Simulation Research of Chain Management’s Distribution Network

Li-xin ZHAO, Xue SUN and Jian-guo ZHANG
Beijing Union University, Beijing, China

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Abstract. In this paper, in terms of the problems existing in franchising management area, such as low efficiency, poor timeliness and high transportation cost, a simulation model for franchising management network was created with Anylogic. This model can be used to centered distribution network as well distributed distribution network. Orders can be processed in total measure batch and time window batch, which enhanced the adaptability of the model. With the data from a franchised retailer as the input, the model was tested and the output data was analyzed, so to made right decision about the truck loading strategy and route planning strategy according to the customers’ needs.

Introduction

Distribution is a modern logistics service model. By integrating the functions of storage, processing, classification, sorting and transportation, the warehouse that has been used to store merchandise has become a distribution center providing a variety of services to the society. Distribution center is the “gathering place” and “birthplace” of distribution activities. It is also the hub of logistics operation, and the core and symbol of modern logistics. From the successful experience of the development of chain management giants in the world, chain management’s success comes from strong economic strength and brand effect. Chain management’s distribution center with high efficiency and low cost-effectiveness can enhance the competitiveness of chain management.

With the expansion of chain operation, competition in commodity market is becoming increasingly fierce, which is severe test to chain management. The scale of commodity circulation expands and the speed of circulation is quickening, which is challenging cost control and efficiency of distribution system. In the logistics system, inventory cost and transportation cost account for a large proportion of the total cost. Therefore, we can reduce the cost of the entire logistics system by controlling the inventory cost and transportation cost. The distribution efficiency can be improved through optimized selection of distribution strategy.

Transportation cost accounts for a large proportion in total logistics cost. Therefore, transportation rationalization is an important way to reduce logistics cost. Distribution is the terminal transportation of supply chain network, and the logistics cost is reduced by efficient delivery. The main way to reduce the distribution cost is to increase loading rate and arrange the distribution plan reasonably. The loading rate, the number of vehicles and the distribution distance may be a paradox, so it is necessary to ensure the lowest delivery cost by ensuring a higher loading rate and less vehicle number and shorter distribution distance.

Many scholars domestic and abroad are devoting to the study of logistics distribution, aiming to find ways to improve distribution efficiency, reduce distribution costs and improve customer service level. Literature [1] combines the vehicle routing problem and vehicle loading problem in the distribution process to consider the problem of vehicle loading and vehicle loading. The improved genetic algorithm is used to study the integration problem, so as optimize the vehicle distribution route and vehicle loading scheme at the same time. Literature [2] aims to maximizes the total vehicle utilization rate, which consider the constraint of vehicle rated load and the constrain of vehicle full load, a mixed integer programming model is established for the transport scheduling problem of load which coming out three rules for matching of orders and vehicles. Based on these rules, a heuristic algorithm for solving vehicle scheduling problem is designed. In Literature [3], the area of the distribution center is divided and functions of the area are decided, the layout planning
and flow line analysis are carried out by dynamic-line arrangement, and the reasonable plan is determined. Finally, the simulation model of distribution center is established by using Flexsim simulation software basing on plane layout planning. Literature [4] proposes a fast distribution route planning method of logistics transportation based on ant colony algorithm and data envelopment analysis. The fast distribution route planning mathematical model of logistics transportation is set up, and the weight value determination theory of fuzzy mathematics is used to determine the weight value of the fast distribution route of logistics transportation, and the objective function of the fast distribution route planning of logistics transportation is given, and the optimal selection of the transportation route is realized.

In this paper, firstly, the data of distribution center are analyzed, and the relational database of distribution center is established by using Access. Secondly, the simulation model of distribution center based on GIS map is established by using Anylogic simulation software. In the model, vehicle loading strategy and distribution route planning are comprehensively considered. Lastly, taking the data of a supermarket chain's distribution center as input data and running model, output data from the model are captured and analyzed to find the best delivery strategy.

**Data Requirements**

The agents in distribution system include distribution centers, retailers, orders, order details and vehicles. The attributes of distribution center include name, ID, longitude, latitude and other attributes. The attributes of retailer include ID, name, priority, longitude, latitude and other attributes. The attributes of Order include delivery date, retailer ID, order ID and other attributes. The attributes of Order details include goods, weight and volume and other attributes. The attributes of Vehicle include vehicle type, loading capacity and other information.

**Simulation Model**

**Data Structure Design and Data Initialization**

In the model, a series of agents are defined, and corresponding agent populations are created, as shown in Table 1.

<table>
<thead>
<tr>
<th>Entity</th>
<th>Agent</th>
<th>Agent population</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>Distributor</td>
<td>distributors</td>
<td>Read from Table</td>
</tr>
<tr>
<td>Retailer</td>
<td>Retailer</td>
<td>retailers</td>
<td>Read from Table</td>
</tr>
<tr>
<td>Order</td>
<td>Order</td>
<td>orders</td>
<td>Generated by code</td>
</tr>
<tr>
<td>OD</td>
<td>OrderDetail</td>
<td>Orderdetails</td>
<td>Read from Table</td>
</tr>
<tr>
<td>Vehicle</td>
<td>Truck</td>
<td>trucks</td>
<td>Generated by code</td>
</tr>
</tbody>
</table>

The position of distribution centers, retailers and vehicles is located on the GIS map according to the latitude and longitude of distribution centers and retailers. Every distribution center is assigned several trucks to deliver goods. Order details are read from the database table and then grouped according to order ID and information of goods is aggregated according to requirements, such as total weight and total volume, then stored in the order agent population. The order of each retailer located on the GIS map with the location of the retailer. The retailers and orders which every distribution center is in charge of are determined.

**Truck Loading**

Truck loading takes First-Fit algorithm and Best-Fit algorithm into account. First-Fit algorithm searches from the first truck in distribution center's truck collection, and assigns the first truck that meet the loading requirements to the order. Best-Fit algorithm searches from the first truck in distribution center’s truck collection and assigns the first truck that meet the loading requirement
but with least weight space left to the order. This method can make the truck's remaining loading space as small as possible, and improve the loading rate of trucks. In order to adapt to this algorithm, the remaining loading space of trucks should be sorted from small to large.

**Distribution Route Planning**

The distribution route determines the efficiency and timeliness of the distribution center. The selection of distribution routes is a typical TSP problem. Many scholars have applied the heuristic algorithm to solve the TSP problem in their own research. In the literature [5], the distribution route is optimized, the basic ant colony algorithm is improved, and the improved ant colony algorithm is used to solve the model of the distribution route optimization problem, and the distribution optimization strategy is obtained. Literature [6] uses the heuristic algorithm of simulated annealing algorithm and genetic algorithm to study the delivery route design in the logistics system. According to the delivery route map, the delivery route model is established. The optimal delivery route is calculated by using the heuristic algorithm, and the applicability of the model and the algorithm is analyzed.

The selection of vehicle routing in this paper provides several options: arrival time of the orders, priority of the orders, and selection of distribution routes according to the nearest neighbor's heuristic algorithm.

**Model Testing**

**Model Data Input**

A chain business has many high-level chain stores all over the country. The information system includes store information, distribution center information, commodity information, and daily sale information of the stores. The category group of includes leisure group, home group, wine& drink group, general merchandise group etc. Table 2 gives the distribution data of one of the groups of products of some day.

<table>
<thead>
<tr>
<th>Order ID</th>
<th>DC A Store</th>
<th>weight(kg)</th>
<th>Order ID</th>
<th>DC B Store</th>
<th>weight(kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>NO.1</td>
<td>23712</td>
<td>7</td>
<td>NO.7</td>
<td>55128</td>
</tr>
<tr>
<td>0</td>
<td>NO.2</td>
<td>34648</td>
<td>8</td>
<td>NO.8</td>
<td>116240</td>
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<tr>
<td>1</td>
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<td>56308</td>
<td>9</td>
<td>NO.9</td>
<td>130065</td>
</tr>
<tr>
<td>3</td>
<td>NO.4</td>
<td>49540</td>
<td>10</td>
<td>NO.10</td>
<td>50788</td>
</tr>
<tr>
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<td>NO.5</td>
<td>217703</td>
<td>12</td>
<td>NO.11</td>
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</tr>
<tr>
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<td>NO.6</td>
<td>72117</td>
<td>2</td>
<td>NO.12</td>
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<td></td>
<td></td>
<td></td>
<td>4</td>
<td>NO.13</td>
<td>91974</td>
</tr>
</tbody>
</table>

**Model Running Configuration**

Model start time: 8:00AM  
Truck speed: 30km/h  
The two distribution centers are responsible for the distribution of 13 stores.

**Statistical Results**

The output data of the model include the loading rate of trucks, the distance of the truck and the time to reach the stores, so the distribution strategy can be selected to meet the requirements of distribution.
Summary
This paper takes the distribution center of chain management as the background to obtain the original data from the distribution center and retailers, establishes the simulation model of distribution center according to order arrival time, order priority, driving distance. According to the analysis of operation results, it provides support for the determination of distribution planning, improves the service level of distribution, and decreases transportation cost to a certain extent.

There are two deficiencies in this research: firstly, the volume factor is not considered when loading, only the weight factor is taken into account. Secondly, traffic situation is not considered in the model.

Acknowledgement
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References
[3] Planning and Simulation on Logistics System of Distribution Center of Fresh Product [D]. Li Qian. Wuhan University of Technology. 2013