Abstract  In this paper, we will introduce a heuristic to solve a single leg revenue management problem with postponement, arising from the sea cargo industry. Based on previous work, it was shown that the optimal policy to allocate the capacity of the ship is a threshold policy. Based on the sample average approximation method, we formulate a mixed integer linear programming problem to determine the stationary threshold policy. A heuristic (known as the perturbation approach) is proposed to solve the problem. From the numerical result, it is shown that our approach performs better than some of the methods used to solve the mixed-integer programming problem.

Keywords  Sea cargo · Revenue management

1 Introduction

Recently, many countries are reviewing the regulatory system for liner shipping. These countries include Australia, Canada, the European Union, Japan, South Korea and the United States (The World Shipping Council 2000). One significant event was the amendment of the Ocean Shipping Reform Act (OSRA) by the United States in 1998.

The change gives more legal freedom to negotiation and provision of ocean transportation services in the United States, hence bringing the business relationship between the carriers and the shippers to a new dimension. For example, the United States Department of Agriculture (2001) reported that the contracts for transportation of agricultural product are no longer simply volume discounts, but increasingly contain negotiated and tailored service provisions. This is also observed in other trade areas (see Federal Maritime Commission (2001) for further detail). As a result of the amendment, Federal Maritime Commission (2001) reported that, there is at least a 200 percent increase in the number of service
contracts being signed. The number of service contract filed is expected to increase further as Federal Maritime Commission recently agreed to allow Non-vessel-operating common carriers (NVOCCs) to sign confidential contacts with their shipper customers in December 2004.

Motivated by a particular practice in the sea cargo industry, a revenue management model for the carrier is proposed in our working paper (Lee et al. 2005). We have obtained some structural results on the problem and proved that the optimal policy to allocate the capacity of the ship is a threshold policy. To determine the threshold policy, a mathematical model will be presented here in Section 2. In Section 3, an efficient approach to solve the problem will be proposed. Lastly, some numerical results will be presented in Section 4.

2 The sea cargo revenue management model

2.1 Revenue management

The airline industry in the United States started applying revenue management in the 1970s after deregulation of air transportation. With revenue management, the airline carriers have efficiently allocated the airlines seats such that there are enough seats reserved for the full-fare customers arriving at a later time while the remaining available seats are opened to the discount-fare customers. Following the successful stories from the airline industry, revenue management is being applied in other transportation sectors. Kleywegt (2002) presented two models; Contact planning and Booking control, which will help the carriers to determine the optimal strategy to allocate the shipping capacity. The Contact planning model is meant for the carriers to make long-term planning. Given the economical situation and the available capacity on certain voyages, the model seeks to determine a contract that maximizes the carriers’ return. With the inputs from the Contract planning model, the Booking control model is used for short-term allocation of capacity in the ship. Pak and Dekker (2004) formulated the cargo revenue management as a multi-dimensional on-line knapsack problem. They showed that a bid-price acceptance policy is asymptotically optimal if demand and capacity increase proportionally and the bid-prices are set correctly.

2.2 Problem description

Often, in service contracts, the carrier and the shipper will sign an agreement stating a specific number of containers for shipment over a period of time. This amount is known as the Minimum Quantity Commitment (MQ). The carrier will reserve the capacity for those shippers who he/she has signed a service contract with. It is assumed that the reserved capacity is constant here. The remaining capacity of the ship will be opened for booking.

Due to the uncertainty in the demand, the number of containers to ship is sometimes more than the MQ, especially during the peak season. We shall call these additional containers from the contractual shippers as contractual containers here. Furthermore, the rate for a contractual container is similar to the rate stated in the service contract.