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Optimal Routing in Supply Chain Aimed at Minimizing Vehicle Cost and Supply

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Abstract

Transportation plays a vital role in supply chain. An inefficient transportation system disrupts supply chain and imposes severe damages to it. This paper investigates a transportation model with a limited number of vehicles with different capacities. The vehicles are used to handle raw and semi-finished materials from contractors' warehouses to the main factories and to transport finished products to the warehouses of the distribution companies. The main purpose was to cover all transportation requests in a manner that it results in a reduced transportation cost, a reduced use of rental vehicles, and a reduced stopping duration of vehicle in destinations through the optimal use of available resources. In the considered model, first, a web-based system was designed in order to enable the registration of handling requests in the system with the purpose of compensating vehicle shortage. The handling requests are confirmed by drivers and transportation companies through SMS, email, and internet. Then, the proposed model performs network routing in order to completely cover the transportation network and to reduce transportation costs and vehicles stopping duration in destination. Finally, the model was run in different conditions, and the possibility of increasing vehicles with the purpose of reducing costs was studied.

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1. Introduction

The increase in the capacity of computing systems has enabled the wide use of optimization methods in different sciences. Since iteration is the main component of calculation algorithms, higher calculation power means a shorter

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time and a lower cost for obtaining the ideal solution. The algorithms have various applications. Solving transportation and supply chain problems is one of them. Since the problems have numerous variables, they are hardly solved through manual procedures.

The relationship between the components of supply chain is very important. If an activity within the supply chain experiences a problem, the whole system will fail or experience a serious problem and will have a very low performance, which in turn, will result in a reduced productivity. Transportation is one of the most important components of the supply chain which is responsible for coordinating the components of a unit. Transportation means the moving of materials and products between two points of the supply chain. The materials and products required for a customer are not valuable unless they are delivered to the consumer location. Thus, it can be argued that the transportation creates local and time values through handling materials purchased from supplier to the production location, handling semi-finished products between different departments of an organization, and handling finished products to the customer location.

Therefore, it can be concluded that, as a vital activity with a significant added value, the transportation plays a very important role in the success of the supply chain regardless of its cost-making nature. In the modern trade world, the scope of transportation methods exceeds domestic markets and reaches far distances and overseas thanks to the development and growth of global markets as well as the existence of an increased interaction between markets of different countries. Therefore, as a basic factor, it plays a vital role in the determination of competitive situation of a company more than ever.

For example, material flow cost decreases as handling time decreases, or in the event of a delay in a component of the supply chain, the transportation can compensate the delay by improving its performance so that the production cycle time remains intact.

Transportation costs include a main part of logistics costs and thereby finished costs of products. Therefore, organizations are very interested in controlling the costs. According to studies, about 5% to 6% of retail products price belongs to the transportation costs. In some products like foodstuffs, this rises to 30%.

Not meeting customer needs, incomplete coverage of transportation network, incomplete use of vehicles' capacity, and use of vehicles in routes with empty return routes are the important problems of transportation system in the supply chain. All these factors increase transportation costs in the supply chain. Concentrating on optimal use of resources through a well-routed system, the purpose of this paper was to completely cover transportation network and reduce transportation costs in a manner that it minimizes transportation network's costs and vehicles' stopping duration in destinations. To reduce transportation costs, an Internet-based system was designed by which all transportation requests of organizations or factories, contractors, and distribution companies are registered, and then, they are informed to drivers and transportation companies. On the other side, the proposals of drivers and distributor companies are registered in the system. Then, by analyzing the transportation time, and costs as well as the background of the distributor company, the most appropriate alternatives are selected, and finally, the routing process is done in a manner that all transportation requests are met with the minimum possible cost, and the stopping duration of vehicles in destinations is minimized.

2. Literature Review

Laschin et al. introduced a new integrated model for warehouse location, allocation of retailers to warehouses, providing a suitable number of vehicles for submitting handling requests, and routing of the vehicles in order to minimize fixed and operational costs as well as routing costs using linear algebra. Marinakis et al. used HybPSO method, which is a combination of PSO algorithm and MPNS-GRASP search to solve the routing problem, which is one of the most important problems of supply chain management.

Elif et al. studied the integrated planning of production and distribution in a supply chain with unknown demand and production capacity and solved the problem using genetic algorithm. Dung et al. studied a supply chain consisted of producers and retailers with random requests of retailers. Nagorni et al. introduced a balance model of a developed competitive supply chain. The nested structure of the chain was determined, and its balance condition was studied. This paper studied the supply chain design including the location of capabilities, allocation of capabilities, and routing decisions. The purpose of this study was to achieve optimal location, allocation, and routing within supply chain with the minimum possible cost. Marinakis et al. developed a rapid, strong and efficient