ISSN: 2414-1895 DOI: 10.6919/ICJE.202301_9(1).0004

Research on Distribution Route Optimization of Logistics Company based on VSP Model

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Abstract

Due to the rapid development of e-commerce economy, all kinds of logistics companies also develop rapidly, which leads to the busy and idle express delivery. Therefore, it is very important to design the optimal path of logistics distribution. This paper studies the busy problem of express delivery. As for the classic Dijkstra, it is mainly used to calculate the shortest path from the initial node to other nodes, and is not suitable for the path planning of multi-customer logistics distribution. In this paper, a soft time window VSP logistics distribution optimization model based on genetic algorithm is proposed. The model has the advantages of fast solving speed and high delivery path efficiency.

Keywords

Logistics Delivery; VSP Model; Path Optimization; Genetic Algorithm.

1. Introduction

At present, with the advent of the network era, the logistics industry has seen unprecedented prosperity, so the optimal path model and algorithm of logistics distribution research becomes extremely important. The current logistics distribution route research focuses on the following aspects [1] : (1) Without considering the time range of delivery requirements, how should logistics companies achieve the shortest daily delivery distance; (2) If each customer has regulations on the delivery time range, how to make the logistics company the shortest transportation path; (3) If customers' requirements on delivery time range are relaxed, whether the transportation path of logistics companies will change.

Belmecheri(2013)[2] conducted a case study that combined the real return trip user (VRPMB) with the routing problem of hybrid long-distance vehicles, and analyzed the data results. The results show that the particle swarm optimization algorithm using local search can not only improve the performance of the algorithm, but also use this algorithm to analyze the main problem. Amorim(2014)[3] took total cost (max) and freshness (mix) into the category of research consideration, and based on this, conducted a deeper study on the multi-objective model. Yu(2018)[4] proposed the corresponding path optimization problem in the mode of logistics terminal distribution. Zhang[5] constructed a cold chain logistics vehicle routing optimization model, which is special in that it includes the time window in the problem optimization and puts forward an improvement method that can be implemented. This research improves the convergence speed of the common genetic algorithm, and achieves the optimal path and low cost. Wang Daoping[6] put the research focus on logistics distribution, built a model with a two-stage heuristic algorithm, and devoted themselves to solving the core problem of optimal location in the distribution process. The research process emphasizes minimizing the cost of distribution center location and vehicle distribution. However, the experimental data show that although this model has the effectiveness of distribution, it lacks the convenience of distribution. Li Zuoshan (2019)[7] used genetic algorithm to study the scheduling optimization of enterprise vehicles and proposed specific ways to reduce vehicle operation

ISSN: 2414-1895 DOI: 10.6919/ICJE.202301_9(1).0004

costs. Zeng Zhixiong[8] focused on optimizing the distribution cost of litchi cold chain logistics, and chose ant colony algorithm for construction. Fang Wenting[9] put forward a new research idea: transform energy conservation and emission reduction into green cost, and use mixed ant colony algorithm to build simulation modeling of total cost (mix). According to the case study data, the algorithm is effective. The traditional path optimization model is mainly used to calculate the shortest path from the initial node to other nodes, and is not suitable for the path planning of multi-customer logistics distribution. In this paper, a soft time window VSP logistics distribution optimization model based on genetic algorithm is proposed. The model has the advantages of fast solving speed and high delivery path efficiency.

2. Analysis of Existing Model of Distribution Path of Logistics Company

(1) Optimization model of travel agent's shortest path[10]

First of all, from the simplest perspective, logistics companies only consider the shortest distance to send goods, which allows us to contact the travel agent. The problem is that there are many routes from one point to another point, choose the shortest one, and then start from there and so on to find the shortest path. For the delivery problem of logistics companies, the goods can be divided according to a certain range to reduce the distance, and the route is constantly accurate according to this method to ensure that a shortest path through all the locations and the minimum distance can be obtained.

From the above analysis, it can be concluded that the first step to find the shortest path is to find the two places with the shortest distance. In the process of finding the shortest path, we can establish a linear programming model and use greedy algorithm to quickly solve the shortest path of delivery vehicles. In the process of research, it is of great benefit to logistics companies to design an appropriate path, which not only reduces fuel consumption but also reduces the actual cost.

(2) Optimization model of material distribution path under hard time window[11]

In real life, we can not only consider the shortest path, because customers often have requirements on delivery time. Therefore, considering it into the conditions, we should consider how to make the delivery time of each vehicle meet the requirements under the condition of the shortest distance. In order to make the route arrangement have a certain flexibility, we should first consider the number of vehicles that the logistics company should send, and use the vsp model of hard time window to roughly estimate the number of vehicles needed. After the number is determined, we can partition the transport area. After dividing regions, the shortest path of a single region with a time range can be considered.

The above two kinds of path distribution mathematical models have many required constraints, and the solution of the distribution path is complicated. Therefore, this paper proposes the optimization model of soft time window VSP logistics distribution based on genetic algorithm.

3. The Optimal Model of Distribution Path of Logistics Company

3.1 Logistics Distribution Path Optimization Model based on Soft Time Window VSP

The main purpose of the logistics distribution route optimization model is to minimize the distribution cost and meet all kinds of constraints in the whole distribution process. The objective function and constraint conditions of the model are as follows:

The objective function is

$$\min C = \sum_{i=1}^{n} \left\{ \sum_{j=1}^{m-1} \left(S_{i(j+1)} - S_{ij} \right) + \left(S_{im} - S_{i1} \right) \right\}$$

Where, i and j represent different logistics outlets, S represents the distance between different outlets, and C represents the total freight cost of logistics distribution.

Its constraints include:

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(1)The total mass of goods required by each sales outlet on each route should be less than the load weight u of the vehicle:

$$\sum_{j=1}^{n} kij \leq \mathrm{u}$$

Where k is the weight of the goods.

(2) The transport time of each vehicle shall not exceed 24 hours:

$$\left\{\sum_{j=1}^{m-1}\left(S_{i(j+1)}-S_{ij}\right)+\left(S_{im}-S_{i1}\right)\right\}\div v \leq 24$$

(3) The number of sales network points m on each delivery route shall not exceed the total number of outlets t:

$$0 \leq \mathrm{m} \leq \mathrm{t}$$

(4) All sales outlets can receive the goods:

$$\sum_{i=1}^{n} k_i = K$$

(5) The total delivery routes shall not exceed the number of one vehicle to one sales outlet:

$$0 \leq \mathrm{n} \leq \mathrm{u}$$

Because the time specified by the customer is a range, due to a series of uncontrollable factors in the transportation process, the arrival time will change accordingly, and because early arrival will cause waiting loss, in the waiting process will lose the opportunity to deliver other goods, so the arrival time should be properly controlled, and late will be compensated to the customer. So the target is further constrained by introducing penalty function variables. This further improves the shortest path of transportation and relates it to life and reality. Therefore, this paper introduces the delay cost Z to distribution path optimization model to form a soft time window model.

$$\mathrm{Z} = \sum_{k\in K}\sum_{i\in V} blt_{wi}^{k}$$

t_{wi}^{k}indicates the time when vehicle k starts to receive service at node i.

3.2 Using Genetic Algorithm to Solve the Soft Time Window VSP Logistics Distribution Path Optimization Model

Through analysis, this research object belongs to the shortest path problem, is a typical optimization problem. So this paper uses genetic algorithm to solve the model. The principle of genetic algorithm is shown as follows.

(1) Population initialization

The initialization of a chromosome: eight points of sale respectively correspond to the ten numbers of 1~N, each chromosome represents a solution, that is, the eight numbers of 1~N is a kind of arrangement, can randomly produce a number, using the appropriate method to get the number of 1~N, in turn to get and the previous eight numbers do not repeat, constitute a chromosome.

Population initialization: Here we assume that there are M populations, that is, the initialization of the Q chromosome cycle can produce a population.

(2) Calculation of fitness

Find the distance and fitness between two adjacent sales outlets. The shorter the distance, the better the fitness, and the better the result

(3) Cross

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Crossover is when two chromosomes from a population are selected as the parent and two offspring are crossed. Select a set of chromosomes, namely paths, with random numbers for crossover. If the generated random number is less than the crossover rate, it means that the parent generation is selected, then crossover will be performed; otherwise, no crossover will be performed and the parent generation will be retained.

(4) Variation

A random number ranging from 1 to M is generated, and M chromosomes are generated, corresponding to M chromosomes in the population respectively. The generated random number and variation rate are compared. If the variation rate is smaller than that, the mutation will occur; otherwise, the parent generation will be retained.

(5) Selection

According to the fitness of the generated offspring, compared with the parent generation, if the fitness is larger than the parent generation, it will be eliminated directly, and the remaining ones will carry out the next iteration together with the parent generation.

After repeating these processes, the optimal child is selected generation by generation, which is the optimal route.

In the initial population M, increasing the number of iterations will make the result develop in a good direction until it reaches stability, with the result basically unchanged. If the crossover rate is too small, several copies of the population will not be updated and good chromosomes cannot be produced. As a result, several copies of the population will not change and cannot develop in a good direction. Therefore, it is necessary to set a large crossover rate to ensure the generation of new chromosomes in the population. The mutation rate should not be too large, the mutation rate in nature had a small possibility of occurrence, can not be set too large.

4. Experimental Verification

In this paper, the daily scheduling situation of A logistics company is taken as an example to analyze [12]. A company needs to deliver logistics to 8 sales outlets every day, and the total mass of distribution every day is 22t, among which the carrying capacity of each delivery truck is 8t. Therefore, it can be known that at least three vehicles are needed, and the fewer vehicles, the shorter the route. So for the rest of the problem, we're going to consider three cars as the optimal arrangement. In order to verify the superiority of this method, the proposed method is compared with ACA, a common distribution route optimization model, and the results shown in Table 1 are obtained.

Table 1. Corresponding calculation results of different optimization models

model	ACA model	VSP model
MinC	1198.5RMB	987.3RMB

It can be clearly seen that the total freight cost C solved by the optimized model in this paper is smaller than that of the ACA model. Through the practical application of this model and solving algorithm in several other logistics companies, it is found that the cost of logistics companies has been greatly reduced and greatly improved on the original basis. Therefore, it can be seen that the research method and solving algorithm in this paper have certain extensibility and research.

5. Summary

By using the time window VSP model, the transportation problem becomes more flexible and more comprehensive. Fully consider the time requirements of each transportation point, can maximize to meet the customer's time requirements, personally from the consumer's consideration. And it makes the transportation problem more flexible and more comprehensive. Fully consider the time requirements of each transportation point, can maximize to meet the customer's time requirements,

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personally from the consumer's consideration. And using genetic algorithm to solve the model also greatly increases the accuracy and speed of solving.

Acknowledgments

Fund Project: Science Research Project of Hunan University of Arts and Sciences (No. 20YB07).

References

[1] Tian Li-yi, ZENG Ming. Research on Optimization of Food Cold chain logistics Distribution Route of a Logistics Company[J]. Logistics Engineering and Management,2019,41(10):101-102.

[2] Belmecheri. F.Prins. C Yfalaoulf, et al. Particle swarm optimization algorihm for a vehicle routing problem with heterogeneous fieet mixed backhauls and time windows[J]. Journal of Intelligent Manufacturing, 2013(4)775-789.

[3] P. Amorim, B. Almada-Lobo. The impact of food perishablity isues in the vehicle routing problem [J] Computers& Industial Engineering,2014(11)223-233.

[4] YuM. Y'ue, G. Lu. Z. Logistis Terminal Ditribution Mode and Path Optimization Based on Ant Colony Algorthm [J]. Wireless Personal Communications,2018(4):2969-2985.

[5] Liyi Zhang, Ga, Y. Sun Y. Application on Cold Chain Logistics Routing Optimization Based on improved Genetic Algoithm[J]. Automatic Control and Ccomputer Sciences,2019(2):169-180.

[6] Wang Daoping, Xu Zhan, Yang Cen. Research on Logistics Distribution site-path Problem based on Two-stage Heuristic algorithm[J]. Operations Research & Management,2017(4)70-75+83.

[7] Li Zuoshan, Li Yingbo, Zhang Ying, et al. Application Research of Genetic Algorithm in Enterprise Vehicle Scheduling Optimization[J]. Chinese Internal Combustion Engine and Accessories,2019(18)208-209.

[8] Zeng Zhixiong, Zou Chidao, Wei Jianfeng, et al. Optimization of Litchi cold chain logistics Distribution cost Model based on Ant colony Algorithm[J]. Packaging Engineering,2019(11):58-65.

[9] Fang Wenting, Ai Clocking, Wang Qing, et al. Optimization of Cold chain logistics distribution route based on hybrid Ant colony algorithm[J]. China Management Science,2019(11):107-115.

[10] Kong Shan, Zhong Zhaolin, Zhang Jihui. Multi-path Selection Variable speed dual-objective Logistics Distribution path Planning[J]. Complex Systems and Complexity Science,2022,19(01):74-80.

[11] Ma Lirong, Yin Yaojie. Research on Optimization of Emergency logistics Distribution Route in Gansu Province based on Genetic Algorithm[J]. Gansu Science and Technology,2021,37(22):65-68+61.

[12] MawaK K, SWIeTOCHOWska E, SWIeTOCHOWska E, et al. Research on Methods for Air Logistics Route Optimization based on ant colony Algorithm[J]. Information Technology,2021(11):76-80.