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A reward-based algorithm for the stacking of outbound containers

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Abstract

As global trade increases, container transshipment activities increase rapidly. Therefore, high competition among container terminals has emerged. The decision for good stacking positions for containers plays a critical role on the performance of a container terminal, since it influences the productivity of the terminal in a strong sense. In this study, we focus on the minimization of the berthing time of vessels by improving the stacking operations through minimization of non-value-added handling operations of containers, which is called reshuffling, as well as the traveling time of the cranes operating at the storage yard. Most of the containers in the container terminal we focus are outbound, which are transported into the container terminal via external trucks and stored in the stacking yard until they are loaded onto vessels. We propose a reward-based algorithm for the stacking of outbound containers by taking the following four components into consideration; container's distance to the closest RTGC, RTGC's workload, the number of stacked containers at the neighborhood bays, and the current height of the stacks at the storage yard. The inputs of the algorithm include the relevant information of the container to be stacked that are just entered into the terminal gate, current usage information of the storage yard and the current positions of the yard cranes. The proposed stacking strategy is in implementation phase to one of the container terminals in Izmir. The results seem to be promising when compared to the current randomized stacking strategy in the container terminal.

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Keywords: Container terminals; Container stacking; Reshuffling; Reward-based algorithm.

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1. Introduction

With over 80% of world merchandise trade being carried by sea, maritime transport is the backbone of international trade and globalization (UNCTAD, 2015). Containerization, where the transportation of freight is achieved in standardized boxes with high level safety and environmental concerns, is the main driver for global intermodal freight transport. Moreover, container shipping has changed the scale and scope of the global trade by providing transportation of greater quantity of commodity with a similar amount of time at a lower cost by improving the transshipment process (Rodrigue and Notteboom, 2015). Transshipment is the activity of shipping goods to and from certain intermediate points before reaching their final destination and has been playing a significant role in international sea freight transport over the past few decades (Vis and de Koster, 2003). Due to the rapid incline of the global trade, container transshipment activities increase rapidly. Hence, high competition among container terminals has emerged. Container terminals are the nodes where different modalities meet to transport containers. Hence, container terminals are the keys to the performance of sea freight transport, a call for efficient management of port operations is required in order to remain competitive (Tao and Lee, 2015).

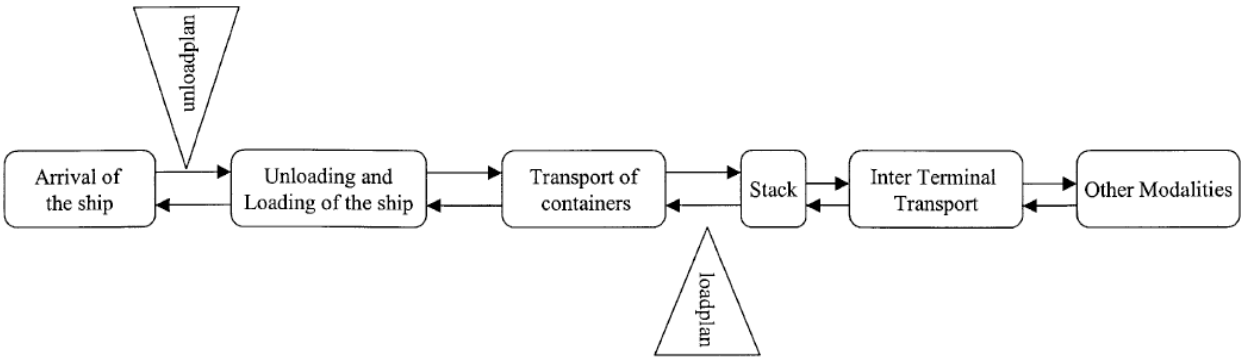

Fig. 1. Processes at a container terminal (Vis and de Koster, 2003).

Based on container handling operations, a container terminal can be partitioned into two main areas, the quayside and the storage yard. Operations at the quayside are triggered with the berthing of vessels. Quay cranes (QCs) are used to discharge inbound (I/B) and transit containers from and to load outbound (O/B) and transit containers to the vessels. Simultaneously, various activities at the storage yard take place in order to transfer the containers from/to vessels. In addition to the quayside operations, several complex activities of container terminals take place in container storage yards, where containers are stored temporarily after they are discharged from vessels, or before they are loaded onto vessels. The sub-processes at a container terminal are depicted in Figure 1.

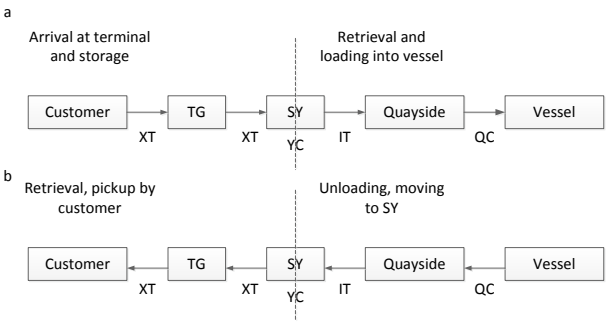

Fig. 2. (a) The flow of outbound containers; (b) The flow of inbound containers (Murty et al., 2005).