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An Integrated Model for Container Terminals

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Abstract

In recent years, improving the process of loading and unloading ships has been the subject of much attention from the terminals authorities. The importance of this issue encouraged engineers to design the best simulation for a particular model to reduce time and subsequently, costs of the process. Determining the best possible method for the handling of quays plays a critical role in increasing the efficiency of container terminals. This paper investigates the Dynamic Discrete Berthing of ships handling time and space allocation problem. A mixed integer linear programming model was formulated with the aim of reducing the total ship service time at port, consequently increasing the overall terminal throughput. The effective tools for solving such models are optimization techniques.

Keywords: container terminal; berth and quay-crane scheduling; mathematical modeling

I. INTRODUCTION

During the last few decades, the total number of container transports at seaport container terminals has dramatically increased (UNCTAD 2011). Accordingly, terminal operators or ports authorities are constantly attempting to boost terminal throughput capacity by considering terminal design, handling equipment as well as technical and tactical applications.

Shipping time and cost are fundamental aspects in the efficiency of sea container transportation. A container terminal, as an intersection of shipping routes, performs as an interchange of the different modes involved on the whole transportation network; therefore, an improvement of efficiency and productivity in terminal operations is essential in decreasing the total voyage time and costs[1]. As a consequence, marine container terminals are some of the most important and challenging links in the global supply chain. The main critical role of container terminals authorities or operators is to smooth the progress of the transition between transport modes within the supply chain and present short term storage of boxes in transshipment, export and import. The economic efficiency and effectiveness of a port rely on making a trade-off between the extremely costly facilities (e.g., building quays, container storage yard, cranes, straddle carriers, stacking cranes, etc.) and service time which should be defined by the demand of the market. The competition between ports and international cargo transportation via container demands has put more and more force on container terminals operation. As the maritime transport industry has developed, it persistently focuses concentrate on route improvement, computerization and decision support to achieve good organization and productivity.

Optimization is a strategic way to achieve better solutions in the container handling process in order to increase port efficiency and reduce delays during the whole process as a whole. In the current study, a mathematical model is proposed to address the economic aspects of improving and updating port's managerial and infrastructural programs for large container ships to serve faster with more reliable equipment, logistics and efficient management. Once the ship has berthed at quay, the number, scheduling and type of quay cranes (QCs) to facilitate and determine need be offered at the quay is next step of the decisions that has to be prepared at the strategic level. Allocating the assignment of QCs to each ship and the scheduling of QCs are two operational level decisions. The number of QCs that need to be allocated to the ship is known as the quay crane assignment problem (QCAP). The number of QCs required depends on the ship's size, the number of containers that need to be loaded and unloaded, availability of QCs and the agreement between the shipper and terminals operator. Additionally, the quay crane scheduling problem (QCSP) tries to optimize the assignment and sequencing of (container handling) job allocations based on a given number of cranes. It can be possible to formulate the berth allocation problem without considering QCs and internal transport vehicles or to combine both berth allocation and QC scheduling and disregard the trucks, by considering the storage yard operation. The container terminal