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Supply Chain Management for Customer Service Levels: A Literature Review

Ki-Seok Choi

Department of Industrial & Management Engineering,

Hankuk University of Foreign Studies, Yongin, 17035, Korea.

Abstract

In order to guarantee customers a satisfactory service level, the whole supply chains should be integrated efficiently. The manufacturer needs to measure and control the influence of supply on customer service level. Since the manufacture usually has a limited capacity, it is important for cost-effectiveness to comprehend how much value the limited resource possesses. The manufacture needs to identify operation policies to deliver guaranteed service level with the limited capacity. In this paper, we review the existing researches on how to manage capacitated supply chains while taking into account customer service level.

Keywords: Supply Chain Management, Service Level, Supply Contract

INTRODUCTION

One of the objectives in supply chain management is to integrate all parties such as suppliers and manufacturers in an efficient and cost-effective manner while satisfying service level requirements. Many researchers have focused on how to coordinate the supply chain parties to achieve a system-wide target. Operational decisions on production, distribution, and/or inventory control at each stage are coordinated by a central planner. In many industries, however, the manufacturer and the supplier are separate organizations and each party in the supply chain makes its own operational decisions. In the electronic manufacturing service (EMS) industry, for example, original equipment manufacturers may not make decisions for the EMS providers on component procurements. In such a decentralized environment with the absence of central decision makers, supply chain partners can usually affect each other's operations only by specifying requirements on observable measures in a contract.

It is an important question on which terms the manufacturer and supplier make agreements in supply contracts. Those terms work as links between the manufacturer and the supplier so that the entire system accomplishes a system-wide target. Special attentions are necessary when the manufacturer's production capacity is limited for it becomes complicated to measure the influence of the supplier performance on customer service level. We survey literatures on how the supply contract should be designed in manufacturing systems with finite capacity.

If the manufacturing operation involves custom components, the flexibility of the supplier works as another capacity limit of supply chains and has substantial impact on customer service level. Due to the lack of other sources for a custom component, the manufacturer prefers and is willing to pay more to a supplier with higher flexibility who can deliver unusually large orders in a short notice. However, it is usually not straightforward to estimate how much value the supplier flexibility possesses in the sense that it helps the manufacturer achieve a target customer service level. We look into existing researches regarding the problem of estimating the value of flexibility in assemble-to-order systems with a custom component.

Another interesting problem in capacitated supply chains is how to guarantee customer service levels with limited resources. One of the common approaches to solve the problem is differentiating service depending on customer classes. High-priority customers receive a better service at the cost of low-priority customers' service levels. It is an efficient method to enhance the system utilization while guaranteeing service levels at least for a part of customers. One of common criteria in practice to determine a customer's priority is whether he/she has a reservation. Customers with a reservation usually receive service based on the time the reservation is made. We examine what have been discovered on the effect of the advance customer arrival information has on customer service levels.

SUPPLY CONTRACTS FOR SERVICE LEVEL

Many researchers have dealt with the problem of achieving a target service level at the most downstream stage in supply chains. We review recent works on capacitated systems and refer readers to Diks et al. and van Houtum et al. for the review of other related literature. Glasserman considers multistage production-inventory systems with limited production capacity. He develops approximations for service level measures and for base-stock levels that achieve required level of the measures. Glasserman and Wang consider ATO systems where finished-products consist of multiple components whose production is controlled by base-stock policies. They show that there exists a tradeoff between base-stock levels and delivery leadtime to deliver a high customer service level. Based on their results, Wang derives approximate solutions of the base-stock levels to minimize total inventory cost while satisfying a fill rate requirement. Sobel consider periodic-review supply chains where each stage has a bound for the production quantity in one period. He formulates the fill rate in terms of base-stock levels and shows that shorter supply chains have higher fill rates.

Most researches have focused on centralized approaches to achieve the system-wide target. When it comes to how to define local targets in decentralized supply chains, however, the existing literature provides no notable results. Cohen and Lee simply assume that they are given while Lee and Billington use a simple search heuristic to find the best local targets, assuming each stage follows a base-stock policy. In Bollapragada et al. and Paschalidis and Liu, the service level of the supplier is set to be greater than or equal to the target customer service level. This rule-of-thumb is based on a common belief that the downstream service level is guaranteed regardless of how the upstream service level is achieved, as long as the upstream service level is high enough.

SUPPLIER FLEXIBILITY VALUATION

Several researchers have considered supply chain models with various types of supplier flexibility. Li and Kouvelis consider a "time-flexible" contract with which the buyer initially specifies how many units he will purchase from the supplier but not when those units will be purchased. They assume that the demand is constant and the purchase price is uncertain, and study how many units to purchase and when to purchase. Minner et al. consider a two-stage supply chain model with supply leadtime flexibility. The outstanding orders from the supplier can be speeded up, and the extent of such order expeditions is referred to as "pipeline flexibility." They provide insights into the trade-off between flexibility costs and inventory costs when the customer demand has a Poisson distribution. Furthermore, the literature concerning leadtime flexibility includes various studies of emergency supply models (Moinzadeh and Schmidt, Aggarwal and Moinzadeh, and Alfredsson and Verrijdt).

The supplier flexibility we considered is of the type that allows the buyer to change order quantities. Moinzadeh and Nahmias consider an inventory model in which the buyer has the option of increasing the delivery quantity at additional cost just prior to the periodic delivery of a fixed quantity. They suggest an approximate policy to reduce cost. Eppen and Iyer consider "backup agreements" in which the buyer has options of purchasing a certain quantity at no additional cost but pays penalty for any quantity not purchased. Barnes-Schuster et al. examine a supply contract with options in a two-period model. In addition to committed orders, the buyer may purchase and exercise options of increasing orders. They evaluate the option exercise price numerically and study the channel coordination. Huang et al. also consider a two-period contract with volume flexibility. The buyer may adjust the initial order both upward and downward at given costs. They find the buyer's optimal policy in some special cases and derive the contract exercise cost. Tsay consider a "quantity flexibility" contract and studies the coordination of a manufacturer-retailer channel in a similar setting to the newsvendor problem. Bassok and Anupindi study "rolling horizon flexibility" contracts which is similar to our fractional adjustment flexibility. They propose several heuristics for the buyer's ordering policy in order to reduce cost.

Tsay and Lovejoy analyze a multistage supply chain with quantity flexibility contracts. They examine where to position flexibility through approximate analysis and extensive numerical experiments.

The value of flexibility in this type of supply chains may not be amenable to analysis. Bassok and Anupindi and Tsay and Lovejoy address the value of flexibility issue, but they only provide insights by numerical experiments.

SERVICE DIFFERENTIATION WITH LIMITED CAPACITY

There is little existing literature concerning service differentiation with advance arrival information. One of notable research streams is the study of queueing systems with scheduled arrivals. Scheduled arrivals are related to our study in the sense the service order is determined by the time on the arrival schedule not by the time when a customer actually arrives. Mercer considers a queueing system in which customers are scheduled to arrive during equal time intervals and must arrive within the scheduled interval. He analyzes the waiting time distribution when the service time is exponential. Sabria and Daganzo consider a model where late customers still join the system and the service may take place in an order different from that of arrivals. They provide light traffic approximations of the expected waiting time for general lateness and service distributions. Doi et al. study a queueing model with general scheduled interarrival times and exponential distributions for delay and service time. The customer arriving after the next scheduled arrival must leave the system immediately. For this model, they provide the steady-state distribution of waiting time.

While the scheduled arrivals are useful to represent practical problems such as berth space scheduling at a sea port, little has been known about the system performance such as customer waiting time for the cases where a late customer can get service even after other customers have arrived. Besides, all the customers are required to make a schedule before arrival.

Another research stream related to service level guarantee is concerning quotation of leadtime. Wein studies due-date setting and priority sequencing problems in the setting a multi-class queueing system. He compares a number of policies through simulation when the objective is to minimize the weighted average of the time between an order arrival and the quoted due date with a constraint on a long-run average tardiness. Duenyas and Hopp consider a system where the customer's behaviors may depend on the quoted leadtime. They prove the optimality of different control policies of accepting orders to maximize profits when the orders are served in a first-come-first-served manner. They also give conditions under which the earliest-due-date policy is optimal. Hopp and Sturgis suggest a method for quoting manufacturing due dates to achieve a target customer fill rate. Using simulation, they show their method of determining leadtimes as a function of work in process predicts accurately the actual leadtime. In the above cases, the estimated leadtime is known to a customer when he places an order. The quoted leadtimes change dynamically even for the customers in the same class.

CONCLUDING REMARKS

Customer satisfaction has become one of the most important objectives of supply chain management. To keep overall system performance under its control, the manufacturer needs to make supply contracts through which it can confine the supplier's influence on the customer service level. Conditions on the supplier's performance in supply contracts are to be devised so that the manufacturer has a definite idea of what the final customer service level will be.

The value of flexibility depends on how the assembler manages the standard component supply. If it imposes the assembler considerable costs to improve standard component shortage level, then high flexibility of the custom component supplier has more value to the assembler. We also observe that additional flexibility of the custom component supplier is much valuable to the assembler when the current supplier flexibility is low. On the other hand, when the supplier flexibility exceeds a certain level, higher flexibility does not help the assembler save costs in standard component supply and thus has little value to the assembler.

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Author Profile:

Ki-Seok Choi received B.S. and M.S. degrees in industrial engineering, respectively from Seoul National University, Seoul, Korea, in 1991, and from KAIST, Daejeon, Korea, in 1993, and Ph.D. degree in industrial and systems engineering from Georgia Institute of Technology, Atlanta, GA, in 2003. He is currently a Full Professor at Department of Industrial and Management Engineering, Hankuk University of Foreign Studies, Korea. Previously he worked at Electronics and Telecommunication Research Institute and Samsung Data Systems. His research interests are in supply chain management and quality of services.