# Research on Vehicle Routing Problem of Fresh Product Distribution Based on Carbon Emission

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***Abstract***

*Considering the time sensitivity and perishability of fresh products, and the carbon emissions of distribution vehicles in the process of product distribution, the formula for calculating the carbon emissions of fresh products is improved, and a multi-objective mixed integer programming model with the minimum carbon emissions and distribution costs as the optimization objectives is established. The main objective method and artificial bee colony algorithm are used to solve the example, and the simulation with MATLAB software confirms the scientificityand validity of the model. This paper provides important theoretical support and practical ideas for improving the distribution route planning model and distribution network optimization method of fresh products.*

**Key words**—*Vehicle routing optimization; Carbon emissions; Fresh products; Artificial bee colony algorithm; Main objective method.*

## I. INTRODUCTION

In recent years, environmental problems such as global warming and air pollution caused by excessive carbon emissions have attracted people's attention. How to reduce carbon emissions has become a worldwide problem, and all countries are facing severe challenges. According to the World Meteorological Organization's bulletin, the average global carbon dioxide concentration in 2016 was 403.3 parts per million, the highest level in nearly one million years. As China's position in the global economy and society becomes more important, environmental problems such as the greenhouse effect caused by high carbon emissions in China are increasingly prominent. In 2016, China's total carbon dioxide emissions exceeded 10 billion tons, accounting for about 30% of global emissions. This also indicates that the increase in total carbon dioxide emissions will become an important factor restricting the green and rapid development of China's economy[1]. Based on this, the Chinese government has also set a goal of achieving a 40%-50% reduction in the carbon emissions per unit of GDP by 2020[2].

Vehicle Routing Problem (VRP) is one of the important research directions of logistics optimization[3], and with the gradual deepening of the concept of sustainable development and the implementation of a number of energy-saving and emission reduction policies, carbon emissions in logistics distribution operations It has also become a key issue that logistics companies have to solve[4], and many companies will consider this factor when formulating the distribution path. Most scholars who are currently studying vehicle routing problems considering carbon emissions focus on adding carbon emission factors into the consideration of distribution costs, and establishing a VRP model with the lowest distribution cost, such as Liu

Xiu[5] based on the cold chain of agricultural products. Logistics has the characteristics of high energy consumption and high carbon emission. It uses the national carbon tax policy to convert carbon emissions into corresponding economic costs, and constructs a mathematical model for the optimization of urban agricultural product cold chain distribution path from a low-carbon perspective; Zhang Ruyun and Liu Qing[6] based on the traditional TDVRP, a model of urban vehicle distribution problem considering low carbon, energy saving and cost saving is constructed, and the minimization of low cost, energy saving and cost saving is taken as the optimization target to plan the vehicle path. Some scholars have minimized carbon emissions to a single optimization goal, such as Li Zhenping and Yang Mengyue[7] considering the vehicle's own weight and load, vehicle travel distance, etc.

Aiming at the problem that the optimization target has certain one-sidedness in the above literature, this paper adds carbon emission factors and fuzzy time windows to the traditional VRP problem, and establishes a multi-objective VRP model with the minimum carbon emission and the lowest distribution cost as the optimization target. The distribution of fresh products is the research object, and at the same time, the efficient algorithm is designed. The feasibility of the model and algorithm is verified by the actual case of a fresh milk distribution company H company.

## II. DESCRIPTION of the PROBLEM

A fresh enterprise arranges for the same car to depart from the same distribution center, and then delivers the customer points in turn. All customer points are serviced once and all vehicles are returned to the distribution center. The location coordinates of the distribution center, the main product parameters, the number of delivery vehicles and vehicle parameters, as well as the location coordinates, demand and service time windows of each customer point are known. Under the conditions of satisfying customer demand, maximum load capacity and driving distance limit, the distribution route of each vehicle is arranged to minimize carbon emission, lowest distribution cost and highest customer satisfaction.

To simplify the problem, make the following assumptions:

1) The location coordinates, demand and ideal service time windows of each customer point are known and remain unchanged;

2) The distribution center is the distribution starting point of each delivery vehicle, passing through each customer point and finally returning to the initial distribution center;

3) The total customer demand on the distribution line providing delivery services for each distribution vehicle shall not exceed the maximum cargo capacity of the vehicle;

4) The total delivery distance of each delivery vehicle may not exceed the maximum limit travel distance of the vehicle, and the travel speed of each delivery vehicle remains unchanged;

5) The starting cost of each delivery vehicle is fixed, and the cost required for the unit driving distance is known and unchanged;

6) The distribution center has sufficient cargo and no shortage of goods is allowed.

## III.MULTI-OBJECTIVEMIXEDINTEGERPROGRAMMINGMODEL

### A. Symbol Description

Table I

Symbol Description

| Symbol | Meaning |
|---|---|
| $m$ | the set of vehicles |
| $n$ | the set of customer point |
| $d_{ij}$ | distance between demand points $i$ and $j$ |
| $L_k$ | maximum delivery distance of vehicle $k$ |
| $c_d$ | transportation cost per unit distance |
| $c_q$ | unit price of fresh produce |
| $V$ | the volume of the compartment of the |

| | |
|---|---|
| | delivery vehicle |
| $l_t$ | worker unloading efficiency $(kg/\min)$ |
| $T_m$ | outside temperature of the cabin $(k)$ |
| $S_m$ | external surface area of the carriage $(m^2)$ |
| $\delta$ | door degree factor of the door at the service demand point |
| $G_d$ | heat load during vehicle travel |
| $cz_d$ | cooling costs consumed during vehicle travel |
| $t_0$ | time when the vehicle departs from the distribution center |
| $[ET_i, LT_i]$ | expected service time for demand point $i$ |
| $S_{ike}$ | vehicle $k$ is the starting time of the customer point $i$ service |
| $\alpha_1$ | the penalty factor for the delivery time of the delivery vehicle before the time period requested by the customer |
| $P_i(S_{ik})$ | time penalty cost for the car $k$ to serve the customer point $i$ |
| $E$ | vehicle carbon emissions |
| $\beta_1$ | percentage of cargo loss per unit of fresh product during vehicle delivery |
| $M_i$ | the quality of the fresh product left in the vehicle when the vehicle reaches the demand point $i$ |
| $k$ | vehicle, $k \subset [1, m]$ |
| $i, j$ | indicates demand point when $i, j \subset [1, n]$ while express distribution center when $i, j = 0$ |
| $t_{ij}$ | delivery time from demand point $i$ to demand point $j$ |
| $c_0$ | fixed cost per delivery vehicle |
| $q_i$ | demand of demand point $i$ |
| $p$ | unit cost of refrigerant |
| $Q$ | maximum load of the vehicle |
| $R$ | thermal conductivity in the cabin $(W/(m^2 \cdot k))$ |
| $T_n$ | interior temperature of the cabin $(k)$ |
| $S_n$ | inner surface area of the carriage $(m^2)$ |
| $\eta$ | damage to the carriage |
| $G_o$ | the heat load of the vehicle when the door is opened |
| $cz_o$ | the cost of cooling consumed when the vehicle opens the door |
| $t_j$ | when the vehicle arrives at customer point $i$ |
| $S_{ik}$ | service start time of vehicle $k$ at demand point $i$ |
| $S_{ikl}$ | end time of vehicle $k$ service for customer points $i$ |
| $\alpha_2$ | penalty factor when the delivery time is later than the time period requested by the customer |
| $u$ | fuel carbon emission coefficient $(kgco_2/L)$ |
| $f$ | fuel consumption per kilometer |
| $\beta_2$ | per unit time loss ratio of fresh products when loading and unloading vehicles |
| $c_{21}$ | carbon emissions from refrigeration of unit weight per unit of weight during transportation |
| $c_{22}$ | carbon emissions from unit-weight cargo cooling at the time of loading and unloading |
| $\beta$ | Customer sensitivity to time, $\beta > 0$ |
| $x_{ijk} = \begin{cases} 1, & \text{vehicle k goes from demand point i to j} \\ 0, & \text{otherwise} \end{cases}$ | |
| $y_{jk} = \begin{cases} 1, & \text{vehicle k serves demand point i} \\ 0, & \text{otherwise} \end{cases}$ | |

### B. Optimization Objectives

#### 1) Minimum Total Cost

Let $C$ be the total cost of vehicle distribution, $C_0$ is the fixed cost, $C_v$ is the variable cost, $C_l$ is the wear cost, $P_i(S_{ik})$ is the time penalty cost; $C_z$ is the cooling cost, and the lowest vehicle total cost $C$ is the objective function, the expression as follows:

$$\min C = C_0 + C_v + C_l + P_i\left(S_{ik}\right) + C_z \tag{1}$$

Among them, the formula for calculating the fixed cost of formula (1) is:

$$C_0 = \sum_{j=1}^{n} y_{jk} \cdot c_0, k = 1, 2, \ldots, m \tag{2}$$

The variable cost is calculated as:

$$C_v = \sum_{i=0}^{n} \sum_{j=1}^{n} \sum_{k=1}^{m} d_{ij} c_d x_{ijk} \tag{3}$$

The cost of wear includes the cost of the vehicle when it is running and the cost of the vehicle when it is unloaded. The formula is:

$$C_l = c_q \cdot \sum_{k=1}^{m} \sum_{j=1}^{n} y_{jk} \left[ \alpha_1 \left(t_j - t_0\right) + \alpha_2 \frac{q_j}{l_t} \right] M_j \tag{4}$$

The time penalty cost $P_i(S_{ik})$ is calculated as:

$$P_i\left(S_{ik}\right) = \begin{cases} \alpha_1 q_i \left(ET_i - S_{ike}\right) & S_{ike} < ET_i \\ 0 & ET_i \le S_{ike}, S_{ikl} \ge L \\ \alpha_2 q_i \left(S_{ike} - LT_i\right) & S_{ike} > LT_i \end{cases} \tag{5}$$

The cooling cost $C_z$ includes the cooling cost $C_{zd}$ of the vehicle while driving and the cooling cost $C_{zo}$ of the vehicle when opening the door. The calculation formula[10] is:

$$\begin{aligned} C_z &= C_{zd} + C_{zo} \\ &= \sum_{k=1}^{m} \begin{Bmatrix} (1+\eta) \cdot R \cdot \sqrt{S_m \cdot S_n} \cdot \left(T_m - T_n\right) \cdot \sum_{i=0}^{n} \sum_{j=1}^{n} [t_{ij} + \max(0, ET_i - t_i)] \cdot p + \\ \left(0.54V + 3.22\right) \cdot \left(T_m - T_n\right) \cdot \delta \cdot \sum_{i=0}^{n} \frac{q_i}{l_t} \cdot p \end{Bmatrix} \end{aligned} \tag{6}$$

2) ***Minimum Carbon Emissions***

With the minimum carbon emission as the objective function, the known carbon emissions are directly proportional to the fuel consumption.

$$\begin{aligned} \min E &= E_1 + E_2 \\ &= u \cdot \sum_{i=0}^{n} \sum_{j=1}^{n} \sum_{k=1}^{m} x_{ijk} d_{ij} f + \sum_{i=0}^{n} \sum_{j=1}^{n} \sum_{k=1}^{m} x_{ijk} \left(Q - q_i\right)\left[d_{ij} c_{21} + t_i c_{22}\right] \end{aligned} \tag{7}$$

Among them, the formula (7) indicates the minimum carbon emission, $E_1$ is the carbon emission when the vehicle is transported, and $E_2$ is the carbon emission of the refrigeration equipment.

### *C. Constraints*

$$\sum_{i=1}^{n} q_i y_{ik} \le Q, \ k = 1, 2, \ldots, m \tag{8}$$

$$\sum_{k=1}^{m} y_{ik} = 1, \ i = 1, 2, \ldots, n \tag{9}$$

$$\sum_{k=0}^{m} y_{0k} = 1 \tag{10}$$

$$\sum_{j=1}^{n} x_{0jk} = 1, \ k = 1, 2, \ldots, m \tag{11}$$

$$\sum_{i=1}^{n} x_{i0k} = 1, \ k = 1, 2, \ldots, m \tag{12}$$

$$\sum_{i=0}^{n} x_{ijk} = y_{jk}, \ j = 1, 2, \ldots, n, \ k = 1, 2, \ldots, m \tag{13}$$

$$\sum_{j=0}^{n} x_{ijk} = y_{ik}, \ i = 0, 1, \ldots, n, \ k = 1, 2, \ldots, m \tag{14}$$

$$\sum_{i=0}^{n} \sum_{j=1}^{n} d_{ij} x_{ijk} \le L_k, \ k = 1, 2, \ldots, m \tag{15}$$

$$\begin{aligned} &S_{ike} + t_i x_{ijk} + t_{ij} x_{ijk} - M\left(1 - x_{ijk}\right) \le S_{jke}, \\ &i = 0, 1, \ldots, n, \ j = 1, 2, \ldots, n, \ k = 1, 2, \ldots, m \end{aligned} \tag{16}$$

$$\begin{aligned} &S_{ikl} + t_{ij} x_{ijk} - M\left(1 - x_{ijk}\right) \le S_{jke}, \\ &i = 0, 1, \ldots, n, \ j = 1, 2, \ldots, n, \ k = 1, 2, \ldots, m \end{aligned} \tag{17}$$

$$S_{ikl} = S_{ike} + t_i y_{ik}, \ i = 0, 1, \ldots, n, \ k = 1, 2, \ldots, n \tag{18}$$

$$S_{ike} \le M y_{ik}, \ i = 0, 1, \ldots, n, \ k = 1, 2, \ldots, m \tag{19}$$

$$S_{ike} \ge 0, \ S_{ikl} \ge S_{ike}, \ i = 0, 1, \ldots, n, \ k = 1, 2, \ldots, m \tag{20}$$

$$S_{0ke} = 0, \ S_{0kl} = 0, \ k = 1, 2, \ldots, m \tag{21}$$

$$\begin{aligned} &x_{ijk} = \begin{cases} 1, & \text{vehicle k goes from demand point i to j} \\ 0, & \text{otherwise} \end{cases}, \\ &i = 0, 1, \ldots, n, \ j = 1, \ldots, n, \ k = 1, \ldots, m \end{aligned} \tag{22}$$

$$y_{jk} = \begin{cases} 1, & \text{vehicle k serves demand point i} \\ 0, & \text{otherwise} \end{cases}, \qquad (23)$$

$$i = 0,1,\ldots,n,\ k = 1,\ldots,m$$

Where, formula (8) indicates that the total demand of each demand point cannot exceed the total supply of the distribution center; formula (9) indicates that there is one and only one vehicle for each demand point; and equation (10) indicates that all vehicles are departing from the distribution center. Equation (11) indicates that there is one and only one vehicle for each demand point; Equation (12) means that each vehicle must return to the distribution center; Equation (13) indicates that if the vehicle reaches demand point $j$ , it must be serviced. Equation (14) indicates that if the vehicle k is serving the demand point $i$ , the end of the delivery must issue the next demand point from $i$ ; the equation (15) indicates that the travel distance of each vehicle cannot exceed the maximum distance of the vehicle; (16) and (17) indicate that the last two expressions represent the time relationship between the delivery vehicle k and the demand point $i$ and the demand point $j$ ;and the equation (18) represents the start and end time of the delivery vehicle $k$ serving the demand point $i$ ; (19) indicates that if the delivery vehicle k does not serve the demand point $i$ , the delivery vehicle k does not reach the demand point $i$ ; the formula (20) indicates the start and end time limit of the delivery vehicle k serving the demand point $i$ ; and the formula (21) indicates the delivery Vehicle from Center starting time is zero time; formula (22) and (23) for the decision variables.

## IV. SOLVINGALGORITHmM

### *A. Main Target Method*

For the multi-objective optimization model, the multi-objective optimization problem is usually transformed into a single-objective optimization problem by the main target method and the linear weighting method, and then solved. According to the characteristics of this model, this paper adopts the main target method, with one of the minimum total distribution cost and the minimum carbon emission of the vehicle as the main target, and the other target can meet certain constraint requirements. How to select the main objective function mainly depends on the strategic planning of the fresh e-commerce enterprise. If the enterprise pursues the minimum total cost of distribution, the minimum total cost of distribution can be used as the main target and the carbon emission of the vehicle can be used as a constraint to solve the model[11], and if the carbon emission of the vehicle is the minimum target under the low-carbon policy, the total distribution cost is taken as a constraint. Taking the example of the company's pursuit of the minimum total distribution cost, the minimum carbon emission of the vehicle is as follows:

$$E \le E_{\max} \qquad (24)$$

Among them, $E_{\max}$ is the maximum threshold for the company's carbon emissions to vehicles. The value of $E_{\max}$ can be formulated according to the company's own strategic planning or policy requirements, and must meet the relevant requirements of carbon emissions.

### *B. Artificial Bee Colony Algorithm*

The vehicle routing problem studied in this paper is NP-hard problem. The traditional solution method is complex and computationally intensive, and it needs to be solved by heuristic algorithm. The Artificial Bee Colony Algorithm (ABC) was first proposed by the Turkish scholar Karaboga[12] in 2005. It is a bionic intelligent calculation method that simulates the bee colony's search for excellent honey sources. The artificial bee colony algorithm has the advantages of fewer parameters and easy adjustment, so that the operation is simple and easy to implement in solving the practical problem. The artificial bee colony algorithm is summarized into the following steps[13]:

***Step 1*** The generation of the initial population. In the population search space, $N$ solutions $\{x_1, x_2, \ldots, x_N\}$ are randomly generated to construct the initial population, where $N$ is the number of honey sources, and the dimension of each solution is $D$ .

***Step 2*** Population update. When a honey bee collects honey at a honey source, it searches for the next food source near the food source, and then chooses to retain the food source with high profitability according to the degree of profit. Follow the bee to observe the information about the profitability of the honey source brought by the bee, follow the probabilistic method to follow the bee to the honey source, follow the bee to select the food source to collect honey, and then find new food near the food source. The source, then the profitability comparison, retains the food source with high profitability. The food source update formula in the above two stages is as shown in the following formula (25):

$$v_{ij} = x_{ij} + \delta\left(x_{ij} - x_{kj}\right) \tag{25}$$

Where: the new food source orientation is recorded as $v_{ij}$ , the original food source orientation is recorded as $x_{ij}$ , and the neighborhood food source of the randomly selected original food source is recorded as $x_{kj}$ . $\delta$ represents a random number and $\delta \in [-1,1]$ . Among them, $k, i \in \{1, 2, 3, \ldots, N\}$ and $j \in \{1, 2, 3, \ldots, D\}$ .

***Step 3*** Honey source selection. The profitability of the food source is an important basis for following the bee's selection. The profitability corresponds to the probability that the food source is selected, and the probability formula is as shown in equation (26). The probability that the food source is selected increases as the value of the profit increases, which means that if the value of the profit decreases, the probability of the food source being selected decreases. The probability selection formula is:

$$P_i = \frac{fit_i}{\sum_{i=1}^{N} fit_i} \tag{26}$$

The quality of the food source is recorded as $fit_i$ , which is the value of the profit of the $i$ solution. The formula for $fit_i$ is:

$$fit_i = \begin{cases} 1 + |f_i|, & f_i < 0 \\ \dfrac{1}{1 + f_i}, & f_i \geq 0 \end{cases}, i = 1, 2, \ldots, N \tag{27}$$

$f_i$ represents the objective function in the real vehicle path optimization problem. Calculate the food source profitability obtained from this iteration and the food source profitability of the previous generation. According to the comparison of the profitability, select a food source with a relatively large value and retain it.

***Step 4*** The population is eliminated. The food source profitability does not change after iterating *limit* times (or following the bee) iteratively, then it can be determined that the current solution (food source) is in a local optimum. The bee (or follow the bee) will abandon this solution and convert it into a scouting bee to continuously search for a new food source. The search formula is as shown in equation (28):

$$x_{ij} = x_{\min j} + rand\,[0,1]\left(x_{\max j} - x_{\min j}\right) \tag{28}$$

Where, $x_{\max j}$ and $x_{\min j}$ represent the individual maximum and the individual minimum respectively.

***Step 5*** Iterative optimization. Repeat steps 2-4 until the maximum number of iterations is reached.

## V CASEANALYSIS

A fresh milk distribution company H company has a distribution center, which needs to serve 16 customer points every day. Assuming that the coordinates of the distribution center are (0,0) , and the milk production in the distribution center is sufficient, there will be no shortage of goods. The yard has 10 delivery vehicles with a load capacity of 2.5 tons and a maximum delivery distance of 500 kilometers. They all start to deliver milk from the distribution center at the moment. The fixed cost of starting each delivery vehicle is 50 yuan, the transportation cost per kilometer is 2 yuan, the fuel consumption per 100 kilometers is 7 liters, and the cooling cost is 18 yuan per kilometer. The coordinates, demand and expected service time window of 16 customer points are shown in Table 2.

**Table 2**

**Customer Information at the Demand Point**

| **Demand Point** | **X** | **Y** | **Demand** | **Expected Service Time Window** | **Service Minutes** |
|---|---|---|---|---|---|
| 1 | 2.43746 | -0.6322 | 2557 | [60,90] | 20 |
| 2 | 2.51656 | -2.29112 | 1964 | [30,120] | 50 |
| 3 | 1.52794 | -0.59728 | 5217 | [30,90] | 30 |
| 4 | 3.77046 | -2.23562 | 1536 | [60,90] | 20 |
| 5 | 2.02992 | -1.07582 | 3262 | [90,120] | 40 |
| 6 | 1.3307 | -1.1391 | 10527 | [0,120] | 20 |
| 7 | 1.60352 | -1.2203 | 8177 | [0,90] | 30 |
| 8 | 1.74026 | -0.4256 | 5084 | [30,180] | 60 |
| 9 | 1.29162 | -1.18792 | 660 | [0,90] | 20 |
| 10 | 1.28136 | -1.72716 | 720 | [0,150] | 20 |
| 11 | 1.18382 | -0.2365 | 1050 | [30,150] | 40 |
| 12 | 2.5491 | -2.51826 | 8781 | [20,100] | 20 |
| 13 | 1.4239 | -1.44078 | 1760 | [30,120] | 10 |
| 14 | 0.97122 | 0.24102 | 178 | [0,90] | 10 |
| 15 | -0.6145 | 2.67648 | 1149 | [30,60] | 10 |
| 16 | -0.65616 | 1.70528 | 2520 | [60,210] | 15 |

In the case of demand determination, the lowest total cost of distribution and the lowest carbon emission of the vehicle are the main objectives, and other targets are transformed into constraints to solve. In this paper, Matlab software is used for simulation, and the artificial bee colony algorithm is programmed to solve the above case programming results. Among them, the main parameters of the artificial bee colony algorithm are: population size $NP = 50$ , food quantity (that is the number of bees collected) $FoodNumber = NP / 2$ , single maximum *limit*=20, maximum iteration number $MaxCycle = 2000$ , in the CPU Inter i5-4210M, running on a Windows system with a frequency of 2.6G Hz. Get the distribution decision plan, including the total cost of the plan and the carbon emissions of the vehicle, as shown in Table 3.

The two non-inferior solutions in Table 3 indicate that there is an inverse relationship between the lowest total cost of distribution and the lowest carbon emissions. For example, if the total cost of distribution is required to be the smallest, the distribution of vehicles will be minimized, and the delivery time and distribution distance will be increased, resulting in a relative increase in carbon emissions. If the minimum carbon emissions are required, the distribution route will be first distributed. The demand point causes a relatively high total cost.

**Table 3**

**Comparison of Results Under Different Main Targets**

| **Main Target** | **Total Cost / yuan** | **Carbon Emissions / kg** | **Distribution Plan** |
|---|---|---|---|
| Minimize Total Cost | 37760.56 | 3117.36 | Path 1 : 0-5-10-15-14-13-7-0 |
| | | | Path 2 : 0-16-6-0 |
| | | | Path 3 : 0-8-2-12-9-11-3-1-4-0 |
| Minimize Carbon Emissions | 42286.18 | 3085.307 | Path 1 : 0-11-8-3-1-4-12-9-0 |
| | | | Path 2 : 0-5-6-0 |
| | | | Path 3 : 0-16-15-14-0 |
| | | | Path 4 : 0-7-13-10-2-0 |

By comparing and analyzing the above values, we can see that when the minimum total cost of distribution is the main goal, the total cost is about 11% lower than the case with the lowest carbon emission as the main target, and the carbon emissions are The increase is about 1%; on the contrary, when the minimum carbon emission is the main goal, the total cost increases by 12%, while the carbon emissions decrease by about 1%. For companies, when the carbon emissions are reduced by about 1% but the cost is increased by 12%, it may be possible to choose a solution that is conducive to enterprise development, that is, to choose a lower cost solution. However, if the government increases relevant considerations in terms of carbon emissions in the future, such as the addition of a carbon tax, companies must also take into account the cost of carbon tax and then make choices. In summary, the value calculated by the model allows companies to choose the solution that suits them according to their own strategies and national development requirements. Therefore, the model has certain advantages.

## VI CONCLUSIONSANDPROSPECTS

In this paper, combined with the high timeliness of the fresh product distribution process and the fragility of fresh products, the time penalty function is set, and the distribution of fresh products is improved by taking into account the carbon emissions and distribution costs incurred during the distribution process. The calculation formula for carbon emissions. On this basis, a multi-objective mixed integer programming model with minimum carbon emission and lowest distribution cost is established. The main target method and the artificial bee colony algorithm are used to solve the calculations, which proves the scientificity and effectiveness of the model. At the same time, the main target method applied in this paper makes the results of the comparison comparative, which can provide fresh enterprises with strategic choices in strategy formulation. Considering that the current state focuses on environmental protection and green development, a series of measures are being taken to reduce China's carbon dioxide emissions. In the future, if measures are taken against related companies, such as the addition of a carbon tax, the calculation of costs in this model can be enriched, which is the part that will be considered later in this paper. In summary, this paper enriches the distribution model of fresh product distribution path, which provides a new theoretical basis for VRP, and has certain practical significance and application value.

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