Rajeeva Moorthy · Chung-Piaw Teo

Berth management in container terminal: The template design problem

Abstract One of the foremost planning problems in container transshipment operation concerns the allocation of home berth (preferred berthing location) to a set of vessels scheduled to call at the terminal on a weekly basis. The home berth location is subsequently used as a key input to yard storage, personnel, and equipment deployment planning. For instance, the yard planners use the home berth template to plan for the storage locations of transshipment containers within the terminal. These decisions (yard storage plan) are in turn used as inputs in actual berthing operations, when the vessels call at the terminal. In this paper, we study the economical impact of the home berth template design problem on container terminal operations. In particular, we show that it involves a delicate trade-off between the service (waiting time for vessels) and cost (movement of containers between berth and yard) dimension of operations in the terminal. The problem is further exacerbated by the fact that the actual arrival time of the vessels often deviates from the scheduled arrival time, resulting in last-minute scrambling and change of plans in the terminal operations. Practitioners on the ground deal with this issue by building (capacity) buffers in the operational plan and to scramble for additional resources if needs be. We propose a framework to address the home berth design problem. We model this as a rectangle packing problem on a cylinder and use a sequence pair based simulated annealing algorithm to solve the problem. The sequence pair approach allows us to optimize over a large class of packing efficiently and decomposes the home berth problem with data uncertainty into two smaller subproblems that can be readily handled using techniques from stochastic project scheduling. To evaluate the quality of a template, we use a dynamic berth allocation package developed recently by Dai et al. (unpublished manuscript, Part of this work was done when the second author was at the SKK Graduate School of Business, Sungkyunkwan University, South Korea.

R. Moorthy · C.-P. Teo (✉)
Department of Decision Sciences, NUS Business School, National University of Singapore, 1 Business Link, 117592, Singapore
E-mail: bizteocp@nus.edu.sg, rajeeva.moorthy@gmail.com
2004) to obtain various berthing statistics associated with the template. Extensive computational results show that the proposed model is able to construct efficient and robust template for transshipment hub operations.

Keywords Container logistics · Transshipment hub · Sequence pair · Project management

1 Introduction

Mega container terminals around the world routinely handle more than 10 million TEU of cargo and serve thousands of vessels in a year. Efficiency of container operations (along berth and within yard), to certain extent, determines the competitiveness of the terminals within the global shipping network. This depends on a delicate coordination of various expensive resources, including the deployment of quay cranes and crews, allocation of prime movers and drivers, planning and deployment of yard resources etc.

Port operations planning can be broadly classified into the following categories:

– **Strategic** planning deals with long-term issues, such as strategic alliances with shipping lines, infrastructure development to support volume growth, etc. A major exercise in this phase is to identify proper allocation of major/feeder services to different terminals or various sections within a terminal to ensure quick vessel turnaround and transship containers in short time windows.

– **Tactical** planning deals primarily with midterm berth and yard planning issues. A berth template and an associated yard template are usually drawn so as to minimize berthing delays and operational bottlenecks. The tactical plans follow the general guidelines laid out in the strategic plans and is a primary driver of the operational planning phase.

– **Operational** planning involves more detailed equipment and manpower deployment plans, taking into consideration real time operational constraints.

![Fig. 1 Tactical and operational planning before mooring a vessel](image-url)