

Chapter 17

A Mathematical Model for Tactical Operations Planning for Response–Base Supply Chains

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ABSTRACT

This article explores the issue of lead-time in response-based supply chains. From a tactical viewpoint of response-based supply chains, the processing time for each stage is assumed to be a random variable since different practices exist in the selection pool of each stage under a specific lead-time requirement. The decision-maker must select suitable practices of operations for each stage to ensure that the lead-time meets a desired requirement. The relationship and the trade-off between the operating costs for the selected practices and the inventory holding cost of safety stock that is in turn affected by the lead-time are discussed. A mathematical model for planning the operations from a manufacturer viewpoint is proposed. The variation in practical situation for the proposed model is also addressed. A hypothetical example is provided to illustrate the effectiveness of the proposed model. With reference to the computational results, the effect of several parameters on the model's optimal solutions was discussed.

INTRODUCTION

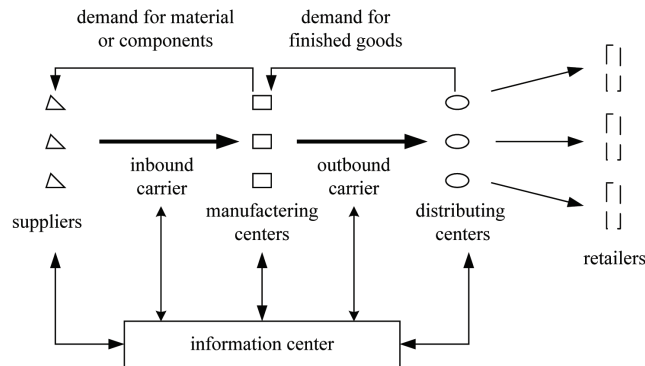
Nowadays, individual firms no longer compete as independent entities, but rather as an integral part of supply chain links. Davis (1993) and Min and Zhou (2002) claim that in a time of shortening product life cycle, complex corporate joint ventures, and stiffening requirements for customer service, it is necessary to manage the supply chain

in a manner of completeness. Lee et al. (2007) find that internal integration is the most important contributor to cost-containment while integration with supplier is the best strategy to achieve reliable supply-chain performance.

A supply chain for a manufacturer is generally defined as an integrated process wherein a number of business entities work together to pursue the objective of the organization. In this article, we address the lead-time-related issues in a response-based supply chain from the manufacturer view-

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Figure 1. The scenario of supply chain



point. Christensen et al. (2007) have shown that as variance in supply-chain lead-times increases, the financial performance of the organization decreases but the average supply-chain lead-times have no direct impact on financial performance. The supply chain that we consider consists of multiple outside suppliers, an inbound carrier, multiple manufacturing centers, an outbound carrier, and multiple distributing centers. Figure 1 depicts the scenario of this supply chain. We assume that the higher strategic level of decision has identified the configuration and other parameters such as the lot size of each replenishment order of this supply chain. Hence, we propose models that take into account the tactical level of managing the supply chain according to the determined configuration.

The supply chain comprises stages that can be controlled by the information center. Figure 1 depicts the supply chain with five stages from the manufacturer viewpoint. In each stage, there is a pool of candidate practices with different operating times and associated costs. For instance, there are different transportation modes for inbound and outbound carriers with different operation times and costs, and the production rate of manufacturing centers may be normal or urgent. The operation time of each practice in each stage is taken as a random variable because there are multiple practices in each stage as well as some other uncontrollable factors. For example, there are multiple manufacturing centers with different

capacities and efficiency in the manufacturing stage. The operation time and cost of one center may be different from those of another. To simplify the problem, we assume that the operating time and cost between stages are statistically independent; for example, the transportation time and cost do not affect the processing time of the manufacturing centers.

For a response-based supply chain, the distributing centers located at the last stage of the chain collect the demands from the retailers served by them. As the amount of demands reaches the reordered point, they give replenishment order notices and desired received dates in the information center. At this point, the information center has to select a practice of each stage and implement them to fulfill the replenishment order while maintaining the lead-time of the whole chain within a desired value. Ishii et al. (1987) discussed a pull-type ordering system consisting of manufacturer, wholesaler and retailer. They deal with the problem of how to determine economic levels for the base stock and lead times for this integrated system. Das and Abdel-Malek (2003) discussed the flexibility of order quantities and lead-times in supply chain under the assumption that for a good supply chain the buyers and suppliers are willing to accommodate the uncertainties and variations in each other's business. Nagar and Fain (2008) proposed a multi-stage model for determining the optimal quantities of procure-

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