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A decision support system using soft computing for modern international container transportation services

Yanbin Liu, Chunguang Zhou, Dongwei Guo, Kangping Wang, Wei Pang, Yandong Zhai *

Jilin University, College of Computer Science and Technology, #2699 Qianjin Street, Changchun 130012, China

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ABSTRACT

A software system has been developed for modern maritime container transportation. This system contains six modules: the demand forecasting, the stowage planning, the shipping line optimization, the slot pricing and allocation, the container distribution, and the contribution analysis. The first three modules will be presented in this paper. The system constructs problem models and uses exponential smoothing, regression analysis, neural network, linear programming, genetic algorithm and sequence alignment methods to solve relevant issues. The reliability and practicality of the software and the algorithms included are confirmed by practical applications or analyzing their estimation accuracy. The system has been tested with the actual transportation and proves to be an effective decision-making tool in maritime transport coordination. The proposed system may help companies significantly increase profit.

1. Introduction

Since the 1970s, the container transportation has been rapidly developed. Nowadays, more than 60% of maritime transportation employs containers with steady 6.4% increase each year. Moreover, it achieves 100% in some developed countries [1]. Fig. 1 shows the volume change of maritime shipping transportation from 1980 to 2004 around the world [2], in which the cylinder denotes the container volume of use, and the curve denotes the percentage of container in the maritime transport. Moreover, all the shipping companies use the big container vessels based on the large-scale economy advantage, and the container type has changed from a single size of 20-foot to that of 20-foot and 40-foot. All these factors have brought more complexity to the maritime transportation management.

There have been a number of systems available in the field of container transportation. For instance, Shen and Khoong presented a support system for the empty container distribution planning [3], Korea Logistic Net developed the port management information system [4], and LOADSTAR was created by IBM [5], etc. However, some of these systems focus on only part scenarios of the whole transportation process, or the problem models solved by the other approaches do not meet the demands of modern logistics. Besides the global economic integration, the container transportation service field faces more challenges, and the companies also need to increase profits. All of these require new software systems to support the decision-making.

Based on the modern demands proposed by COSCO (China Ocean Shipping COmpany), the research team designs and develops a software system named PROFITS (PRofit Optimization For International Transportation Service). This decision support system can be used in all aspects of the maritime transport management. It is a flexible and efficient computer system enabling officers to improve decision-making. PROFITS not only meets all the requirements of the classification society, but also offers strength and stability calculations and a wide range of transportation services and management facilities.

In this paper, we will introduce three modules: the demand forecasting, the stowage planning, and the shipping line optimization. The rest of the paper is organized as follows: in Section 2, we present the system architecture of the software that gives an overview of the proposed solution model. Section 3 discusses the demand forecasting, in which some classical algorithms are employed. In section 4, a detailed description of container stowage planning is presented, and a mathematical model is constructed and optimized by the linear programming method. Section 5 describes the shipping line optimization with genetic algorithm and sequence alignment. Finally, the conclusion and future extensions of the system are summarized in Section 6.

2. Software architecture

The PROFITS system is developed using the Eclipse[1] platform and related technologies. The system architecture is shown in Fig. 2.

* Corresponding author.
E-mail address: zhaiyd@yahoo.com (Y. Zhai).

[1] http://www.eclipse.org.

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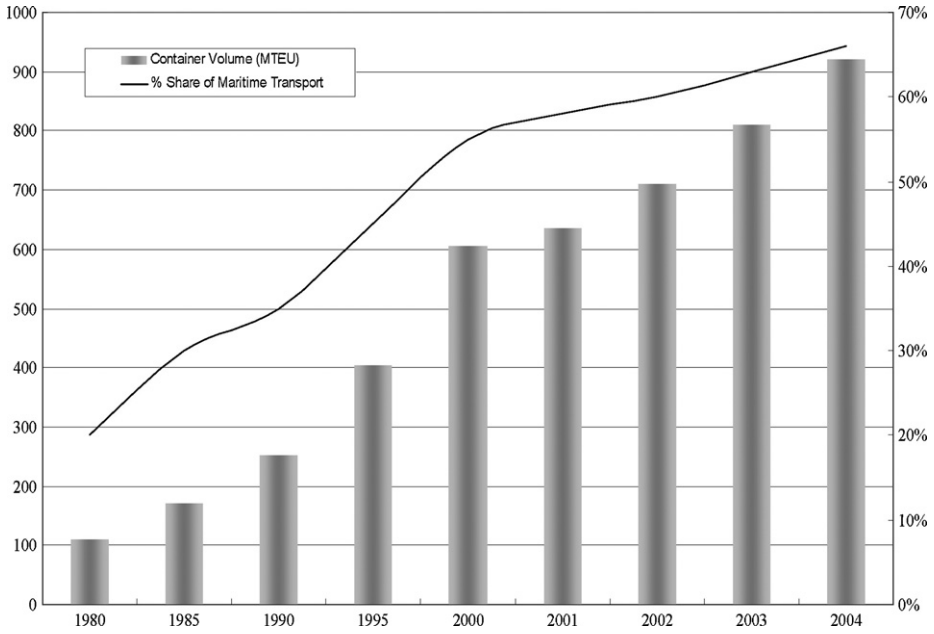

Fig. 1. Container transportation trend.

The container distribution and stowage planning modules belong to the container level; the demand forecasting, the stowage planning(repeat) and slot pricing and allocation modules are at the vessel and voyage level; the contribution analysis and shipping line optimization are at the shipping line level. The detailed descriptions of the functional modules in PROFITS are as follows:

- Demand forecasting: include booking volume and container demand.
- Stowage planning: improve the space utilization and reduce the operation cost.
- Shipping line optimization: for better dynamic alignment among shipping line, demand and profitability. Further, the better shipping line network.
- Slot pricing and allocation: for slot pricing and reservation to maximize revenue.
- Container distribution: how to distribute the empty container to reduce the container operation cost.
- Contribution analysis: to illustrate the profitability of fleets, customer segments, etc.

Next, we will introduce the first three modules in detail.

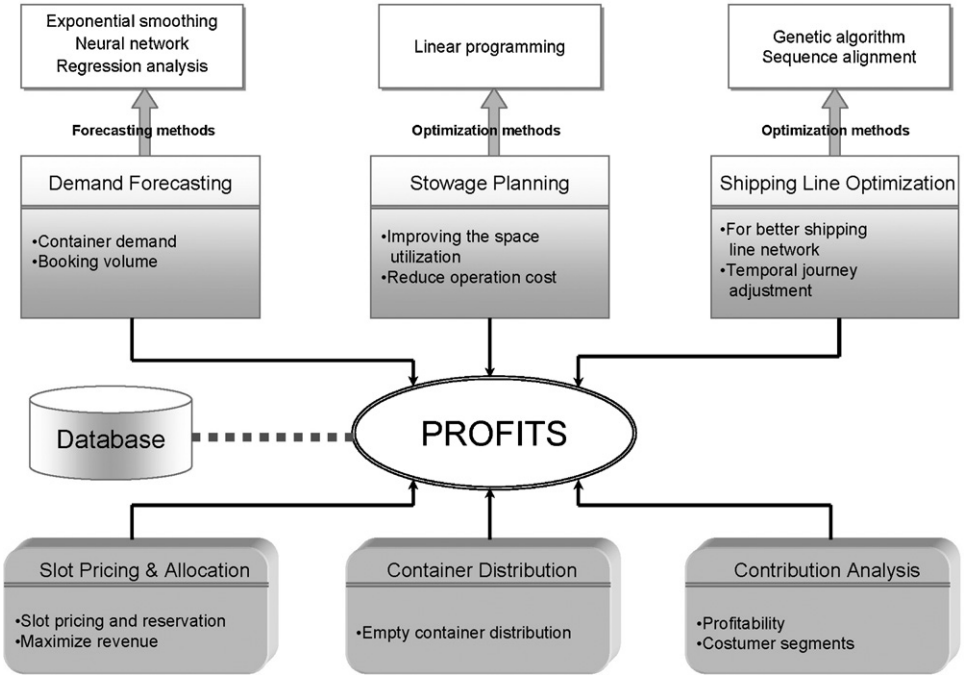

Fig. 2. The architecture of PROFITS.