Advances in Economics, Business and Management Research, volume 85
2nd International Conference on Economy, Management and Entrepreneurship (ICOEME 2019)

Research on Optimization of Cold Chain Logistics Distribution Path of Fresh Agricultural Products

Mingyue Li
School of Management Science and Engineering
Nanjing University of Finance and Economics
Nanjing, China

Run Tang
School of Management Science and Engineering
Nanjing University of Finance and Economics
Nanjing, China

***Abstract*—In view of the long-term deterioration and high cost of cold chain logistics distribution of fresh agricultural products, this paper takes into account the increasingly congested road traffic conditions, uses the existing traffic big data platform to obtain real-time road condition information, and rationally plans the delivery route of the cold chain transport vehicle. Considering the total cost of logistics and distribution (including fixed cost, transportation cost, cooling cost of cold chain car, etc.), the freshness of fresh produce and the time window of customer demand, the mathematical model of distribution path optimization is established. The improved ant colony algorithm is used to solve the above model. The example is verified that the cold chain logistics distribution based on real-time road condition information can effectively reduce the cold chain distribution cost and improve customer satisfaction.**

Keywords—cold chain logistics; path optimization; real-time road conditions; ant colony algorithm

I. Introduction

With the improvement of living standards, people's demand for green and nutritious fruits, vegetables, fresh meat, eggs, milk and other fresh agricultural products is also increasing. Fresh agricultural products are a special kind of agricultural products, their characteristics of perishable and deteriorating are highly demanding for environmental factors such as temperature and humidity during the logistics process[1]. In order to maximize the preservation of these natural agricultural products and send them to consumers, these products need to be pre-cooled, transported, stored and distributed in a suitable low temperature environment. In recent years, due to the increasing of consumption level and the demand for the quality (including the freshness, safety, variety, etc. of the products) of fresh agricultural products of residents, it is necessary to accelerate the development of cold chain logistics, especially cold chain distribution. High-quality fresh produce is sent to the residents' table, which not only satisfies the residents' higher living needs, but also promotes rural and agricultural development and ensures farmers' continued income growth.

At present, the cold chain logistics distribution network of domestic has become more and more perfect, but fresh e-commerce has a loss rate of 95%, mainly due to the high cost of cold chain. The data shows that the cost of fresh cold chain logistics is 1-2 times higher than that of ordinary goods [2]. In addition, because the origin price of agricultural products is already low, and the integration of the industry chain is not high, the competition between upstream and downstream enterprises is greater than cooperation, and agricultural product dealers often reduce logistics costs (including cold chain transportation costs and product loss costs). Therefore, making full use of the existing technology and big data background, optimizing the distribution plan, minimizing the transportation time, and reducing the cost of cold chain distribution, which is of great significance for enhancing the market competitiveness of agricultural products and indirectly promoting farmers' income.

II. Literature Review

Since the American scholars Dantzig and Ramser first proposed the vehicle routing problem (VRP) in transportation in 1959, many scholars have paid attention and made a lot of research. In reality, due to the customer's time requirement, the VRP has developed into a distribution vehicle path problem with time windows (VRPTW). Chen et al. [3] and Azi et al. [4] established a cold chain logistics distribution VRPTW model with rigid requirements for delivery time of perishable food, and the delivery path has been optimized by a heuristic algorithm. Recognizing the advantages of heuristic algorithms for solving vehicle routing problems, more scholars are involved in the study of heuristic algorithms. Dearmas and Melián [5] used a heuristic algorithm that changed the domain search strategy to solve dynamic multi-objective vehicle routing problems; Küçükoglu and Öztürk [6] used a hybrid algorithm for taboo search and simulated annealing to solves vehicle routing problems with backhaul and time windows. In view of the perishability and distribution complexity of fresh agricultural products, Hiassat A [7] considered the perishable characteristics of agricultural products, established an optimization model for distribution center distribution path problems, and solved them with genetic algorithm and local search heuristics; Cai Haoyuan and Pan Yu [8] constructed the metamorphic function of fresh agricultural products, and established a cold chain logistics path optimization model with time window, solved the model by artificial bee colony algorithm.

With the development of social environment and Internet of Things technologies, research on vehicle routing issues has also been focused. Pan Wei and Gan Hongcheng [9] turned the carbon emission into corresponding economic benefits for the increasingly serious environmental problems, and constructed a mathematical model considering carbon emission cost and solved it by ant colony algorithm. The total cost considering carbon emissions is reduced; Li Changbing et al [10] constructed a multi-objective path optimization model considering customer satisfaction and distribution costs based on the advantages of Internet of Things technology and simulated the model using the improved genetic algorithm.

At present, the research on vehicle path optimization mainly focuses on the vehicle routing problem under static network, that is, in the definite case of the distribution center, the delivery vehicle, the traffic condition, the demand for the goods, and the time window, how to arrange the planning of the delivery route to achieve the optimization of the distribution cost. However, in the actual cold chain distribution management process, the deterioration rate of fresh agricultural product, traffic condition and other factors often show uncertain changes. In order to study the path of reducing distribution cost of fresh produce, and improve customer satisfaction, this paper first obtain urban road congestion information from big data and use it to establish a vehicle routing optimization model, and then apply improved ant colony algorithm to solve the problem. The road condition relationship coefficient is added to the model to improve the path selection strategy and achieve the purpose of optimizing the distribution route.

III. Model Building

A. Problem Description

1) Application of traffic big data in cold chain logistics distribution: Traffic big data is defined as a data set composed of a large number of complex electronic maps, roads, vehicles, personnel, positioning, road monitoring, road network construction and other types of traffic information. One of the main applications of urban traffic big data is to integrate and process road data, urban traffic GPS data and electronic map positioning navigation data to produce real-time road conditions with high accuracy and high coverage. For the cold chain logistics distribution with high timeliness requirements, the distribution management information system can be used to manage and direct the transportation vehicles in transit through the traffic big data platform to obtain information such as roads and real-time road conditions. At this time, the vehicle feeds back information such as road conditions and location to the distribution management information system, the data and information of customers, vehicles and even the distributors will be collected by the public data cloud through distribution management information system and the traffic big data platform [11] .The application of traffic big data in cold chain logistics distribution is shown in "Fig. 1".

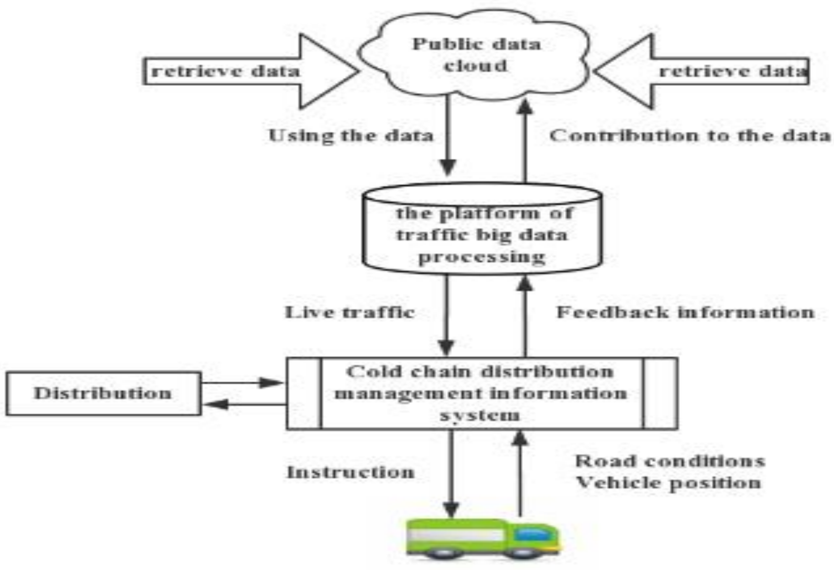

Fig. 1. Application of traffic big data in cold chain logistics distribution.

2) Problem hypothesis: Fresh agricultural products cold chain logistics distribution center I owns M special refrigerated distribution vehicles to provide fresh agricultural products distribution services for J demand points in urban areas. After receiving the order at the demand point, the distribution center quickly optimizes the delivery route and delivers fresh agricultural products to the demand point. Assuming that the number of demand points is determined, the specific demand for each order is also determined. Each order can be ordered in multiple varieties and the following conditions are met:

- The maximum inventory of the distribution center can meet the total demand of all demand points, and the customer's geographical location and time window constraints are known.
- The number of refrigerated delivery vehicles is fixed, and the weight of each vehicle is limited. The total demand of each customer does not exceed the maximum load of the single vehicle.
- During the distribution process, the transportation vehicle starts from the distribution center, meets the needs of each customer node in the distribution network route, and sequentially passes and serves each demand point, finally returns to the distribution center. There is no temporary assignment distribution task during the delivery.
- Each customer is guaranteed to receive the service and the fresh produce required can only be delivered by a refrigerated truck.
- The road congestion condition remains relatively stable, that is, it is unchanged in the time when the delivery decision is made until the delivery vehicle passes the road section, and the total length on each delivery route is not greater than the cruising range of the delivery vehicle (distribution vehicles do not need refueling).
- Assume that the vehicle travels at a constant speed, and the delivery cost per unit of goods is known and constant.
- Regardless of the change of external temperature during the distribution process, the fresh agricultural products remain fresh when they leave the distribution center, the corruption rate is constant during the distribution process and the freshness can be perceived from time to time.

B. *Model Parameters and Variables*

The authors set the following parameters and variables as needed to build the model:

- I: Distribution center i collection;
- J: Agricultural product demand point j collection
- M: Distribution vehicle m collection;
- IC_i: Maximum inventory capacity of distribution center I;
- LC_m: Maximum carrying capacity of cold chain vehicle m;
- d_{ij}: The demand of i meets j;
- l_{ij}: The distance from i to j;
- V_m: Average travel speed of the delivery vehicle m;
- t_{ijm}: Travel time of vehicle m from i to j;
- t_{iml}: Loading and unloading time of vehicle m at distribution center I;
- t_{jml}: Loading and unloading time of vehicle m at demand point j;
- S: The maximum cruising range of the cold chain car;
- G_{ij}: Road condition coefficient from i to j;
- f_{ijm}: The unit freight of the vehicle m from i to j;
- F_{ijm}: Fixed cost of vehicle m from i to j;
- x_{ijk}: Traffic of vehicle m traffic from i to j;
- N_m: Number of models of vehicle m;
- RC_l: Refrigeration cost per unit time when refrigerated trucks are loaded and unloaded;
- RC_t: Refrigeration cost per unit time when refrigerated trucks are transported;
- θ_r: The coefficient of corruption of fresh agricultural products, constant.

C. *Model Building*

The goal of the cold chain logistics distribution route planning of fresh agricultural products is to arrange the driving route of the cold chain distribution vehicles, so that the delivery of fresh agricultural products to each demand point must satisfy the customer's satisfaction with the freshness and time window requirements, while ensuring the lowest total transportation cost.

1) Total cost: Including the fixed cost of distribution vehicles, variable charge and cooling costs for cold chain vehicles. Fixed costs such as vehicle loss costs, variable costs such as transportation costs, etc., are related to the number of refrigerated delivery vehicles, traveled distance, the volume of traffic, and the traffic congestion coefficient Gij, which obtained real-time road condition of urban roads through Baidu maps and high-tech maps. Where Gij=Gji, $0 \le Gij \le 1$, and 0 to 1 sequentially indicate different congestion levels, 0 means unblocked, and 1 means complete blockage. The cold chain car refrigeration cost is the cost incurred by the refrigerated truck to maintain the temperature of the fresh product in the refrigerated compartment. It is divided into the cooling cost during transportation and the cooling cost generated when the car door is opened during unloading.

$$\delta_1 = \sum_{i\in I}\sum_{j\in J}\sum_{m\in M} F_{ijm} G_{ij} l_{ij} x_{ijm} N_m + \sum_{i\in I}\sum_{j\in J}\sum_{m\in M} f_{ijm} G_{ij} l_{ij} x_{ijm} N_m + \sum_{i\in I}\sum_{j\in J}\sum_{m\in M} RG_t \frac{l_{ij}}{V_m(1-G_{ij})} N_m + \sum_{i\in I}\sum_{j\in J}\sum_{m\in M} RG_l (t_{imt} + t_{jmt}) N_m \quad (1)$$

2) Freshness: As the appearance of the quality, freshness has the characteristics of intuitive observation and is the important decision-making basis for consumers. The characteristics of fresh agricultural products such as perishable deterioration and short shelf life make the product transportation time and delivery mileage have a great impact on freshness. Therefore, this paper considers the transportation time and transportation distance as variables to form the freshness formula:

$$\phi_{jr} = (1-\theta_r)^{\sum_{i\in I}\sum_{j\in J}\sum_{m\in M}[\lambda_1 \frac{l_{ij}}{V_m(1-G_{ij})} + \lambda_2 l_{ij}] z_{ijm}} \quad (2)$$

The transportation time weight isλ_1, the transportation distance weight isλ_2, and the weight is based on the specific transportation distance and transportation distance, and $\lambda_1+\lambda_2=1$. Let $\lambda_1=\lambda_2=0.5$ in this paper.

To facilitate the solution, the dissatisfaction formula is as follows:

$$\delta_2 = 1 - \frac{\sum_{i\in I}\sum_{j\in J}\phi_{jr} d_{ij}}{\sum_{i\in I}\sum_{j\in J} d_{ij}} \quad (3)$$

3) Customer demand time window: Supposing that the time window for demand chain j is $[d_j, u_j]$, the maximum tolerance time window is $[D_j, U_j]$($D_j \le d_j$, $u_j \le U_j$).That is to say, if the delivery time is within $[d_j, u_j]$, the penalty cost is 0; there is a penalty cost outside $[d_j, u_j]$ but within $[D_j, U_j]$; rejection outside $[D_j, U_j]$,The penalty cost is + ∞. The penalty coefficient sent is ω_1 before the time window $[d_j, u_j]$, and ω_2 after the time window $[d_j, u_j]$. Assuming T_j is the time point at which the delivery vehicle arrives at the customer j ($D_j \le T_j \le U_j$), the penalty function that violates the customer demand time window can be expressed as:

$$\delta_3 = \omega_1 \sum_{j=1}^{J} \max\{d_j - T_j, 0\} + \omega_2 \sum_{j=1}^{J} \max\{T_j - u_j, 0\} \quad (4)$$

4) Cold chain distribution path optimization model: Considering the above objective function, the mathematical model produce based on real-time road conditions and consumer satisfaction is constructed as follows:

$$\begin{aligned} \min \delta &= \min(\delta_1 + \delta_2 + \delta_3) \\ &= \min\Bigg\{ \sum_{i\in I}\sum_{j\in J}\sum_{m\in M} F_{ijm} G_{ij} l_{ij} x_{ijm} N_m + \sum_{i\in I}\sum_{j\in J}\sum_{m\in M} f_{ijm} G_{ij} l_{ij} x_{ijm} N_m + \sum_{i\in I}\sum_{j\in J}\sum_{m\in M} RG_t \frac{l_{ij}}{V_m(1-G_{ij})} N_m + \sum_{i\in I}\sum_{j\in J}\sum_{m\in M} RG_l (t_{imt} + t_{jmt}) N_m \\ &\quad + (1 - \frac{\sum_{i\in I}\sum_{j\in J}\phi_{jr} d_{ij}}{\sum_{i\in I}\sum_{j\in J} d_{ij}}) \\ &\quad + \omega_1 \sum_{j=1}^{J} \max\{d_j - T_j, 0\} + \omega_2 \sum_{j=1}^{J} \max\{T_j - u_j, 0\} \Bigg\} \end{aligned} \quad (5)$$

$$s.t.\begin{cases} \sum_{j\in J} d_{ij} \le IC_i, (i = 1,2,3,\wedge I) & (6) \\ \sum_{i\in I} z_{ijm} = 1, (j = 1,2,3,\wedge J) & (7) \\ \sum_{m\in M} z_{ijm} = 1, (j = 1,2,3,\wedge J) & (8) \\ \sum_{m\in M} x_{ijm} z_{ijm} \ge d_{ij}, (j = 1,2,3,\wedge J) & (9) \\ \sum_{j\in J} x_{ijm} z_{ijm} \le LC_m, (m = 1,2,3,\wedge M) & (10) \\ \sum_{i\in I}\sum_{j\in J} l_{ij} z_{ijm} \le S, (m = 1,2,3,\wedge M) & (11) \\ z_{ijm} = \begin{cases} 1 & \text{Delivered from the distribution center } i \text{ to the demand point by the vehicle } m \\ 0 & \text{otherwise} \end{cases} & (12) \end{cases}$$

Equation (6) is the inventory constraint of the distribution center i, and the fresh agricultural products that are put into or out of the warehouse do not exceed the maximum inventory capacity; the formula (7) indicates that only one distribution center is required for each demand point; the formula (8) indicates that only one vehicle for distribution at a demand point; formula (9) indicates that the traffic delivered to the demand point cannot be less than the demand due to the possible cargo damage; the formula (10) is the vehicle load constraint, and the total amount of goods transported by the vehicle is not exceeding the maximum load limit of the vehicle; equation (11) indicates that each delivery vehicle has a delivery distance less than the maximum cruising range; equation (12) is a decision variable constraint.

IV. Model Solving

Based on the problem of cold chain distribution vehicle routing optimization, this model aims at the optimal distribution path with the goal of minimum distribution cost and consumer dissatisfaction. For the case of many influencing factors and constraints, it is very difficult to use the exact algorithm. The ant colony algorithm is a random search algorithm that simulates the ant colony foraging behavior to find the shortest path and is widely used in vehicle scheduling and tasks distribution and other fields. The process of finding the shortest route for vehicle distribution is very similar to the ant foraging, and the ant colony algorithm has a fast search time, high efficiency, and good optimization effect. Therefore, this paper uses the ant colony algorithm to solve the model.

A. Algorithm Design

The number of ants in the algorithm is the number M of the cold chain car, the number of food is the demand point J, and the $\tau_{ij}(T)$is the amount of pheromone left on the path that ant (cold chain car) from the food i to the food j at time T. At the same time, after each ant m passes through a demand point, the demand point number is added to the taboo table $Tabu_k$ corresponding to the ant m. Let $\rho_{ij}^{k}(T)$ denote the probability that the mth ant moves from i to j at time T, then $\rho_{ij}^{k}(T)$ is defined as follows:

$$\rho_{\mathrm{ij}}^{k}(T)=\begin{cases}\dfrac{\tau_{ij}^{\alpha}(T)\eta_{ij}^{\beta}(T)}{\sum_{s\in allowed_k}\tau_{ij}^{\alpha}(T)\eta_{ij}^{\beta}(T)} & j\in tabu_k\\ 0 & otherwise\end{cases} \quad (13)$$

In the formula (13), $allow_k$={1, 2, ^, J} represents a set of demand points adjacent to the current demand point and the ant m has not yet accessed.α and β are two weight coefficients, respectively, where α represents the influence of the remaining pheromone on the path ij on the subsequent ant selection path. When α=0, it means that there is no influence on the ants, and the path is completely selected with random probability; β is a prior knowledge heuristic factor, indicating the degree of influence of prior knowledge (predictability) on the ant selection path. When β=0, it means that the ants will choose according to the pheromone concentration. $\eta_{ij}(T)$ is a heuristic function, indicating the probability that an ant moves from i to j. According to the specific problem of this article, it is defined as

$$\eta_{ij}(T)=\frac{1-G_{ij}}{l_{ij}} \quad (14)$$

Here l_{ij} is the distance from i to j, and G_{ij} is the congestion coefficient of the road. Since pheromone concentration is an important factor affecting the ant selection path, it is necessary to update the pheromone in time. The pheromone update formula is:

$$\tau_{ij}(T+1)=(1-\rho)\tau_{ij}(T)+\rho\Delta\tau_{ij}(T,T+1) \quad (15)$$

In equation (15), ρ is the pheromone volatilization coefficient, and ρ is in the range of 0<ρ<1, in order to avoid an infinite increase in the pheromone on the path; $\Delta\tau_{ij}$ represents the increment of the pheromone released by the ant from i and the movement to j. Usually, the initial pheromone $\tau_{ij}(T)=0$, $\Delta\tau_{ij}^{k}(T)$ represents the concentration of pheromone released by ant k on ij, $\Delta\tau_{ij}(T, T+1)$ represents the increase in pheromone after the ant passes the ij path:

$$\Delta\tau_{ij}(T,T+1)=\sum_{k=1}^{m}\Delta\tau_{ij}^{k}(T,T+1) \quad (16)$$

After all the demand points have been completed, the taboo table $Tabu_k$ has been filled. By calculating the comprehensive cost of distribution of each ant (cold chain car), Pairwise comparison to find out that the comprehensive cost of distribution is smaller, that is, and the better is the path. Then repeatedly repeating the loop until you can't find a better solution.

B. Algorithm Implementation

The algorithm implementation steps are:

Step 1: Initialize the parameters. At the beginning of the calculation, the relevant parameters need to be initialized, such as the ant colony size (the number of ants) m, the pheromone importance factor α, the prior knowledge heuristic factor β, and the like. Let T=0, the iteration number iter=0, iter_max is the maximum number of iterations, the initial pheromone quantity $\tau_{ij}(0)$=c(c is a constant), the pheromone increment $\Delta\tau_{ij}(0)=0$, define and clear the taboo table tabu;

Step 2: Place M ants at J demand points;

Step 3: Start loop count iter=iter+1;

Step 4: Let the taboo table index number k=1;

Step 5: k=k+1;

Step 6: Calculate the probability that the ant selects the demand point j according to the transition probability formula (13);

Step 7: Compare the transfer probability of each demand point, and then move the ant to the demand point with the highest transfer probability, and this point is included in the taboo tab tabuk;

Step 8: If k<J, indicating that the demand point is still not accessed, go to Step5, otherwise continue to the next step;

Step 9: Calculate the comprehensive cost δ of the path that the ant (cold chain car) has passed, and update the pheromone according to formulas (15) and (16);

Step 10: If the number of iterations is iter<iter_max, clear the taboo table and go to Step3, otherwise the loop terminates and the result is output.

V. Numerical Calculation and Analysis

A. Parameter Settings

It is known that there is one distribution center within the A area, and there are 11 demand points. The coordinates, demand, service time and service time window of the demand point are shown in Table 1 below. The inventory of the distribution center is 100t, the maximum load of the cold chain vehicle is 5t, the unit freight is 1.8 dollar / (t ·km), the fixed cost is 0.8 dollar / (t ·km).The average speed of the cold chain car is 30km/h. In order to simplify the subsequent calculations, this numerical calculation only considers the distribution of two kinds of fresh agricultural products. The corruption coefficients are θ_1=0.15 and θ_2=0.02, respectively. The penalty coefficients before the time window and later than the time window are set to ω_1=5 and ω_2=20 respectively. On the map of Gaode, the shortest route distance between each distribution node is separately inquired as the distribution distance between the nodes. For the road congestion coefficient, the real-time road conditions are divided into four levels: “unblocked”, “slowly”, “crowded”, and “seriously congested”. On the one road, the road traffic congestion level accounts for the largest proportion of the road conditions on this path. Since the value of the congestion coefficient is (0, 1), 0 means unblocked, 1 means complete blockage, and for the simplified calculation, the congestion coefficients are 0.2, 0.4, 0.6, and 0.8 for each of the four levels.

The parameters of the ant colony algorithm are: ant number M=15, pheromone initial concentration τ_0=0.3, pheromone importance factor α=2, prior knowledge heuristic factor β=5, pheromone volatilization coefficient ρ=0.2, maximum iteration iter_max=100. (See “Table I”)

TABLE I. Distribution Center and Demand Point Coordinates, Demand and Service Time, Time Window

No.	abscissa	ordinate	demand quantity	service time service	service time window	acceptable time window
0	70	40		40		
1	39.2	70.4	0.102	17	6: 30-8: 30	6: 00-10: 00
2	22.4	45.6	0.113	13	6: 30-8: 30	6: 00-10: 00
3	97.1	45.6	0.095	15	6: 30-8: 30	6: 00-10: 00
4	6	28.7	0.131	20	6: 30-8: 30	6: 00-10: 00
5	62.3	79.6	0.029	10	6: 30-8: 30	6: 00-8: 30
6	42.8	88.5	0.306	18	6: 30-8: 30	6: 00-8: 30
7	86.7	3.4	0.532	22	6: 30-8: 30	6: 00-8: 30
8	87.4	61.2	0.617	15	7: 00-9: 00	6: 00-8: 30
9	88.8	91.3	0.232	20	7: 00-9: 00	6: 00-8: 30
10	14.6	13.2	0.459	15	7: 00-9: 00	6: 00-10: 00
11	46.6	77.6	0.121	18	7: 00-9: 00	6: 00-10: 00

B. Calculation Results and Analysis

Using the model and algorithm of this paper to solve the above numerical examples, using Matlab2018 software to simulate, the distribution path is shown in “Fig. 2”, the number of algorithm iterations is shown in “Fig. 3”. In this algorithm, each ant searches for the optimal solution in parallel in multiple points in the problem space, which has strong robustness and global search ability, and strengthens the ant colony system Positive feedback capability by improving the calculation rules of ant state transition probability, guiding the entire system to accelerate evolution towards the optimal solution.

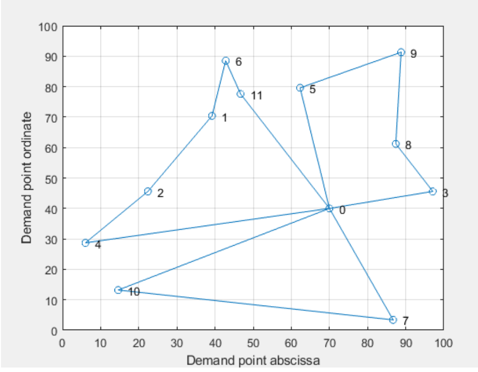

Fig. 2. Distribution path diagram.

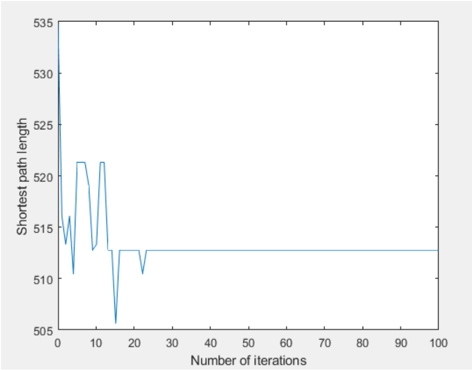

Fig. 3. Algorithm iterations.

The optimal solution and the initial strategy result without considering the road congestion status are shown in "Table II". From the perspective of the optimal scheme and cost under each strategy, the introduction of urban road real-time road conditions in the distribution decision has effectively reduced the cost of the distribution route. This is because the refrigerated delivery vehicle actively evades the extremely congested sections after considering the real-time road conditions. The time spent on the road of the refrigerated truck reduces the transportation cost and improves customer satisfaction.

TABLE II. COMPARISON OF EACH STRATEGY RESULT

Strategy	Minimum distribution cost/dollar	Corresponding delivery route
initial strategy	5604.59	vehicle 1: 0→8→9→5→11→0 vehicle 2: 0→4→10→7→3→0 vehicle 3: 0→6→1→2→0
Based on real-time traffic	5056.04	vehicle 1: 0→3→8→9→5→0 vehicle 2: 0→7→10→0 vehicle 3: 0→11→6→1→2→4→0

VI. CONCLUSION

Aiming at the problem that the increase cold chain logistics cost of fresh produce directly affects market competitiveness and indirectly affects farmers' income, this paper studies the optimization of agricultural product cold chain logistics distribution path under the background of traffic big data, considering the constraints of time window, distribution vehicle and customer demand, the real-time congestion of urban roads is obtained through traffic big data, the mathematical model of agricultural product path optimization based on real-time road conditions is constructed with the goal of the total cost of vehicle fixed cost, transportation cost, cooling cost, customer dissatisfaction and penalty cost is minimized. The ant colony algorithm is used to design the model solving method, which has strong robustness. In the big data environment, it is more complicated to optimize the cold chain logistics distribution path. This paper only studies the cold chain distribution path optimization of real-time road conditions. Future research can also pay attention to the change of road conditions and the dynamic demand of customers in the distribution process, and some distribution points have to be connected to the shuttle bus due to narrow roads, and how to combine optimization algorithms and manual scheduling experience and so on.

ACKNOWLEDGMENT

This research was financially supported by the Postgraduate Research & Practice Innovation Program of Jiangsu Province (KYCX18_1327), Key Foundation of Philosophy and Social Sciences for Universities in Jiangsu Province (Project Code: 2017ZDIXM062), and National Social Science Foundation(Project Code: 16BGL130).

REFERENCES

[1] Feng Ying, Li Zhihui, Zhang Yanzhi. Evaluation of the efficiency of supply chain contract of fresh agricultural products under the guidance of retailers under TPL, Management Review, vol.3, pp. 215-225, 2018.

[2] Zhou Xiang. Problems and Countermeasures in the Logistics Distribution of Fresh E-commerce Cold Chain in China, Logistics Engineering and Management, vol.5, pp.104-105, 2017.

[3] Chen H. K. , Hsueh C. F. , Chang M. S. Production Scheduling and Vehicle Routing with Time Windows for Perishable Food Products, Computers & Operations Research, vol.36, pp.2311-2319, 2009.

[4] Azi N., Gendreau M., Potvin J. Y. An Exact Algorithm for A Single-Vehicle Muting Problem with Time Windows and Multiple routes, European Journal of Operation Research, vol.178, pp.755-766, 2007.

[5] Dearmas J., Melián B. B. Variable Neighborhood Search for a Dynamic Rich Vehicle Routing Problem with Time Windows, Computers and Industrial Engineering, vol.85, pp.120-131, 2015.

[6] Kücükoglu I., Öztürk N. An Advanced Hybrid Meta-Heuristic Algorithm for the Vehicle Routing Problem with Backhauls and Time Windows, Computers and Industrial Engineering, vol.86, pp.60-68, 2015.

[7] Hiassat A, Diabat A, Rahwan I.A Genetic Algorithm Approach for Location-Inventory Routing Problem with Perishable Products, Journal of Manufacturing Systems (S0278-6125),vol.42, pp.93-103, 2017.

[8] Cai Haoyuan, Pan Yu. Optimization of Cold Chain Logistics Distribution Path of Fresh Agricultural Products Based on Artificial Bee Colony Algorithm, Jiangsu Agricultural Sciences, vol.45, pp.318-321, 2017.

[9] Pan Wei, Gan Hongcheng. Research on Optimization of Cold Chain Logistics Distribution Path Considering Carbon Emission, Mathematics Practice and Theory, vol.46, pp.62-68, 2016.

[10] Li Changbing, Wang Erjing, Yuan Jiabin. Research on Logistics Distribution Path Optimization of Fresh Agricultural Products under the Environment of Internet of Things, Commercial Research, vol.4, pp.1-9, 2017.

[11] Wu Shuping, Yu Baoqin. Research on the Cooperative Development Path of E-commerce and Express Logistics, Management Review, vol.28, pp.93-101, 2016.