A Simulation Based Model for the Berth Allocation and Quay Crane Assignment Problem

Mostafa Ahmed Abedel Hafez Ahmed¹ --- Hubbard, N.J.² --- Tipi, N.S.³

¹,²,³ Arab Academy for Science, Technology and Maritime Transport

Abstract

With the global development of container transport, container terminals have become important nodes in transport networks which serve as hubs for the transshipment of containerized goods from ship to ship or from ship to other transport modes. As the container transport system is capital intensive, the turnaround time of ships at container terminals is an important factor for liner shipping companies to consider in order to decrease their costs. The turnaround time includes berthing, unloading, loading and departure and therefore, berth allocation and quay cranes assignment for unloading and loading operations is critical to the efficiency of container terminal systems. In addition, the rising competition between ports has compelled them to improve their service levels with the efficiency of container terminal operations becoming an important factor for success (Zeng, 2009). The berth allocation problem (BAP) and the quay crane assignment problem (QCAP) has been analysed in other studies (Yang et al., 2012). By definition, the former determines the berthing positions and berthing time for incoming ships, while the latter determines the assignments of quay cranes to each ship). Existing approaches to these problems can be classified into two categories: the independent approach and the integrated approach (Yang et al., 2012). The literature provides many approaches for the individual and integrated Berth and Quay Crane Assignment Problems (BAQCAP) using mathematical models. On the other hand, few publications have used simultaneous BAQCAP. Simulation modelling techniques are being applied to a wide range of container terminal (CT) planning processes and operational analysis of container handling systems (Park et al. 2012). These models have become extremely valuable as decision support tools during the planning and modelling of CT operations. The application of Discrete Event Simulation (DES) where there exists queuing and scarcity of the number or availability of resources is viewed as a valid approach in simulating a CT (Bruzone, 1999). Discrete event simulation is probably the most widely used simulation technique in Operational Research. As the name suggests it models a process as a series of discrete events. This means that entities (the general name for what is being considered; e.g. "ships") are thought of as moving between different states as time passes. The entities enter the system and visit some of the states (not necessarily only once) before leaving the system. Discrete event simulation is a relatively easy to use tool, but, needs extensive effort in model development and validation, in order to have practical value. Most simulation based container terminal models are general ones examining the general performance of the container terminal. These models are coded in different simulation languages. The different types of simulation languages that have been used include PORTSIM, Modsim III, SIMPLE++, ARENA and SLX, Visual SLAM and AweSim. In this paper we present a framework for a simulation based model for the BAQCAP that can be used as a decision support tool for the container terminal planner to decide on the allocation that
achieves the best solution according to different operational requirements. Given a specific set of vessels to process in a typical week, and the related container loading and unloading requirements, the model helps the decision maker develop a set of operational plans illustrating the different performance parameters associated with each plan. The plan includes the start time and service time for each vessel at the specified berth, and the timed assignments of the different quay cranes to the different vessels. This paper is organized as follows. In Section 2, a brief review of previous works is given. The framework and procedure of the simulation optimization model is developed in Section 3. The results of the simulation model is presented in Section 4. Conclusions and future work are given in Section 5.

Keywords: Simulation Based Model, Berth Allocation, Assignment Problem