for Design and Management in the 21st Century," Decision Sciences, Vol. 29, No. 3 (1998), pp. 537-552.

[44] G. Davies and E. Brito, "The Relative Cost Structures of Competing Grocery Supply Chains," The International Journal of Logistics Management, Vol. 7, No. 1 (1996), pp. 49-60.

[45] H. L. Lee, V. Padmanabhan, and S. Whang, "The Bullwhip Effect in Supply Chains," Sloan Management Review, Vol. 38, No. 3 (Spring 1997), pp. 93-102.

[46] R. E. Spekman, "Strategic Supplier Selection: Understanding Long-Term Buyer Relationships," Business Horizons, Vol. 31 (July-August 1988), pp. 75-81.

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