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Mid-term Planning Coordination Between Maker And Retailer By (P,Q) Demand Information Sharing

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ABSTRACT

In the research, we propose the mid-term planning coordination method between maker and retailer by hiring the ideas of capacity reservation based contract. Also, we suggest the more complicated demand information that we called (P, Q) demand information in the research, not the simple demand forecasts, is indispensible for the proposed coordination method. Finally, we verify strengths and weaknesses of the proposed method by dynamic simulation with various business environments. Simulation results show that SC members are able to execute operations smoothly according to tactical level plan that result in more profitable outcomes.

KEYWORDS: Collaborative SCM, Mid-term planning coordination, Capacity reservation, (P, Q) demand information

INTRODUCTION

Supply Chain Management is business process and operation management to meet the needs of the end-customer efficiently and effectively across SC. As the globalization of SC has progressed, there are many sources of uncertainty over the entire SC such as demand uncertainty and supply uncertainty due to unskilled labors and sudden breakdown of production facilities of upstream player (Gjerdrum et al. 2002). It causes lots of problems like excessive inventory holding and declined service level. To handle with these puzzling situations the SCM initiative, which is based on collaboration, is required.

Collaborative SCM is the systematic and synchronized business initiatives among SC members to settle the various problems occurred in SC. And many different approaches are adopted by the level of decision-making such as strategic, tactical and operational (Hernandez et al. 2008). It is the challenging issue, especially in high-tech equipment industry experiencing severe market demand change, to keep the stable and also profitable operation rate. Achieving the objectives of tactical level, SC members need coordination schemes for mutual profits and the success of SC over the competitive one. Ryu et al. (2009) suggested collaborative method for bargaining contract in operational level and verified the performances of the proposed method. However, the results related with limitations of the proposed method showed us that the problems should be tackled by the tactical level approaches.

In the research, we propose the mid-term planning coordination method between maker and retailer by hiring the ideas of capacity reservation contract. We develop the contract between maker and retailer to have double phased decision-making process based on capacity

reservation. Also, we suggest the more complicated demand information that we called (P, Q) demand information in the research, than simple demand quantity forecasts, is indispensible for the proposed coordination method. Finally, we verify strengths and weaknesses of the proposed method by dynamic simulation with various business environments. Simulation results show us that SC members are able to execute operations smoothly according to tactical level plan that result in more profitable outcomes. The proposed method shows great excellences in operation rates by hedging the risk of the possible loss especially in resource utilizations rate.

LITERATURE REVIEW

Maker and retailer make production plan and sales plan for the mid-term span in the electronic industry. One of the most important activities which determine the performance of the supply chain is the decision making on bargaining contract determining quantity, price and delivery between maker and retailer. They conduct negotiation to set up their own production and sales plan periodically. Also, the bargaining contract has a great effect on individual efficiency of both maker and retailer, because it is very closely related with the maker's production plan and retailer's sales plan. If there are no partnerships which can help to align the different objectives of maker and retailer, the production efficiency of maker and utilization of retailer might decline radically. And moreover, the negotiation of bargaining contract tends to be non- cooperative competition arguing for each player's own profits.

Nash (1950) presented a new treatment to the bargaining problems which occurred in many forms in bilateral monopoly. In his treatment, a few general assumptions were made concerning the behavior of a single individual and a group of individuals in certain economic environments. In later Nash (1953) extended his previous treatment to a wider class of situations. And also, he proposed the method to derive the solution of two-person cooperative game. Since then much research has been done in the territory of bargaining problems.

There are three streams of research related with the bargaining problems between maker and retailer. The first stream is primarily focusing on the relationship between maker and retailer. Braun et al. (2006) proposed the generalized 'Nash bargaining solution' from game theory with the assumption that both relational features and network positions. Li et al. (2002) explored the role of franchising efficiency with respect to transactions between franchisor and a franchisee through fixed lump-sum fees, royalties, wholesale prices and retail prices.

The second stream is about the role and the benefits from the bargaining contract between players. Gurnani (2006) discussed the role of using a down-payment or non-delivery penalty in the contract especially with the case of a first-time interaction between retailer and maker who is unreliable in delivery. Zhao et al. (2005) identified the impact of the maker's incentives, subsides, and transshipment fees on the retailer's sharing behavior. Balasubramanian et al. (2004) analyzed the equilibrium in incentive plans when it is possible to choose between compromise and perfect coordination. Houba et al. (2006) investigated the effects of non-stationary contracts in the negotiation model where two players have a riskless asset to share in each of infinitely many periods. Cachon et al. (2005) demonstrated that revenue sharing coordinates a supply chain with a single retailer and arbitrarily allocates the supply chain's profit.

The third one tries to identify the influences of the changes of environment about bargaining problems, for instance the impact of market demand uncertainty. Hua et al. (2008) showed the changes of retailer's dominance over the maker with the fluctuation of market demand by theoretical and numerical analysis. Lau et al. (2002) considered ad non-cooperative game

between maker and retailer in a two echelon supply chain. They studied how the level of market demand uncertainty would affect the player's decisions. Kohli et al. (1989) investigated quantity discount in the context of a bargaining problem and discuss the effect of risk sensitivity & bargaining power.

In the research, we extend our previous model and propose the coordination method between maker and retailer by hiring the ideas of capacity reservation contract. And it is composed of double phased decision making process based on capacity reservation contract. Also, we evaluate the benefit of (P, Q) demand information sharing and also demonstrate the information is indispensible for the proposed coordination method.

BARGAINING CONTRACT MODEL

In the research, maker and retailer is willing to determine the bargain quantity and price of the product for three months that will be deployed to market in six months later through negotiation.

Maker is willing to determine the bargain quantity and price maximizing his own profits with the constraints of minimal required profit rate, minimal required operating rate and maximal required production capacity. On the other hand, retailer decides bargain quantity, bargain price and sales price to maximize profits with the constraints of minimal required profit rate, minimal required operating rate.

Decision Making of Maker

Maker sets up production plan according to the decision making logic stated as below.

$$Decision\ Var.: Bargain\ Quantity\ (Q_B), Bargain\ Price\ (P_B)$$
$$Objective\ Function: max\{[P_B\text{-}C(Q_B)*Q_B]\}$$
$$Constraints: Q_B \geq Q_{max}*r_{min} = Q_{min},$$
$$Q_B \leq Q_{max}$$
$$P_B \geq (1+\alpha M_{min})*C(Q_B)$$

Decision Making of Retailer

Retailer makes sales plan according to the decision making logic stated as below.

$$Decision\ Var.: Bargain\ Quantity\ (Q_B), Bargain\ Price\ (P_B),$$
$$Sales\ Price\ (P_D)$$
$$Objective\ Function: max\{[P_D\text{-}P_B\text{-}C(Q_B)*Q_B]\}$$
$$Constraints: Q_B \leq PD,$$
$$\theta\text{-}3\sigma \leq P_D \leq \theta + 3\sigma$$
$$P_D \geq (1+\alpha R_{min})*[P_B + C(Q_B)]$$

Market Demand

Market demand is the expected demand dependent on the variable of sales price (P_D). It is assumed that there is potential demand (PD) and the expected demand is expressed by mean market price (θ) and standard deviation (σ) which are related with sales price (P_D).

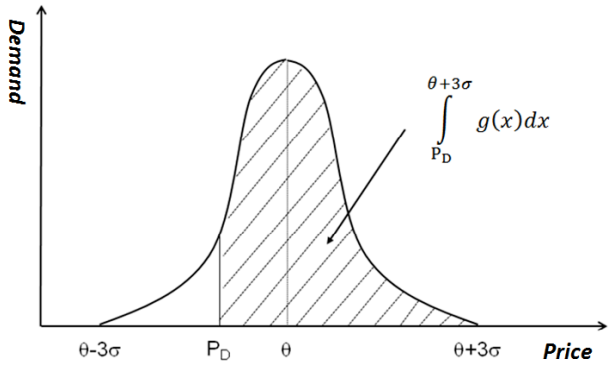

FIGURE 1: Market Demand vs. Sales Price

MID-TERM PLANNING COORDINATION

Collaborative SCM is the systematic and synchronized business initiative across SC for problem solving, performance improving, discovering business chances, and achieving competitive edge. SC Integration (i.e. structural & functional collaboration for specific objective) and SC Coordination (i.e. process & operation collaboration based on mutual understanding or contract) are also included in Collaborative SCM in a broad sense. We identify three levels of Collaborative SCM according to the management level in Figure 2.

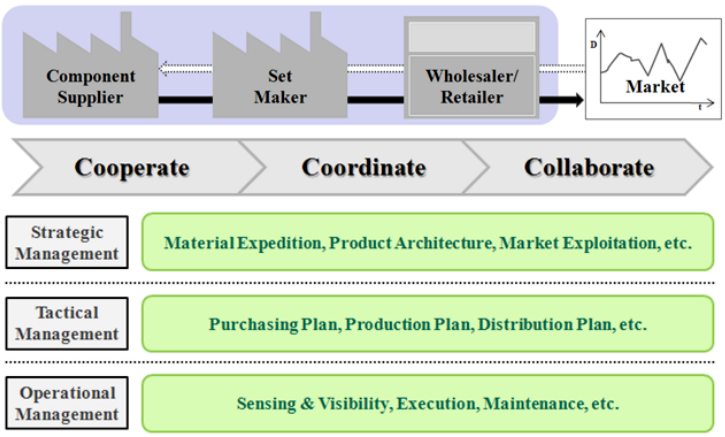

FIGURE 2: Collaborative SCM

We consider mid-term planning coordination, based on capacity reservation contract, as tactical management level of Collaborative SCM.

Capacity Reservation Scheme

Time horizon is composed of a planning span and a horizon for capacity reservation considering lead-time between maker and retailer. Retailer can reserve the production capacity of maker based on his own market demand forecast in advance. However, demand forecast accuracy for the reservable horizon is not good as that of planning span. It means that the decision making for this horizon closely related with the risk. And it is assumed that retailer can hedge his risk of supply uncertainty by 'reserved capacity' and does same as maker. We show the details of capacity reservation in Figure 3.

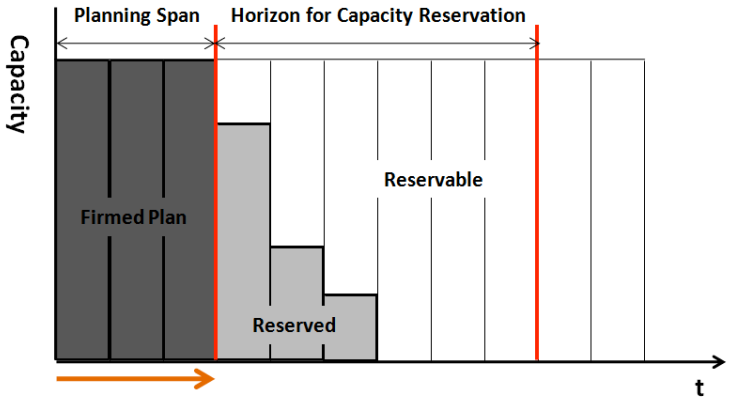

FIGURE 3: Capacity Reservation

(P, Q) Demand Information

The forecasted demand quantity is usually considered as important information in bargaining problems between maker and retailer. And here we suggest more complicate information is needed for mid-term planning coordination for the players to balance the risks related with capacity reservation. In the research, we call this kind of demand information as (P, Q) demand. It is the information including price elasticity as well as demand quantity as expressed in Figure 4.

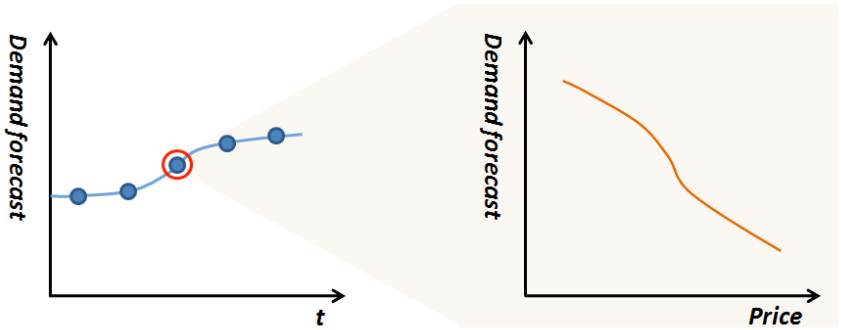

FIGURE 4: (P, Q) Demand Information

Suggested Coordination Method

In the previous research, we modeled the coordination scheme by adopting collaborative negotiation between maker and retailer as depicted in Figure 5.

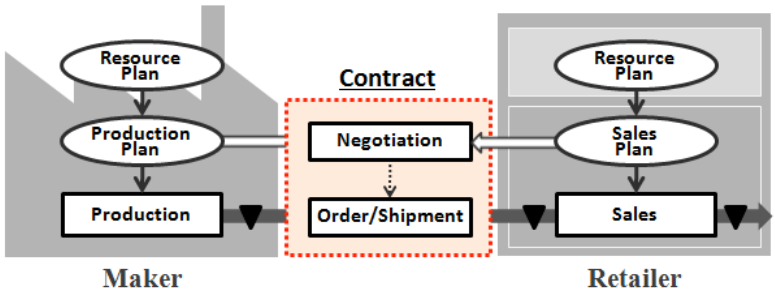

FIGURE 5: Contract Model at Operation Leve

We extend our previous model into two-phased contract model for the mid-term planning coordination. As showed in Figure 6, resource plans of maker and retailer can be coordinated by capacity reservation process.

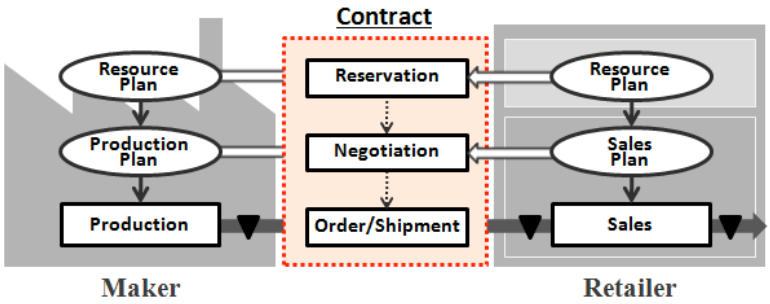

FIGURE 6: Two-Phased Contract Model

RESULTS AND CONCLUSIONS

We verified the strengths and weaknesses of the suggested coordination method by numerical experiment based on simulation.
As shown in Figure 7, Simulation results show that SC members are able to execute operations smoothly according to tactical level plan that result in more profitable outcomes.

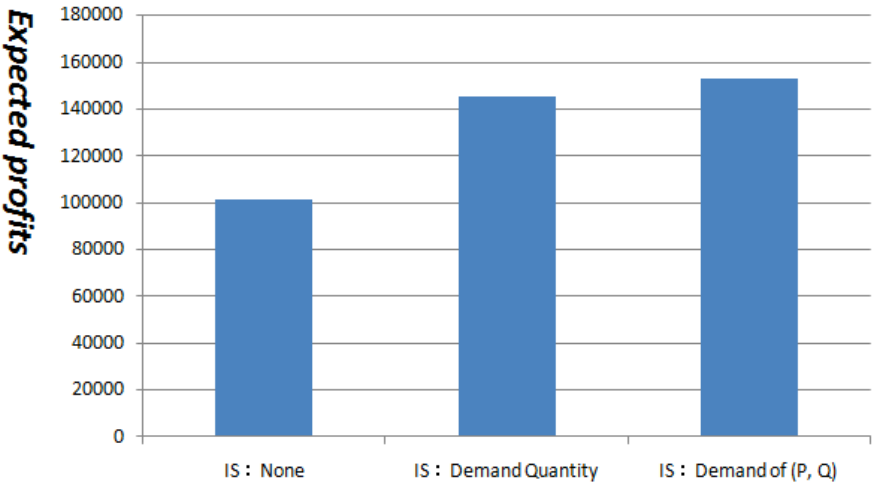

FIGURE 7: Extended Profits vs. IS Levels

Also, we found that the proposed method show great excellences in operation rates by hedging the risk of the possible loss especially in resource utilizations as depicted in Figure 8.

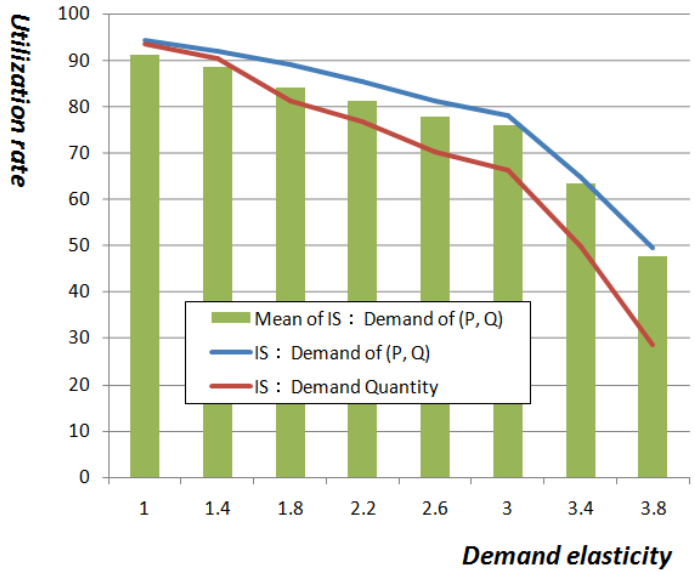

FIGURE 8: Utilization Rate vs. Demand Elasticity

In the previous research, we suggested collaborative method for bargaining contract in operational level and verified the performances of the proposed method. However the results, related with limitations of proposed method, showed us that the problems should be tackled by the tactical level approaches. In the research, we extended our previous model and proposed the coordination method between maker and retailer by hiring the ideas of capacity reservation contract. And also, we developed the contract between maker and retailer to have two-phased decision making process. From the simulation results, (P, Q) demand information is indispensible for the suggested mid-term planning coordination method. And we identified that SC members should be able to execute operations smoothly according to tactical level planning coordination that resulted in more profitable outcomes. Especially, the proposed method showed great excellences in utilization rates by hedging the risk of the possible loss in resource utilizations.

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