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Itinerary provision and pricing in container liner shipping revenue management

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ABSTRACT

A shipping line may have more than one itinerary to transport containers from origin to destination. Customers choose which itinerary to use or using other shipping lines' itinerary. We use the logit model to formulate customer's behavior. We find that, on one side, when the freight rates of the itineraries are fixed, providing all itineraries to a customer may not maximize the shipping line's profit. When the market share of the shipping line is low, more itineraries should be provided, and vice versa. On the other hand, when the freight rates of the itineraries could be optimized, all itineraries are provided for maximizing the expected profit. Models and algorithms are developed that determine the optimal subset of itineraries to provide with given freight rates, and the optimal freight rates when they could be adjusted.

1. Introduction

Containers are transported by container shipping lines on liner service routes. Among all the sea cargos, 52 per cent in dollar terms are containerized. The total container trade volume amounted in 151 million twenty-foot equivalent units (TEUs) in 2011 (UNCTAD, 2012). Container shipping lines transport containers based on long-term contracts and containers from the spot market (Du et al., 2011; Qi and Song, 2012). Large industrial customers such as Nike have tens or even hundreds of containers to be transported every week. They usually sign a long-term contract (e.g., one-year or two-year contract) with shipping companies and enjoy a very competitive freight rate. By contrast, individual customers from the spot market usually have at most a few containers. For example, a family needs to relocate from Europe to the US, and packs everything in one container. Such an individual customer either makes a phone call to a shipping line (more often than not, agents of the shipping line), or logs on to the websites of the shipping lines to seek information on potential services. The customer will compare the prices and levels of service of the shipping line with what he expects and/or what other shipping lines provide, and make a decision of whether to book a service from the shipping line, and which one of the services to book from the shipping line.

We focus on the booking process of individual customers from the spot market. When a shipping line receives an enquiry from such a potential customer (by phone or on the website), the shipping line will check available services, and then provide the customer with the available alternatives. Since the shipping line faces competition from other shipping lines, one might conjecture that the shipping line should provide as many alternatives for the potential customer as possible, so that

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there is a higher chance that the customer would choose one of its alternatives. However, such a conjecture may not be correct, as shown in the example below.

1.1. A two-alternative example

Consider the container shipping services in Fig. 1. The figure has a network of three ship routes and four ports: Singapore (SGP), Hong Kong (HKG), Shanghai (SHA), and Pusan (PUS). Each ship route has a weekly frequency. The port rotations and arrival days at each port of call of the ship routes are also shown. Assume that a customer has a container that needs to be transported from Singapore to Shanghai. Suppose that the container will be available at Singapore on a particular Sunday, which is defined as day 0. The container shipping company that operates the network in Fig. 1 has two choices to transport the container: The first choice is to transport the container on ship Route 1, and the second choice is to transport on ship Routes 2 and 3 by transshipping at HKG. The possible paths of transporting containers from their origin to their destination are called *itineraries* or *container itineraries*. Table 1 summarizes the two container itineraries. By itinerary 1, the container will arrive on Friday (day 12); by itinerary 2, the container will arrive on Wednesday (day 10). Hence, the transportation time on itinerary 2 is shorter. The revenue of the shipping company in Table 1 is the freight rate paid by the customer. We assume that the shipping line needs to pay the handling costs at the origin, destination and transshipment ports. Suppose that the freight rate of itinerary 1 is \$1340; the freight rate of itinerary 2 is \$1400; the loading, discharge and transshipment costs are all \$150. The column "operating cost" in Table 1 is handling costs that are paid by the shipping line. Hence, the profit gained from transporting the container on itinerary 1 is \$1340 − \$300 = \$1040, and the profit on itinerary 2 is \$1400 − \$450 = \$950.

If the shipping line provides both itineraries for the customer, it is likely that the customer will choose itinerary 2 because its transportation time is shorter than itinerary 1. If the shipping line only provides itinerary 1 for the customer (although itinerary 2 also has enough capacity to transport containers), then the customer may have to choose itinerary 1. If we also consider the competition from other shipping lines, the problem is more complex and interesting.

The aforementioned example demonstrates the importance of controlling the availability of itineraries for customers in container liner shipping. Improving the profitability has become more urgent and significant since the economic crisis in 2008 and the oversupply of containership capacity in recent years.

1.2. Literature review

1.2.1. Studies on container liner shipping

Determining which itineraries to provide for customers in container liner shipping is an operational-level decision problem. In container liner shipping literature, studies focusing on tactical planning problems usually consider weekly container shipment demand, that is, the demand is deterministic and the same in each week. In general, operational-level decision problems have received little attention. We review the most relevant studies on tactical and operational decision problems in container liner shipping. Other studies can be found in Christiansen et al. (2013) and Meng et al. (2014).

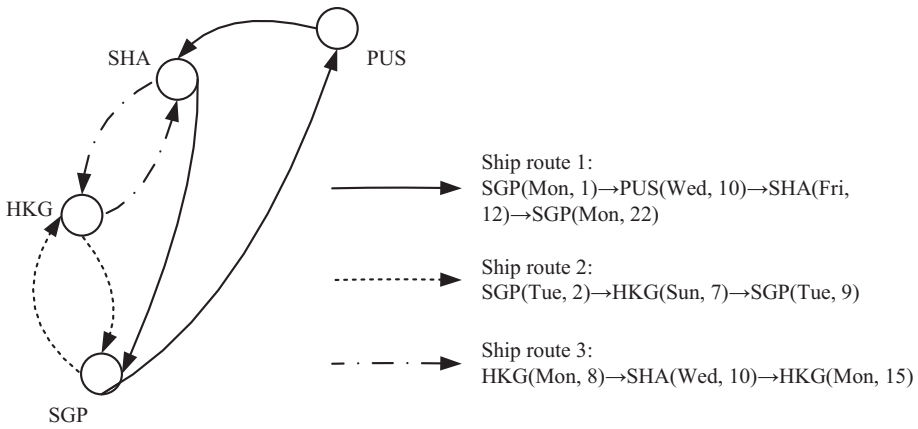

Fig. 1. A two-alternative example. Note: "Mon, 8" means day 8. Day 0 refers to a particular Sunday.

Table 1
Two itineraries.

Container itinerary	Details	Transportation time (days)	Revenue or freight rate (\$)	Operating cost (\$)
1	Ship route 1	12	1340	300
2	Ship route 2 and 3	10	1400	450