Chapter 1
A Framework for Improving Logistics Operations at Container Terminals

Julio Mar-Ortiz
Universidad Autónoma de Tamaulipas, Mexico

Maria D. Gracia
Universidad Autónoma de Tamaulipas, Mexico

Rosa G. González-Ramírez
Universidad de Los Andes, Chile

ABSTRACT

Container terminals as strategic nodes in global supply chains require improving logistics operations in order to compete. This chapter addresses the problem of how to improve logistics operations to increase the container terminal's throughput and capacity by lean logistics principles and simulation optimization methods. Current research in container terminals is focused on solving specific decision problems at container terminals, e.g., determining the optimal number of equipment to increase productivity. However, there is little evidence of studies related to designing operations to increase performance indicators, such as truck turnaround times or crane productivity, through simulation-optimization models and lean logistics principles. Consequently, the aim of this chapter is to describe a methodological framework for improving logistics operations at container terminals using lean logistics principles and simulation-optimization techniques. A research agenda to explore the applicability and usefulness of the proposed approach on a set of integrated problems is finally proposed.

1. INTRODUCTION

International trade has shown a significant growing trend during the last decades. In 2013 the world merchandise traffic reaches US$ 18,301 Billion (World Trade Organization, 2014), and more than 58.47% of this international trade was containerized. In 2011, a total of 143 Latin-American and the Caribbean commercial ports transferred over 41.3 million of TEUs (Twenty feet Equivalent Units containers), and

DOI: 10.4018/978-1-5225-0130-5.ch001

four countries accounted for 53% of the regional traffic: Brazil, Panama, Mexico and Chile (Rodrigue, 2012). In 2013, the North America region moved more than 32 million of TEUs constituted as follows: United States (74.38%), Canada (14.09%) and Mexico (11.53%). A container terminal is an intermodal node in which different transport modes with different characteristics converge; it is the link between the wet and dry sides of a transport network (Casaca, 2005). The container terminals have become strategic nodes of high impact on total logistics' costs, demanding highly coordinated and synchronized operations to accommodate the cargo being transferred. The main problem is that most Latin-American ports could face an operational collapse in the coming years due to the low competitiveness of many service providers of the port logistics chain, and the slow reaction of governments to the needs of new infrastructure, trade facilitation public policies, etc. If only the traffic was increased by 10% at this time, long queues outside the terminals and large congestion levels would occur not only within the terminal but also in the surrounding area, affecting the port city where the port is located.

Accordingly, container terminals have been forced to look at their productivity, quality of service offered, terminal capacity, physical characteristics, and other constraints, to develop more efficient strategies and solutions for loading, unloading and moving containers within the port terminals, as well as dealing with the competitiveness and modernization lags. Along a container terminal a wide variety of logistics and scheduling problems that may be efficiently solved by industrial engineering and operations research techniques may be found. In the literature there is a wide variety of reviews (Vis & Koster, 2003; Steenken, Voß, & Stahlbock, 2004) and books (Günther & Kim, 2005) dealing with the optimization of port operations issues. Fromm the analysis of previous research it can be deduced that the vast majority of papers have been developed on fully automated terminals, which move more than 1 million TEUs per week. To the best of the authors knowledge, few papers has been written about how to increase the performance of non-automated terminals, as the ones presented in the Latin-America region. In a container terminal, the general flow of import containers begins in the quay side; it continues to the yard and ends at the terminal´s gate. Several planning problems arise along this chain, which occur at different timeframes. Coordinating the flow of containers is a fundamental task for container terminals. Since most problems are strongly interrelated, it leads to a paradox that reflects the complex situation: on one hand trying to optimize these problems independently leads to sub-optimization, on the other hand, because the problems occur at different planning horizons, the integrated resolution has not much sense.

Several studies reveal that most terminals are now taking measures to increase their throughput and capacity by improving their productivity. There are four common measures terminal operators are looking at to improve process and productivity: (1) adding yard cranes or increasing their current technological capabilities, (2) employing a truck appointment system (Zehendner & Feillet, 2014; Zhang, Zeng, & Chen, 2013), (3) implementing operational strategies according to the characteristics of each scenario realization, or (4) leaning operations and optimizing strategic decision within the yard planning management (Linn, Liu, Wan, Zhang, & Murty, 2003). The issue surrounding adding yard cranes is whether or not to invest, after all each yard crane cost approximately 1.5 million US dollars. The idea of a truck appointment system is to flatten the gate activity to an efficient and proportionate level to reduce the trucks' queuing time (Zehendner & Feillet, 2014). The issue surrounding implementing a truck appointment system is on how to motivate the coordination and availability among the stakeholders of the port community (transporters, port authorities, container terminals, users, etc.). It is expected that more terminals will use the appointment system to gain more control of the trucks coming into their gates. However, before committing capital and resources, most terminals would want to know clearly the benefits and consequences of employing the truck appointment system. The issue surrounding formulating