Optimization-Simulation for Maritime Containers Transfer

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ABSTRACT

This paper proposes a simulation model to analyze the handling and the transfer system of containers in Le Havre seaport. The decision variables of simulation are determined by using the CPLEX optimization software. The goal is to determine the least expensive strategy for the transfer of a set of containers between container terminals. The simulation model is developed using an object-oriented approach and Flexsim CT simulation software. The objective is to obtain an efficient operating process for the multimodal terminal of Le Havre which is an intermediate platform for transferring containers (collection and delivery) by rail and river (trains and barges). The goal is to evaluate the performance of the containers transfer by rail shuttles between the future multimodal terminal and the maritime terminals. The aim is to analyze and to evaluate performance indicators of port logistics chain (costs, resource occupancy rate, service rate), and to test several management strategies.

Keywords: Decision Support, Discrete Event Simulation, Mathematical Optimization, Performance, Port Logistics

1. INTRODUCTION

Nowadays, maritime transport plays an important role in the economic world. This emphasis is justified by the evolution of increased volume of shipping freight. Given this economic context, the seaports must be more powerful than before (Henesey, 2006). Taking the case of Le Havre seaport, the overall containers transfer between the port and its hinterland (mainly the Paris area) is principally done by using the road. This transfer directly between the maritime terminals and delivery areas causes congestion for handlers and saturation of storage areas of maritime terminals. To deal with this problem, the creation of a multimodal terminal has become a necessity in order to manage the growth of maritime traffic by offering more possibilities concerning the means of massified transport (Agence Paris Centre Normandie, 2011). The future multimodal terminal of Le Havre seaport is an intermediate platform which ensures the transport of containers (collection and delivery) using a new container management transfers by

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trains, river barges and road. With the construction of multimodal terminal, the containers will be evacuated to the multimodal terminal (Mega-hub) to be delivered later to their final destination by truck, barge or trains.

This new configuration of Le Havre seaport requires organizing tours of rail shuttles to transfer containers between the maritime terminals and the future multimodal terminal (internal transfer of containers). Many problems such as Berth Allocation, Quay Cranes Scheduling and Security Risk Management, arise from this new organization. Furthermore, improving performance indicators of a port is often a very important issue, especially because of the associated costs and the impact on container handling capacity (Armando & Stefano, 2012; Kefi, 2008). To this end, several studies concerning the optimization of port operations based on simulation and operational research methods have increased (Sammarra et al., 2007; Lim et al., 2005; Benghalia et al., 2014a; Henesey., 2006; Bielli et al., 2006; Rosa et al., 2012). According to (Ung and Masanobu, 2009), simulation is the best tool used to represent any real-world system. It is often used for the analysis of complex systems and is recommended to analyze container terminal systems (Won & Yong, 1999). Contrary to the optimization, simulation alone cannot optimize a process (Almeder et al., 2009); it can only answer the question: what happens if we test this scenario? However, the simplifications introduced in the mathematical formulation do not allow finding a directly exploitable solution (Belmokhtar et al., 2010). It is at this level that the simulation is supposed to provide a realistic assessment of the system while testing the robustness of the solutions generated by the optimization.

The aim of our study is to develop an object-oriented simulation model to analyze the multimodal terminal system. This analysis includes the processes of handling and transfer of containers. The flow of containers is between the multimodal terminal and the maritime terminal Atlantic on the one hand and between the multimodal terminal and the maritime terminal port 2000 on the other hand (Figure 1). We determine performance indicators to measure the impact of activities and to evaluate the status of processes in terms of productivity and efficiency.

In this work, we present an overview on the different operating modes that we have studied. Numerical results are presented and analyzed to show the effectiveness of our approach.

In Section 2, we present some works on container terminals. Section 3 describes the transfer system of containers between different terminals. Simulation and optimization of the containers transfer are presented in Sections 4 and 5. Finally, a comparison between different transfer modes is presented in Section 6.

2. RELATED WORKS

A container terminal is an equipped place for the handling and the storage of containers for both import and export processes. It is a set of quays allowing the arrival and the departure of ships, storage areas and resources (handling equipment, wagons, dock workers, etc.) for transport and for the various operations associated with the handling of containers.

A container terminal can be divided into two zones (Vis et al., 2003): the dock area and courtyard. The dock area contains the docking portion of the vessels and the cranes or the quay cranes which ensure loading and unloading of containers. The courtyard is used for temporary operations of loading, unloading and transshipment of containers. The process of loading and unloading can be divided into several sub-processes, described below. When a ship arrives in port, containers’ handling by the quay cranes begins. Then, the containers are transferred by vehicles between the ship and the storage stack. This stack consists of a number of lanes, where containers can be stored for a certain period. The routes are served by equipment such as cranes and straddle carriers, which can both transport and store the containers. After a time passed in the storage area, the stored containers will be loaded by cranes to be delivered by inland waterway, rail or road.
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