A Ship Berthing Model with Uncertain Factors for Shipyards

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ABSTRACT

This paper research the shipyard existing ship management methods of different ship dispatched on quay, and put forward a kind of anti-interference and continuous dynamic model of the ship berth scheduling in condition of uncertainty. There conduct a large amount of computational experiments which are carried out with many ship berth arrangement at quay, and it actually show that the proposed model is effective, that can improves the current berth management efficiency. Moreover, a meta-heuristic approach is proposed for solving the above problem.

KEY WORDS: Berth scheduling; shipyard; Dynamic continuous model; uncertain factors; disruption management; Meta-heuristic; neighborhood search algorithm.

INTRODUCTION

Ship dispatching is an important work for the ship-repairing yard. It is the first priority to formulate a berth operation plan among all the operations in a shipyard, including arranging ships in and out of the shipyard, as well as docking, undock and berthing. Thus a comprehensive and reasonable plan can effectively improve the operation efficiency, lower the operation costs and enhance customer satisfaction.

During the practical operation in the shipyard, external environment is always in dynamic, active and complex changes. Uncertain events are inevitable and usually unpredictable. Therefore, they always make certain disruptions to the original plan. Such circumstances will always cause changes to the original plan, disrupt the normal operations of other ships, and finally lead to economic losses to the company. How to deal with these interference factors effectively, make the minimum disturbance on quay, has become an urgent problem in shipyard.

Foreign scholars have conducted more researches on berth allocation issue compared with China. Korean scholar Kim and moon(2003) solved the calculation problem of the total of fees caused by minimized berth location disadvantages as well as the fines caused by delayed leaving time via the simulated annealing algorithm. Japanese researcher Imai and Nishimura and Papadimitriou(2003) adopted Lagrangian relaxation technique to solve the optimization problem of total ship waiting time and operation time. He also studied the influences on the length of stay and use ratio of berth by applying the services priority level in the berth allocation management. Heuristic algorithm was employed to solve non-linear issues.

This paper aims to research on how to manage the time and berths for the expected coming ships after the planned schedule has been executed. Dynamic continuous ship berthing model is set up, and the model was revised by analyzing the uncertain factors, finally, A heuristic algorithm is proposed to obtain the approximate optimal solution of the model.

Problem background

Berth dispatching system comprises of discrete and continuous arrangement according to the actual berth arrangement method at dockyard. Discrete berth arrangement means that ships cannot span multi-berths and can only stay within certain space of some berths. Continuous berth arrangement means that ships directly berth as per the physical marks on the bank and can span multi-berths. On the other hand, berth dispatching can also be divided into static and dynamic arrangement based on the sequence of ships arriving at the shipyard and execution of berth arrangement. Static arrangement means that all ships have arrived at the shipyard for repairing and all of them will be arranged in the next operation period; while dynamic arrangement means that there are still ships arriving at the shipyard when the dispatching operation has started.

Dynamic continuous berth allocation can be abstracted as: find an area for each vessel in the diagram, to meet the requirements of the ship's length and assignment. The occupancy of berth resources by each vessel is reflected by the rectangular area in the coordinates. As shown in Fig. 1.