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[Field Research]

Review of Collaborative Planning, Forecasting, and Replenishment as a Supply Chain Collaboration Program*

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Abstract

Purpose - This study primarily aims to represent the current trend of research on CPFR as a promising supply chain collaboration program and proposes a new framework for analyzing any collaboration programs in terms of three key collaborative features.

Research design, data, and methodology - This study employs a literature review of selected studies that conduct research on CPFR. CPFR is analyzed based on the proposed framework that characterizes collaboration programs in terms of three key collaborative features.

Results - The analysis based on the proposed framework reveals that the current form of CPFR continues to have some collaborative features that are not fully utilized to create an advanced collaboration program. The literature review indicates that most past studies ignore critical issues including the dynamic nature of the multiple-stage supply chain system and negotiation process for collaborative agreement in CPFR implementation.

Conclusions - Results indicate that CPFR can become a better supply chain collaboration program by incorporating coordinative cost payment and joint decision making processes. Based on observations on the existing literature of CPFR, this study indicates several important issues to be addressed by future studies.

Keywords: Supply Chain Collaboration, Collaborative Planning, Forecasting, and Replenishment (CPFR), Information Sharing, Cost Payment, Decision Authority.

JEL Classifications: M11, M19, M21.

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1. Introduction

Collaboration has been a main research subject in the area of supply chain management, since its potentials to improve the efficiency of entire supply chain operations are noticed by many studies (Simchi-Levi et al., 2000). Among various supply chain collaboration programs including Quick Response (QR), Efficient Consumer Response (ECR), and Vendor-Managed Inventory (VMI), Collaborative Planning, Forecasting, and Replenishment (CPFR) is the most recent initiative that have been introduced to industries and received heavy attentions from both academic researchers and business practitioners. In fact, CPFR has been already used in diverse industries including grocery, retail, manufacturing, healthcare, agriculture, finance, and transportation (Du et al., 2009; Lin & Ho, 2014; Shu et al., 2010; Wang et al., 2005), and its application shows a worldwide expansion starting from North America and Europe to Asia, South America, and Africa (Wang et al., 2005).

This study conducts a literature review on the past studies that research CPFR as a collaboration program. The main objective of this study is to provide the detailed knowledge about CPFR, including its definition and benefits as the organized contents appeared in the existing studies. Based on the analyses on the key research subjects of the most past studies, this study also raises critical issues that are ignored by the majority of the past studies and can be addressed by future studies. In particular, in behalf of the researchers who intend to learn about the exact collaborative natures of CPFR and identify the opportunity to improve the current CPFR into the more advanced collaboration program, this study provides a framework to analyze any collaboration programs in terms of three key collaborative features. The outcomes of analysis based on the proposed framework reveal that CPFR still requires being fully collaborative in terms of cost payment and decision authority.

While the most past review papers about the supply chain collaboration merely explain the study trend about the individual program in their general perspectives, this study examines the unique collaborative features of CPFR through the direct comparison with the other collaboration programs based on the proposed framework. Furthermore, the analysis with the proposed

framework reveals the potentials of CPFR to be a better collaboration program.

The major contributions of this study are twofold. First, this study provides a comprehensive knowledge about CPFR. By organizing the details about CPFR as they appear in many past studies, this study gives the complete illustration about CPFR including its definition and benefits. In particular, unlike the most past studies that simply point out the performances as the benefits of CPFR, this study explains their details along with the CPFR functions that cause them.

Second, this study shows that the current form of CPFR still has a room for further improvements. The viewpoint of this study on collaboration is not limited within CPFR, and this study analyzes the collaborative features of CPFR by using the proposed framework to search for better collaboration program. The result of the analyses implies the chance to develop an advanced collaboration program that may achieve greater performance than CPFR by enhancing a full level of collaboration in cost payment and decision authority.

2. Background Information about CPFR

First of all, this study provides the detailed description about CPFR including its definition, origin, and benefits.

2.1. Definition and Origin

According to the Voluntary Inter-industry Commerce Standards (VICS) association (VICS, 2002), Collaborative Planning, Forecasting, and Replenishment (CPFR) is defined as a "formalized process between two trading partners used to agree upon a joint plan and forecast, monitor success through replenishment, and recognize and respond to any exceptions". CPFR is the newest program for the supply chain collaboration, which is established based on the Efficient Consumer Response (ECR) principles followed by Vendor Managed Inventory (VMI), Jointly Managed Inventory (JMI), Continuous Replenishment (CR), and Category Management. The basic concept of CPFR is the advanced business model that takes a holistic approach to supply chain management among a network of trading partners and synchronizes activities to deliver products in response to market demand through exchange of information based on a collaborative relationship (Sherman, 1998). In details, CPFR represents the collaborative supply chain system wherein all trading partners jointly initiate and execute business plans and processes including sales and order forecast, shipping and production plans, and order generation (Boone & Ganeshan, 2000).

CPFR originates from the business concept developed by benchmarking partners with funding support from Wal-Mart, IBM, SAP, and Manugistics in 1996 (Fliedner, 2003). At its early development stage, it had been referred as Collaborative Forecasting, which focuses on an exchange of early demand information between trading partners. The concept that is close to the current CPFR appeared later as Collaborative Forecasting and Replenishment (CFAR). CFAR represents joint activities of forecasting and replenishment based on a coordinative relationship with OEMs. The first CFAR was established by the pilot study of a new software system developed by Warner-Lambert, the consumer goods manufacturer, and Wal-Mart, the department store in fall of 1996 (Simchi-Levi et al., 2000). Today, this business concept has evolved into CPFR, which emphasizes coordinating activities in a wide range of operations in the whole supply chain system, including demand forecasting, production and purchasing planning, and inventory replenishment. Currently, more than 50 retailing and manufacturing companies associated in the Dynamic Information Sharing Committee under sponsorship of VICS involve in developing CPFR.

2.2. Benefits

CPFR has the special features that result in the benefits of both supplier and buyer. First, the key feature of CPFR is joint forecasting that is conducted through the coordination works of buyer and supplier. Conventionally, sales forecasting is the buyer's job and the supplier just receives information about buyer's orders. Through the coordinated forecasting activities, CPFR permits customer demand-pull-based forecasts, which is time-phased across the value chain (White, 1997). Forecasting under the CPFR program utilizes knowledge, information, and expertise from the multi-tier members of the entire supply chain and generates a single forecast result that is determined based on the negotiation and consensus of participants (Helms et al., 2000; Triantis, 2001/2002). This collaborative forecasting enables the participants to improve the accuracy of forecasts and increase the quality of forecast information based on the predictable order cycles (Lapide, 2002; Raghunathan, 1999). The resulting accurate forecasts and high-quality information regarding demand benefit both suppliers and buyers in the form of increased sales, reduced inventory holding costs, improved customer service, and increased technology return on investment (McCarthy & Golicic, 2002). In addition, the improved forecast accuracy contributes to minimizing the demand distortion (bullwhip effect) (McKaige, 2001).

Second, the collaborative forecasting entails the category management that uses rank and share and utilizes input from buyer's existing planning process. The category forecasting enables the buyer to simplify the planning process and obtain the detailed forecasts of multiple and independent demands for different purposes (Holmstrom et al., 2002). Improved forecast accuracy and high quality of forecast information caused by category forecasting lead to the decreased inventory level, improved customer service, reduced safety stock, and reduced stock out.

Third, the CPFR program emphasizes collaboration of various business processes in the supply chain system. Through the collaboration among different supply chain members, the CPFR program strengthens the relationship between the supplier and

buyer and maintains the continuous interaction among multi-tiers of the supply chain system (Attaran & Attaran, 2007). The close relationship among the participants establishes trust and builds a long-term relationship. Based on the improved trust and reliable interaction, both buyer and supplier can decrease the transaction cost, improve long-term flexibility of the system, and make more sensible decisions for mutual benefits under the CPFR program.

Fourth, the planning of production and replenishment are determined jointly by all participants in CPFR. The collaborative planning improves the efficiency of the business plans for both supplier and buyer and leads to accurate production schedules (VICS, 2002). Due to the improved planning processes, the supplier can make better decisions on transportation and production. In the transportation activities, CPFR makes smaller shipment and more frequent deliveries and reduces product damages. The shipment under the CPFR program installs more receiver friendly loads. The collaborative planning results in the increased sales, improved customer satisfaction, efficient transportation, cost efficient production capacity and scheduling, and reduced product obsolescence and deterioration.

Fifth, information sharing is a key component of the CPFR program (Esper & Williams, 2003). Information sharing occurring in CPFR enables the supplier to access the POS data to monitor sales, and he can make better plan and execute his business operations (Aviv, 2002; Boone & Ganeshan, 2000). The improved visibility of the supplier leads to the improved service level for both buyer and customer.

Sixth, category management is also jointly operated by the supplier and buyer in the CPFR program (McKaige, 2001). Under the joint category management, prior inspection for SKU(Stock Keeping Unit)s ensures adequate days of supply and proper exposure to the customers. In addition, the joint category management leads to better decisions on forecasts based on the proper product scheme for SKU evaluation and product opportunities (Holmstrom et al., 2002). Consequently, under the CPFR program, the buyer can improve shelf positioning and customer service.

Seventh, joint performance evaluation is one of critical practices required for the CPFR program (Wilson, 2001). With the performance evaluation system, all trading partners share performance metrics and jointly evaluate their performances to assure continuous improvement with the CPFR program. The joint performance evaluation enables CPFR participants to track progress, identify opportunities to improve the processes, and keep checking performances against goals based on clearly defined roles and responsibilities assigned to each participant. Through the joint performance evaluation, the CPFR system maintains continuous improvement of the targeted performance and strengthens a cooperative relationship among participants (Diehn, 2000-2001).

Finally, even transportation is managed in the collaborative way based on the agreement between the buyer and supplier in the CPFR program. Collaborative transportation management improves the efficiency of transportation by eliminating excessive empty backhauls and dwell time, reducing empty loads that are unpaid to the carrier, and increasing on-time and perfect order delivery. As a result, the CPFR program reduces transportation cost, increases asset utilization, improves the customer service level, and eliminate the uncertainty of shipping (Wilson, 2001). After all, the collaborative transportation management increases end-customer satisfaction and leads to increased revenues for both supplier and buyer (Esper & Williams, 2003).

3. Literature Reviews on CPFR

There have been many studies that conduct research on CPFR in the past. This study reviews the selected literature on CPFR and provide its taxonomy in terms of the research goal, the form of supply chain system, focused operations in CPFR, performance measure, and research methodology. Appendix A shows the detailed contents of the taxonomy about CPFR. In addition, this study focuses on demand forecasting and inventory management as two major issues related to CPFR, and looks into the key contents of some existing studies that are selectively chosen to have noticeable achievements regarding these issues.

The main purpose of this literature review is to identify the overall trend of research on CPFR rather than analyze the individual past studies in details. Based on the observation on the overall study trend, this study also identifies the critical issues that have been ignored by the most past studies and suggests them as the potential research topics for the future studies.

3.1. Demand Forecasting

Since the collaborative forecasting is the key element of CPFR, many researchers have focused on demand forecasting in their studies. Russell's study on CPFR (2000) identifies the key barriers to full implementation of CPFR. His CPFR model in the supply chain context mainly addresses the collaborative practices of forecasting and planning. The result of his case studies on CPFR pilots implies that four key factors – relationship among team members, effective use of information technology, engaging employees in the workplace, and information sharing, explain the variance in the performance of collaborative forecasting and planning pilots.

Efficient consumer response (ECR) combining efficient replenishment and category management is a critical practice in the grocery industry. On the other hand, the current ECR lacks the integration of systems and its processes are independently operated by retailers, distributors, and suppliers. Holmstrom et al. consider that the collaborative forecasting and planning can work on the missing link in integrated operations under the ECR (2002). They pay attention to the major problem in typical joint forecasting methods, which is that the retailers do not forecast

demands with the sufficient stocks or on the SKU level. Holmstom et al. propose the alternative way to forecast demands based on mass collaboration and category forecasting. Under the mass collaboration, the supplier makes the replenishment more robust by applying the customer's category management as the basis of the collaboration process. In addition, the efficient control of the information technology system is critical to make the planning processes truly viable in the business network among independent organizations. The category forecasting reduces works for the retailers through processing with categories, not individual stock keeping units when the forecasting is made. Under the category forecasting, the planning process is streamlined by focusing on ranking, and category sharing enables the supplier to obtain the point of sales data that is used to improve the accuracy of the forecast. To support this new forecasting system, the authors also emphasize the importance of the proper performance measurements.

Huang focuses on the collaborative forecasting practice in his study on CPFR (2004). He develops the exception-based demand forecasting collaboration model by applying a principal-agent model under the context of a simple make-to-order where only the retailer owns the private demand information. The exception is defined as the case when the difference between manufacturer's and retailer's forecasts exceeds a pre-defined threshold. The analyses of the model indicate that the current collaboration practice recommended by Voluntary Inter-industry Commerce Standards (VICS) may not guarantee truthful information sharing. Alternatively, he proposes the exception-based incentive mechanisms and considers the cost associated with collaboration and the retailer's incentives in manipulating private information. Two types of exception-based incentive mechanisms are examined in his study: reward type and penalty type, and they are different in the way that the manufacturer commits to the retailer's update when it falls into the threshold range. According to the analyses of the proposed models, the mechanisms that let the manufacturer always over-commit or under-commit are effective in extracting true information from the retailer. On the other hand, the credible information may not be exchanged under the mechanism that let the manufacturer have moderate commitment.

Sagar's study on CPFR (2003/2004) also focuses on the forecasting activity occurring in a real industry case. Based on the case study of Whirlpool Corporation, he investigates the actual implementation of CPFR and identifies its key processes. According to his study on the CPFR pilot with two retailers, the major change in operations due to CPFR occurs in the way to forecast the demand. Under the CPFR program, forecasting becomes the iterative process in that the cycle starts with the bottom-up forecasts generated by both Whirlpool and its collaborative trade partners and results in a joint estimate of sales based on all the knowledge of existing events and unconstrained supports. At the next step, the forecast is enriched via the internal collaboration with the marketing forecast, which is based on the product, brand, trade partner, channel level, and the top down inputs such as industry forecasts and market share expectation. The pilot study indicates that CPFR results in the significant improvement of forecasting accuracy.

Some studies show that CPFR is remained at the preliminary stage of the pilot program implementation and the most of these pilot programs still focus on only the joint forecasting activities. Barratt and Oliveira (2001) examine the detailed processes of CPFR implementation and identify the barriers and enablers of CPFR process. According to their survey on CPFR pilot programs, the most practitioners still think that the use of software package and automation is for managing the sales and order forecast under the CPFR program. On the other hand, the joint business plan receives relatively less attentions regarding advanced technology application in spite of its potential to benefit the supply chain system. They point out that ineffective replenishment and planning, no shared targets, difficulty to manage forecast exceptions, poor communication, and lack of discipline to execute the key phases of the CPFR process limit the visibility of the supply chain when CPFR is implemented. A single point of contacts, clear definition of agenda for collaboration, continuous sharing of information, and trust are considered to be the key factors that let CPFR lead to the true supply chain integration.

Boone and Ganeshan's study (2000)also focuses on the forecasting aspect of CPFR and examines the impact of CPFR on business processes and system performance. They claim that the forecasting process can be improved by using different business processes instead of applying better forecasting tools. The new business process of CPFR represents the active supply chain collaboration wherein all members of the system actively engage under the CPFR program. Their concept of CPFR is close to the centralized decision making system in that all the information of POS data, forecasts, shipping, and production plans are shared among members. In addition, forecasting and order planning are jointly made by members and all parties who involve in initiating and executing the business plans and processes together. The result of their case study indicates that, compared with the traditional system, CPFR leads to 6.5% reduction of inventory while maintaining the same customer service level.

Aviv (2001) develops sophisticated models to address the CPFR system based on a two-stage supply chain with a single product. On the purpose of assessing changes in the supply chain performance due to collaborative forecasting, he constructs three different scenarios based on forecasting and ordering policies –baseline setting, local forecasting setting, and collaborative forecasting setting. In the local forecasting setting, a supplier and a retailer share static data of demand and forecasting processes and make joint decisions on their own policies. The collaborative forecasting setting is different from the local forecasting setting in that the supplier and retailer share a single forecasting process and integrate this joint forecasting process into their own replenishment polices. The numerical study shows that the local forecasting setting outperforms the base setting by

11.1% of supply chain cost savings on average. In the collaborative forecasting setting, the whole supply chain spends less cost by an average of 19.43% than in the base setting. One special factor that the author considers to be a main characteristic of the forecasting model is the diversification of forecasting capabilities that is measured as the correlation between an adjustment used in the supplier's forecasting model and one used in retailer's. According to simulation outcomes, the marginal benefits of collaborative forecasting over the local forecasting are more significant when forecasting capabilities are diversified.

McCarthy and Golicic (2002) recognize that collaboration and sales forecasting have been treated as two business practices that independently contribute to improved supply chain performance. They claim that the combination of these two practices-collaborative forecasting can systematically coordinate trading firms and provide a substantial opportunity to improve the supply chain performance. According to their case studies, training boundary-spanning personnel and regular scheduled meeting between sales and purchasing departments are the key requirements for implementing the collaborative forecasting. Meanwhile, substantial investment on technology is considered less critical for collaborative forecasting. The results of the case study also imply that the collaborative forecasting can improve the system performance in terms of customer responsiveness, product availability, inventory associated costs, and revenues/earnings.

The recent advanced communication technology leads to the efficient business process and also changes the way to manage the operations in the supply chain system. Disney et al. focus on the Internet and related information and communication technologies (ICT) on the supply chain performance (2004). Their study evaluates the impact of e-business on the different supply chain modes including CPFR in the beer game situation. The simulation outcomes indicate that the e-business enabled POS system with CPFR outperforms the VMI as well as the traditional system in terms of both inventory holding cost and bullwhip effect.

Chung and Leung's case study in the copper clad laminate industry examine the value of CPFR in practices (2005). Facing the problems such as excessive inventory, long leadtime, and insufficient production capacity, the company in the case study finds the opportunity to increase the forecasting accuracy and consolidate the complicated orders efficiently by adapting the CPFR program to its supply chain operations. The application of CPFR brings the significant benefits such as lowering the inventory level by 37% and shortening lead time by 60% on average.

Danese investigates the differences of CPFR implementation in practices (2006a). He classifies six types of CPFR practices in terms of the depth of collaboration and the number of interacting units. His case study on seven real companies reveals that either technical (ICTs) or organizational (liaison devices) adoption for supporting CPFR should be selectively used depending on the specific types of collaboration. He extends his study by focusing on the contingent factors including CPFR goals, products and market characteristics, supply network structure, and CPFR development stage (2007). His study provides the explanation about the different managerial styles of CPFR implementation by connecting the contingent factors with the dimensions of different collaboration.

Chang et al. proposes an augmented CPFR model, which is extended CPFR with the addition of an Application Service Provider (ASP) mode (2007). Under the proposed form of CPFFR, the retailer can promptly respond to changes in the market demand. The simulation outcomes show that the new CPFR system outperforms the existing system in terms of the forecasting accuracy, inventory requirement, and bullwhip effect because of the earlier detection and forecasting of demand fluctuation in market and adjustment in sales forecast data and replenishment quantities.

Chen et al. evaluate four types of CPFR, which are different depending on who had a lead role in sales forecasting, order forecasting, and order generation (2007). Under the CPFR system, the retailer and manufacturer share information of promotion, sales, inventory, and resolve the capacity and forecasting exceptions. The simulation outcomes show that CPFR significantly improves the supply chain performance but the superior CPFR type is different depending on the specific performance measurement used.

3.2. Inventory Management

Some researchers focus on collaboration in the inventory management in addition to the collaborative forecasting in the CPFR system. Raghuna than (1999) formulates the basic inventory management problem based on the classic newsvendor model and investigates the benefit of CPFR in the supply chain consisting of one manufacturer and two independent identical retailer. He assumes that the manufacturer knows the exact amount of demand for the retailer who participate in CPFR, and no inventory holding cost and shortage cost occur for the manufacturer to serve that retailer. He also examines the impact of non-participant in CPFR on the performance of CPFR under two different scenarios of shortage allocation policies: when shortage is equally allocated and when all the shortage is given to the non-participant. The results of the model analyses indicate that the manufacturer’s cost is reduced when CPFR is applied compared with the traditional system. In particular, the incremental cost reduction is higher when both retailers participate in CPFR than when only one of them does. However, if the manufacture guarantees the delivery of order quantity to the participant, the manufacturer’s cost of serving the non-participant is higher than the non-CPFR case. CPFR also decreases the costs of retailers, who are not only the participant but even non-participant when the shortage is equally allocated. His analyses imply that non-participant can have a free ride on the participant unless the manufacturer guarantees the order quantity for the participant.

Aviv (2002)investigates individual collaboration practices of information sharing, VMI, and collaborative forecasting by analyzing three supply chain models and examine their impacts on the supply chain performance. Three types of supply chain configurations represent the coordinated replenishment without information sharing, the VMI, and the centralized system with collaborative forecasting and replenishment. The numerical examples of the proposed models indicate that CPFR outperforms the other systems and the benefits of the advanced collaboration practices such as VMI and collaborative forecasting and replenishment become greater as the demand process is more correlated across periods and as the retailer and the supplier can explain more about the demand uncertainty through the early demand information. In addition, the result of his analyses implies that the magnitude of benefits of these advanced collaboration initiatives are significantly sensitive to the retailer and supplier's relative explanatory power about demand uncertainty.

Instead of following the slavish step-by-step model recommended by VICS, Skjoett-Larsen et al. (2003) proposes a dynamic process of CPFR implementation. By using two theoretical perspectives - transaction cost economics and network approach, and they explain the CPFR process in terms of economic and strategic relationship management perspectives. In order to support their theoretical concept of CPFR, they conduct an empirical study on Danish firms and examine their attitudes towards the inter-organizational collaboration. The outcomes of the survey results indicate that, in general, the firm managers think that the opportunistic behavior and related need for control through written contracts are critical in extent of collaboration. In addition, they have positive attitudes towards the most elements of collaboration including collaboration of production, transportation, and forecasting.

With intention to determine the proper collaboration level, Sari compares VMI and CPFR with the traditional non-collaborative system under the different business conditions (2008). In CPFR, all the supply chain members share diverse information including inventory levels, POS data, promotion plans, and sales forecasts, and they make a single joint demand forecast. Furthermore, the replenishment decisions are made in the consideration of inventory positions and costs of every supply chain member. The simulation outcomes indicate that CPFR outperforms VMI as well as the traditional system in terms of the supply chain cost and retailer's customer service level. Meanwhile, the difference in performances between VMI and CPFR is significant enough to rationalize the additional resources required for CPFR in a case of the large production capacity, high demand variability, or long replenishment leadtime.

Yuan et al. examines how different supply chain collaboration systems manages the gap of the demand trajectory in new high-tech product diffusion (Yuan et al., 2010). In their study, VMI, JMI (Joint Managed Inventory), and CPFR are compared with the traditional system in terms of the demand fulfillment, inventory level, and shortage. JMI is a kind of the consignment stock management system, where inventories in the entire supply chain are centrally controlled. In the CPFR system, each supply chain member can efficiently manage his inventory by using customer's final demand information shared among all the members in the supply chain system. The simulation outcomes supports the superiority of CPFR over the other systems, and the difference in the performance between CPFR and JMI is minimal.

Yao et al. evaluates the value of CPFR in terms of the organization learning effects (Yao et al., 2013). In their study, the effect of CPFR is classified into two distinct operational functions, which are collaborative forecasting and collaborative replenishment, and they examine the impact of CPFR experiences on the forecast accuracy and inventory requirement. The results of the empirical study on the mobile phone retail industry indicates that CPFR provides a significant benefit to the supply chain system, but its magnitude depends on time when the learning curve is assessed.

3.3. Implications

Enlightened about the potential to improve the supply chain operations, many researchers have conducted momentous studies on CPFR. Based on the literature review, this study points out the key issues that may be missed by the past studies, and discusses about the ways to address them in future studies.

First, the taxonomy of the existing studies on CPFR indicates that the majority of them rely on the case study as the research method. The case study may be the appropriate way to learn about CPFR, which is was quite recently introduced to the industry and academia. In order to apply other research tools such as the model analysis, simulation, and empirical study, at first, the researchers need to have a more detailed basic form of CPFR, which is generally acceptable by anyone in both academia and industries. In order to figure out the detailed nature of CPFR, however, diverse research tools other than the case study are required for the sophisticated analysis on CPFR. In particular, the impact of various managerial and environmental factors on CPFR processes and performances can be evaluated in the empirical study that uses the statistical analyses (Danese, 2006b). In future studies, the researchers may conduct the model analyses on CPFR and obtain the managerial implication about how to achieve the best possible value from it. The thorough experiments on CPFR and other collaboration programs such as VMI in simulation models may enable the future studies to identify the chance to improve the current form of CPFR to be a more advanced collaboration program (Sari, 2008).

Second, there are a few studies that analyze the mathematical models or run simulations for the research on CPFR, but the most of them assume a two stage supply chain system with a single supplier and one buyer (Caridi et al., 2006; Chen et al., 2007). The assumption of the simple supply chain system enables the researchers to conduct thorough analyses on the given supply chain model, and it is sufficient in the most cases that the collaborative forecasting is the main research subject.

When the studies intends to confirm the reduction of bullwhip effect, which is considered to be a key benefit of CPFR, however, the researchers can accurately measure the bullwhip effect only when they have a supply chain model with more than two stages (Disney et al., 2004; McKaige, 2001). In addition, the future study needs to have the supply chain model where each echelon contains more than one supply chain members in order to learn about the complicated interactions that happen among different members in the real supply chain system (Yuan et al., 2010).

Third, many existing studies supports the benefit of collaborative forecasting in CPFR, but only a few of them address the issue about how to forecast demands collaboratively. Those studies point out that the supply chain system can obtain more accurate forecast by using the advance demand information from diverse sources (Tan et al., 2007). Some studies show their trials to explain about how the retailer forecasts demands jointly with the other supply chain member, for example, through the standardized information sharing (Cho et al., 2001) and the combination of statistical methods and managerial judgment (Eroglu & Knemeyer, 2010; Kim & Lee, 2005). However, they hardly explain about the specific technique to collaboratively forecast demands in a way to generate more accurate forecasts than the conventional forecasting method that each individual supply chain member is used to apply alone. Therefore, the future studies need to conduct research on the nature of collectively obtained demand information and develop the specific techniques to forecast demands in a collaborative way.

Fourth, the existing studies rarely raise the issue about how to build collaboration among different supply chain members in CPFR (Barratt & Oliveira, 2001). According to the VICS's CPFR process model (2002), the first step of implementation of CPFR is the development of collaborative agreement among the participants. It is the most important basis for CPFR implementation, because the most operations in later steps including information sharing, forecasting, and replenishment planning are determined based on the pre-set agreement. Some past studies show their efforts to develop theoretical processes to bring the collaborative agreement, such as a blackboard-based collaboration agent system (Kim et al., 2003a) and agent-driven negotiation process (Caridi et al., 2005; Caridi et al., 2006). More studies on the relevant issues of trust (Barratt & Oliveira, 2001; Fliedner, 2003; Kim, 2014; Williams, 1999) and negotiation (Helms et al., 2000) are still required to develop the comprehensive collaboration process that is suitable for CPFR.

Finally, the most researchers still focus on only collaborative forecasting in their studies on CPFR. The complete form of CPFR utilizes collaboration over all the operational activities occurring in the whole supply chain system. A benefit of CPFR is not mere the effect of information sharing but the synergy of dynamic cooperation among more than one individual supply chain members (Boone & Ganeshan, 2000). Once quite various forms of CPFR are observed in practices (Cassivi, 2006; Han, 2008), some past studies discuss about its potential to improve the supply chain performance in the operational areas other than forecasting, such as production planning and control (Kim et al., 2004), work flow system (Hvolby & Trienekens, 2010), ERP system planning activities (Fliedner, 2003), process management (Kubde, 2012), transportation management (Esper & Williams, 2003), product development, demand planning, logistics planning (Lapide, 2010), and marketing activities (Skjoett-Larsen et al., 2003). Meanwhile, the studies that examine the effect of collaboration in the operational areas other than forecasting are still rarely observed in these days. Future studies need to look for the diverse operational areas to which active collaborative features of the CPFR program is applied in order to figure out the true value of CPFR. In addition, in the future studies, the researchers should search for any chance to improve the current CPFR into a better collaboration program that utilizes the complete level of collaboration over the entire supply chain operations. This research goal can be accomplished through thorough investigation on the collaborative features of CPFR and the direct comparison with other kinds of collaboration programs such as VMI (Kim & Kim, 2002). In the next chapter, this study offers a new framework to analyze any collaboration programs to any researchers who want to examine the collaborative features of CPFR or look for its potentials to be a more advanced collaboration program.

4. Framework for Analyzing Supply Chain Collaboration Programs

On the purpose of identifying the specific collaborative nature of CPFR, this study applies a new framework for analyzing the unique features of any collaboration programs (Ryu, 2007). The past studies on the supply chain collaboration programs including CPFR indicate that most collaboration programs share one or more specific features that lead to collaboration among supply chain members. This study uses three collaborative features - information sharing, cost payment, and decision authority.

Information sharing is a typical form of collaboration that can be found in most collaboration programs. Information sharing represents that supply chain members at the same or different echelons actively share information with intention to improve the supply chain operations (Kim & Song, 2013). Many past studies that address the issue of information sharing evaluate the value of information sharing and they examine the diverse types of information including customer's demand (Cachon & Fisher, 2000; Cachon & Zipkin, 1999; Gavirneni et al., 1999), customer's orders (Aviv, 2001; Cachon & Lariviere, 2001; Lee et al., 2000), inventory policy (Chopra & Meindl, 2004), and demand forecast (Gerber, 1991).

Another form of supply chain collaboration can be found in the cases that atypical cost payment scheme is applied. With the modified cost pay methods (for example, price discount) or the different member who is responsible for paying the specific

cost items (for example, VMI), the collaboration among different supply chain members is realized and it brings the efficiency of supply chain operations.

Quantity discount has been frequently used to realize supply chain collaboration through increased throughputs and reducedsupply chain costs (Sjoerdsma, 1991; Valentini & Zavanella, 2003; Williams, 2000). Under Vendor-Managed Inventory (VMI), which is another well-known collaboration program, the vendor is responsible for paying the ordering and holding costs for the inventory stored at the buyer's warehouse (Chen et al., 2001; Weng, 1995).

The decision authority specifying who makes the particular operational decisions is the key element of some collaboration programs. In general, the authority to make decisions for the specific operation ties to its ownership. On the other hand, some collaboration programs allow a member to make decisions about the operations, which is not owned by him. Under VMI, for example, the vendor has a full authority to make decisions about the inventories stored at buyer's warehouse, even though they are still owned by the buyer (Webster, 1995). The more advanced collaboration program such as CPFR let supply chain members make the operational decisions based on the pre-set agreement instead of the monopolized decision authority (Webster, 1995).

Through the proposed framework, the researcher can analyze any supply chain collaboration programs including CPFR in terms of three collaborative features and identify the special features that build collaboration in the supply chain system. Furthermore, the proposed framework enables the researcher to figure out the chance to develop better collaboration programs. Since the most past studies focus on only the collaborative forecasting in the CPFR program, the future studies can figure out the room to improve the current form of CPFR by searching for the other operational areas to where collaboration can be enhanced.

5. Analyses on CPFR and Other Collaboration Programs

By applying the proposed framework, this study analyzes the several well-known collaboration programs including CPFR. Through the direct comparison with the other collaboration programs, this study intends to figure out the unique collaborative features of CPFR and the potential for being a better collaboration program.

Total four well-known collaboration programs - Quick Response (QR), Efficient Consumer Response (ECR), Vendor-Managed Inventory (VMI), and CPFR(Collaborative Planning, Forecasting, and Replenishment) are considered. Quick Response (QR) was introduced by a group of leaders in the U.S. apparel and textile industries in 1984 (Webster, 1995), and it becomes a remedy against an unreasonably long lead-time, which has caused serious problems of inventory management by improving the visibility of customer's demand information and enabling the supplier to forecast demand accurately (Cetinkaya & Lee, 2000).

Efficient Consumer Response (ECR) was first applied by the leaders of the grocery industry in 1992, and it equips the efficient supply channel operations as well as information sharing activity (Simchi-Levi et al., 2000). Through the efficient store management, replenishment, promotion, and product introduction, ECR brings the efficient supply chain processes and improves customer services.

Under the Vendor-Managed Inventory, which was developed by Wal-Mart, a vendor takes full charge of managing buyer's inventories (Boone & Ganeshan, 2000). The VMI enables the buyer to reduce the burden of inventory management and the vendor to build flexible order replenishment and delivery plans.

<Table 1> Analyses on supply chain systems in terms of three collaborative features

Supply chain systems	Information sharing	Cost payment	Decision authority
Traditional system	No information is shared.	Associated with ownership.	Associated with ownership.
QR	Limited information about demand is shared.	Associated with ownership.	Associated with ownership.
ECR	Limited information about demand is shared.	Associated with ownership.	Associated with ownership.
VMI	Information about buyer's inventory and demand is shared.	Supplier bears the entire cost of ordering and holding inventory.	Supplier makes decisions regarding ordering and holding inventory at the buyer's warehouse.
CPFR	Information about demand, planning, and forecasting is shared.	Associated with ownership.	Associated with ownership, but decisions are made based on pre-set agreements

Source: Ryu(2007).

The results of the analysis based on the proposed framework can be found in <Table 1>.The outcomes of analysis are based on the literature reviews on the past studies about the individual collaboration programs, and the detailed contents can be found in the previous study on the supply chain coordination (Ryu, 2007).

The traditional system represents a non-collaborative supply chain system, where the supply chain members do not share any information except buyer's orders received by the supplier. Under the traditional system, each supply chain member pays the cost and makes decisions that are strictly associated with the ownership.

Under the QR, the buyer and supplier share only a limited

type of information, which is market demand. However, QR shows no difference from the traditional system in terms of cost payment and decision authority. ECR is identical to QR.

VMI allows the supplier to receive the information about market demands directly from the buyer. In most cases, the supplier is responsible for paying the costs for ordering and inventory holding at buyer's warehouse. The supplier makes decisions about ordering and inventory holding, which are determined by the buyer under the traditional system. The VMI system is considered to be a partially centralized decision-making system where the supplier holds the decision authority and pays the costs related to wider operational areas with more information. Although the VMI system equips all three collaborative features to some extent, its collaboration level is not high enough to be a fully collaborated program. Under the VMI, the ordering decision is made by a single member rather than jointly made by the buyer and supplier, and they share only the limited information about the market demand.

Compared with the other programs, the supply chain members under CPFR share more diverse types of information including the market demand, forecast, and plans. Regarding the decision authority, each individual member makes the decisions about the operations that he owns just like the traditional system. On the other hand, the most decisions about replenishment are made based on the pre-set agreement among the members. The cost payment under CPFR is identical to the traditional system.

In conclusion, this study analyzes four well-known supply chain collaboration programs based on the proposed framework with three collaborative features and finds out that all considered programs still has either one or more key features that are not fully utilized to achieve the complete level of collaboration. In particular, CPFR does not equip the collaborative feature of cost payment. This study identifies that CPFR applies collaboration to the decision authority to some extent but it is not a sufficient level to make a fully collaborated supply chain system. By implication, CPFR can become a more advanced collaboration program by having the collaborative cost payment scheme and joint decision making process.

While the most past studies that review the literature about the supply chain collaboration merely focus on the individual programs in their general perspectives (Choi & Sethi, 2010; Govindan, 2013; Marques et al., 2010), this study provides a new framework for analyzing any collaboration programs and shows the unique collaborative features of CPFR by directly comparing with the other types of collaboration programs. Furthermore, the analysis with the proposed framework presents the opportunities to improve the current form of CPFR into a better collaboration program.

6. Conclusion

This study conducts the literature reviews on the past studies that research CPFR as a supply chain collaboration program. Through the careful organization of the information about CPFR appeared in many past studies, this study provides the comprehensive knowledge about CPFR including its definition and benefits.

This study identifies some important issues that are ignored by the majority of the past studies, and the researchers can address these issues in their future studies and figure out the true nature of CPFR. More studies that apply diverse research methods other than the case study is required to examine the exact value of CPFR. In particular, the model analysis or simulation based on the supply chain model is recommended as a proper research tool for the experiments on CPFR under the various conditions. While the most studies using the model analysis or simulation assume the simple supply chain system with a single buyer and one supplier in their models, the researchers can obtain the additional founding about the dynamic interaction among different supply chain members by using the sophisticated supply chain model with more than two echelons and multiple players at each stage,. This study also points out that more researchers need to pay attentions to the development of specific techniques of collaborative forecasting and collaborative agreement among different supply chain members.

In behalf of the researchers who intend to learn about the collaborative natures of CPFR, this study provides a framework to analyze any collaboration programs in terms of three key collaborative features. The outcomes of analysis based on the proposed framework reveal that CPFR still requires being fully collaborative in terms of cost payment and decision authority.

While the most past studies that review the literature about the supply chain collaboration merely illustrate the study trend about the individual program in their general perspectives, this study points out the unique collaborative features of CPFR by comparing with the other collaboration programs based on the proposed framework. Furthermore, this study presents the opportunities to improve the current form of CPFR into abetter collaboration program based on the analysis with the proposed framework.

This study has some limitations, and they imply the research issues that can be addressed by future studies. First, this study focuses on only one aspect of CPFR, which is the supply chain collaboration, and ignores other important issues regarding CPFR. Different viewpoints on CPFR other than the collaborative features, such as technical support system (Choi et al., 2003; Kim et al., 2003b) may allow the future studies to learn how to improve the practical operation of CPFR.

Second, this study reviews only the selected studies on CPFR and they are not a sufficient basis to signify the practical form of CPFR. More researchers are expected to study about CPFR with diverse issues, and in particular, extensive research on the application of CPFR will provide the future studies with valuable insights about the practical standard form of CPFR.

While this study suggests a new framework for analyzing any supply chain collaboration programs, the proposed framework

still relies on the conventional collaborative aspects. In the proposed framework, three collaborative features, which are information sharing, cost payment, and decision authority, can be frequently found in the past literature about supply chain collaboration. Future studies need to continue searching the new aspect of supply chain collaboration, and in particular, it is essential to develop a new supply chain collaboration program. that is superior to CPFR.

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Appendix A. Taxonomy of Studies on CPFR

Author (Year)	Study topic	Supply chain structure	Operations addressed	Performance measure	Methodology
Raghunathan (1999)	Investigating CPFR in a coordinative buyer-seller partnership	One manufacturer andtwo independent retailers	Production, inventory, and replenishment management	Manufacturer's total cost (inventory holding cost and shortage cost)	Model analyses
Boone and Ganeshan (2000)	Examining the impact of CPFR on supply chain performance	A retail supply chain with distribution centers and plants for regional retail markets	Forecasting, inventory, and shipment management	Inventory level, customer service measures, working capital, and long-term flexibility of supply chain	Case study
Russell (2000)	Investigating the three key determinants of success of the CPFR program	A general supply chain system	Information sharing, organization management, and technology	-	Action research, case studies, and perception/attitude survey
Aviv (2001)	Examining the impact of collaborative forecasting on supply chain performance	One retailer and one supplier	Forecasting, inventory, and replenishment management	Inventory holding and shortage costs	Model analyses and numerical examples
Barratt and Oliveira (2001)	Examining the CPFR implementation process to find solutions to overcome some barriers	A general supply chain system	Front-end agreement, joint business plan, and forecasting	-	Survey
Kim (2001)	Reengineering distribution process with CPFR technology	One supplier and multiple distributors	Demand forecasting and replenishment	Cycle time, sales revenue, and lead time	Case study
Aviv (2002)	Performance comparisons of the traditional system, VMI, and CPFR	One retailer and one supplier	Inventory, replenishment and forecasting management	Long-run average total supply chain cost per period (inventory holding cost)	Model analyses and numerical examples
Holmstrom et al. (2002)	Examining forecasting, replenishment, and distributed software solutions for CPFR	Multiple suppliers and multiple customers	Forecasting, replenishment, distributed planning system, and architecture of distributed software	Forecasting accuracy and time benefits	Process verification pilots
McCarthy and Golicic (2002)	Examining the implementation of collaborative forecasting and its impact on supply chain performance	A general supply chain system	Forecasting	Responsiveness, product availability assurance, inventory costs, and revenues/earnings	Case studies
Esper and Williams (2003)	Evaluating collaborative transportation management	-	Information sharing	Transportation cost, on-time performance, asset utilization, and administration cost	Descriptive case study
Sagar (2003/2004)	Examining the implementation and effects of CPFR	A supplier and its trade partners	Forecasting	Forecasting error and order variability	Case study
Skjoett-Larsen et al. (2003)	Presenting a theoretical framework for analyzing CPFR in terms of relational coordination of processes among participants	A general supply chain system	Product development, production, promotion, transport, forecasting, and replenishment	-	Empirical study
Smaros (2003)	Evaluating collaborative forecasting	One supplier and one retailer	Collaborative forecasting	Forecasting accuracy	Case study
Danese et al. (2004)	Examining different coordination types and characteristics of interdependency in CPFR implementation	-	Forecasting and joint planning	-	Case study
Disney et al. (2004)	Evaluating the performances of different types of e-business-enabled supply chain models	One retailer, one distributor, one warehouse, and one factory	Information sharing	Bullwhip effect	Beer game and z-transform evaluation
Caridi et al. (2005)	Proposing a multi-agent model for optimizing the CPFR negotiation process	One retailer and one manufacturer	Negotiation process	Costs, inventory levels, stockout level, and sales	Simulation
Chung and Leung (2005)	Validating the CPFR system in the manufacturing industry	One manufacturer and one supplier	Demand forecasting and joint planning	Inventory level, stockout instances, forecast accuracy,	Case study

				scrap, responsiveness to market change, and running costs	
Kim and Lee (2005)	Proposing a new forecasting system involving collaboration and judgmental adjustments	-	Demand forecasting	-	Literature reviews
Wang et al. (2005)	Analyzing the critical factors for successful CPFR implementation	Multiple-tier supply chain (retailer, wholesalers, suppliers, etc.)	Demand forecasting	-	Case study
Caridi et al. (2006)	Proposing a multi-agent system for automating and optimizing collaboration within the supply chain	One retailer and one manufacturer	Negotiation process	Costs, inventory level, stockout level, and sales	Simulation
Cassivi (2006)	Identifying the types and levels of collaboration planning in e-collaboration	One manufacturer and multiple suppliers	Information sharing	-	Field study and survey
Danese (2006)	Examining the different types of collaboration in CPFR implementation	-	Forecasting and joint planning	-	Multiple case study
Chang et al. (2007)	Proposing an augmented CPFR model for improving forecasting accuracy	One manufacturer and one supplier	Demand and order forecasting	Turnover rates, stockout rates, service levels, forecast accuracy (MAD), and variance of inventory	Case study and simulation
Chen et al. (2007)	Examining the performances of different CPFR systems depending on who leads main operations	One retailer and one manufacturer	Information sharing	Service levels, fulfillment rates, order cycle times, and system costs	Simulation
Danese (2007)	Analyzing the relationship between different dimensions of collaboration and contingent factors in CPFR implementation	-	Forecasting and joint planning	-	Case study
D'Aubeterre et al. (2008)	Developing a design artifact for incorporating secure and coordinated exchange of information and knowledge	One seller and one buyer	Information and knowledge sharing	-	Case study
Sari (2008)	Evaluating the value of CPFR over other supply chain initiatives under different conditions	One retailer, one distributor, and one manufacturer	Information sharing regarding demand, inventory, and promotion plans	Total cost (back order, inventory holding) and customer service level	Simulation
Du et al. (2009)	Proposing the CPFR procurement model for agricultural products	N-tier supply chain	Demand forecasting	Service level, inventory variance, forecasting accuracy, and inventory loss	Case study
Shu et al. (2010)	Proposing the selection model for granting credit based on AVE-based CPFR	One commercial bank and multiple loan clients	Joint forecasting and replenishment	Risk compensation and expected yield	Empirical study
Smith et al. (2010)	Evaluating the integration of S&OP and CPFR	One retailer and one manufacturer	Information sharing	Intangible performance (trust, customer satisfaction, etc.)	Case study
Yuan et al. (2010)	Evaluating the impact of different collaboration effects on the demand gap in new high-tech product diffusion	Multiple tiers and multiple players	Information sharing and joint inventory management	Demand fulfillment, inventory, and shortage	Simulation
Cho and Yu (2013)	Examining the relationship between CPFR implementation factors and performance	-	Demand and order forecasting	Customer-oriented and operation-oriented performance	Empirical study
Yao et al. (2013)	Evaluating the value of CPFR based on learning curves	One manufacturer, one retailer, and multiple end-customers	Collaborative forecasting and replenishment	Forecasting accuracy and inventory level	Empirical study
Lin and Ho (2014)	Proposing a CPFR program for the healthcare industry and evaluating its benefits	Hospitals and medicine suppliers	Demand forecasting	Cost, time, and quality	Survey and analytic hierarchy process (AHP)