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L Company Logistics Distribution Vehicle Path Optimization

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Abstract

In this paper, aming at the existing problem, the time requirements of customers and the actual situation in L company, a logistics distribution vehicle path optimization model is constructed with the objective of the minimizing comprehensive cost. Based on the data provided by L company, the model is solved by genetic algorithm, and then the vehicle path optimization scheme of each distribution center of L company is obtained. The research results of this paper can provide some reference value for the development and implementation of vehicle path optimization scheme.

Keywords

Logistics and Distribution; Vehicle Path Optimization.

1. Introduction

With the development of China's economy and the continuous improvement of modern technology, logistics activities have shown an active state, and modern logistics is regarded as the "third source of profit". Logistics industry continues to develop rapidly and has become an important part of the national economy. The development of network economy and information technology has driven the development of wisdom and informationization of logistics industry. Logistics distribution path optimization is a hot issue in the logistics field. The study of vehicle path optimization in logistics distribution and the development of distribution path scheme are the keys to reduce logistics distribution costs and improve service quality. The research object of this paper:L company. L company is still in a relatively backward situation in logistics and distribution, and there are problems such as strict control of logistics and distribution time, cross and duplicate distribution routes, high distribution costs, and unstructured logistics and distribution.For this reason, this paper uses the basic data of logistics distribution of L company, and uses MATLAB R2018b program development platform to calculate the optimal distribution plan for vehicles.

2. L Company Logistics Distribution Path Optimization Model Constrution

2.1. Problem Description

In this paper, we study the L company logistics distribution situation. L company has three distribution centers (i.e. X,Y,Z) in a region, and the three distribution centers distribute 31 customer points collaboratively in a region. In each cycle, L company receives orders and completes the production of goods, and the workers finish loading the trucks. After that, the goods are transported to each demand point by transportation vehicles, which leave from each distribution center and return to each distribution center. The specific operational process is shown in Figure 1.

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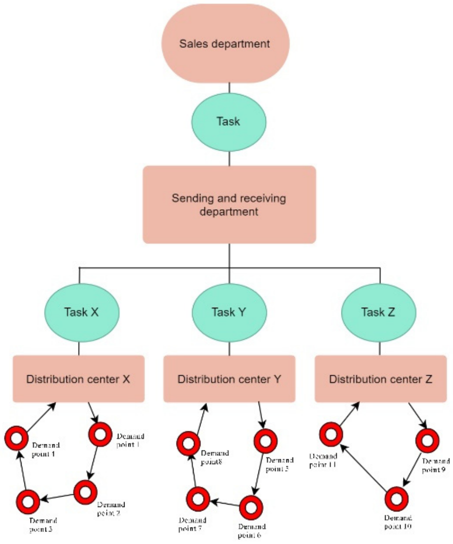

Figure 1. Operation procedure

2.2. Parameter Symbol Setting

The parameter representation in the model is defined as follows:

ET : The earliest time a customer can expect a delivery vehicle to arrive;

LT : The latest time the customer expects the delivery vehicle to arrive;

ET_i : Earliest arrival time of the delivery vehicle allowed by the customer;

LT_i : The latest arrival time of the delivery vehicle allowed by the customer;

M : Collection of demand points, $M = \{1,2,3,\dots,i,\dots,m\}$;

N : Collection of distribution center, $N = \{1,2,3,\dots,i,\dots,n\}$;

a_i : Quantity demand for demand point i , $i = \{1,2,3,\dots,i,\dots,M\}$;

a_{ij} : Volume of shipments from demand point i to demand point j ;

d_{ij} : Distance from i to j , i, $j = \{1,2,3,\dots,i,\dots,M\}$;

K : Collection of transport vehicles,

v : Vehicle travel speed;

C_1 : Fixed costs of distribution vehicle;

C_2 : Total transportation cost;

f_k : Fixed cost of the kth vehicle;

c_1 : Transportation costs per unit mile driven by distribution vehicles;

t_{ij} : Time for a distribution vehicle to travel from demand point i to demand point j ;

δ_1 : Penalty cost that arriving before the time window;

δ_2 : Penalty cost that arriving after the time window;

t_j^k : Time of arrival of distribution vehicle k at demand point j;

$[ET, LT]$: Desired time window for demand point i ;

$[ET_i, LT_i]$: Maximum acceptable time window for demand point i ;

W_k : Maximum loading weight of the vehicle k , $K = \{1,2,3,\dots,k\}$;

$x_{ij}^k = \begin{cases} 1,\text{distribution vehicle } k \text{ from customer point } i \text{ to customer point } j \\ 0,\text{or} \end{cases}$;

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$$x_i^k = \begin{cases} 1, \text{the demand of customer point } i \text{ is satisfied by vehicle } k \\ 0, \text{or} \end{cases}.$$

2.3. Objective Function Setting

2.3.1. Fixed Costs C_1

Fixed costs mainly include wear and tear depreciation of vehicles and wages of accompanying personnel such as drivers.

$$C_1 = \sum_{k=1}^{k} f_k \tag{1}$$

2.3.2. Shipping Costs C_2.

The transportation costs of distribution vehicles include: fuel consumption costs, vehicle maintenance and repair costs, etc.

$$C_2 = \sum_{j=0}^{m} \sum_{k=1}^{k} c_1 d_{ij} x_{ij}^k \tag{2}$$

2.3.3. Penalty Costs C_3

Penalty cost refers to the waiting cost and delayed penalty cost. The waiting cost is caused by delivery vehicles arriving at the customer point earlier than the customer's expected time, while delayed penalty cost is caused by delivery vehicles arriving at the customer point later than the customer's expected time.

$$C_3 = \sum_{i=0}^{m} \sum_{k}^{K} (\delta_1 \max((ET - t_j^k),0) + \delta_2 \max((t_j^k - LT),0)) \tag{3}$$

2.4. Mathematical Modeling

The establishment of the mathematical model in this paper takes the minimum comprehensive cost as the objective function, while the comprehensive cost in this paper is composed of fixed cost (C_1), shipping cost (C_2) and penalty cost (C_3). The logistics model of distribution path optimization for L company is established as follows:

$$MinZ = \sum_{k=1}^{K} f_k + \sum_{j=0}^{m} \sum_{k=1}^{K} c_1 d_{ij} x_{ij}^k + \sum_{i=0}^{m} \sum_{k}^{K} (\delta_1 \max((ET - t_j^k),0) + \delta_2 \max(t_j^k - LT),0)) \tag{4}$$

s. t.

$$\sum_{i,j=0}^{m} \sum_{k=1}^{K} k x_{ij}^k \le K, i, j = (0,1,2,\ldots,m), k = (1,2,\ldots,K) \tag{5}$$

$$\sum_{j=1}^{m} x_{ij}^k = \sum_{i=1}^{m} x_{ji}^k \le 1, i, j = (0,1,2,\ldots,m), k = (1,2,\ldots,K) \tag{6}$$

$$\sum_{i,j=0}^{m} \sum_{k}^{K} w_i x_{ij}^k \le W_k, i, j = (0,1,2,\ldots,m), k = (1,2,\ldots,K) \tag{7}$$

$$\sum_{i=1}^{m} \sum_{k}^{K} x_{ij}^k = 1, i, j = (0,1,2,\ldots,m), k = (1,2,\ldots,K) \tag{8}$$

$$\sum_{j=0}^{m} \sum_{k=1}^{K} x_{ij}^k = 1, i, j = (0,1,2,\ldots,m), k = (1,2,\ldots,K) \tag{9}$$

$$ET_j \le t_j^k \le LT_j, j = (0,1,2,\ldots,m), k = (1,2,\ldots,K) \tag{10}$$

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$$x_j^k = \{0,1\}, j = (0,1,2,\ldots,m), k = (1,2,\ldots,K) \quad (11)$$

$$x_{ij}^k = \{0,1\}, i, j = (0,1,2,\ldots,m), k = (1,2,\ldots,K) \quad (12)$$

3. The Scheme Analysis of Logistics Distribution Path Optimization in L Company

According to the model of logistics distribution path optimization in L company, the genetic algorithm design of the model is carried out afterwards, and the coding operation, fitness function, initial population generation and genetic operator are analyzed and designed. In order to prevent the genetic algorithm from iterating an infinite loop, therefore, this paper designs the algorithm termination condition before the program execution. In this paper, the number of iterations is set for the program run to terminate the program run, and the model is solved by using Matlab R2018b software.

3.1. Customer Point Location and Customer Demand Number

L company has three factories and 31 customer locations, and we plot the coordinates of customer points and distribution centers, as shown in Figure 2, where the horizontal axis is longitude, the vertical axis is latitude, the red dots represent the distribution centers, and the green dots represent each of the 31 distribution points.

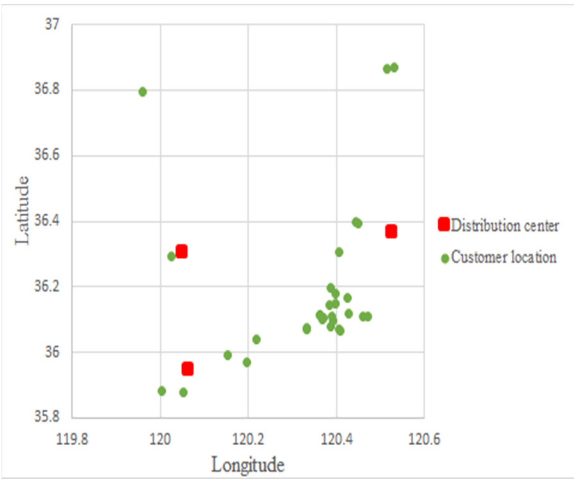

Figure 2. Geographical scatter diagram of distribution centers and customer points

3.2. Distribution Center Data Description

The transport vehicle type and transport personnel costs of L company in a region of three distribution centers (X,Y,Z) are same. The average speed of transport vehicles is 25km/h. According to the previous transport experience and the statistics by relevant professionals, the fixed cost of each vehicle is 270 RMB, and the unit distance transport cost is 6 RMB/km. The unit waiting cost of vehicle arriving early is 1 RMB/min, and the unit penalty cost of delayed arrival vehicle is 2 RMB/min.

3.3. Logistics Transportation Route Optimization Solutions

The model of logistics distribution path optimization in L company is solved by Matlab R2018b. The three distribution centers distribute 31 customer points, indicated by the numbers 1-31, and the transport vehicle transport path is solved by the model after 300 iterations to obtain an approximate optimal solution of 5172.41 RMB. The specific customer points delivered by each vehicle are shown in Table 1.

Table 1. Optimal vehicle distribution path

Distribution center	Number of customers		Vehicle serial number	Customer service order	Target value (RMB)
X	17	6	1	X-15-24-6-11-3-13-X	5172.41
		6	2	X-18-25-21-8-16-12-X	
		5	3	X-26-9-10-1-5-X	
Y	9	5	1	Y-22-17-2-30-4-Y	
		4	2	Y-7-14-31-19-Y	
Z	5	5	1	Z-27-29-28-20-23-Z	

4. Conclusion

This paper combines the actual situation of logistics distribution of L company and establishes a logistics distribution path optimization model for L company. We establish a logistics distribution path optimization model for L company with the minimum comprehensive cost as the objective function. By setting each parameter, an approximate optimal solution of 5172.41 RMB for this problem is obtained by genetic algorithm. The optimization scheme of logistics distribution developed for daily situations of L company meets the specific needs of customers.

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