

Chapter 17

Prediction Reliability of Container Terminal Simulation Models: A Before and After Study

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ABSTRACT

In this chapter attention is focused on the container terminal optimization problem, given that today most international cargo is transported through seaports and on containerized vessels. In this context, in order to manage a container terminal it is sometimes necessary to develop a Decision Support System (DSS). This chapter investigated the prediction reliability of container terminal simulation models (DSS), through a before and after analysis, taking advantage of some significant investment made by the Salerno Container Terminal (Italy) between 2003 and 2008. In particular, disaggregate and an aggregate simulation models implemented in 2003 were validated with a large set of data acquired in 2008 after some structural and functional terminal modifications. Through this analysis it was possible to study both the mathematical details required for model application and the field of application (prediction reliability) of the different simulation approaches implemented.

INTRODUCTION

The current financial crisis seems to be seriously affecting the freight transport system. In this scenario, transport terminals play a crucial role to avert the risk of recession by increasing their efficiency and automation. Only in this way is it possible both to reduce the price of the services offered (loading, unloading, dwelling, logistic services ...) and increase terminal earnings.

In this chapter attention is focused on the container terminal optimization problem, given that today most international cargo is transported through seaports and on containerized vessels. Hence the efficiency of container terminals plays a major role in transport chain economics.

A container terminal should manage in the most efficient way container vessel berths on the docks, inbound container unloading (empty or filled with cargo), outbound container loading and storage yards. This can be achieved by coordinating the

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berthing time of vessels, the resources needed for handling the workload, the waiting time of customer trucks and, at the same time, by reducing congestion on the roads, at the storage blocks and docks inside the terminal, as well as making the best use of storage space. Each of these activities significantly affects port efficiency, with consequences on the local and global economy of the freight transport system. Management of container terminal operations has thus become crucial to meet container traffic demand both effectively and efficiently.

In this context, in order to manage a container terminal it is sometimes necessary to develop a Decision Support System (DSS), i.e. a mathematical model, required both to analyze the actual system situation (to identify system inadequacies or critical points) and to verify one or more alternative projects/interventions. Indeed, a crucial element in the management process is the simulation of the effects or impacts of a project scenario. Most of these impacts can be quantitatively simulated using mathematical models, which allow us to estimate system indicators (cost-benefit indicators; multi-criteria indicators, ...) without physically carrying out the hypothesized projects. Although much work has been done in this direction, the prediction reliability of such models remains uncertain.

Design and project appraisal of container terminals can be carried out through *disaggregate models* (sometimes termed microscopic models) or *aggregate models* (sometimes called macroscopic models). The main advantage of the disaggregate approach is that it allows a detailed analysis in which each activity is analysed. Of course this approach may lead to computational problems and is rather computer demanding, especially when the resulting models are to be used to support optimization. It seems better suited to operative planning or operations management. On the other hand, decisions about the container terminal configuration regarding type and amount of handling equipment, berth and yard layout, etc. are better

considered within strategic planning. In this case an aggregate approach, based on container flows rather than single container movements, could be effective.

The existing literature reports approaches to either managing a container terminal as a system and trying to simulate all elements or managing a sub-set of activities (simultaneously or sequentially following a set hierarchy). The main approaches developed are optimization and simulation. The first seeks to maximize the whole terminal efficiency or the efficiency of a specific sub-area (or activity) inside the terminal through deterministic or stochastic optimization models (for a recent review see: Steenken et al., 2004).

Examples of the former approach are in Van Hee and Wijbrands (1988), Yun et. Al. (1999), Shabayek et al. (2002) e Murty et al. (2005), where it is developed a decision support system for capacity planning of container terminals. Different approaches have regarded container storage and retrieval in the yard operations (Taleb-Ibrahimi et al., 1993), space requirement problems (Kim and Kim, 1998), space requirement and crane capacity (Kim and Bae, 1998), re-marshaling strategy (Zhang et al., 2003) and storage space allocation (Zhang et al., 2002; Cheung and Lin, 2002). Regarding quay-side problems, readers can refer to Wilson (2001) and Avriel et al. (1998) for stowage of vessels, and to Chen et al. (2002), Imai et al. (1997, 2001), Lau et al. (1992) and Nishimura et al. (2001) for berth allocation. The most followed approaches are based on deterministic optimization methods. Recently a stochastic optimization model have been proposed for maximize terminal efficiency (Murty et al., 2005).

An effective, stimulating alternative approach to container terminal system analysis may lie in discrete simulation, which is the subject of this chapter. Although numerous efforts to simulate a container terminal have been made, most papers fail to adequately address model set-up, calibration and validation (see e.g. Koh et al., 1994; Yun, Choi, 1999; Shabayek, Yeung, 2002; Kia et al., 2002;

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