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〔Article〕

Supply Chain Cost Management:

A Life Cycle Perspective

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Abstract

Recently, nearly all goods have been experiencing shrinking life cycles, and drastic changes in consumer demand have occurred. The challenges presented by this changing market can be successfully coped with through the appropriate use of supply chains. Supply chains naturally excel at sharing market- and management-related information among participants, thereby enabling the swift provision of goods needed by consumers. The development of individual firms depends largely on whether they can become part of well-integrated and highly competitive supply chain. This requirement for competitiveness applies to all firms, whether they are up-stream or down-stream firms. Without a doubt, competition among supply chains will become more intense in the future. The purpose of this study is to theoretically and logically examine effective supply chain cost management.

Keywords: supply chain cost management, life cycle management

サプライチェーン・コストマネジメント

――ライフ・サイクルの視点から――

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1. Introduction

In recent years, many global markets have experienced enhanced volatility in the demand for finished

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goods. This has highlighted the challenges that firms faced in swiftly responding to fluctuations in consumer demand for such goods. Supply chains can enable participants to overcome such challenges effectively and efficiently. They intrinsically provide strategic value by creating partnership frameworks and facilitating the sharing of information on competitive factors such as consumer demand. In this way, supply chains help companies to optimize consumer satisfaction, and thus the ability to participate in well-integrated and highly cooperative supply chains provides companies with a competitive edge. The managerial issue of staying competitive is one faced by all companies, irrespective of whether they are engaged in upstream, midstream, or downstream operations. Hence, being part of an effective and efficient supply chain has become a core strategy for sustainable corporate development, which has led to intensified competition between different supply chains.

According to Cäker and Strömsten (2010), the inter-organizational controls related to problem-solving that business practitioners and academic researchers try to establish should aim to truly achieve the goal of consumer satisfaction. Hence, the rule of thumb in deciding which practice to use in supply chain management is to choose the practice that customer will value the most.

The stage of the life cycle that a product is in has an impact on consumer demand for that product. Consequently, consumer demand for products in the growth stage differs from that for products in the mature stage. This study explores effective supply chain strategies across key stages of the product life cycle.

The technologies embedded in growing products are still in the introduction and growth stages of the product technology life cycle, and thus offer huge potential for extensive and radical product innovation creation. These characteristics of growing products facilitate firms' frequent and rapid new product releases. Partly led by the expansion of product innovation on the supply side, consumers are increasingly demanding the further releases of new products by firms. Meanwhile, mature products, which are in the mature stages of their technology life cycles, offer low potential for product innovation. Consumers in mature product markets tend to more highly value "efficient and effective purchases" in selecting mature products, which is explained in more detail below. Based on this perspective of supply chain management, this study makes a distinction between supply chains that market growth products and those that supply mature products. The purpose of the study is to theoretically and logically examine relevant cost management systems in the respective inter-firm networks, based on a review of relevant literature. In addition, this study addresses the control of supply chains comprised of independent companies, in which all partners are engaged in the long-term implementation of supply chain operations. Supply chain development through exchange partners is not part of the framework of this study.

2. Review of related literature

2.1. Cost management that suits the characteristics of products offered by supply chains

Fisher (1997) has proposed a research framework for examining supply chain management control systems that suit the characteristics of products that they supply. This research perspective has been applied to the classification of products into functional and innovative categories (Fisher, 1997). This approach regards a functional product as one with the central characteristics of being widely distributed, relatively inexpensive, and frequently purchased. The requirements for increasing the profitability of functional products include the minimization of costs needed to serve consumers. In contrast, innovative products are considered identical to growing products described in section 1 above. Once supply chains that provide innovative products are no longer capable of marketing new and emerging products, they fail to compete with other supply chains.

2.2. Customer accounting that fosters increases in customer value

Lind and Wedin (2005) and Lind and Strömsten (2006) have created two research frameworks for supply chains. The first of these concerns the four basic types of customer relationships, in terms of a relationship matrix of customer and product traits. The second addresses the conceptualized customer accounting systems for particular customer relationships. In the conceptualization of customer accounting, products are divided into two categories: growing products that are in introductory and growth stages and thus meet new customer demands, and mature products that are produced in accordance with predetermined and standardized specifications. In addition, customers are classified into higher or lower categories in a firm's sales ranking, according to whether they are heavy purchasers or light purchasers, respectively.

The conceptual categorization of customer accounting proposed by Lind and Wedin (2005), and Lind and Strömsten (2006) is based on two fundamental considerations with regard to the customer information that is desired by companies. First, firms that are marketing growing products hope to gain information related to expected returns on future investments in these growing products, since market demand for the products is expected to increase over time. Meanwhile, firms that supply mature products seek out information about profitability and returns gained from supplying products to individual customers during a certain period. Second, firms managing relationships with light purchasers need information gained through segmental profitability analysis.

Lind and Wedin (2005) and Lind and Strömsten (2006) also explain four types of customer accounting and the information required in each particular case. First, the management of relationships with light purchasers for mature product markets requires segmental profitability analysis, based on groups of customers possessing common characteristics. Second, the management of relationships with heavy purchasers in mature product markets involves a need for information on the current

profitability of individual customers. Third, the management of relationships with heavy purchasers in growing product markets requires the analysis of customer lifetime value. Customer lifetime value is a measurement of the potential for an existing relationship with a customer to continue into the future, and is generally calculated as the sum of cumulative discounted cash flows for a customer over his or her entire lifetime with the firm. Fourth, the management of relationships with lead users of a growing product whose purchases of the product are not yet heavy requires customer equity analysis. Customer equity, which presents the total value of a firm as its total customer value, is defined in terms of the lifetime value of all of the customers of the firm.

3. Achieving growth in supply chains through cost management

This study distinguishes supply chains that market growing products from inter-firm networks that supply mature products. It then identifies consumer demand for the final products of these respective types of supply chain. The research framework of the study makes it possible to examine the types of cost management that are required to satisfy customers in both types of supply chains.

3.1. Supply chains marketing growing products

3.1.1. Consumer needs for growing products

Growing products are in the growth stage of the technology life cycle, in which there is particularly huge potential for product innovation. Increased product innovation on the supply side can also further increase the market demand for the release of new products. Hence, growing products can facilitate product technology breakthroughs. At the same time, markets for growing products regularly generate increases in the demand for new products, making it impossible for firms to survive unless they continue to release new products. This competitive environment inevitably mandates increases in capital investment. Therefore, firms that belong to growing product markets face the problem of how to raise sufficient funds to survive product innovation races. One source of funds for financing such investments is “cash cow” of PPM (product portfolio management) (Abegglen and the Boston Consulting Group, 1977).

More importantly, the ability to swiftly generate profit thorough the marketing of growing products positively affects the establishment of sustainable competitive advantages. This is taken into account in the research perspective of this study.

3.1.2. Life cycle cost analysis

The essence of competitive strategies in growing product markets is how to effectively and efficiently satisfy consumer demand through the rapid acquisition of newly emerging products. This means that capital investment in the development and supply of new products is crucial to a

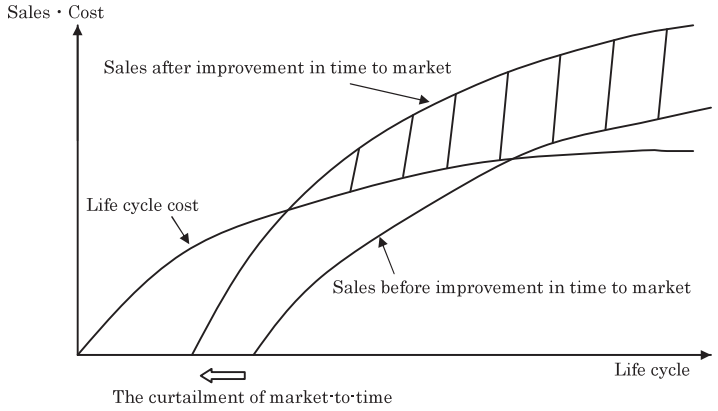

Fig. 1 Impact of reducing time to market on life cycle profit
(Source) Based on Cohen et al. (1996).
(Notes) The area marked by slanted lines shows the incremental increase in sales generated by reduction in time to market without increasing life cycle cost.

supply chain's competitive advantage over others. Growing market environments also force supply chain participants to accelerate time-to-market (TTM) for new products at low costs to gain crucial competitive advantages. Break even time (BET), which Hewlett-Packard utilizes for each new product development project, is an effective performance metric for managerially auditing the achievement of agile TTM. BET is defined as the amount of time that it takes to recoup total investment expenditures. The longer the BET, the riskier an investment will be, since it will take a longer period of time for the investor to recoup the invested capital on the basis of discounted cash flow (House and Price, 1991).

In Figure 1, the BET is the point at which the sales line and the life cycle cost (see Figure 2) for a certain product intersect. If it is assumed that the first developer of a new product will exclusively monopolize demand, the acceleration of TTM can bring about a rise in the gradient of the sales line, as shown in Figure 1. Effective cost management enables the acceleration of TTM-driven revenue improvement, thereby yielding a reduction in the BET.

According to Clark and Fujimoto (1991), the best practices for reducing TTM include overlapped product development and joint research and development (R&D) between upstream-downstream firms. With regard to R&D management, the most important challenge is the optimization of time-cost trade-off in R&D (Cohen et al., 1996). Unless firms can succeed in reducing both TTM- and R&D-related costs simultaneously, they cannot improve their profitability. To tackle such a challenge, it is important for firms to practice life cycle cost analysis.

It is also important to consider how component switching brought about by the redesign of products affects their life cycle costs. As shown in Figure 3, the switching of components used in products changes during production process design. Further, switching components affects production methods, while decisions about which parts to use in production affect part procurement costs. Finally, the

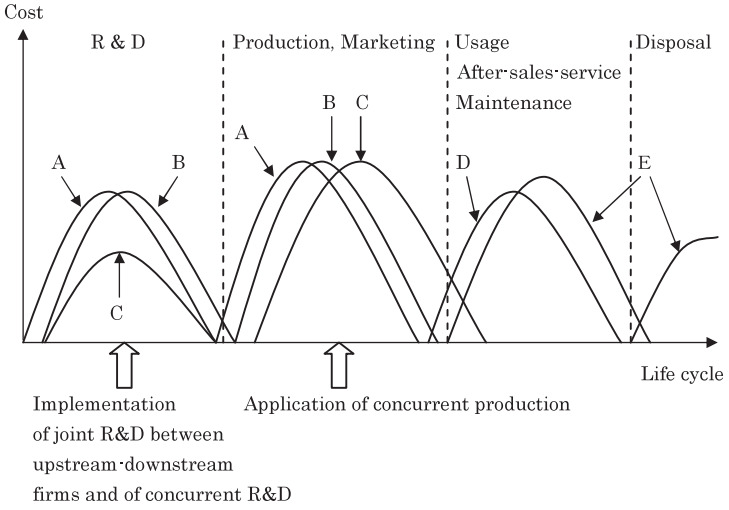

Fig. 2 Conceptualization of supply chain life cycle costing

(Notes)

(1) A: Parts manufacturers B: Finished product manufacturers
C: Marketing firms D: Manufacturing industries E: Consumers

(2) Joint R&D and concurrent production are based on Fijimoto (2001).

Decision-making and functions affected by the redesigning of products	Production process design	Production methods	Procurement of parts	Disposal methods
Corresponding stages in the life cycle	R&D	Production	Usage and Maintenance	Disposal

Fig. 3 Decision-making and functional activities affected by the redesigning of products

(Sources) Based on Wang et al. (2007)

redesign of products determines product disposal costs (Wang et al., 2007).

Life cycle cost can generate activity-based and resource-consumption-driven cost information at different stages in the product life cycle (Dunk, 2004, p. 404). The most critical factor in the success of supply chains offering fast-growing products is the swift marketing of new products. The extent to which this can be carried out can be evaluated based on the performance level of the BET for new products. Supply chains that market fast-growing products in the growth stage of the product life cycle should determine a targeted BET for new products and decide whether the targeted life cycle cost is affordable for the BET. Targeted life cycle costs include costs incurred at each stage over the product life cycle from the introduction to the disposal phase. The targeted life cycle cost can thus be broken down according to the participants engaged in operations across the supply chain. This means that individual supply chain participants can be made responsible for the achievement of time and cost targets for all operations. Cost management based on the life cycle costs for supply chains' products

enables participants to determine how to effectively execute their operational activities while reducing activity costs.

Based on the approach mentioned above, activity-based life cycle costing (ABLCC) can be regarded as an integrated system of life cycle costing and activity-based costing that provides firms with cutting-edge management practice (Emblemsvåg, 2003). ABLCC is characteristic of a process-oriented approach (Emblemsvåg, 2003), and applies activity-based costing to the respective phases of the product life cycle, regarding the cycle as a chain of activities. As such, ABLCC can make the operational activities conducted by supply chain participants manageable. The achievement of targeted life cycle cost over the product life cycle requires optimal decision-making regarding what activities to execute, how to perform them, and how to carry out intra-participant interface activities. These issues can be solved optimally through the application of ABLCC.

3.1.3. Participant allocation of joint supply chain profits

The successful management of trade-offs between TTM and supply chain costs is a positive factor in increased profits. The provision of monetary incentives to supply chain participants is a useful means of facilitating the improvement of time-cost trade-off. However, it is important to consider what kind of incentives should be offered and how much should be offered in order to maximize effectiveness. The most important factor for the maximization of joint profit across a supply chain is enhanced cooperation between its participants. Therefore, the allocation of joint supply chain profit among participants is essential to improving partnerships. With regard to rules for allocating a supply chain's joint profit, this study sheds light on the distribution of joint supply chain profit to individual participants in proportion to the ratio of total costs. Joint profit across the supply chain is calculated as follows:

Supply chain joint profit from certain finished products＝turnover of the finished products－supply chain's total variable costs for the finished products, excluding those incurred through internal purchases within the supply chain－supply chain's total capacity costs for the finished products

The capacity-related cost for a firm is cost that is associated with human capital and productive facilities, and which is incurred as a result of possessing those facilities and preparing them to be usable at any time (Monden, 2001, chap. 3).

The allocation of a supply chain's joint profit based on individual participants' costs leads to equal profit per unit of cost across supply chain participants (Fleischmann, 1999, p. 184; Dudek, 2003, p. 134). In this respect, joint profit distribution based on cost is fair.

It is also necessary to compare the allocation of a supply chain's total profit based on participants' costs and the allocation of the turnover of finished products in proportion to participants' costs. Both allocation rules give rise to the same profit for each participant. The allocation of total supply chain profit can motivate participants to focus on the total profit of the whole supply chain, thereby facilitating participants' struggles to increase the supply chain's overall profit.

3.2. Supply chains marketing mature, standardized goods

3.2.1. Lean consumption (Womack and Jones, 2005)

Products that are standardized because they have reached maturity in the product life cycle can be said to be in mature phase of the technology life cycle. Once products have reached such a period of maturity, intense future product innovation is not expected. Therefore, the provision of products that satisfy customers is not the most critical factor in the successful sales promotion of mature products. Most importantly, supply chains that distribute mature products need to improve the convenience of customer purchasing. Womack and Jones' (2005) lean consumption approach, involving the optimization of purchase processes, applies the concept of purchase convenience as an analytical instrument. According to Womack and Jones (2005), the requirements for firms to achieve lean consumption are as follows: ①Solving any problems faced by consumers completely (p. 61), by excluding the source of these problems. ②Helping and prompting the valuable utilization of consumer time (p. 62) by excluding non-value-added time from the precious total time that consumers can spare. ③Providing exactly the goods that customers want. Firms should not struggle to distribute what they want to sell to consumers, but rather need to strive to satisfy market demand by offering precisely what consumers want (p. 63). ④Satisfying consumers by providing what they want exactly where they want it. In order to meet more consumers' needs, it is important to segment customers into smaller groups according to the places or stores where they make purchases, and then construct distribution channels for these stores. This allows customers to get what they want where they want it. As a result, retailers can earn greater revenues (pp. 66–67). ⑤Providing the right customers with the right items in the right stores exactly at the right time (p. 67). ⑥Continually adding new value to goods, thereby satisfying greatly expanded consumer demands. If consumers can satisfy their various demands with goods offered by a single firm, they can save the significant amount of time needed to transact with many firms (p. 68).

3.2.2. Cost to serve customers

Consumers hardly perceive the functional differentiation among different companies' goods. Instead, items ②-⑤ regarding lean consumption more strongly affect consumers' purchase decisions. In other words, one of the most important factors in gaining competitiveness in the sales of mature goods is to swiftly and conveniently provide what consumers want at low prices.

In this case, the most important issue for a supply chain to solve is how to improve convenience in consumer purchasing without increasing costs, since the improvement of purchase convenience typically brings up costs. Standardized goods that have passed through the growth period in the product life cycle are unlikely to earn large revenues if they remain as they are. Therefore, supply chains that supply mature goods need to reduce costs to achieve profit expansion.

It is mandatory for supply chains that provide mature goods to gain a good understanding of the

kind of purchase assistance that consumers want them to implement and how much of the purchase assistance consumers demand. Based on marketing information, supply chains also need to decide what purchase assistance to provide with to segmented consumers and how to provide it. However, supply chains' success in such cases depends on serving customers at a low cost. Given this, any solution must consider cost to properly serve customers.

The cost to serve customers is instrumental in making decisions based on customer profitability analysis (Shapiro et al., 1987; Braithwaite and Samakh, 1998; Guerreiro et al., 2008). Cost to serve customers is also useful for analyzing product-segmentation-based marketing cost in activity-based costing involving contribution margin analysis, such as that proposed by Monden (2001, chap. 3). This kind of analysis integrates activity-based costing with contribution margin analysis to achieve the more accurate staged recovery of fixed cost, which allows for the more useful customer profitability management. Shapiro et al. (1987) classify cost to serve customers into three categories: order getting and order entry activity cost, production cost, and delivery cost. As described above, consumers' purchase selections of standardized goods supplied by supply chains are significantly affected by supply chains' quality of customer service, including purchasing assistance, delivery, and after-sales-service. Since this study examines the impact of cost to serve customers on the improvement of customer value for mature products, it is appropriate to consider the different types of cost to serve (CTS) except in the case of production-related cost. According to Guerreiro et al. (2008, p. 392), in existing research, diverse terms have been used interchangeably to describe CTS, including customer service cost in the work of Hansen and Mowen (2000), marketing cost in Foster and Gupta (1994), and marketing and logistics cost in Stapleton et al. (2003). This study uses cost to serve customers to describe this cost concept (CTS).

Management practices based on the cost to serve customers identify cost drivers for marketing activities and consumer purchase-supporting activities, such as successful order, distribution, and after-sales-services based on activity-based costing. Analysis of these drivers should be followed by decisions based on how much it will cost to provide the customer services that customers want.

Figure 4 shows how important the analysis of cost to serve customers is, by using the marketing cost approach of Coughlan et al. (2006). Marketing activity costs include storage and logistics cost, inventory carrying cost, order winning cost, negotiation cost, proceed collection cost, cost related compensation, repair, and after-sales-service, receiving and placing order cost, and payment cost.

Cost to serve customers determines cost drivers, which open doors for the determination of quality and quantity standards for individual categories of firms' customer service activities demanded by customers. This capability of cost drivers can lead to the generation of customer service activity cost functions. For example, if inventory carrying cost is proportional to order placing frequency, inventory carrying cost and order placing frequency, inventory carrying cost for individual customers' order placement frequency can be estimated.

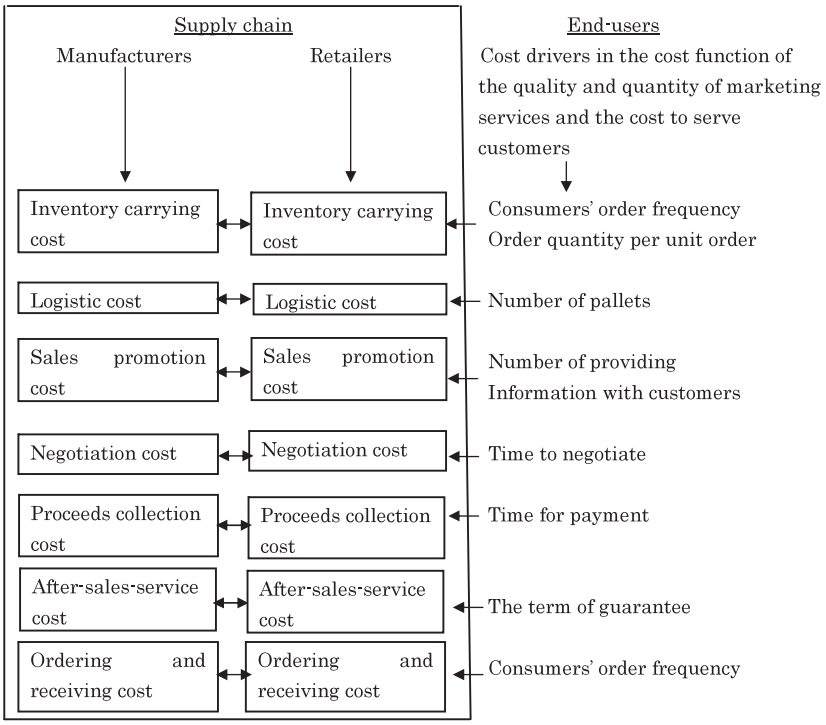

Fig. 4 Illustration of cost of providing services to customers
(Notes) The categorization of activities to serve customers is based on Couglan et al. (2006, p. 74).

3.2.3. Managerial effectiveness of cost to serve customers

3.2.3.1. Determination of activities that achieve excellent and efficient customer service

Many industry sectors are currently facing the shortening of product life cycles. Under these market conditions, sales will inevitably decline. The shorter a product's life cycle is, the more serious the challenge of reducing operational cost is. The most important issue regarding cost reduction for supply chains that provide mature goods is the achievement of highly efficient consumer purchases. Achieving this requires an understanding of the cost to serve consumers.

Among strategies to boost the sales of mature goods is the marketing of a wide variety of goods. A high-variety manufacturing and marketing approach can be responsive to the diversification of consumer demands, thereby enabling boosts in sales. However, it is almost impossible to increase the sales of mature goods. Because of this, it is mandatory that supply chains reduce cost to serve to increase the profitability of mature goods.

When choosing which individual supply chains' goods are best, consumers prioritize the quality of purchase assistance provided by firms over the functionality of goods. The acceleration of high-variety offerings inescapably brings about an increase in cost to serve customers. Therefore, the achievement of efficient customer service is the most decisive factor in boosting the sales of mature goods. To

solve this managerial issue successfully, it is necessary to carry out managerial analysis, based on the cost to serve customers, and this means developing a good understanding of the content and quality of purchase assistance demanded by customers, followed by an estimation of the cost to serve customers in the manner demanded.

Another business strategy for supply chains that market mature goods is the selection of and concentration on core goods as a core competence. Appropriately concentration on core goods requires effective customer profitability analysis. Cost to serve customers based on activity-based costing is instrumental in correctly allocating overhead-related marketing activities to customer segments.

3.2.3.2. Shiftability of marketing activities among supply chain participants

The improvement of effectiveness and efficiency in consumers' purchases requires the involvement of supply chain participants such as part manufacturers, manufacturers of finished products, and retailers, so that the fundamental restructuring of ways to provide consumers with goods can be thoroughly examined. Such innovative management techniques include functional shiftability. In order for supply chains to efficiently achieve customer satisfaction, it is important that they decide which performers are best for individual functions in a supply chain, and then shift responsibilities for performing specific functions as necessary. This is the role of functional shiftability (Mallen, 1973). Functional shiftability is more feasible in well-integrated trust-based supply chains than in arms-length transactions.

Functional-shiftability-driven decision-making on best-performing participants for specific business operations across the supply chain is crucial to achieve the lean consumption. Cost to serve customers is indispensable to the measurement of the effects of functional shiftability on supply chains' overall costs. Many practical cases of functional shiftability in marketing channels have been recorded (Kollat et al., 1972). One related business practice is that of vendor-managed inventory (VMI). VMI shifts responsibility for shelf replenishment at a retailer away from the retailer and to the product's manufacturer (Iwashima and Yamamoto, 1996, p. 146). The work of Kulp (2002) makes it possible to consider the advantage of VMI by comparing it with a traditional method for inventory control in a supply chain comprised of a retailer and finished product manufacture. Under the traditional stock replenishment system, retailers monitor the amount of on-hand inventory and forecast consumer demand, based on which they place orders with the manufacturer. The retailers then store and control the received inventory. In VMI, in return for providing demand data to manufacturers, retailers can transfer the responsibility for stock replenishment at their store shelves to the manufactures.

Therefore, transferring from traditional inventory replenishment to VMI generates functional shiftability, and makes it unnecessary for retailers to engage in placing orders. Successful decision-making on whether to transfer to VMI or not requires activity-based costing across the supply chain, in order to accurately determine the difference between the supply chain's overall cost before and after the application of VMI.

Functional shiftability can help save time needed for goods to reach customers. However, functional shiftability in supply chains typically brings about an increase in the operational costs of participants that have to carry out new tasks transferred from other participants. Therefore, the focal firm of a supply chain must create incentives for participants to accept functional shiftability in spite the increased costs involved. Among these incentives is the allocation of joint profits to participants across the supply chain.

4. Concluding remarks

Recently, nearly all goods have been experiencing shrinking life cycles, and drastic changes in consumer demand have occurred. The challenges presented by this changing market can be successfully coped with through the appropriate use of supply chains. Supply chains naturally excel at sharing market- and management-related information among participants, thereby enabling the swift provision of goods needed by consumers. The development of individual firms depends largely on whether they can become part of well-integrated and highly competitive supply chain. This requirement for competitiveness applies to all firms, whether they are up-stream or down-stream firms. Without a doubt, competition among supply chains will become more intense in the future. Therefore, the focal participants in a supply chain need to introduce excellent managerial practices across the supply chain. This study has examined effective supply chain cost management.

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