Research on vehicle scheduling based on C-W algorithm

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Abstract. Vehicle scheduling is one of the most important links in logistics distribution, a large number of demands also lead to logistics companies have to reasonably arrange the transportation of vehicle routes to save costs. By optimizing the distribution routes of vehicles, logistics companies can save transportation mileage and thus save transportation costs. In this paper, 10 demand points of an agricultural products logistics company in Beijing are selected, and the location of the distribution center is obtained through the center of gravity method. Finally, the route allocation is completed by using the mileage saving algorithm, and the scheduling of transport vehicles is realized. The example shows that the mileage saving algorithm can optimize the vehicle route and realize route allocation.

Keywords: vehicle scheduling, path optimization, C-W algorithm, Logistics distribution.

1. Introduction

As people life quality rise, demand for goods quantity more and more, however, demand is increasing at the same time, also in each demand point is relatively dispersed, and there is no rule, logistics companies to save costs, tend to consider transport vehicle route problem, through the optimization of vehicle transport routes, reduce the transportation vehicles Process, and then achieve the purpose of cost savings. Domestic and foreign scholars are somewhat different in the study of vehicle scheduling problems. Foreign scholars mainly study vehicle scheduling on the basis of a certain prerequisite, focusing on solving problems, using algorithms as a tool to solve, and finally put forward a conclusion. Domestic scholars mainly focus on method research, propose which algorithm is suitable for vehicle scheduling, give simple examples, and verify the applicability of the algorithm through calculation examples and simulation experiments.

PEI et al. [1] established a mixed integer nonlinear programming model to balance the cost of operation and the cost of passenger travel time, so as to better complete vehicle scheduling. TARIT et al. [2] established a network model to study the multi-supplier vehicle scheduling problem in the whole logistics network. CHAI et al. [3] proposed a vehicle scheduling model, obtained the transportation lines of vehicles based on the improved genetic algorithm, and proposed a visualized vehicle scheduling scheme for decision makers. Zhang Qiuling et al. [4] briefly described the vehicle scheduling problem of cold chain logistics and evaluated the vehicle scheduling system. Yin Lingling [5] proposed an improved ant colony algorithm, summarized the application of ant colony algorithm in vehicle...
scheduling, and verified the feasibility of the improved ant colony algorithm through simulation experiments.

Song Yaqing et al. [6] analyzed and summarized the current situation of vehicle scheduling, focusing on the classification of analysis methods and characteristics, and described the heuristic algorithm in detail in this paper. Chen Yiguang [7] analyzed, designed, implemented and tested the study of logistics vehicle scheduling system, and analyzed the test results. By scheduling vehicles, the utilization rate of packing was optimized. Zhang Di et al. [8] constructed an improved C-W saving algorithm, established a vehicle distribution model, and finally found the optimal logistics distribution path. Cao Jingxia [9] pointed out that heuristic algorithms are often used to solve current vehicle scheduling problems, and C-W algorithm is taken as an example to solve the scheduling problem of distribution vehicles.

In this paper, the mileage saving algorithm is used to optimize the logistics distribution of the single distribution center. First, according to the coordinates of each distribution point, Excel is used to solve the location of the distribution center. Then, according to the demand of each demand point, vehicle arrangement and scheduling problems are carried out to achieve the purpose of mileage saving and cost saving.

2. Distribution Center Location Solution

This paper takes the fresh agricultural products distribution of Beijing Q Company as the research object and selects ten demand points that the company needs to distribute. However, due to the reconstruction of plant and the migration of distribution center, the specific location of distribution center needs to be determined in order to minimize the distribution cost. Table 1 shows the location and demand information of relevant demand points.

| demand point | Xcoordinates | Ycoordinates | Demand (ton) | Freight ($/ Ton Mile) |
|--------------|--------------|--------------|--------------|-----------------------|
| 1            | 21           | 49.5         | 1.2          | 1.5                   |
| 2            | 23.8         | 67.4         | 0.5          | 1.5                   |
| 3            | 52           | 74.5         | 0.9          | 1.5                   |
| 4            | 48.1         | 83.2         | 1.1          | 1.5                   |
| 5            | 57.8         | 80.3         | 0.4          | 1.5                   |
| 6            | 69           | 50.2         | 0.9          | 1.5                   |
| 7            | 58.4         | 36.1         | 0.9          | 1.5                   |
| 8            | 37           | 94.4         | 0.8          | 1.5                   |
| 9            | 43.4         | 28.6         | 0.7          | 1.5                   |
| 10           | 55.6         | 47.3         | 1.2          | 1.5                   |

Given the location of each demand point, we take the minimum cost as the constraint function and use the barycenter method to solve the location coordinate of the demand point.

\[ d_n = \sqrt{(x - x_0)^2 + (y - y_0)^2} = \sqrt{\sum (x - x_i)^2 + (y - y_i)^2} \]  

(1)

In formula (1), DN is the distance between two points, x and y respectively represent the abscissa and ordinate of the distribution center, and Xn and yn are the positions of each demand point.

\[ C = \min \sum_{i=1}^{10} d_n * Dn * fn \]  

(2)

Formula (2) represents the minimum transportation cost, where DN is the distance between two points, DN is the demand of point, and fn is the freight rate per unit distance.

By planning and solving in Excel, equation (2) was taken as the objective function, and the x and Y coordinates of the distribution center were taken as variable cells. Finally, the location coordinates of the distribution center were (49.2, 58.5), and the final transportation cost was $312.6, as shown in Figure 1.
3. Model construction

3.1. Problem description

There is only one distribution center to transport agricultural products to each demand point. The route formed in the transportation process is, from the distribution center to the demand point, and finally back to the distribution center.

Model assumes:

1) The vehicle is of the same model; 2) In the process of distribution, the maximum carrying capacity of distribution vehicles is greater than the demand of any demand point; 3) The goods delivered are of the same kind; 4) The vehicle will transport the goods from the distribution center to the demand point and then return to the distribution center. In this process, it is assumed that the transportation cost does not change; 5) When the vehicle leaves the previous demand point and determines the next demand point, the customer's demand will not increase or decrease; The vehicle starts on a fixed path and the node sequence is fixed.

Constraints:

1) The products of the service center must meet the requirements of all demand points; 2) The number of transport vehicles meets the demand of product transport; 3) The weight of the goods to be transported is less than the maximum carrying weight of the transport vehicle; 4) Customer needs can only be addressed one car at a time.

\[
\sum_{k=1}^{K} x_{ij}^k q_i \leq Q, \forall k \in K \tag{3}
\]

\[
\sum_{k=1}^{K} x_{ij}^k = 1, \forall i \in N \tag{4}
\]

\[
\sum_{j=1}^{J} x_{ij}^k = \sum_{j=1}^{J} x_{ji}^k \leq 1, i = 0, \forall k \in K \tag{5}
\]

\[
x_{ij}^k = \begin{cases} 1, & \text{Demand point } i \text{ is transported by } k \text{ cart} \\ 0, & \text{Other} \end{cases} \tag{6}
\]

\[
x_{ij}^k = \begin{cases} 1, & \text{The } k \text{th car goes from point } i \text{ to point } j \\ 0, & \text{Other} \end{cases} \tag{7}
\]

Formula (3) indicates that the demand of each customer point is less than the maximum carrying capacity of vehicles; Formula (4) indicates that each customer can only be served by one vehicle;
Formula (5) indicates that the starting point of each vehicle is the distribution center; Formula (6) and (7) represent the variables of Formula 0-1.

3.2. Algorithm Introduction

The core idea of mileage saving method is to calculate the mileage saved by using one vehicle and two vehicles at all customer points, and then find the point with the largest mileage saving for combined transportation (to meet the vehicle capacity limit), and the specific distance saved is $C_{oi}+C_{oj}-C_{ij}$.

(1) Calculate the distance between distribution centers of each demand point to form a two-dimensional matrix, calculate the distance saved between each point to form a single new matrix
(2) After saving the path sorting, add the demand of the two demand points from top to bottom
(3) according to the sum of the demand of the two points, compare with the capacity of the vehicle
(4) If the vehicle capacity is exceeded, a line can be formed, otherwise, no (5) until all points form a route, then stop.

4. Model Solution

Fresh agricultural products distribution of Q company in Beijing as the research object is selecting a large distribution center as a distribution center, select 10 supermarkets as a demand point, according to the calculation results, the maximum load for Q company need 3 to 3 tons of homogeneous vehicles In this paper, we select demand point is to choose according to the distance The result was the final delivery routes.

Table 2. Location coordinates between each demand point and distribution center

|   | 0  |  1 |  2 |  3 |  4 |  5 |  6 |  7 |  8 |  9 | 10 |
|---|----|----|----|----|----|----|----|----|----|----|----|
| 0 | 0  | 29.6 | 26.9 | 16.2 | 24.7 | 23.4 | 21.5 | 24.2 | 37.9 | 30.5 | 12.9 |
| 1 |  0 | 18.1 | 39.8 | 43.2 | 48.0 | 48.0 | 39.7 | 47.7 | 30.6 | 34.7 |
| 2 |  0 | 29.1 | 29.0 | 36.4 | 48.4 | 46.7 | 30.1 | 43.5 | 37.6 |
| 3 |  0 |  9.5 |  8.2 | 29.7 | 38.9 | 24.9 | 46.7 | 27.4 |
| 4 |  0 | 10.1 | 39.1 | 48.2 | 15.8 | 54.8 | 36.7 |
| 5 |  0 | 32.1 | 44.2 | 25.1 | 53.7 | 33.1 |
| 6 |  0 | 17.6 | 54.6 | 33.5 | 13.7 |
| 7 |  0 | 62.1 | 16.8 | 11.5 |
| 8 |  0 | 66.1 | 50.6 |
| 9 |  0 | 22.3 |
|10|   |     |     |     |     |     |

4.1. Route and algorithm

Article adopts C - W algorithm for, the just capture the most core algorithms, the algorithm is a parallel process of the vehicle, and through the algorithm, each vehicle distribution between routes, you can see from the picture at the completion of the whole logistics activities involve three cars, and starting from the distribution center to distribution center line, can be very intuitive to see from the picture each The delivery paths of one vehicle are 0-2-8-4-5-0;0-3-6-10-0;0-1-9-7-0.
4.2. Result Analysis
We can see from the last route planning, through the optimization of route, logistics distribution company only need to send three cars, this rather than blindly to send before the vehicle greatly save the cost, and finally vehicle traffic mileage is also reduced, reduce the transportation cost, thus side to save the total cost of logistics.

Table 3. Route planning and total mileage

| The vehicle number | Route     | total distance |
|--------------------|-----------|---------------|
| 1                  | 0-2-8-4-5-0 | 106.3         |
| 2                  | 0-3-6-10-0  | 101.22        |
| 3                  | 0-1-9-7-0   | 72.51         |

5. Conclusions and Prospects
According to the requirements of each demand point and the coordinates of each point of distribution costs, on the premise of distribution cost minimum, finally obtains the location of the distribution center, according to the distribution center location, by saving mileage algorithm was used to solve an example, the simulation experiments are carried out, the results showed that through the optimization algorithm, we only through the three cars on each demand point distribution, and compared Enterprises blindly before the delivery, greatly saving the total mileage of transportation, thus saving transportation costs. This paper only uses the mileage saving algorithm to carry out a simple optimization of the path. In the future, multiple studies can be carried out, such as: in the case of cost constraint, adding time window to achieve a win-win situation of cost and customer satisfaction, while reducing cost, customer satisfaction can also be achieved; At the same time, quarantine costs can also be added to the cost of the whole cold chain logistics, and carbon emissions can also be introduced as an objective function to study vehicle route optimization of cold chain logistics under the normal situation of the epidemic

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