Optimizing Empty Containers Repositioning Problem by Using NFT technology and block chain smart contracts

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Abstract This article suggests a new way to deal with Empty Container Repositioning (ECR) problem which results from the maritime shipping imbalance, by building a model maritime network based on block chain technology where every container is registered under NFT – (Non-Fungible Token), in order to encourage Collaboration between the shipping companies by increasing the trust between them. The model is built of transportation model and study how changes in factors among the network can motivate the shipping companies to use this technology.

Keywords: Empty Containers Repositioning, NFT, Block Chain, Optimization, smart contract, transshipment.

1 Introduction

The ECR (Empty Containers Repositioning) problem is an excess of containers at one side of the sea routes and shortage at the other, due to the imbalance of maritime shipping, as almost every one in three containers is shipped empty. Many studies have already suggested the idea of collaboration between the shippers in order to improve the ECR problem and lower the costs, but due to low trust the solution wasn't implemented. The blockchain technology may give a solution due to the reliable tracing it allows and also the usage of smart contracts by registering every containers as an NFT - Non-Fungible Token in a worldwide network based on blockchain technology. In this way, the companies would accept using this technology, but it is necessary to prove its effectiveness. This study learns how to combine in the best way factors that affect the ECR costs. The paper examines a scenario of a closed network of two shipping companies with an intermediate port and based on real ports in the Pacific Ocean. This paper shows that container sharing using blockchain technology increases the profit of the entire supply chain.

2 The optimization models

This model optimizes the cost of empty containers repositioning (ECR). First, a network of ports is built, containing source ports, intermediate ports and destination ports. In order to balance the network, we add also dummy ports. Every company ship its containers from another source port, Part of the intermediate ports is used by one shipping company and the rest are used by the other except one port which is used by both companies. The destination ports are used by both companies. We assume that the total shipping cost for every arch in the network is a product of the distance and constant cost (so the cost of the routes is the real distance between them) plus operation costs, multiply with the containers which are transferred through it. The objective function of the network is the total sum of the arches transferring costs. Two scenarios are investigated: At the first scenario, we find the optimized route for each shipping company by solving a transshipment model, using linear programming. At the second scenario, the network is the same but since we assume perfect collaboration, we have one big shipping company which its demand is the sum of the demands of the two prior liners and it's also can use any of their ports. The containers demand in both scenarios are the same and also the constrains – our goal is to show the cost which is saved by using collaboration. The model shows two sea-cargo liner companies, which load empty containers from ports which are located in the US, and ship them to a final destination (which are actually sources of full containers). We first build a network that contains 18 ports in the pacific. Every source port has containers in stock that must be supplied. We use DOE (Design of Experience) method to evaluate how shipping company's profit is affected by other factors: 1. Different operating cost of the shipping companies. 2. Cost of transferring containers from one company to another. In order to use the DOE method, we build 4 scenarios – in the 1ts and the 4th' the different between the shipping companies' cost is high, in the other it's low. However, in the 1st and 3rd scenarios the containers' transfer cost between the companies is high and in the other it's low.

3 Results, conclusions and future research

In this paper, the cost of empty containers repositioning (ECR) is optimized by changing the factors of containers transferring from one company to another and in the second hand, operational costs changing. When the Liners are collaborating and share empty containers, the total cost is lower and we also get the optimized route in each scenario. The saved cost is significant, as every present of the liners cost can be up to tens of million dollars a year. In the future, more factors influence should be investigated, like a case where the supply / demand is bigger than the biggest port capacity which might cause delay and storage costs.

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