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Optimal Path Analysis of Fresh Food Logistics and Distribution in 5G Internet of Things Environment

Xin Zhang[1, ✉]

[1.] College of Business, Jiaxing University, Jiaxing, Zhejiang, 314001, China

ABSTRACT
Fresh items have become an essential necessity for modern people, and the daily diet structure is growing more and more rich as people's attention to health increases. One of the characteristics of fresh products is that they are hard to retain at room temperature. As a result, IoT logistics technology assistance is frequently needed in logistics linkages including distribution, transportation, and warehousing. Through the scientific and logical planning of the route of fresh food logistics distribution vehicles, this paper aims to effectively lower the overall economic cost of logistics distribution, guarantee the freshness of the fresh food distribution process, satisfy the various individualized needs of customers for delivery time, and enhance logistics distribution. security. This study suggests an enhanced ant colony algorithm in artificial intelligence that can efficiently determine the shortest path. This algorithm can be used to find the best route for new logistics distribution and lower transportation losses. It is based on 5G Internet of Things technology. The ant colony method prior to the enhancement had the longest optimization time of 25. 06 seconds in the 8 search process, according to the experimental data presented in this study. The enhanced ant colony algorithm had the longest optimization time of 17. 89 seconds. In finding the optimal path, after the improvement, the ant colony algorithm takes less time. In the comparison of transportation costs, the cost of the improved ant colony algorithm is reduced by about 1, 100 yuan, the vehicles required are less than those of the ant colony algorithm before the improvement, and the decay rate is also reduced a lot. It can be seen that the improved ant colony algorithm is more suitable for the analysis of the optimal path of fresh logistics distribution.

Keywords: Fresh Logistics Distribution, Ant Colony Algorithm, 5G IoT, Optimal Path Problem

1. Introduction

With the rapid development of China's economy and the continuous improvement of people's living standards, consumers' demand for fresh food and other cold chain food is also increasing. With the deepening of the degree of informationization and the enhancement of the timeliness of demand,

✉ Corresponding author.
E-mail address: zcxin9@163.com (X. Zhang).
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people can not only realize the purchase of fresh products offline, but also enrich the purchase channels of various small programs and apps [1-4]. At the same time, the accessibility of various means of transportation is getting higher and higher, people's travel time is greatly shortened, and people's demand for the timeliness of logistics and distribution is also getting higher and higher, but nowadays the development of the logistics industry still exists the problem of low distribution efficiency and high cost [5-8]. Fresh food is rich in categories, including fresh fruits and vegetables, milk, meat, aquatic products and so on. Fresh food is characterized by easy deterioration and decay, which makes the transportation and distribution process more difficult than that of general commodities. Relevant government documents show that the food safety and distribution of fresh food has been increasingly emphasized at the national level, and relevant legal provisions have been adopted to promote the development and quality protection of fresh food [9-13].

Due to the unique food characteristics of fresh food, its shelf life is generally shorter, and for the preservation of temperature and humidity has high requirements, it is difficult to be preserved at room temperature. Therefore, fresh food in storage, transportation, distribution and other aspects of transportation vehicles and temperature and humidity hardware equipment have high requirements [14-16]. At present, China's cold chain logistics infrastructure development level is still not high, the cold chain distribution process is still very imperfect, and the efficiency of the transportation link is low [17-18]. According to relevant information, in developed countries, the circulation rate of fresh fruits and fresh agricultural meat reaches more than 93%. At present, nearly more than half of the time and cost in the commodity circulation of fresh products occurs in the transportation and distribution [19-20]. China's fresh food cold chain logistics and distribution still exists "distribution and transportation costs remain high, affecting the efficiency of business development", "fresh food distribution facilities and equipment are backward, the rate of food spoilage is high, food waste is serious", "low customer satisfaction, poor time window fulfillment rate" and other problems [21-22]. Therefore, it is very important research significance to optimize the existing fresh food logistics and distribution paths in order to improve the distribution efficiency and distribution quality, reduce the time cost and operation cost, and improve the customer satisfaction and the business results of enterprises [23-25].

With the continuous development of global information technology, the fifth generation communication technology (5G) has gradually appeared in people's vision. The circulation mode of fresh products in the Internet environment is to rely on Internet technology, transform the traditional delivery mode into an information mode, and use technology to guide logistics and delivery. Compared with other countries, China's logistics has a relatively slow start of research and development of low-temperature logistics, backward refrigeration and preservation technology, and a relatively lack of professional talents, which lead to a great reduction in the freshness of fresh products during the distribution process. Among all the links of logistics, the planning of the delivery vehicle route is a crucial link, which has the most direct impact on the total economic cost of logistics, the quality of delivery and customer satisfaction. The innovation of this paper is that based on the Internet of Things environment, the ant colony algorithm is proposed and improved. The traditional fresh food logistics distribution method is introduced, the improved ant colony algorithm is applied to the optimal path of fresh food logistics distribution, and experiments are carried out.

2. The Application of Ant Colony Algorithm based on the Internet of Things in the Optimal Path of Logistics Distribution

2.1. Logistics and Distribution Mode of Fresh and Fresh Products in the Internet of Things Environment

Since fresh food cannot be kept fresh at room temperature, it must be transported from the point of origin to the consumer terminal utilizing low-temperature logistics, which frequently calls for logistics technical assistance in a number of linkages, including distribution, transportation, and warehousing. Food safety has become very important to the nation and its citizens in recent years due to the regular food safety issues. The traditional fresh logistics distribution mode is shown in Figure 1:

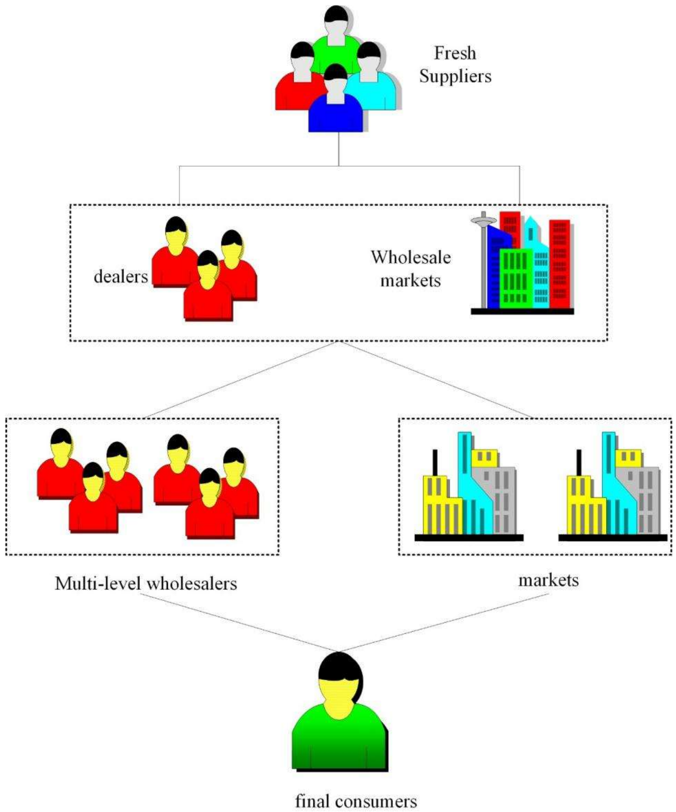


Fig. 1. Traditional fresh product logistics and distribution mode

As shown in Figure 1: Fruits and vegetables and other foods are indispensable in people's daily life, and their quality and safety are directly linked to consumers' health and nutritional balance. Therefore, how to ensure the quality and quantity and distribute fresh food according to the requirements of customers is very important for fresh food merchants. However, facing the constraints of many factors such as business scale, business philosophy, equipment resources, etc, the transportation of fresh food in China has experienced many dangers and tests in the process of growth.

The fresh product circulation link connects the complete fresh product supply chain and is an important link in the fresh product industry chain. GPS, RFID, sensors and other technologies can realize all-weather tracking and positioning of vehicles, monitor the status of transit products in real time, and realize truly intelligent and visualized logistics. The logistics distribution mode in the IoT environment is shown in Figure 2:

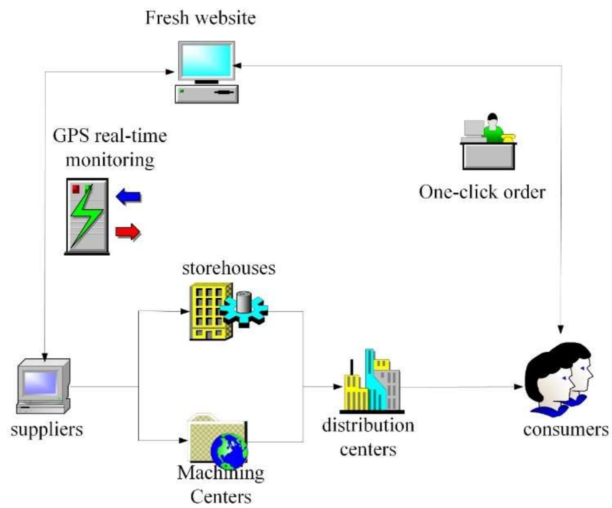


Fig. 2. Logistics distribution mode in the IoT environment

As shown in Figure 2: GPS technology is used to correctly track and locate the vehicle position, understand the vehicle transportation status in real time, and take quick action in case of emergency. RFID technology can capture product information in real time, avoid product loss, and ensure that products arrive at their destination without error. A variety of sensing technologies can collect environmental information of fresh products in real time, allowing employees to monitor and change the temperature and humidity in the compartment in real time, thereby ensuring product quality.

2.2. Classic Vehicle Path Optimization Problem

Vehicle routing optimization problem (VRP) refers to the premise that when the number of service customers is constant and the quantity of goods ordered by each customer is also unchanged, one or several dispatch centers will deliver and transport these customers. As shown in Figure 3:

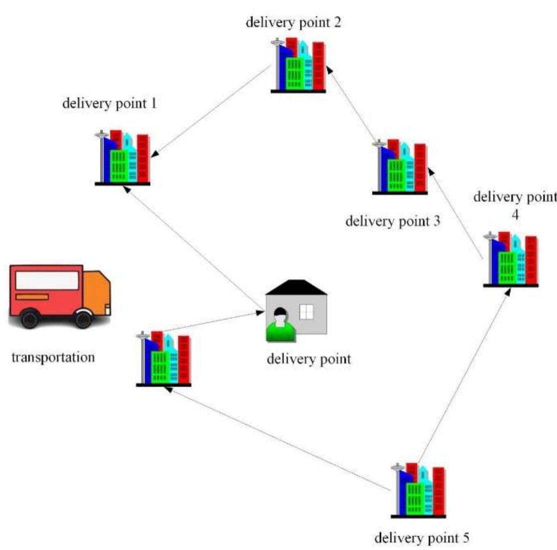


Fig. 3. VRP schematic

As shown in Figure 3: The delivery task is assigned to one of the fleets to be completed. These vehicles need to formulate a complete delivery route. Under the constant constraints, the purpose of achieving the satisfaction of each customer should be taken into account. At the same time, the shortest delivery route and transportation The transportation standard with the lowest cost and the least transportation time.

In this paper, the time window is fuzzified to adapt to the actual time demand of consumers as in Equation 1:

$$U(S_i)=\left(\frac{S-EET_i}{ET_i-EET_i}\right)^{\beta} \tag{1}$$

Customer service starts at S_i. In order to avoid the loss of customers due to poor service, it is assumed that each customer has a minimum service level parameter, and the satisfaction of each customer is guaranteed as formula 2:

$$g(i,\theta)=\left(\frac{ELT_i-S_i}{ELT_i-LT_i}\right)^{\beta} \tag{2}$$

When satisfying customer i with θ minimum satisfaction of a, the service start time is Equation 3:

$$Sup(i,\theta)=g_i^{-1}(i,\theta)=\theta^{\frac{1}{\beta}}\cdot LT_i+\left(1-\theta^{\frac{1}{\beta}}\right)\cdot ELT_i \tag{3}$$

Customer satisfaction $Sup(i,\theta)$ will be affected by factors such as the punctuality, correctness and integrity of the fresh product distribution organization. If there is a problem in transportation, the overall consumer satisfaction will also decrease. Conversely, the overall customer satisfaction is ideal only when each customer obtains the best time satisfaction, and the satisfaction objective function is Equation 4:

$$s_1=\sum_{i=1}^{n}g_i\sqrt{\prod_{i}^{n}U(S_i)^{g_i}} \tag{4}$$

By incorporating Internet of Things technology into the fresh product circulation process, fresh product loss can be minimized by automatically adjusting the temperature and monitoring it in real time. However, this study suggests an ant colony algorithm for logistics distribution path optimization because typical truck route optimization necessitates numerous calculations that cannot satisfy the demands of quick calculation.

2.3. Logistics Distribution Path Optimization based on Basic Ant Colony Algorithm

By observing real ant colonies in nature, scholars found that when ants are searching for food in their burrows, they will release special secretions-pheromones on the ground. The shortest route between the cave and the food source is finally found. The ant colony algorithm to find the shortest path is shown in Figure 4:

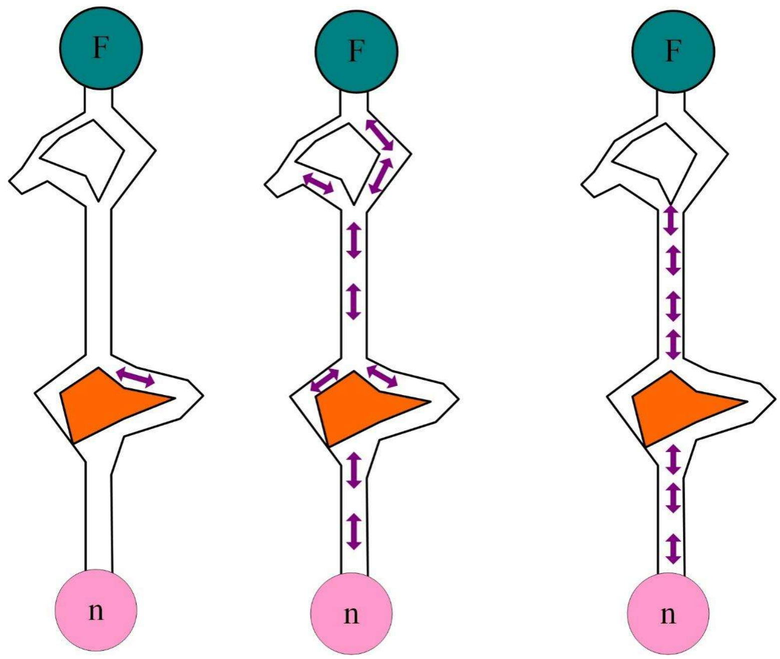


Fig. 4. Ant colony algorithm to find the shortest path

As shown in Figure 4, the ant colony algorithm realizes the search for the target through the simulation of ants, and its process is actually a simulation of the process of ant colony searching for food from the cave. Ant algorithm has been widely used in the well-known business travel problem and workpiece sorting, and has also penetrated into other problem areas such as graph coloring problem and vehicle scheduling problem.

At present, through careful observation of ants, experts have summarized several rules from the process of ants looking for food. Assuming that the number of demand points is n and the number of ants in the ant colony is m, then there is formula 5:

$$m=\sum_{i=1}^{n} b_i(t) \tag{5}$$

Among them, $b_i(t)$ is the number of ants located at demand point i at time t, and satisfies Equation 6:

$$T=\{\tau_{ij}(t)\} \tag{6}$$

$\tau_{ij}(t)$ represents the pheromone concentration on the path (i,j) at time t.

Assuming that when the ant colony first seeks the shortest delivery route, the concentration of pheromone on each route is equal, and $\tau_{ij}(0)=0$, at this time, the probability of its transfer to the next node can be calculated as formula 7:

$$P_{ij}^{k}(t)=\frac{[\tau_{ij}(t)]^{\alpha}[\eta_{ij}(t)]^{\beta}}{\sum[\tau_{ij}(t)]^{\alpha}[\eta_{ij}(t)]^{\beta}} \tag{7}$$

$\eta_{ij}(t)$ is the visibility at time t, and the update rule of path pheromone intensity is as shown in Equation 8:

$$\Delta\tau_{ij}(t)=\sum_{k=1}^{m}\Delta\tau_{ij}^{k}(t) \tag{8}$$

$\Delta\tau_{ij}$ represents the increment of pheromone, and $\Delta\tau_{ij}(t)$ represents the amount of moving information. When there are enough ants, after such a large number of carpet searches, the pathfinding method can gradually converge and finally reach the global optimal solution.

2.4. Improvement of Ant Colony Algorithm

The advantage of ant colony algorithm is that it has strong adaptability and can solve a wide range of path optimization problems. But it also has disadvantages: computational complexity and long search time. In view of these shortcomings of ant colony algorithm, many scholars have done related research and proposed some improved ant colony algorithm.
1) Ant Colony System. The modified ant colony algorithm is called the ant colony system. Create a new constant with the value range $q_0 \in [0,1)$. Every time ant k chooses a path, a random number q is generated, and there exists q_0 to follow this random number, the ant's route will follow the following guidelines:

Assuming that the node where ant k is now is i, PP indicates that the rule that ant k follows from node i to node j is formula 9:

$$pp = \begin{cases} \arg\max\{[\tau_{ij}]^{\alpha}[\tau_{ij}]^{\beta}\}, q \le q_0 \\ P_{ij}^{k}, q \succ q_0 \end{cases} \tag{9}$$

The shortest path is used to update the global pheromone, and the specific update techniques are shown in Equations 10 and 11:

$$\tau_{ij} = (1\text{-}\rho) * \tau_{ij}(t-1) + \rho * \Delta\tau_{ij} \tag{10}$$

$$\Delta\tau_{ij} = \frac{1}{L_{best}} \tag{11}$$

$\Delta\tau_{ij}$ represents the pheromone increment on the path, ρ is the pheromone volatilization parameter, and L_{best} is the global optimal path. This paper also improves the local pheromone update strategy, as shown in Equation 12:

$$\tau_{ij}(t) = (1\text{-}\xi) * \tau_{ij}(t-1) + \xi * \tau_0 \tag{12}$$

τ_0 represents the pheromone concentration on the path when the algorithm is initialized; ξ is a tunable parameter.
2) Elite Ant Colony System. In order to solve the problem that the basic ant colony algorithm has a slow convergence speed and is difficult to generate an optimal solution, scholars have created an elite ant colony system. The specific enhancement work of the algorithm is as follows:

$$\tau_{ij} = (1\text{-}\rho) * \tau_{ij}(t-1) + \Delta\tau_{ij} \tag{13}$$

$$\Delta\tau_{ij} = \sum_{k=1}^{m} \Delta\tau_{ij}^{k} + \lambda\tau_{ij}^{best} \tag{14}$$

Equation 14 shows the pheromone-increasing strength technique, which is the same as the previous system and provides a parameter for adjusting the influence weight of the ideal solution.
3) Improvement of Pheromone Volatile Factor. The ant colony method has some drawbacks, including a lengthy search time and a propensity for premature convergence, despite its strengths in global optimization, tremendous adaptability, and strong positive and negative feedback. Currently, some researchers have improved the ant colony algorithm's current issues. To enhance the algorithm's performance, the pheromone volatility coefficient's value must be set sensibly.

The Ant-Cycle model's Ant colony algorithm is typically applied to real-world issue resolution. This study suggests a pheromone volatile factor with iteration to circumvent the issue that the algorithm has weak optimization capacity in the beginning stage and is prone to falling into a local optimum after achieving a better solution. As the number of times rises, the approach varies. The specific rules are as follows:

$$\rho=\begin{cases}0.2, if NC\in[0,0.25NC\_\max]\\ 0.3, if NC\in[0.25NC\_\max,0.75NC\_\max]\\ 0.5, if NC\in[0.75NC\_\max,NC\_\max]\end{cases} \quad (15)$$

The convergence rate was accelerated at the start of the iteration by using a smaller pheromone volatility coefficient, and in order to prevent local optimum, the value of the pheromone volatility coefficient was suitably raised in the middle and end stages.

4) Improvement of Heuristic Function (Visibility). The conventional rule network-global search network, or a fully connected transportation network graph (all nodes can be directly connected to each other), is where the majority of previous research on the VRP problem was conducted. There are instances in real life where two client nodes cannot be joined directly. This research suggests an improved ant colony algorithm for the VRP problem in the incompletely linked transportation network graph. In the event that nodes in the transportation network cannot be directly contacted, the shortest path algorithm (also known as the Dijkstra matrix algorithm) is added to preprocess the data.

The idea of the algorithm is to construct a distance matrix and store the weighted graph $G=\{V,E,L,W\}$ in the matrix $A=(a_{ij})_{n*n}$, which is defined as Equation 16:

$$a_{ij}=\begin{Bmatrix}0 & if i=j\\ l_{ij} & if w_{ij}=1\end{Bmatrix} \quad (16)$$

In this paper, considering that there is a disconnected state between nodes, the connection relationship factor w_{ij} is introduced to improve the visibility and indirectly improve the selection probability. The visibility in the ant colony algorithm is improved as formula 17:

$$\eta_{ij}=\begin{Bmatrix}\dfrac{1}{l_{ij}} & if w_{ij}=1\\ \dfrac{1}{d_{ij}} & if w_{ij}\neq 1\end{Bmatrix} \quad (17)$$

w_{ij} indicates whether node i and node j are directly connected, the distance l_{ij} between the nodes when they are directly connected is obtained by the distance formula of the given coordinates between the two points, and d_{ij} is obtained by the shortest path algorithm when they are not directly connected.

3. Results and Discussion of Fresh Food Logistics and Distribution

3.1. Investigation Results of Problems Existing in Fresh Products

Fresh products mainly include: meat, fresh fruits and vegetables, aquatic products, cooked food, fresh milk, etc. After such products are transported from the place of origin to the terminal, they can be sold or eaten directly after simple packaging. In recent years, the rapid development of the Internet has also greatly increased people's purchase of fresh products. However, fresh products are prone to damage and staleness during transportation, which is also an important reason why fresh food cannot be delivered to consumers in good condition.

As an important source of people's food structure, fresh food occupies a large market share. In recent years, the sales of fresh food have increased year by year, and it has become the category with the highest sales growth rate in chain supermarkets. The annual output and growth rate of fresh food from 2019 to 2023 are shown in Table 1 and Table 2:

Table 1. 2019-2023 Annual Fresh Production (10, 000 tons)

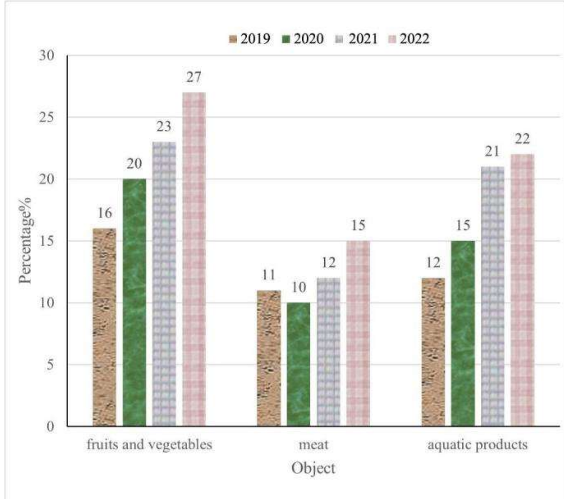
years/type	fruit	meat products	aquatic products
2019	578642	67908	56543
2020	620971	75640	65781
2021	890455	85623	78093
2022	1098900	90921	90982
2023	1233426	102756	109067

Table 2. Annual growth rate of fresh production from 2019 to 2023

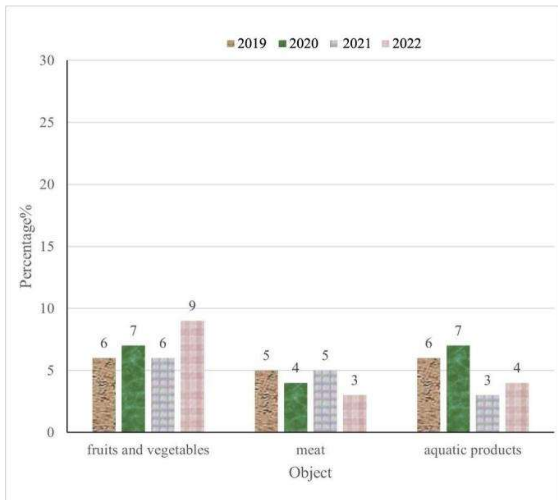
years/type	fruit	meat products	aquatic products
2019	22%	13%	18%
2020	21%	19%	14%
2021	18%	17%	12%
2022	23%	15%	13%
2023	25%	18%	16%
average growth rate	21. 8%	16. 4%	14. 6

As shown in Table 1 and Table 2: The huge consumption demand for fresh food has promoted the steady growth of the output of fresh products in China. According to statistics, the annual output of fruit from 2019 to 2023 increased from 5, 786. 42 million tons to 1, 233, 426 tons, with an average growth rate of 21. 8%; from 2019 to 2023, the annual output of meat products increased from 679. 08 million tons to 102, 756 tons, with an average growth rate of 16. 4%. From 2019 to 2023, the annual output of aquatic products increased from 565. 43 million tons to 109, 067 tons, with an average growth rate of 14. 6%. By calculating the year-on-year growth rate in recent years, it can be found that the annual output value of fresh food is increasing year by year, and with the improvement of the per capita GDP level, the market demand and supply of fresh food will also increase year by year.

Although the demand for fresh food in China is huge and the average annual output is at a relatively high level, due to the backward technology in cold chain transportation, storage, processing and other links, the rate of spoilage and loss of fresh food in logistics is relatively high. Taking fresh fruits and vegetables as an example, there is a phenomenon of spoiled fruits and vegetables every year. The spoilage rates of fresh fruits and vegetables in China and other countries are shown in Figure 5:



(a) The spoilage rate of fresh food transportation in China



(b) The spoilage rate of fresh food transportation in other countries

Fig. 5. Comparison of spoilage rates in fresh food transportation in China and other countries

As shown in Figure 5, the problems of fresh food in China are: such as unscientific logistics process management and immature cold chain preservation technology, these problems reduce the efficiency of fresh food distribution and lead to high spoilage loss rate. In addition, in terms of logistics cost control, China's fresh logistics costs are generally high, which is not only unfavorable for enterprises to control product prices, but may be indirectly passed on to consumers, resulting in the possibility of high fresh prices. It can be seen from this that China's fresh food logistics is still imperfect, with a low delivery timeliness rate, a high spoilage loss rate, and a large proportion of logistics and distribution costs.

In this paper, a fresh food supermarket is selected to deliver fresh food to 12 demand stores that provide services. The maximum load of refrigerated trucks used in this distribution center is 2. 5 tons, and the number of vehicles is 5. The coordinates of the distribution center and each distribution point are The demand is shown in Table 3:

Table 3. Coordinates of each customer point and demand

clients	A coordinate (km)	B coordinate (km)	Demand for goods (t)

Client 1	134	204	1200
Client 2	140	253	1300
Client 3	145	250	900
Client 4	120	243	1000
Client 5	117	241	1600
Client 6	152	236	2200
Client 7	135	235	800
Client 8	150	231	600

As shown in Table 3: MATLAB software programming is used to solve the ant colony algorithm proposed above, and the network distance of the distribution center and each demand store, as well as the demand information of each store, the set time window and other information are brought into the matrix as a matrix, program, and set the information heuristic factor as 1, the expected heuristic factor as 5, the volatilization rate of pheromone as 5. 0, and the maximum number of iterations as 100.

3.2. Comparison of Optimization Results of Ant Colony Algorithm before and after Improvement

In order to facilitate the comparison, this paper conducts nearly 30 searches. In the search process, it was found that the length of the shortest path obtained before and after the improvement was almost the same, but there was a difference in time, so only 8 solutions and their respective search times were selected and recorded when the same optimal solution was obtained, as shown in Table 4 and as shown in Table 5:

Table 4. The results obtained by the 8 times recorded after the algorithm before the improvement has been continuously searched for many times

number of searches	optimal path length (km)	Search time (s)
1	399. 72	17. 16
2	387. 29	18. 31
3	419. 40	17. 04
4	379. 83	21. 21
5	385. 47	17. 18
6	392. 69	25. 06
7	421. 10	21. 33
8	375. 74	17. 18

Table 5. The results obtained by the 8 times recorded after the improved algorithm searched for many times in a row

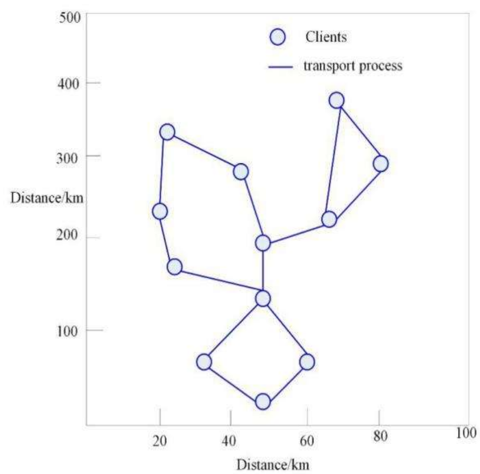
number of searches	optimal path length (km)	Search time (s)
1	386. 86	17. 12
2	387. 29	17. 38
3	419. 40	17. 17
4	379. 83	16. 01
5	385. 47	17. 02
6	394. 65	17. 77
7	434. 22	17. 89
8	375. 74	17. 10

As shown in Table 4 and Table 5: the optimal path length of the algorithm before the improvement is up to 421. 10km and the shortest is 375. 74km; the optimal path length of the improved algorithm is up to 434. 22km and the shortest is 375. 74km. There is no difference in the optimization distance. The optimization time of the algorithm before the improvement is up to 25. 06s and the shortest is 17. 04s; the optimization time of the improved algorithm is up to 17. 89s and the shortest is 16. 01s;

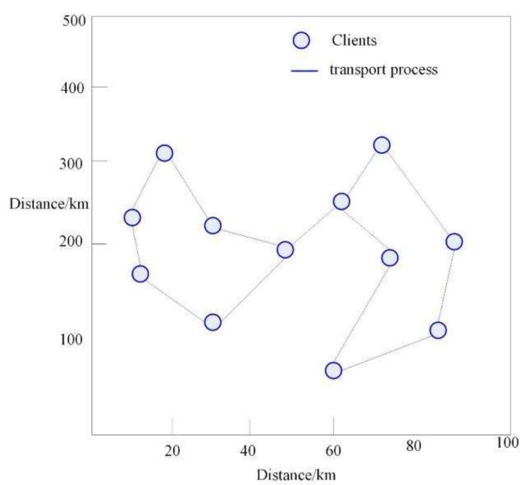
the improved algorithm not only obtains its optimal path in the search The time required is relatively stable and, on average, shorter than the algorithm before the improvement.

3.3. Comparison of the Best Solutions of the Ant Colony Algorithm before and after Improvement

Because the route obtained after transformation may have points that are not directly connected, it is necessary to find out which node or nodes are indirectly connected to the node. The optimal distribution scheme obtained by the algorithm before and after the improvement is shown in Figure 6.



(a) The optimal delivery scheme obtained by the algorithm before the improvement



(b) The optimal delivery scheme obtained by the improved algorithm

Fig. 6. Matlab software solves the optimal results of the algorithm before and after the improvement

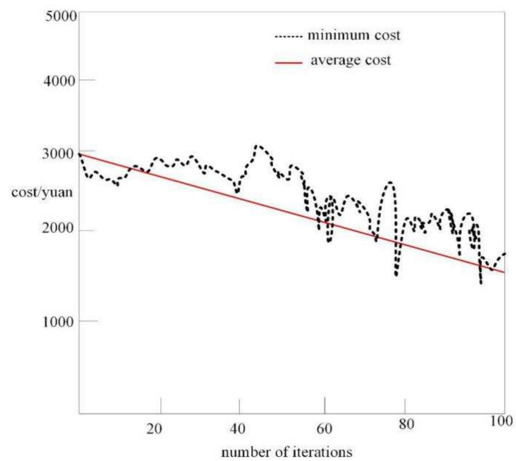
As shown in Figure 6: the shortest distance obtained by the ant colony algorithm before the improvement is 528. 46km, and the initial distribution scheme obtained is as follows: at least 3 vehicles are required, and the distribution routes are: route 1-7-12-11-1, Route 1-3-11-8-6-9-10-1, Route 1-19-2-4-9-1.

The improved ant colony algorithm needs 2 vehicles for distribution, with a total driving distance of 357. 68km. The distribution routes of each vehicle are: route 1-11-9-7-4-5-12-9-1; route 1-11-9-6-5-11-1.

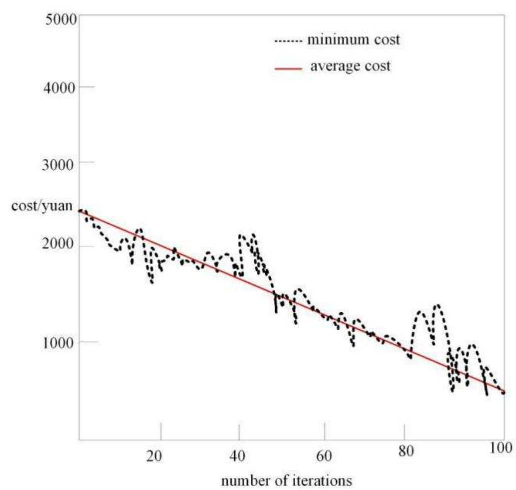
The improved ant colony algorithm has one less vehicle delivery and the distance is 170. 78km less than the improved ant colony algorithm, which shows that the improved ant colony algorithm is better than the solution obtained by the improved ant colony algorithm.

3.4. Comparison of Transportation Cost of Ant Colony Algorithm before and after Improvement

The MATLAB program's maximum number of iterations is set at 100. It is discovered that as the maximum number of iterations increases steadily, the improved algorithm's average logistics distribution cost continuously becomes closer to the lowest cost. Figure 7 compares the algorithm's average distribution cost prior to and following the enhancement.



(a) The average cost of the algorithm before the improvement



(b) The average cost of the algorithm after the improvement

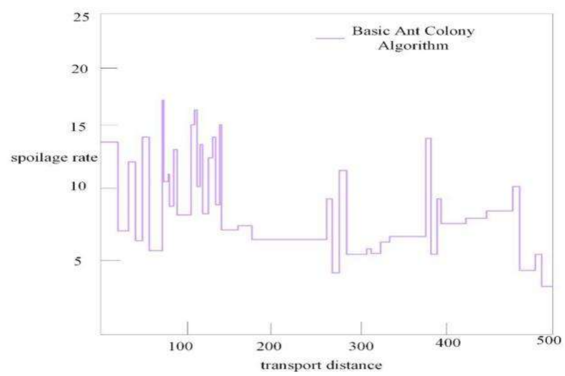
Fig. 7. Comparison of the average cost of the algorithm before and after the improvement

As shown in Figure 7: The distribution route of the original distribution center is divided and distributed according to the location of the fresh food demand store and the street. The average distribution cost of distribution according to the ant colony algorithm before the improvement is about 2, 500 yuan. The improved algorithm After the optimization, the average distribution cost is about 1400 yuan, and it can be seen that the total distribution cost is reduced by 1100 yuan. This example proves that ant colony algorithm is feasible and effective in cost optimization.

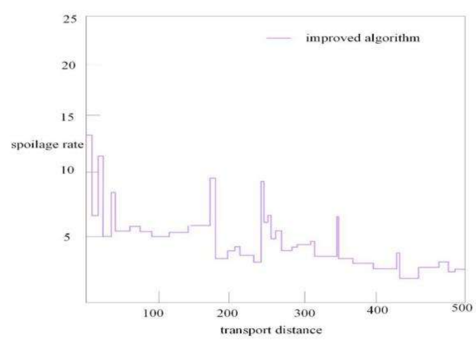
The improved ant colony algorithm is used to solve this model and the scheme is obtained after 100 iterations of MATLAB software. It is found that in this scheme, each refrigerated truck travels a shorter distance in the delivery task and requires less cost.

3.5. Comparison of the Decay Rate of the Ant Colony Algorithm before and after Improvement

In people's minds, dietary health has become a key issue in life, especially in the quality and safety of raw, cold and fresh food. First of all, to ensure the fresh quality of fresh food can ensure the quality and safety of fresh food; secondly, in terms of green food, the health knowledge of green food is gradually popularized, which makes it more and more popular in people's lives, and the corruption of the algorithm before and after improvement is improved. The bad rate comparison is shown in Figure 8:



(a) The corruption rate of the algorithm before the improvement



(b) The corruption rate of the improved algorithm

Fig. 8. Comparison of the corruption rate of the algorithm before and after the improvement

The distribution method employing the ant colony algorithm prior to the upgrade had a greater spoiling rate than the modified algorithm, as illustrated in Figure 8. Last but not least, to further meet consumer demand for fresh food that is safe to eat right away, it is essential to guarantee the safety and smoothness of the fresh food circulation process. This means ensuring the traceability of fresh food circulation information, including fast speed, quality, and quantity.

4. Conclusions

As fresh products become more and more popular, their demand is also increasing. With the development of the Internet of Things, more and more customers choose to purchase fresh products on the Internet. However, during the transportation process, due to the characteristics of fresh products that are not easy to keep fresh, the cost is too high and the customer satisfaction is not high. The phenomenon appears, so this paper analyzes the optimal path of fresh logistics distribution. In order to find the most suitable logistics distribution scheme, this paper proposes an ant colony algorithm based on the Internet of Things. In the method part, the algorithm is introduced in detail and improved. Problems arising from the transportation of fresh products are also described. In order to verify that the ant colony algorithm proposed in this paper can be used to find the optimal path for fresh food logistics distribution, this paper conducts experiments before and after the improvement of the algorithm. The improved ant colony algorithm has more advantages than the former algorithm. Therefore, the improved ant colony algorithm can be applied to the optimal path problem of fresh logistics distribution in the future. However, the author's knowledge is not too hard. In many aspects, it needs to be better. The author will continue to work hard to complete the work better in the future.

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