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Strategic alliance in freight consolidation

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ABSTRACT

The utilization of unfilled space in dispatching trucks requires collaboration among aligned partners. We consider two collaboration modes: strategic alliance and full collaboration, where outbound shipments could be reassigned among the partnering agents in freight consolidation with shipment delivery deadline. The effects of partnership are studied in an economic model where the product substitutability in price setting and discount offer are introduced. We adopt a simulation approach to find the optimal shipment dispatching plan in collaborative freight consolidation. A comprehensive analysis is presented to identify those factors which affect profit performance and collaboration decisions.

1. Introduction

Cooperation and outsourcing have received serious attention in passenger and cargo transport. Logistics service providers are aware that economies of scale reduce costs and they keep searching for ways of improvement. A strategic alliance is an agreement on collaboration among firms. Oum et al. (2000) described a strategic alliance as a medium- to long-term partnership formed by two or more firms with a common goal of improving competitiveness. Full collaboration, on the other hand, is a deeper mode of cooperation. When two or more firms form a strategic alliance, each partnering firm operates as an independent unit. When companies form a full collaboration they operate in a coordinated way and work like a single company. Although full collaboration usually outperforms strategic alliance, it is often not feasible, or a significant investment is required for two or more independent entities to operate in a close mode. Therefore, more companies resort to strategic alliances, from which they derive benefits through cooperation while maintaining their independence.

Freight consolidation is considered an effective approach in reducing transport cost. Cetinkaya and Lee (2002) described freight consolidation as the combination of many small shipments so that a larger, more economical load can be dispatched on the same vehicle. In practice, dispatching a vehicle with empty space means a waste of transport capacity. Common vehicle dispatching policies are: (i) the quantity policy, according to which a vehicle is dispatched when the accumulated freight quantity exceeds a predetermined limit; (ii) the time policy, according to which a vehicle is dispatched when a shipment deadline arrives; and (iii) the time-and-quantity policy, according to which a vehicle is dispatched whenever a shipment deadline arrives or a predetermined accumulated freight quantity is reached.

Consolidation and distribution studies seldom examine the effects of alliances in the operation. In this study, we consider service agents who operate in the same transport market. Freight is accumulated at the consolidation centre and then dispatched to the final destination. Here we assume two service agents collaborate in two plausible partnership modes: strategic alliance and full collaboration. For the cooperating pair, outbound freight could be reassigned to fill up the empty space in a truck dispatch. To deal with shipment reliability, we consider the time constraint where each shipment should be delivered to the destination before a specific deadline. Shipment deadline has, in general, not previously been considered in

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freight consolidation studies. The expiration of a shipment deadline induces a vehicle dispatch and the utilization of unfilled capacity initiates the collaboration among aligned agents. We also consider collaborative price setting in the transport market and discount offers for transferred freight. This study provides a basic model for studying collaborative strategies that could be used by firms in competing with other practitioners in freight consolidation.

The paper is organized as follows. Section 2 is a brief review of consolidation and partnership in the transport industry. Section 3 describes the competition problem, examines collaboration under different partnership agreements, and formulates economic models for freight operation. Section 4 presents an illustrative example based on industry data in the China freight transport market. The effectiveness of collaborative freight consolidation is examined under different collaboration modes. Section 5 gives a comprehensive analysis of those key factors that impinge on the effectiveness of strategic alliance and full collaboration. Managerial insights for practitioners in the cargo transport market are also discussed. Section 6 presents the conclusion of the study.

2. Literature review

Strategic alliance is considered to be an effective way to improve performance in passenger transport (e.g., Brueckner, 2001; Park, 1997; Park and Zhang, 1998; Park et al., 2001). Zhang et al. (2004) discussed air cargo alliance and competition in passenger transport. They adopted an oligopoly model to investigate the effects of an air cargo alliance on the competition in passenger markets. Zhang et al. (2007) studied alliance and rivalry in cargo transport. They examined the effects of multimodal integration on the rivalry between two transport chains: a forwarder–airline alliance and an integrator.

Consolidation has been widely investigated in transportation research using analytical tools and simulation studies. Brennan (1981) and Cetinkaya and Bookbinder (2003) utilized the renewal theory. Minkoff (1993) and Higginson and Bookbinder (1995) used a Markov decision processes. Higginson (1995) applied marginal analysis, and Gupta and Bagchi (1987) and Bookbinder and Higginson (2002) presented stochastic clearing system models. Masters (1980), Jackson (1981), Closs and Cook (1987) and Higginson and Bookbinder (1994) adopted the simulation approach to analyze freight consolidation systems.

In this study, we first consider alliance synergies and cooperation in freight consolidation, and then formulate economic models for a strategic alliance and full collaboration. The simulation approach is used to investigate the optimal operating environment under different collaboration modes. We evaluate the optimal shipment limits, make comparisons of the expected profits, and examine the effectiveness of partnerships.

3. Problem and modeling

In a competitive environment, freight service agents gain most of their incomes from efficient integration, consolidation, and distribution. Freight consolidation combines many small shipments so that a larger, hence a more economical load can be dispatched on the same vehicle. A well designed freight dispatching policy contributes to the optimal use of warehousing facilities, trucking capacities, and personnel.

Consider three agents, A, B and C in the market. The word "agent" is used in this paper to mean a trucking operator, freight forwarder, or any company providing freight transportation services. The three agents compete among themselves in a business environment that also provides opportunities for collaboration. For simplicity, we consider only one fixed route where these agents provide similar freight services; however, this study may be extended to multi-route situations where similar agents operate in the same region. Assume that agent C operates independently throughout the study. We examine how the partnering agents A and B compete with the independent agent C. Two different modes of collaboration, strategic alliance and full collaboration, are considered, where shipments are dispatched under different partnership arrangements.

A collaborative freight dispatching model is shown in Fig. 1. Assume that each agent has a freight consolidation centre, and shipments arrive at the centre at random with a known arrival rate. A truck is dispatched to the destination when the accumulated freight quantity at the consolidation centre reaches the predetermined dispatching limit. Assume also that each arrival shipment has a delivery deadline. This time constraint can trigger a dispatch from the consolidation centre with a less-than-full truckload, which initiates the opportunity for strategic partnership.

3.1. Shipment arrivals

Fig. 2 depicts the shipment arrival process at consolidation centre A. Each shipment has a random arrival time, a random freight quantity and a delivery deadline. The arrival pattern at consolidation centre i is described by an inter-arrival probability density function f_i and a shipment quantity probability density function g_i, where $i = 1, 2, 3$, representing the three agents A, B and C respectively.

Let t_i^j be the arrival time of the jth shipment arriving at consolidation centre i. Let q_i^j be the shipment quantity and d_i^j be the associated shipment deadline. In Fig. 2, the third shipment (t_1^3, q_1^3, d_1^3) arrives before the shipment deadline, i.e., $t_1^3 < \{t_1^1 + d_1^1, t_1^2 + d_1^2\}$. A dispatch is initiated when the accumulated quantity $q_1^1 + q_1^2 + q_1^3$ exceeds the dispatching limit Ω_1.

We assume that the market is large enough to accommodate the three agents, who may work independently to maximize their returns in setting their own dispatching limits. We consider the possibility of collaboration between partnering pair A