A Decision-Making Tool for the Optimization of Empty Containers’ Return in the Liner Shipping: Optimization by Using the Genetic Algorithm

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ABSTRACT
This article describes how in the maritime transportation sector, containerization represents one of the most remarkable improvements. In fact, the different shipping companies provide great efforts, whose purpose is to reduce the cost of this transport. However, these companies are facing a problem of empty containers, which are not available at some ports of Maritime Transport Network (MTN) to meet the clients’ demands. This problem is simply a consequence of the imbalance in the distribution of containers through the MTN due to the set of containers that do not return to the origin port. This work offers a decision-making tool to this problem by proposing an optimal return of empty containers. The proposed application is based on evolutionary heuristics. Its principle is to find an optimal solution from a set of several feasible solutions generated during an initial population in order to enable the search of empty containers at lower cost.

KEYWORDS
Algorithm Genetics, Client’s Demand, Decision Support System, Empty Container, Maritime Transport Network (MTN), Transfer Costs

1. INTRODUCTION
Our study concerns and focuses on the empty containers’ return problem into a shipping network. These are unloaded and directed to a storage zone while other ports are in short supply and they face an empty containers’ availability problem to fulfill their maritime activities. Therefore, through this paper, the authors present an optimization mechanism facilitating the search and return of these containers from different ports of the Marine Transportation Network.

The satisfaction of the client’s demand means sending containers loaded with their merchandise to a destination port, which requires the availability of empty containers, so the source port should procure the appropriate number of empty containers by having it in its storage zone, or it will get them by launching the searching procedure of empty containers, that the authors will detail later.

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The researchers are interested in this problem of returning empty containers in a maritime transport network because the growth of the container shipping industry continues to grow. Indeed, a study carried out by the organization of United Nations in 2010 on the Maritime Transport, shows that despite the recent economic crisis, the global trade passes more and more by the shipping lines and sometimes much more in the case of developing countries (Asariotis et al., 2010).

An interdependent relationship is noticed between containerized shipping and the economy. Effectively, the high-value cargo, in particular manufactured goods, are transported in containers.

Our study aims at examining the problem of empty container management and proposes a decision support system to optimize the return of the latter to a port where the stock of empty containers is insufficient to satisfy the customer.

The present paper is organized as follows: In Section 2, the authors present a state of the art for this research. In the section 3, they talk about the issue addressed. Section 4, is devoted to a detailed presentation of our contribution, then they discuss the results obtained in Section 5. Finally, the authors conclude this paper with a synthesis in Section 6, and a conclusion and some perspectives in Section 7.

2. STATE OF ART

The key aspect of our research is situated within the framework of the activities of a shipping company owner of empty containers, which aims to minimize the cost of returning empty containers that represent a return flow in the transport logistics, whose purpose is to maximize the gain obtained on containers full transported in a merchandise shipping operation.

In order to concentrate on everything that is connected to this work, the authors propose the state of the art as follows on the return logistics and repositioning of empty containers.

A discrete-time linear analytical model was proposed by Hu et al. (2002), it consists of four critical activities: collection, storage, treatment, and distribution. The objective function allows to solve a minimization problem of the total cost of reverse logistics concerning the returned hazardous waste. Another model was proposed by Min et al. (2006), who used genetic algorithms to study the problem of the management of returned products. Also, Zhou et al. (2010) proposed a design of a reverse logistics network with a consideration of the repair and recovery options simultaneously. For this reason, a mathematical model of linear programming was proposed, where the objective function of the model is to minimize the total cost of the management of returned products.

On another side, Srivastava (2008) provided a design of a reverse logistics network, and he offered a three-level design (products returned by clients, collection centers, factories). He considered that the client is the source of the returned products. The proposed objective function is to maximize the profit, which is equal to revenues minus the sum of resales cost of reverse logistics and the price of resolution.

Besides, Lee et al. (2009) offered a work that addressed a problem of reverse logistics process for a remanufacturing of returned products. This problem is one of the most important problems in the environment of the recovery of the used products. The proposed model focuses on minimizing the total cost of reverse logistics using genetic algorithms combined with a method based on priority and heuristics. Still in the context of reverse logistics, Mutha and Pokharel (2009) presented a strategy for the design of a reverse logistics network and re-manufacturing by using new or old product modules. The returned products must be consolidated in the warehouse before being sent to recycling centers for inspection. The disassembled parts are sent for re-manufacturing or to a secondary market as spare parts. The objective function consists of minimizing the cost of transportation, inventory, disposal of unused parts, and assembly cost.

Alumur et al. (2012) proposed a linear programming for a reverse logistics network design, where, the objective function maximizes the gain that is equal to the sum of profit of recycling centers, manufacturing plants, and the secondary market minus the fixed costs of establishing of operating and transportation facilities, storage, and purchasing components. The model is applied to washing...
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