



The decision-making on an in-house logistic division's operation strategies

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Received 1 November 2003; accepted 1 March 2004

Abstract

This paper mathematically proves under which situations a firm should run its in-house logistic division as a cost center, as a profit center, or as an outsourced logistic to 3PL providers. By studying the effects of queuing delays and users' related costs on the decision of a time-sensitive in-house logistics division, this research concludes that to maximize the value of an organization as a whole, the in-house logistics division should work as a deficit center. If operated as a profit center, an in-house logistic division will bring quicker service to its customers, but at a higher price and lower utilization.

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Keywords: Queuing; Logistics; Cost/profit center; 3PL; Optimization

1. Introduction

In this paper, we consider an in-house logistics division for which timeliness is vital in its operations and demands are stochastic. Here, "in-house logistic division" means that a firm possesses its own material handling and distribution facilities, warehousing or delivering goods without outside assistance. Without loss of generality, we assume that the in-house logistic

division manager is facing uncertain demands and has limited capacity, so he/she must cope with random but time-sensitive orders which can be modeled using queuing methodology. We try to reveal that an in-house division of this kind has to work as a "deficit center" rather than a "profit center" in order to optimize its parent company's macro-level benefits rather than its own micro-level profit.

The importance of individual versus social optimization of admission to a queuing system is well known. In the early stage of this type of research (Naor, 1969; Yechiali, 1971; Knudsen, 1972; Lippman and Stidham, 1975; Mendelson

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and Yechiali, 1981), modes were restricted to the case of a fixed-capacity queuing system and study the optimal balking policies as a function of the number of customers in the queue were studied. They have shown that the use of queue size as a rationing device cannot lead to an optimal allocation of resources unless prices are simultaneously imposed. The pricing and long-run capacity (flexible-capacity) decisions of a service facility have been studied by Mendelson (1985). Since then, papers have built on this framework by studying multiclass queue and incentive-compatible priority pricing (Dewan and Mendelson, 1990; Mendelson and Whang, 1990; Stidham, 1992; Hassin, 1998; Ha, 1998; Cachon and Harker, 2002). It is not as clear, however, what the implications of these effects on the management and control of in-house logistics divisions are, thus there is a gap between the technical level and the management level. This gap limits the ability of an in-house logistics manager to make sound resource allocation and capacity decisions, and hampers his ability to justify investments for the purpose of improving response time, increasing order fill rate, or reducing costs to high-level management. As third-party-logistics (3PL) is emerging as a selectable strategy, a firm should decide which kinds of logistic services are suitable for outsourcing, and which ones should be kept in-house. So far, however, we rarely find rigorous mathematical proofs to support such logistics decision-making.

In the next section, we will set up a queuing delay-related framework for our analysis and introduce the marginal cost equation. In Section 3, we will analyze an in-house logistics division which works under Strategy I: maximizing the net-value of its organization as a whole. Our results show that this strategy unavoidably brings loss to the in-house logistics division. In Section 4, we will analyze Strategy II for an in-house logistics division: maximizing its own profits. From a mathematical standpoint, the mechanism of this strategy is identical with the 3PL's mechanism, because both of them pursue the maximization of their own profits. We will find that under this strategy, the division will charge its users more but produce less. We will conclude our research in Section 5.

2. Framework for analysis

Now we can formulate the model that will be utilized in our analysis. We describe the feature of time-sensitive and capacity-limited features of an in-house logistics division by the following elements:

1. λ : We assume that the times between successive-order arrivals are independent and identically distributed (i.i.d.) random variables with finite mean $1/\lambda$. The order may be an internal order in the firm (e.g. a plant requires the in-house logistic division to deliver necessary parts from a warehouse), or an external order out of the firm (e.g. a customer needs the firm to deliver final products).
2. μ : We also assume that orders are served according to the first come first served (FCFS) queue discipline. Service times are assumed to be i.i.d. variables. μ is a scale parameter representing the service rate, or the processing capacity of an in-house logistics division. To ensure that the queuing system has a stationary equilibrium, we require throughout that $\lambda < \mu$.
3. $V(\lambda)$: An in-house logistics division adds value to its organization by filling orders. The expected value of logistics to the whole organization per unit of time is specified by a value function $V(\lambda)$, which aggregates the values of logistics corresponding to the arrival rate λ . If the in-house logistic division receives two orders, λ_1 and λ_2 , from two plants, P_1 and P_2 , then there will be two potential delivery plans: delivering λ_1 and λ_2 separately to P_1 and P_2 , or combining λ_1 and λ_2 in a single freight. In the first plan, the value for the firm can be expressed in a linear form: $V(\lambda) = V(\lambda_1) + V(\lambda_2)$. In the second plan, however, the whole value should not be simply described in such a linear form. A single freight's costs absolutely differ with two separated freights' costs. In reality, an in-house logistic division faces $\lambda_1, \lambda_2, \dots, \lambda_n$ orders, P_1, P_2, \dots, P_m internal destinations, and C_1, C_2, \dots, C_q external destinations. Therefore, the in-house logistic division usually makes order-combined deliveries in reality. To reflect this fact, we have to describe the value

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