The Impact of Cooperation on SCM

by

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Abstract

In recent years, cooperation in a supply chain has become a new trend in supply chain management. The benefit of cooperation in a supply chain has been indicated and realized in many studies and pilot projects. Various concepts and approaches have been developed. Through examining the most popular concepts and approaches in recent year, this thesis intends to study the long-term impact of cooperation on a supply chain and discuss several factors necessary to keep the cooperation healthy.

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Chapter 1 Introduction

Cooperation in supply chain management has gained much more attention than ever before. A supply chain refers to the production and distribution process from raw materials to finished goods. A supply chain includes of raw material suppliers through end users. Every party in a supply chain is usually an independent business. Those businesses have their own objectives, interest and perspectives of demand forecast. They try to gain competitive advantages to maximize their profit. However, the individual objectives and interest may conflict with those of others. The conflicts limit the competitiveness of every company and worsen the performance of a supply chain. Therefore, when companies face intense competition, companies cannot fully use their competitive advantage. To avoid such situations, many companies have realized the importance of cooperation.

In recent years, many cooperation methods and concepts have been developed. Those methods and concepts consist of information sharing, collaborative forecasting, early order commitment, VMI (vendor managed inventory), CFAR (collaborative forecasting and replenishment) and CPFR (collaborative planning, forecasting and replenishment). Those methods require each member in a supply chain to have a deep understanding of supply chain management. Every company must shift their focuses from their own segments to the whole supply chain. Through improving the performance of the whole supply chain, every party can benefit from the improvement. In practice, sharing information among members of a supply chain is basic method to achieve the improvement. With cooperation among members of a supply chain, the information to be

shared would be different from the conventional information in speed, quantity and quality.

Nowadays the information exchanged in a supply chain is through Internet enabled systems with advanced software. Therefore, information can be exchanged in real-time. Furthermore, the information shared in a supply chain includes information that was viewed as sensitive and confidential information in the past. In addition, the methods used by each company to generate the information are also shared and understood by members of the supply chain. This practice is useful in picking useful information from a large amount of information and various sources. Furthermore, although the various cooperation methods and concepts are towards the same goal, they have different focuses and different ways of applications. This paper intends to examine the mechanism of each method and concept. The paper also discusses the impact of the cooperation of supply chain and the ways businesses should engage into cooperation. Cooperation can definitely improve the performance of a supply chain. However, in the long run, the cooperation could cause problems without certain rules to keep it on the right course. Thus, cooperation could be a universal solution to improve supply chain management only when members pay attention to certain matters and adopt certain rules.

Chapter 2 Literature Review

In recent years, cooperation has been treated as a powerful measure to improve the efficiency of supply chain management. Many research studies and articles were published in many kinds of journals. Most of them held a positive view of cooperation. Those paper and article usually approached cooperation in an experimental way. With this approach, a model was built and the process was simplified. The results came from the comparison of a model without cooperation, which served as a benchmark and a model with cooperation in a supply chain. At least, in this pure academic and quantitative approach, despite of any particular method, the result of the model with cooperation was always better than that of one without cooperation.

The basic method was information sharing. In a study [1], U.W. Thonemann analyzed the impact of sharing advance demand information on the performance of a supply chain. They considered a supply chain with multiple customers, a single manufacture and multiple products. In the case, the multiple products belonged to one category. A customer could order from different manufacturers. Therefore, even if the manufacturer knew the demand information, it was still uncertain whether it could get the order. There were two kinds of advance demand information to be shared. They were aggregated advance demand information and detailed advance demand information. With aggregated advance demand information, customers provided the information whether they would place order in the next period to the manufacturer, but they didn't provide the information about which product they would order and where they were going to place the order. They focused on cost saving by using both information-sharing methods. The costs of information sharing were different between the two methods. Since aggregated

advance demand information needed less information than detailed advance demand information did, the cost of it was lower, but the benefit was also lower. They found that aggregated advance demand information sharing reached its highest value in a supply chain when the products had highly unbalanced demand rates. On the other side, detailed advance demand information reached its highest value when the product demand rates were balanced. The benefit of information sharing was at manufacturer. The customers benefited because the manufacturer could offer better offers. They also built a model to take inventory holding cost and shortage penalty cost into account. They found that all members of the supply chain benefited from information sharing without affecting production cost. Inventory holding cost deceased while the number of customers sharing information. Furthermore, the cost was lower when members shared detailed advance demand information than that when they shared aggregated advance demand information. With information sharing system, in a supply chain with multiple products, the value of detailed advance demand information was higher than that of aggregated advance demand information. The difference increased when the number of products increased. Both types of information had their highest value when the order probability was low and the quality of information was high. The two types of information worked almost the same when the demand rates were highly unbalanced, but detailer advance demand information had higher value than aggregated advance demand information when the demand rates were balanced.

The objective of collaborative forecasting is to eliminate forecasting errors. Srinivasan (1994) [2] examined the impact of vertically integrated information on the shipment performance of suppliers who used a just-in-time (JIT) system. The integration

of information was based on EDI. Through studying supplier shipment date in the automobile industry, they found that establishing integrated information system to support information-sharing system of scheduling could largely reduce the number of shipment discrepancy. The study was based on the manufacturer-supplier relationship and on the shipment date of a single US manufacturer. In another paper, Srinivasan (1995) [3] also indicated that the information sharing system could save $100 per vehicle and $220M per year for Chrysler by analyzing the data in one decade of the assembly center.

One of many factors that cause forecasting errors is the bullwhip effect. The errors occur at one end of the supply chain are amplified to upstream. For instance, the errors occurring at retailers cause larger errors at distributors and manufacturers. Therefore, the production forecast would be meaningless. The objective of information sharing system is to minimize the bullwhip effect.

Lee et al. (1997) [4] studied the demand variability amplification in a supply chain and named it bullwhip effect. They identified four causes for the bullwhip effect. They also mathematically proved that the demand variation was amplified when orders went through the supply chain. In another study, Chen et al. (2000) [5] used a simple, two-stage supply chain to quantify the bullwhip effect. The model consisted of a single retailer and a single manufacturer. The retailer in the model use a moving-average model for demand forecast and held a simple order-up-to inventory policy for replenishment. Under those assumptions, the variance of the orders was always higher than that of demand. The variance was largely affected by the number of observations used in the moving average, the lead-time between the retailer and the manufacturer. When they

extended the analysis to a multiple stage model, they found that sharing demand information with every party in the supply chain could reduce the bullwhip effect. The bullwhip effect is also affected by the forecast method and the demand pattern. In another paper, Chen et al. (2000) [6] analyzed the effect of forecast methods and the demand pattern on the bullwhip effect. They used an exponential-smoothing forecasting model and a moving-average model to make the comparison. They also made comparison of a correlated demand and a demand with a linear trend. They found that short lead-time and smoother forecast could reduce the influence of bullwhip effect. However, the paper didn't take the effect of the variance amplification and the production decision of the manufacturer into account.

Another factor causes forecasting error is the forecasting methods. A recent paper by Zhao et al. (2002) [7] examined the impact of the selection of forecasting models on the value of information sharing in a supply chain. Their study focused on one supplier and four retailers. They used a simulation model to examine the influence of information sharing in different circumstances. Five typical forecast methods were used by the retailers. They were a naïve method (NAV), a simple moving average (SMA), a two-parameter double exponential smoothing (DES), a no-trend Winter's method (NTW), and a three-parameter Winter's model (WIN). There were three different circumstances for the manufacturer:

- The supplier made decision based on the orders placed by the retailers without information sharing.
- The supplier used both orders placed and the net requirements forecasted by the retailers as gross requirements in its production decision.

- The supplier used both the retailer's planned orders and placed order as gross requirement in its production decision.

They found that the factors that most significantly influenced the total costs of the supply chain were the capacity tightness on the supplier side, the demand pattern on the retailer side and the information sharing method between both sides. The forecasting model had significant influence on total cost and service level of both sides. Moreover, the interaction between forecasting models and demand patterns also had impact on total cost for retailers, total cost for the supplier, total cost for the entire supply chain, the service level of supplier and the service level of the retailers.

The study indicated that the information sharing had largely impact on the performance of a supply chain. Sharing future order information was more beneficial than sharing future demand information. The cost of the entire supply chain could be reduced largely under most circumstances. The demand pattern, the forecasting model and capacity tightness also had large influence on the value of information sharing. The accuracy of information could affect the value of sharing information largely. The study also found that the benefit to different parties in the supply chain could fairly different under different circumstances. The supplier could reduce its cost and improve its service level largely under any circumstance. However, the retailers might not be able to benefit form information sharing and even worsen when the capacity tightness was low. The study indicated that supplier needed to provide incentives to retailer to encourage them participate in sharing information. The study limited its analysis in a two-stage supply chain and didn't take other factors such as inventory level and capacity information into account.

With information sharing system in a supply chain, there are many mutual commitments among participating members. Early order commitment is one of them. Early order commitment is to put a fixed order quantity and delivery time from a supplier before the actual order takes place. The forecast errors of early order commitment can largely influence the performance of early order commitment. In a study [8], Zhao et al. analyzed the impact of errors on early order commitment. This study focused on the impact on the performance from downstream to up stream. They built a model consisting of one supplier and four retailers. There was only one product in the supply chain. The demand for a single period was the same and all demand came from the retailers. The simulation indicated that the errors had the greatest impact on the total cost of the entire supply chain. They found that forecast bias and forecast deviation had large influence on total cost, total cost of supplier and total cost of retailers. The total cost was at its lowest point when there were no forecast bias and forecast deviation. The forecast deviation had more impact on total cost of supplier than on total cost and total cost of retailers. Total cost and total cost of retailers, but not total cost of supplier reached their lowest points when forecast bias didn't exist. Negative and positive forecast bias also had different implications with total cost of retailers. When the forecast bias was below zero, the retailers constantly underestimated the demand. Therefore, retailers would have a high level of shortage cost and backorder cost. Those costs diminished as the forecast bias approached zero. When the forecast bias went above zero. This meant that the retailers constantly overestimated the demand. They began to have the holding cost and the holding cost became the dominant cost. However, for the total cost of supplier, there was another picture. As the forecast bias went below zero, total cost of supplier decreased. A

negative forecast bias meant that the supplier could satisfy the retailers' orders that were underestimated. Therefore, supplier had a lower backorder cost and total cost of supplier. One other hand, when forecast bias went above zero, the retailers placed more orders that were over estimated on the supplier. Thus, extra holding cost recurred on the supplier side and total cost of supplier was pushed up. Another factor that affected the performance of a supply chain was early order commitment period. It represents the number of ordering cycles before which retailers have to put orders in order to receive products at a certain point (not include transportation time). It is the order lead-time. They found that the early order commitment period had significant impact on the cost performance. The relationship between total cost and early order commitment period was U-shaped. Furthermore, the incremental cost increased as forecast bias increased. The backorder cost of supplier declined as the early order commitment period became large and the relationship between total cost of supplier and early order commitment period was also U-shaped. However, on the retailer side, the total cost of retailers constantly went up as the early order commitment period became large, since early order commitment period by retailers made it possible for the supplier to optimize its production decision over a longer planning horizon and better utilize its production capacity. The rate of increase in early order commitment had large impact on the improvement of capacity utilization. However, for the retailers, early order commitment period deteriorated the accuracy of their forecast. Therefore, retailers faced large potential backorder cost or holding cost. Through this study, they indicated that early order commitment could reduce the total cost of a supply chain, but the benefit only could be realized within a range of early commitment period. The small early order

commitment period tended to realize big benefit. The large forecast errors consisting of bias and deviation resulted in short early order commitment period in order to benefit from early order commitment. In practice, when the retailers were not able to make accurate forecast, they should not make an order commitment too early. The benefit of early order commitment was not evenly distributed to all members of a supply chain. Early order commitment usually more benefited supplier than benefited retailers. It was practically useful in a supply chain owned by one company or companies engaging in gain-sharing programs. The trend in demand pattern increased the total cost of a supply chain. A negative trend caused higher total cost of a supply chain than a positive trend did. The structure of costs usually did not have large influence on the total cost of a supply chain. The value of early order commitment increased when the number of retailers in a supply chain increased. The findings in this study were valid when the capacity cushion of the supplier increased or the capacity cushion could be adjusted periodically. When the capacity tightness was low, the value of early order commitment increased and the valid early order commitment period became wider. On the other hand, when the capacity tightness was high, a larger positive forecast bias was helpful in reducing the total cost. The paper didn't mention a supply chain with multiple ties. In this study, supplier used only a particular lot-sizing rule to make production decision and the retailers used only EOQ to control their inventory. This study didn't take incentives into account and only focused on one particular supply chain.

VMI has been one of the popular cooperation methods in recent year. Matt Waller et al. [9] examined effect of VMI in a study. They used computerized models to evaluate the VMI approach. Their models demonstrated the effect on VMI of demand variability,

partial adoption of the approach, and limited manufacturing capacity. They found that the operational benefit of VMI is clear since the costs of many technologies associated with VMI were declining. The approach also could largely reduce the inventory of all participants. The reduction resulted from frequent inventory review, order intervals and delivers. However, demand volatility didn't have significant influence on the benefit of VMI. Because of the stable condition of manufacturers, all of the VMI participants could benefit from the approach under any condition. The study also indicated that the trustful relationship among partners was critical to the implementation of VMI. The success of the VMI approach largely depended on partnership among participants, metrics and organizational structure. However, the paper didn't mention how to develop the partnership among the participants.

Quick response is another collaborative concept that has been gain attention in recent years. In a study [10], M. Eric Johnson and Gary Scudder followed four different production rules to simulate the inventory level of a Hewlett-Packard division that produced small oscilloscopes. The division had a 24-hour shipment goal. The first production rule used in this case was a lot-for-lot that was actually used in production. The quantity of production was determined by the sales on previous day. The assembly line produced each SKU in a fixed cycle at the convenience of operators. The second was similar to the first, but the product with the smallest days of supply would be produced first. The third was that instead of using previous sales, the quantity for each SKU would be determined to maximize the minimum days of supply. The last was based on the estimated probability of meeting the next day's demand for each product. They found that the fourth rule achieved the best and the first rule compared to others performed the

worst. Furthermore, they indicated that the difference between rules became the largest when variability and line utilization were high.

Srinivasan Raghunathan (1999) [11] analyzed the effect of CFAR on a manufacturer- retailer two stage supply chain. The model consisted of one manufacturer and two identical retailers. Any shortages were backordered at the manufacturer and retailers. Shortages were equally divided into two parts and allocated to the two retailers. In the first step, the two retailers were supposed to have the same shortage allocation policy. In other words, both of them participated or didn't participate in CFAR. When they participated in CFAR, demand and production information was shared in the whole supply chain. Otherwise, each of them had its own forecasting. There was no effort of information sharing. The result without CFAR of first step served as a benchmark. The second step was that there was only one retailer participated in CFAR. Because the shortage allocation policy became different, the two retailers were subject to different shortage allocation policy and were no long the same. The participant didn't face any risk of shortage, since the manufacturer knew its demand information before production and would ensure its order quantity as the return for the demand information. All of the shortage was allocated to the non-participant.

The results were consistent with expected outcomes. On the manufacturer side, the manufacturer cost was lower with CFAR than that without CFAR. The incremental cost of the manufacture decreased as well. Compared with the benchmark, the cost of manufacturer with the participant was lower than that with the non-participant. On the retailer side, the cost of the participant was lower with CFAR. The reduction of incremental cost became higher when the other participated in CFAR. When there was

only one participant, compared with the benchmark, the cost of participant was lower and that of the non-participant was higher. This paper also indicated an interesting result. When the manufacturer held only one shortage policy for both retailers, the non-participant could have a free ride on saving cost. Although this situation was rare in reality, it might exist. According to this paper, manufacturers could put pressure on non-participants by financial incentive and retailers would be encouraged to participate in CFAR for their own interest. However, this approach depended on cost saving. It didn't take other factors that might discourage the retailers to participate into account. For instance, the cost of implementation and maintenance of EDI (Electronic Data Interchange) system was a concern. The information sharing system involved extensive technology and substantial cost. The errors of retailer forecast might undermine the effort of CFAR. In addition, in reality, CFAR reduced the number of retailers as trade partner. However, since CFAR reduced coordination cost, the number of retailers should increase. The contradictory relationship between the reality and the theory wasn't clarified.
The studies above provided insight about the potential benefit about information sharing, collaborative forecasting and CPFR. The benefit of the cooperation within a supply chain had been examined. However, in the reality, few companies have had large success through the cooperation of supply chain management. There was a gap between the reality and theories. There were also a lot of difficulties that could be quantified. There were many study address the problem from different approach.

Simatupang et al. (2002) [12] addressed the collaborative supply chain from managerial aspects. They indicated that the difference in interest was a major difficulty for practicing collaborative supply chain. Every member in a supply chain had its own

interest. Many of those members were independent business. They worked at their best interest. Their decisions were usually based on local perspective and opportunistic behavior. They habitually would try to maximize the profit of their own parts. However, in many occasions, maximizing the profit of a part of a supply chain was at the expense of losing the profit of other parts and the whole supply chain. Since the common objective of a collaborative supply chain was to pursue the highest satisfaction of customers, the difference in interest caused mismatch between supply and demand and made the supply chain inefficient. To the members of a supply chain, the mismatch could cause many kinds of loss, such as shortage cost, holding cost, and transportation cost. There were many conflicts within a supply chain. Distrust among members was a major cause of the inefficiency of a supply chain. Distrust often impeded the effort of the members to improve the efficiency of the overall supply chain. The conflicts didn't directly relate to dysfunctional results of a supply chain, but the resolution of those conflicts could lead to dysfunctional outcomes. Furthermore, those dysfunctional results could cause further conflicts and influence the original cause. There were three types of conflict causes, differences between members' goal and objectives, disagreement over domain of decisions and actions and difference in perceptions of reality used in joint decision-making. Those differences were caused by the differences in the ways chain members acquired and processed information about their supply chains such as roles, expectation and communication. Furthermore, the obsolescence of existing procedures impeded the new level of cooperation among multiple parties of a supply chain that required global perspective to effectively manage the supply chain. However, there was a common dilemma. A company usually made the decision based on local perspectives, but

the best decision should be based on global perspectives. It was difficult for the managers of a single company, since they were trained to work as a single entity only guided by local perspectives and often exhibited opportunistic behavior. There were many other factors that affected the performance of a supply chain.

Inappropriate measures of performance were one of those factors. Inappropriate measures referred to existing traditional measures of individual performance irrelevant to the maximization of supply chain profit. In many cases, members didn't have an overall picture about the supply chain. The most calculations available to examine the profit of a supply chain were simplified and focused on one or several particular segments of a supply chain. The profit was also measure in cost-reduction. In those calculations, sometimes, when the overall profit of a supply chain was maximized, certain parties in the supply chain suffered loss of profit. For an independent business, it would tend to minimize its own cost rather than to maximize the overall profit of the supply chain. Therefore, the measure used to improve the performance of a particular party in a supply chain might undermine the effort to improve the performance of a supply chain. For instance, every member in a supply chain was likely to push its inventory to its downstream member without considering the actual demand. Therefore, a mismatch between demand and supply would be caused in such a situation. Such mismatches caused excessive shortage cost and holding cost. The emphasis on cost minimization might cause conflicts among department within a company. For instance, the sale department tended to keep large amount of inventory in order to keep the service level high while the logistics department wanted to reduce the inventory in order to reduce the cost. Another factor undermined the performance of a supply chain was asymmetric

information. It was that different parties in one supply chain had different states of private information about demand, products and the chain operation. Asymmetric information was caused by the lack of willingness that each party had to share its private information with others completely and faithfully. Therefore, member didn't have enough visibility to make trade-off and the best decision for the supply chain operation might not be able to reach. Asymmetric information also caused opportunistic behavior. Some parties with more accurate information might take advantages of others. The performance of a supply chain could be adversely affected. Other than factors mentioned above, incentive misalignment was a major factor that had negative impact on a collaborative supply chain. Since members of a supply chain didn't have power to force each other to make adjustment in order to realize the optimal performance of a supply chain, every member tended to work separately on its best interest. In this study, Simatupang et al. indicated six ways to improve a collaborative supply chain. They were mutual objectives, integrated policies, appropriate performance measure, decision domain, information sharing and incentive alignment. Members in a supply chain should have the same objectives and be willing to share the information with others. The decision should be based on overall scope of the supply chain. Members of a supply chain should hold integrated policies. This paper provided a general view of cooperation in a supply chain, but it didn't mention details to implement a cooperative environment.

Many papers were focused on how efficient a supply chain could be when each member of the supply chain cooperated with each other. The benefit of cooperation was also often calculated with a simplified supply chain. However, there were few papers

addressing that why there were few companies that succeed by exploiting the benefit of cooperation.

Chapter 3 Methodology

Through collecting information and data from a wide range of articles, this paper would get insight about the impact of cooperation on supply chain management from a practical aspect. The conclusion would be based on the examination and comparison of a large number of materials published in past ten years. Those material included papers, surveys, articles and other kinds of study about the cooperation of supply chain management. Through examining each popular method and concept, the paper will discuss the features, potential application and limitation. Since the long-term cooperation and short-term cooperation, and the extent of cooperation have large impact on the cooperation, cooperation in a supply chain could reach different results. Some of the results were potentially negative. Because some adverse situations resulted from long-term improper cooperation, those adverse results could not be simply discovered by calculations, but they could have large and long-term impact on the supply chain and economy. Cooperation in a supply chain with a sound beginning might not have a sound result in the long run. This paper will suggest several ways to keep a supply chain healthy in the long run. This paper is going to address following questions: What are the differences among various models of cooperation? How should the structure of supply chain be? Does excessive cooperation within a supply chain have any adverse effect on the economy or the future of the supply chain?

Chapter 4 Results and analysis

Cooperation of supply chain management is a general concept. It includes many methods and concepts such as information sharing, collaborative forecasting, early order commitment, CFAR (collaborative forecasting and replenishment), CPFR (collaborative planning, forecasting and replenishment), VMI (vendor managed inventory), quick response, etc. Although each method has the emphasis on the cooperation in supply chains, those methods and concepts have different focuses and extent on the cooperation in supply chain management. The existing studies generally hold a positive point of view towards cooperation in a supply chain. Furthermore, many studies and surveys indicated the profit of such cooperation. Many studies analyzed detailed steps of implementing advanced technology to achieve the goal of cooperation. There were a lot of terminologies used to describe the cooperation within a supply chain. Those terminologies had many factors in common, but there were still differences among those terminologies.

Information Sharing

Information sharing is the fundamental method for the cooperation of supply chain management. It is the physical manifestation of such cooperation in this information technology era. Sharing information with a supply chain makes it possible for every member of the supply chain to cooperate with each other. The shared information mainly ranges from forecasting information of retailers to replenish information of suppliers or manufacturers. Those various types of information are very useful for the entire supply chain, especially for those upstream parties, such as distributors, manufacturers and suppliers. The more detailed the information to be shared,

the more effective the information sharing system. The mechanism and purpose of information sharing is to make it possible for every party of a supply chain to have access to the most relevant and accurate information. Furthermore, information-sharing system also make it possible for each party to make decision based on the same information. Therefore, the forecasting bias could be minimized and the efficiency and profit of the supply chain management could be maximized. Nowadays, the information is shared via complicated electronic networks. The cost of implementation and the choice of proper software are the keys of success. The concern of information sharing system is that companies largely rely on the infrastructures. Since the implementations require extensive technology, in most cases, outside consulting companies decide the type of software and do the implementation. Therefore, there is a dilemma that people who use the system and are familiar with the actual situations are not able to choose the tools, but people who choose the tools don't use them and are not familiar with the actual situation in depth. However, the understanding of the situation is critical to sort and choose the most relevant information from large amount of available information. In addition, many companies have sensitive information that is very difficult to share with outsiders. The trustful relationship among members is necessary. Furthermore, the substantial cost of implementation limits the ability of middle-sized and small business that have less market power to choose the systems. Those businesses are forced to be part of an information sharing system implemented by dominant businesses. The information system is generally in favor of the host businesses since such systems are based on the needs of those host businesses. The information sharing system also has an explicit characteristic

that the more information shared, the tighter the relationship among the members of a supply chain. The tight relationship can also accelerate the integration of a supply chain.

Collaborative forecasting

As a concept, collaborative forecasting is to make accurate forecast by sharing the demand information, inventory information with members in a supply chain. In practice, this concept is usually used between retailers and manufacturers or among departments that are evaluated with their independent performance, such as sales department and warehouses, within the same business. Although there are many studies about collaborative forecasting, those studies are generally based on a two-stage assumption, such as retailers and manufacturers or distributors and manufacturers. Therefore, the scope of studies about collaborative forecasting is relatively small. In those small scopes, the profit of collaborative forecasting has been clearly identified in many studies. The mechanism of collaborative forecasting is to eliminate the bias of forecast by alleviating the bullwhip effect and integrating forecasting methods. Through sharing the demand information from downstream parties of a supply chain such as retailers and sale department and understanding the forecasting methods used by other parties, the upstream parties such as manufactures and production department are able to make more accurate forecast and quick responses to the demand. The collaborative forecasting increases the speed of information flow and reduces the cost of forecasting of upstream parties. In other words, the role of forecasting is largely shifted to the downstream parties. Since the downstream parties are much more sensitive to the change of demand and the closest to customers, they are thought to be at the best positions to make forecast.

To fully exploit the benefit of the demand information from downstream parties, the upstream parties need to understand the perspectives and concepts from which the downstream parties make the forecast, since different perspectives may determine the concept to be used and different forecast methods may lead to different results of forecast. For instance, if the retailers used moving average to forecast the demand, the sensitivity to the change of demand largely depended on the number of periods used in forecasting. The fewer the number used, the more sensitive the forecast to the change of demand. In such situation, if the manufacturer doesn't have an understanding of the demand pattern and apply the forecast easily to its production, the production process could fluctuate largely and cause difficulties in manufacturing. The unstable production could recur excessive inventory cost and shortage cost. Thus, the collaborative forecasting could turn out to be meaningless. Furthermore, according to the mechanism of collaborative forecasting, the downstream parties face most of the risk of forecast. Thus, the collaborative forecasting generally benefit upstream parties. For instance, the manufactures can make more accurate forecast and more efficient and stable production planning. For the whole supply chain, the collaborative forecasting can result in large saving of inventory cost and shortage cost. However, for those down stream parties such as retailers, the benefit of saving may not be significant. Currently, in most case, collaborative forecasting incurs large system implementation cost. Therefore, collaborative forecasting may not be attractive to those downstream parties. In practice, the upstream parties need to give incentives to the downstream parties. The incentive could be discount of price and guaranteed replenishment. Those incentives could encourage those downstream parties to participate in collaborative forecasting and enable

the downstream parties to share the benefit of savings. Furthermore, the collaborative forecasting could improve the relationship among parties that participated in a collaborative forecasting program. The whole supply chain would be more efficient and gain more market power.

Early order commitment

Early order commitment is a model of cooperation in a supply chain. The model is focused on manufacturers and retailers. The retailers and manufacturers are usually different businesses. Usually the early order commitment can be observed between a single manufacturer and multiple retailers. The concept of early order commitment is that the retailers make a potential order as early as possible before they make the actual order. The manufacturers plan production on those pre-orders. Since manufacturers can get orders at a relatively early point, they may have enough time to organize the production in an efficient way and fully utilize the capacity of production. The mechanism of early order commitment is that by giving manufacturers enough time to make production plan, the production cost and other related costs such as the inventory cost of raw materials and finished goods can be largely saved. Thus, the costs of supply chain can be reduced significantly. Theoretically, early order commitment is a sound idea. It is similar to information sharing. The pre-orders are actually forecasts of the real orders. However, early order commitment requires closer relationship between manufacturers and retailers, because the early orders at least mean that the retailers have decided to put orders on a particular manufacturer. No matter whether a contract exists, early order commitment imposes responsibility to the retailers and manufacturers. Especially, the retailers give up the right to choose manufacturers at the point they join an early order commitment

program. Therefore, according to the mechanism of early order commitment, the retailers don't benefit from early order commitment. Retailers must expect the return of the profit of early order commitment from the manufacturer.

Furthermore, even if the retailers are willing to participate in an early order commitment program and they are sure that the manufacturer would be willing to share the benefit of early order commitment with them, there are still several obstacles to the practice of early order commitment.

The accuracy of the pre-order is the main concern of early order commitment. Although the pre-order is not the real order, it must be very close to the real one. Otherwise, the pre-order would be meaningless and therefore, the effort of early order commitment would be waste as well.

According to various studies, to certain extent (feasible range), the longer the lead-time, the more saving recurs in the cost of a supply chain and the cost of manufacturers. The saving mainly consists of the saving of manufacturers' inventory cost and shortage cost. The best length of period of early order commitment is around four natural order periods. For retailers, it is a very long time. In some case, when the saving reaches its peak, the cost of retailers is higher than that with early order commitment. In other word, the manufacturers enjoy all the saving and the retailers face more demand risk. Therefore, it is very important to distribute the profit of early order commitment to every party in the supply chain with a fair policy.

In addition, when the number of retailer participating in early order commitment increases, the saving increases and the feasible range becomes wider, since the increased

number of retailers make it possible for the manufacturers to handle the demand as a whole and be able avoid the lumpiness in production.

As a conclusion, first of all, early order commitment should involve the most powerful retailer in a supply chain at least and attract as many members as possible. Second, every party in the supply chain should accept the same benefit distribution policy. Finally, whether to adopt early order commitment should be based on the realty of the industry and the ability of forecasting. For instance, in the fashion business, manufacturers usually have to commit to new product one year before the produce reach the market. The retailers are not able to predict the fashion needs in more than one year. Therefore, the early order commitment doesn't make a lot of sense to the industry. Early order commitment is suitable to those industries with every SKU that needs different materials and the natural order cycle is short. Businesses need to have a thorough understanding about the industry before deciding whether to adapt early order commitment or not.

VMI (Vendor managed inventory)

VMI was a new way to manage the inventory. The basic concept is that manufacturers or vendors manage the inventory at retail stores. In general, manufacturers and vendors have more expertise to manage the inventory than retailers do. They use MRP (manufacturing resource planning) and DRP (distribution requirement planning) to control their inventory and make forecast while retailers largely depend on time-to-time needs. Furthermore, manufacturers face more inventory issues than retailers do. Since they have to track every part of products and have access to multiple retailers, they have the most accurate data about inventory. Although VMI have substantial applications, it is

especially suitable to basic merchandise such as clothes. Basic merchandise generally has to be replenished on the one-for-one basis. Since customer expected to find a particular item at anytime, retailers must keep their SKU level and make order at anytime. This can cause fluctuations in production. Manufacturers prefer VMI, because they have control on total inventory [13]. Therefore, service can be improved and production can be stabilized without additional cost. In some sense, VMI is similar to CRP (continuous replenishment planning) The difference between them is that suppliers are in charge of replenishment. Furthermore, in practice, VMI can reduce the workload of distribution. The jobs that suppliers do when suppliers ship products to retailers are the same jobs that retailers do in a reversed order after they receive the shipment. For instance, manufacturers have to pick items from the shelves in their warehouse, pack them in the way retailers required and ship them. The retailers have to unpack those items and put them on the shelves in the stores. With VMI, suppliers can pack items in the way items are supposed to be on the shelves in stores. Therefore, certain packing procedures can be skipped. In addition, since the suppliers did the replenishment, the ordering cost of retailers can be reduced significantly.

Although VMI is an efficient means to improve the performance of a supply chain, there are several issues that have to be clarified.

First, VMI is different from other types of cooperation in a supply chain. Most types of cooperation are based on information sharing system, such as collaborative forecasting, early order commitment, CPFR, etc. VMI is a type of outsourcing. In general, companies would manage inventory and plan replenishment themselves. They must have corresponding personnel, skills and information system to deal with inventory

and replenishment. The companies with VMI don't outsource production or service, but outsource management of inventory and replenishment, a part of management. Vendors assume the part of management.

Second, since the inventory is managed by vendors, company might not be able to have complete and accurate information and data about their inventory and truly understand the movement of inventory. They might also worry about that once they engage in VMI, they would be at an unfavorable position. They might believe that when vendor hold knowledge and power on inventory control, the companies with VMI had to largely rely on vendors and lose the freedom to choose vendors. As vendors, they wanted to sell as many products as possible. They would replenish their products even though it is better for retailers to replace certain products with those from other vendors. Therefore, retailers might miss lucrative opportunities, lose the valuable knowledge about inventory and lose the control on quality. However, vendors also have their concern. By definition of VMI, vendors have to own and manage the inventory. In other words, vendors would own the products until they are sold. For instance, Wal-Mart claimed that vendor would not get money until their products were on the shelves. Theoretically, VMI could cause extra cost on vendors and saving on the retailer side. In this case, vendor had extra cost of managing inventory and faced extra risk. The saving on production may be offset by the costs. The inventory is simply shifted from retailers to vendors. Therefore, without trustful relationship and long-term partnership between vendor and retailers, both parties would not be willing to engage in VMI.

In addition, VMI is a one-way communication process. Vendors get information from retailers. They don't take the change of orders at the last moment into account. They

also don't consider that retailer should order from other vendors to improve their profit. Furthermore, the forecast of VMI is mainly based on warehouse withdrawal. In fact, the forecast at warehouse level might cause stock-out at store level, since the demand in short period may be arbitrary.

Thus, to commit to VMI, both parties of VMI must have active information communication and shared business perspectives. Both parties also have to select partners carefully before engaging in VMI and find long-term common interest between each other.

Quick response

By definition, "quick response is a process that uses real-time or near-real-time signals to trigger replenishment responses in the supply chain for manufacturers or retailers. This improves inventory turns, product allocation and replenishment times and helps retailers avoid running out of important stock." [14] Quick response allows manufacturers and retailers to exchange real-time inventory information and needs. Thus, the manufacturers are able to adjust production when demand changes. The method, quick response is especially useful in industries with different products that can be made from the same or similar materials. Otherwise, since every order is for a specific product that cannot be replaced with other items or made from other materials, manufacturers would have to large amount of inventory of raw materials. Quick response is a very powerful tool to reduce uncertainty. When manufacturers are able to fulfill orders from retailers in relatively short period, retailers can make orders with more accurate information and reduce costs such as mark off and excessive inventory.

Quick response has proved to be able to improve the performance of the whole supply chain. However, quick response is inherently in favor of retailers. Retailers can have more time to get demand information and make proper orders. They could reduce the loss of mark off and total inventory. For the manufacturers, quick response can be a measure to improve the relationship between manufacturers and retailers in the long run. However, in short term, quick response could cause many difficulties and costs to the manufacturers. First, quick response requires short lead-time. To meet the request from retailers, manufacturers have to shorten their production cycle. To do so, manufacturers need to shorten the set-up time and make adjustment on raw material inventory level, procurement and other issues. Therefore, frequent change of products can lose production capacity and recur additional set-up cost. When the set-up time is long, the economically feasible batch of product became large. Large batches increase the length of production cycle. Thus, for some products, quick response may lose its capability. Furthermore, quick response could be related to frequent product line change. This situation may result in the small size of each lot. Thus, manufacturers may lose economy of scale and increased production cost. Finally, quick response was not a universal solution. It has its limits. Other than set-up time, it is also limited by product processing time and raw material availability. When a product needs long processing time, quick response is also likely to lose its capability. For instance, paper needed many processes such as drying that required considerable time. The drying time could be a constraint on quick response. In addition, to meet the demand change, manufacturers needed a full range material. To keep a full range raw material can result in large inventory holding cost. To avoid such cost, raw materials should also be available at a short time. Without the cooperation of

manufacturers' upstream parties, quick response would lose its capability as well. Therefore, to maximize the capability of quick response, quick response should be adopted not only by manufacturers and retailers, but also by the whole supply chain.

CFAR (Collaborative forecasting and replenishment)

CFAR was a pilot project initiated by Wal-Mart. The first members of the pilot project were Wal-Mart and Warner-Lambert Company, a manufacturer. Those company extensively shared demand information to make collaborative demand forecasts and production schedules through Internet and EDI (electronic data interchange) system. The CFAR was intended to be an open inter-organizational system to help retailers and manufacturers to coordinate their decisions by sharing real-time demand and production information. The objective of CFAR was to be an industry-wide standard. The participants of CFAR claimed that CFAR was the fastest way to reduce the inventory holding cost and avoid shortage in production. According to various studies, CFAR proved to be able to achieve great saving in a supply chain. The mechanism of CFAR was to optimize the buyer-seller relationship and reduce the cost of a supply chain by reducing the uncertainty in demand through extensive information exchange. The advanced information technology enabled the prompt information exchange. At the point of the pilot project, the participants were established company. Those companies had larger influence and market power in each industry. Therefore, CFAR had following characteristics.

- The participating companies must have the ability to implement the EDI system and have ability to integrate their organization to fully exploit the benefit of

CFAR. They also could attract other member in their supply chain to participate CFAR.

- Although CFAR could involve numerous companies, it only focused on two-stage supply chains, retailers and manufacturers. It would form a network among retailers and manufacturers. However, there were neither connections among retailers nor connections among manufacturers.
- The information shared in a CFAR system was very sensitive and important to members. Such information could be secret in the past. Therefore, members must expect to gain profit that was large enough to cover the risk.
- Since there was more information available for retailer and manufacturer sides, both sides could make better business decisions.

Theoretically, CFAR would have large positive impact on supply chain management. It would reduce the overall inventory cost and shortage cost. It might benefit manufacturers more than retailers. Therefore, an incentive system should be established between manufacturers and retailers in order to encourage the participation of retailers. The more participants of retailers with a single manufacturer, the more saving in the two-stage supply chain.

However, in realty, there are several concerns. First of all, although participants have more freedom to choose partners, the number of partners declines. This phenomenon may be explained in the following way. Since very sensitive information would be shared between partners, companies may choose their partners more carefully and tend to maintain long-term relationship. Furthermore, multiple companies will choose the companies that can provide better service and goods. The phenomenon may

accelerate vertical integration in a supply chain and cause other impacts. Second, those companies that have numerous partners, such as Wal-Mart, have access to a larger amount of information and have apparent advantages. In addition, in a supply chain with CFAR, members who don't participate in CFAR could have benefit from the saving of CFAR as well. Although the manufacturer can impose penalty or give incentives to participants to distinguish non-participants from others, it is difficult to do so when those members were on the top of priority list of the manufacturer.

Thus, in a CFAR program, participant needed to establish a fair benefit allocation policy and each member have to adopt it. Furthermore, participants also needed to establish guard lines to ensure that the information is shared in a healthy way.

CPFR (Collaborative planning, forecasting and replenishment)

CPFR (Collaborative planning, forecasting and replenishment) is believed to be the most powerful process for consumer satisfaction in the 21st Century [15]. It is initiated by VICS (Voluntary Interindustry Commerce Standards committee). It emphasizes cooperation among businesses. CPFR requires that members in a supply chain work together toward the same goal. The ultimate goal of CPFR is to achieve high consumer satisfaction and large profit for the members participating in the collaboration process. The model of CPFR is actually the extension of CFAR initiated by Wal-Mart and other companies. CPFR is much more ambitious than CFAR. It is supposed to establish a standard across industries. It targets at a huge supply chain network. The most ambitious feature of CPFR is to build a collaborative culture. Although CPFR depended on internet-enabled data exchange, the success of CPFR largely relies on the mindset of each participant. The mechanism of CPFR is clear and simple. The profit of supply chain

is improved through close relationship among trade partners and extensive real-time information exchange. In a CPFR program, every member takes care of each other and shares information with each other. The results of collaborative estimates of demand can be more accurate than those done by each member independently. CPFR can not only reduce the cost of the supply chain, but also increase the sales, since the purpose of CPFR is to improve the consumer satisfaction. In other word, the CPFR also involves consumers. CPFR is the model of cooperation of a supply chain, which completely matches the definition of supply chain, a chain from raw material suppliers to end-users. CPFR also would create a new culture in the business world. Traditionally, the behaviors of business are short-term profit oriented. Companies can change trade partner frequently to obtain the maximum profit. In the traditional environment, companies are not able to build a trustful relationship with their trade partners. Therefore, the extensive open information exchange is impossible. Because of the lack of information, retailers are hard to keep their inventory at a proper level. Thus, they either carry excessive inventory cost, or lost sale. This situation results in low service level. The same situation is also faced by manufacturers. Even if a manufacturer has ability to predict the demand correctly in the long run, it is not able to predict the demand of occasional promotions, since such temporary changes in the demand pattern are view as noise and are neglected. To capture such needs that are hard to predict, CPFR provided the solution that trade partners should share information at real time basis. In general, CPFR would reduce the total inventory in a supply chain and the work lord on forecasting and replenishment. Retailers and manufacturers would avoid shortage. CPFR seemed to be the universal solution to improve the performance of supply chains.

However, the adoption of CPFR is slower than expected. There are several facts responsible for this situation. First, CPFR requires large scale and a fundamental change in the business culture. Traditionally, every business is concerned about its own interest and pays little attention to the whole supply chain. Without the effort of each business and large market power, the benefit of CPFR can be diminished. That is why only big companies such as Wal-Mart and Target could carry out successful pilot projects of CPFR. Companies without substantial market power are afraid that they would be taken advantage if they start CPFR first. Thus, many companies are waiting for other companies to go first. Second, although companies engage in CPFR have a large amount of information, they need efficient tools to identify relevant data immediately. Implementing and choosing the right tools are difficult tasks for those companies. Finally, the data accuracy and perspective from which companies generate data have large impact on CPFR. Since CPFR is supposed to involve various industries and numerous companies, data are generated from different sources with different perspectives and historical background. Companies participating in CPFR must have the ability to choose data suitable to their situations from various relevant data sources. This situation presents dilemma that accurate forecast of demand cannot make without substantial information, but it is hard to make when there is too much information. Companies must use advanced and customized tool to find the information that is really useful for them. Therefore, companies without a complete understanding about CPFR is not likely to be successful.

There are other issues that arose about CPFR. CPFR [16] emphasizes on open information sharing and long-term partnership. In fact, only long-term partnership can

result in trustful relationship and lead to share critical information with each other. Those companies with large market power such as Wal-Mart are likely to vertically integrate their supply chain to achieve such objectives. Another issue is that CPFR requires change of conventional purpose of business. In realty, when a company has dominant power in an industry, consumer power would be undermined because consumers can't have enough choices. For instance, the big three American automobile makers had huge before 1970s and achieved high profit without having high consumer satisfaction. Therefore, even if a lot of pilot projects has proved that CPFR is a sound and feasible idea in certain circumstances, it would take a long time to have industries adopt CPFR and a lot of measures have to be made to ensure the soundness of CPFR.

Chapter 5 Conclusions and implications

The cooperation tools mentioned above have different features and mechanism. Cooperation in a supply chain is necessary to improve the performance of a supply chain. Although there are many different concepts and methods to obtain the same objective, there are certain common issues that companies should pay attention when companies engage in cooperation with other parties in a supply chain.

The first common mechanism among them is that all of them try to make the speed of information flow fast. The objective is to match the supply pattern for demand patterns and stabilize the production level. There are two ways to reach the objective. One is that companies share information as early as possible. Collaborative forecasting, CFAR, CPFR, early order commitment, etc are in this category. VMI is in another way. Methods in this way try to shorten the length of supply chain. For instance, with VMI, vendors assume the role of retailer to manage the inventory for vendors. In this sense, vendors and retailers become one party.

Furthermore, those methods focus on the integration of information system of each party in a supply chain. Since every party has its own perspectives and methods to forecast demand. Information from different parties may not compatible with each other. To fully use such information, every party in a supply chain has to understand the process through which its partners get the information.

Finally, through quick and substantial exchanges of information, those methods try to make the structure of the whole supply chain and the structure of each party clear. Since different methods have different mechanisms, the profit of each cooperation method is not evenly distributed among parties. Each party has to understand the

mechanism of cooperation to adopt a fair profit allocation policy. Trustful partnership long-term cooperation is required among parties in a supply chain.

Although various cooperation methods have several aspects in common, to make the cooperation smooth, the members of a supply chain have to pay attention to several important factors.

First, the ultimate objective of those cooperation methods and concept is to match supply patterns for demand patterns and stabilize production levels. Thus, through improving the consumer satisfaction and reduce costs, a supply chain can maximize long-term profit. Although savings have been calculated in many studies, those savings don't account for all the profit of cooperation in a supply chain. A large part of profit is from increased sales by improving consumer satisfaction. Although cooperation can reduce the costs in a supply chain, reducing cost is not the objective of cooperation, but maximizing long-term profit is. Cooperation only focusing on cost reduction tends to consider demand a constant and concentrate on short-term profit. Since supply chain includes consumers by definition, companies have to take consumers into account. Consumer demand is not a constant, but a variable. It can change frequently and quickly. Different needs could emerge at anytime. If a company concentrates on cost reduction and short-term profit, it may abandon certain unprofitable operations that differentiate the company form its competitors. In fact, differentiation brings competitive advantages to the company and gains long-term profit. With long-term vision and an overall perspective of the supply chain, Company can make strategic changes to react to changes in demand and cooperate with others to gain sustainable competitive advantages. Understanding of the

ultimate objective of cooperation is necessary for every member in a supply chain to improve the performance of a supply chain.

Second, since the profit of cooperation is not allocated evenly among members, a fair profit allocation policy is needed. For instance, early order commitment is in favor of the upstream parties such as manufacturers. It requires long lead-time. Quick response is in favor of the downstream parties such as retailers. It requires short lead-time. Profit mainly generates in those favored parties. Unless a common understanding about the supply chain and trustful relationship exist among the members, the profit of a supply chain can't be maximized. A fair profit allocation policy makes it possible for each party to share the profit and make the cooperation a sustainable advantage.

Third, throughout various studies, the successful projects of cooperation have one feature in common. All of those supply chains used in the studies must include one or several companies with dominant market power such as Wal-Mart and target. Such companies are the driving power in a supply chain. They are organizer of a supply chain. Other members are around them. In fact, every supply chain needs an organizer. Nowadays, the information exchange relies on Internet enabled system. To implement such systems, heavy investment is needed. The heavy investment is not affordable for small businesses and is inefficient without economy of scale. Therefore, only large companies can form collaborative relationship in large scale and gain large profit. Furthermore, having long-term partnership with a dominant company itself is an incentive to encourage companies to participate in cooperation. Finally, only those large companies have the power to establish the cooperation policy that members are willing to accept. Thus, every supply chain should have one or several large companies as leaders.

In addition, when a supply chain includes the three factors mentioned above, it has the basic conditions to be an efficient supply chain. However, in the long run, such a supply chain may not be a successful one. A supply chain with the three factors tends to be vertically integrated by its leader. For instance, a dominant retailer may have manufacturers that mainly or exclusively serve it or a manufacturer may have retailers mainly sell its products. Such a supply chain may become a KERETSU, a Japanese industrial structure. A KERETSU usually consists of one major bank, many major companies and countless small companies. Each company in a KERETSU is an independent business. The bank is the flagship of the whole KERETSU. Each major become the flagship of each sub KERETSU in an industry. A KERETSU can have huge power in one or many industries. In fact, a handful KERETSUs dominate a considerable part of Japanese economy. Companies within a KERETSU share information and resources officially and unofficially. Even in the past without the help of Internet, information could be transferred very fast and efficiently in the KERETSU. Those companies have long-term partnership with each other and focus on the prosperity. In the past, the structure of KERETSU brought huge profit to those companies and largely contributed to the economy. Furthermore, since cooperation exists among KERETSUs, they have overwhelming power to consumers. However, as time passed, the structure of KERETSU became bureaucratic static, and inefficient. Because the long-term partnership, companies in a KERETSU didn't face competition even though they might not be competitive. One other hand, those competitive companies couldn't enter a KERETSU to get more advantages due to the extremely high invisible entry barrier. The

structure of KERETSU has caused large problem to itself and economy. The structure has started to fall apart in Japan.

Thus, companies in a supply chain must eliminate the barrier of entry and keep competition and dynamics both internally and externally while integrating the supply chain and building long-term partnership. The cooperation in supply chain management can be fully exploited when the supply chain management is dynamic.

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