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The two-stage batch ordering strategy of logistics service capacity with demand update

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ABSTRACT

This paper discusses a logistics service integrator (LSI) orders logistics service capacity from a functional logistics service provider (FLSP) before the selling season with two opportunities. The optimal two-stage batch ordering strategy of LSI with demand update is studied. Standard batch size is introduced into LSI's two-stage capacity ordering strategy model, which is built upon the decision-making sequence and actually observed demand signals between the two ordering instants. The model solution method is designed based on scenario analysis and enumerative algorithm. Sensitivity analysis of the optimal adjustment ordering time point is then carried out and a numerical analysis is presented.

1. Introduction

Procurement is the means that enterprises acquire physical products or services from the supply market as business resources. Procurement is a basic and universal activity of supply chain management. Similar to the way that the manufacturer sources raw materials from the supplier in the manufacturing supply chain, the service integrator also orders services from the service provider in the service supply chain. Typically, in the logistics service supply chain (LSSC), the logistics service integrator (LSI) orders logistics service capacity from the functional logistics service provider (FLSP) (Choy et al., 2007; Liu et al., 2011). One important issue of procurement is the formulation of ordering strategy, which directly affects the company's procurement performance.

The practical issue of standard batch size exists in many operations: the quantities ordered by retailers, the quantities produced and shipped by suppliers (Hwang and Wan, 2013), and the materials flowed in factory with fixed batch sizes (Li and Sridharan, 2008; Noblesse et al., 2014; Yang et al., 2014). Compared to the raw materials, the unique features of logistics service capacity make the development of its ordering strategy more complex. On one side, the production and consumption of a service happens simultaneously (Nie and Kellogg, 1999), and there is no inventory for service capacity. The value of the remaining service capacity offered by the FLSP after the selling season is almost nothing. On the other side, batching ordering is universe in the procurement of logistics service capacity. Logistics service provider usually delivers the cargo with fixed batch sizes by standard size container (Chen and Lee, 2008; Agnetis et al., 2014). In LSSC, given the economies of scale and the convenience of communication, the FLSP always requires that the LSI implement batch ordering of fixed batch size (the fixed batch size can be a truckload or a container, etc. (Almehdawe and Jewkes, 2013)). Despite of this,

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batch ordering models in LSSC are still relatively understudied as the consideration of standard batch size would increase the complexity of developing the optimal ordering strategy. In this paper, except for unique features, we also consider the increasingly greater demand fluctuation in logistics service capacity ordering in recent years. For example, on 11/11/2011, express companies in China underwent an unprecedented demand boom because of the big sale of many E-commerce enterprises. On China-based Taobao.com, the electronic transactions in a single day reached 3.36 billion yuan (Ram, 2011). Take China Yuantong Express Company as an example: Its networks nationwide received 2.67 million units of packages in total from online merchants on that day, and all those goods should be received by customers of 31 provinces nationwide in 3–5 days. The booming demand completely broke the expectation of Yuantong Express, and inadequate preparation placed great pressure on Yuantong (Zhang and Xiao, 2011). Problems arose, such as "overflowing" warehouses, delayed delivery, and cargo damage. Consequently, transferring the traditional ordering strategy of one-stage ordering to an ordering strategy based on demand update is significant (Fisher and Raman, 1996; Ettl et al., 2000) because the buyer can be more responsive to demand fluctuation under demand update. These are the practical motivations for our research.

From a theoretical perspective, previous research has not considered the batch ordering issues of logistics service capacity, and there are three aspects of deficiencies in existent studies of ordering strategy including demand update, batch size ordering and uncertainty of renewal time point.

Firstly, previous researchers mostly establish the nested newsvendor model and adopt dynamic programming based on backward induction to identify the optimal ordering quantity of the two opportunities (Zheng et al., 2015). Hence, under this approach, demand update is based on the predicted demand update information before the first-stage ordering instance, rather than the actual observed market signals after the first-stage ordering opportunity (Gurnani and Tang, 1999; Donohue, 2000; Song, 2014). However, in reality, with the development of information technology, the enterprises' capability of information collection has improved greatly. As a result, the buyer tends to adopt actual observed demand update information rather than predicted demand update information in its demand update process to increase the efficiency and accuracy of demand update. Hence, in this paper the ordering strategy model of logistics service capacity follows the actual decision process, and uses the observed market signals for demand update.

Secondly, the shortcoming of previous research is that even though many scholars have studied the ordering issues of logistics service capacity, these studies primarily consider the situation of one-stage ordering opportunity, and do not reflect the existence of standard batch size in practical logistics service capacity ordering (Liu et al., 2012a; Liu and Xu, 2012b). Although Liu et al. (2015) studied the logistics service capacity with demand updating, they have not obtained the optimal order quantity while only presented the impacts of demand uncertainty revelation and quality guarantee change cost on the service capacity procurement of LSI.

Thirdly, previous studies on ordering issues under demand update mostly assume that the time point of demand update is fixed and that the uncertainty of the renewal time point is ignored (Iyer and Bergen, 1997; Choi et al., 2006; Chen et al., 2006; Özen et al., 2012; Song et al., 2014). However, as the renewal time point is actually a critical decision factor of the buyer, exploring the optimal renewal time point of demand update is of great significance.

In summary, this paper considers a two-echelon LSSC consisting of one FLSP and one LSI, and addresses the batch ordering strategy issue of the LSI that conducts demand update based on actual observed demand update information. The FLSP gives the LSI two opportunities to order, before and after demand update. The LSI is the decision maker that orders batches of logistics service capacity from the FLSP and aims to formulate the optimal ordering strategy of each ordering instance. Issues our research expects to settle are as follows:

- Under demand update, the LSI has two options for adjusting ordering strategy: reordering or returning. So what is the optimal reordering time point or the returning time point? And how to identify it?
- To better reflect the practical situation of logistics service capacity ordering, we decided to introduce standard batch size into our decision model. Hence, how to express this condition of batch ordering?
- How can the LSI and the FLSP utilize the findings of this paper to better handle the service capacity ordering with demand update?

To solve the above problems, in this paper, standard batch size is introduced into LSI's two-stage capacity ordering strategy model, which is built upon the decision-making sequence and actually observed demand signals between the two ordering instants. The model solution method is designed based on scenario analysis and enumerative algorithm. Sensitivity analysis of the optimal adjustment ordering time point is then carried out and a numerical analysis is presented. Our contributions in this paper are shown as follows.

Firstly, compared to previous literatures, unique features of our batch ordering strategy model are the introduction of standard batch size, the consideration of ordering time point, and the demand update based on actual observed demand update information.

Secondly, a solution methodology on the basis of scenario analysis and enumerative analysis is proposed to solve our model. The methodology is intuitively appealing and easily implemented, and is a good reference for future researches.

Thirdly, the characteristics of the optimal adjustment ordering time point are identified. Some important findings are obtained which could be referenced to managers in logistics service capacity ordering. For example, we find that the optimal profit of the LSI by reordering during the second stage decreases as the initial wholesale price and wholesale price coefficient