Research on optimization of distribution route for cold chain logistics cooperative distribution of fresh e-commerce based on price discount

Xinxin Wang* and Wujun Cao
School of Management and Engineering, Zhengzhou University, Zhengzhou, China;
*Corresponding author e-mail:1689981604@qq.com

Abstract. In order to solve the problem that the development of self-built logistics cannot meet the development of fresh e-commerce, a coordinated distribution strategy of self-built logistics and third-party logistics is proposed. The tasks assigned by third-party logistics are used to determine the price discount ratio. Third-party distribution outsourcing cost function, customer satisfaction function, and freshness function of fresh produce. Aiming at the goal of minimum delivery cost, maximum customer satisfaction, and maximum freshness of fresh produce, a collaborative delivery optimization model was established, and a corresponding genetic algorithm was designed with examples. Simulation results show that: collaborative distribution can effectively reduce the cost of distribution, when the proportion of price discount increases, the cost of collaborative distribution decreases. It has a certain reference value for the optimization of fresh e-commerce enterprises’ distribution mode.

1. Introduction
In recent years, with the development of economy and the guarantee of people's consumption level, the public's requirements for freshness, diversification and green of fresh agricultural products have been constantly improved, and fresh e-commerce has emerged. Distribution is the most important logistics link of fresh e-commerce, but the development of distribution can not catch up with the development of fresh e-commerce. In order to ensure the quality of fresh agricultural products, we need to continuously strengthen the distribution of the whole cold chain. With the increase of distribution distance, various uncertainties in the distribution process increase, resulting in the increase of distribution cost, the decrease of fresh agricultural products freshness, the decrease of customer satisfaction, and the decrease of profit of fresh e-commerce enterprises. Therefore, many fresh e-commerce enterprises only choose short-distance customer distribution. For long-distance customers, the way of business outsourcing is adopted, which is distributed by professional third-party cold chain logistics, which not only reduces the distribution cost, ensures the freshness of fresh agricultural products, but also alleviates the problem of insufficient cold chain distribution after the business expansion of fresh e-commerce.

The key of fresh e-commerce distribution is to make scientific distribution path planning. At present, many scholars at home and abroad have carried out relevant research on this issue and achieved some research results. Martin et al. [1] took intercity trunk transportation as the research object, and studied the relationship between self-built logistics and third-party logistics. Brito et al. [2] added fuzzy constraints to the short-distance open vehicle routing problem with time window and solved it with hybrid ant colony algorithm. Amorim et al. [3] studied and compared the freshness and
distribution cost of fresh agricultural products under different distribution environment and product deterioration coefficient, and used the mixed MOEA method to solve the problem. Xu Zhao et al. [4] put forward relevant countermeasures and suggestions for collaborative distribution of e-commerce platform self built logistics and third-party logistics by studying users' perceived value of logistics services and profit of stakeholders. Qingkui Cao et al. [5] constructed a collaborative distribution model between logistics center and customers aiming at the minimum total cost for the high cost of general logistics distribution, and solved it with genetic algorithm, which pointed out the direction for logistics enterprises to reduce resource consumption. Yuhui Xiao et al. [6] studied the vehicle routing problem of multiple distribution centers by establishing a vehicle collaborative distribution model of cloud and time window, and designed a tabu algorithm variable neighborhood search model to solve the model.

In the research of fresh food e-commerce distribution path, most of the scholars focus on self delivery fresh food e-commerce, but less on self delivery and third-party collaborative delivery. In the research of self distribution and third-party collaborative distribution, most of them are related to the distribution mode, and there is no research on the third-party price discount in the case of collaborative distribution. Based on the above research and analysis, this paper studies the distribution path planning of fresh e-commerce from the perspective of self distribution and third-party collaborative distribution. Considering the cost, satisfaction and freshness of fresh agricultural products under the condition that the third party gives the distribution price discount, the effectiveness and applicability of the model are verified by building a mixed integer planning model and combining with specific examples.

2. Problem description

The path planning of fresh agricultural products based on the collaborative distribution of self built logistics and the third party cold chain logistics can be defined as: fresh agricultural products e-commerce enterprises have a distribution center is o the vehicle set is, a third-party cold chain service provider has a vehicle set of, the total vehicle set is, Set of demand points, provide the distribution task of fresh agricultural products. According to the distribution distance, the short-distance customers are distributed by the fresh enterprise, and the long-distance customers are distributed by the third-party cold chain service provider. According to the amount of distribution tasks, a total of K vehicles are dispatched to complete the distribution tasks. According to different customer positions and requirements, vehicles with a certain amount of fresh agricultural products will start distribution from the distribution center, and return to the fresh enterprise after completing the distribution task. The maximum load limit of distribution vehicles is u, the demand of each customer is not greater than the maximum load limit of each vehicle, and each customer point can only provide distribution services by one vehicle. Each customer's demand is different, and the delivery time is also different. It is required to complete the delivery task within the time required by the customer. Early arrival or late arrival will result in loss of freshness and penalty cost. According to the requirements of customer time window and the specific location of customers, a specific distribution scheme is designed to minimize the distribution cost and ensure the freshness of fresh agricultural products and customer satisfaction.

3. Model building

3.1. Model definition

3.1.1. Basic assumptions. The relevant assumptions of the model are as follows:

(1) There is a distribution center, each customer's location and demand are known, and only one distribution vehicle can provide distribution services for them;

(2) If the delivery time window of is known, the delivery task must be completed within the specified time window, otherwise the corresponding penalty cost and freshness loss cost will be incurred, which are all borne by fresh e-commerce enterprises;

(3) Order cannot be split;
(4) Without considering the resource capacity constraints of the third-party logistics service providers, that is, after the distribution tasks are assigned to the third party, there will be no shortage of services.

(5) The third-party logistics service chamber of Commerce will give a certain discount to the distribution price according to the distribution tasks.

3.1.2. Parameter definition. The relevant symbols are as follows:

- $Z$: Number of customers;
- $\mu$: The minimum limit of fresh agricultural products freshness;
- $k$: Total number of vehicles;
- $k_1$: Self delivery vehicle;
- $k_2$: Third party distribution vehicles;
- $v$: Vehicle speed;
- $U$: Maximum load limit of vehicle;
- $a$: The lowest price discount offered by the third party;
- $a_k$: The price discount factor of the third party logistics;
- $\Delta L_{ij}$: Distance from customer $i$ to customer $j$;
- $\Delta L$: Time of arrival to ensure the minimum freshness of fresh agricultural products;
- $\Delta L_{ij}$: Time of arrival to ensure the optimal freshness of fresh agricultural products;
- $\Delta L_{ij}$: Shelf life of fresh products;
- $\rho_1$: Loss cost per unit fresh agricultural product freshness;
- $\rho_2$: Fixed penalty cost for early arrival of vehicles;
- $\rho_3$: Fixed penalty cost for late arrival of vehicles;
- $\rho_4$: Unit distance distribution price of the third party logistics;
- $\lambda$: Price discount factor;
- $u_{ik}$: Whether the third party vehicles $k$ provide distribution service for demand point $i$;
- $u_{ik}$: Whether vehicle $k$ from customer $i$ to customer $j$ is 1, otherwise it is 0;
- $v_{ik}$: Whether vehicle $k$ completes delivery for customer $i$;
- $Q(i)$: Customer satisfaction function;
- $\theta(i)$: Freshness loss function of fresh agricultural products;
- $c_1$: Fixed penalty cost for early arrival of vehicles;
- $c_2$: Fixed penalty cost for late arrival of vehicles;
- $c_3$: Number of distribution center owned vehicles;
- $k_3$: Number of third party vehicle rentals;
- $\Delta L_{ij}$: Time when the vehicle reaches the demand point;
- $\Delta L_{ij}$: Whether vehicle $k$ completes delivery for customer $i$; and its value is 1, otherwise it is 0;
- $u_{ik}$: Indicates that the third-party vehicle $k$ provides distribution service for customer $i$ and its value is 1; otherwise it is 0.

Decision variable: $\Delta L_{ij}$ indicates that the value of vehicle $k$ from customer $i$ to customer $j$ is 1, otherwise it is 0; $v_{ik}$ indicates that vehicle $k$ completes distribution for customer $i$, and its value is 1, otherwise it is 0; $u_{ik}$ indicates that the third-party vehicle $k$ provides distribution service for customer $i$, and its value is 1, otherwise it is 0.

\[
x_{ik} = \begin{cases} 1, & \text{vehicle } k \text{ from customer } i \text{ to customer } j \\ 0, & \text{other} \end{cases}
\]

\[
y_{ik} = \begin{cases} 1, & \text{vehicle } k \text{ completes delivery for customer } i \\ 0, & \text{other} \end{cases}
\]

\[
u_{ik} = \begin{cases} 1, & \text{ Whether the third party vehicles } k \text{ provide distribution service for demand point } i \\ 0, & \text{ other} \end{cases}
\]

3.2. Model construction.

Based on the price discount, the collaborative path planning model of self built logistics and the third party logistics of fresh e-commerce enterprises takes the minimum total distribution cost, the maximum customer satisfaction and the maximum fresh agricultural products freshness as the objective function. The optimization objectives include fixed departure cost, variable vehicle driving cost, outsourcing cost, freshness loss cost and penalty cost, while ensuring freshness of fresh agricultural products and customer satisfaction.

\[
C = \min \left[ \sum_{i=1}^{N} \Delta L_{ik} + c_1 \sum_{i=1}^{N} \sum_{j=1}^{N} \Delta L_{ij} v_{ik} + a \sum_{i=1}^{N} \sum_{j=1}^{N} \Delta L_{ij} a_k + \rho_1 \sum_{i=1}^{N} \sum_{j=1}^{N} \theta(i) y_{ik} + c_2 \sum_{i=1}^{N} \sum_{j=1}^{N} \left( \Delta L_{ij} - \Delta L_{ij} \right) \right]
\]

\[
M_r = \max \left[ \sum_{i=1}^{N} Q(i) \right]
\]

\[
M_r = \max \left[ \sum_{i=1}^{N} \sum_{j=1}^{N} Q(i, j, \theta(i, j)) \right]
\]
S.t.

\[ E_i \leq t_a \leq L_i, \]

\[ t_s < T_p, \]

\[ \varphi(t_a) = \begin{cases} \frac{t_s - E_i}{E_i - E_i}, & E_i \leq t_a \leq \epsilon_i, \\ \frac{L_i - t_a}{L_i - L_i}, & L_i \leq t_a \leq L_i, \\ 1, & \epsilon_i \leq t_a \leq L_i, \\ 0, & \text{other} \end{cases} \]

\[ \varrho(t_a) = 1 - e^{-\frac{t_a}{T_p}} \]

\[ a_i = \begin{cases} 1 - \lambda \sum_{j=1}^{n} u_{b_j}, & 1 - \lambda \sum_{j=1}^{n} u_{b_j} > a_b, \\ a_b, & a_b \geq 1 - \lambda \sum_{j=1}^{n} u_{b_j} \end{cases} \]

Formula (1) shows that the total cost of distribution is the smallest, the fixed departure cost is the smallest, the variable driving cost of vehicles is the smallest, and the driving cost of third-party vehicles is the smallest; formula (2) shows that the customer satisfaction is the largest; formula (3) shows that the freshness of fresh agricultural products is the largest. Constraint(4) indicates that the vehicle arrival time is not earlier than the earliest acceptable time, but not later than the latest acceptable time; constraint (5) indicates that the vehicle arrival time is not earlier than the earliest acceptable time, but not later than the latest acceptable time. The transportation time of fresh agricultural products is not longer than the quality guarantee time; Constraint (6) indicates the change of customer satisfaction with different delivery time.;Constraint (7)[7] indicates the freshness loss of fresh agricultural products;Constraint (8) refers to the price discount given by the third party logistics service provider, indicates the price discount given by the third-party logistics service provider, \( \lambda \) refers to the price discount factor, \( \alpha \) refers to the price discount proportion given by the third party logistics service provider according to the task received, and \( \beta \) refers to the lowest price discount given by the third party logistics service provider.

4. **Algorithm of the paper**

4.1. **Main objective method**

The model established in this paper is a multi-objective optimization model. In the multi-objective optimization model, there are conflicts and incommensurability between the sub objectives, so it is difficult to find the optimal solution of the multi-objective problem. Therefore, the multi-objective programming model usually uses membership function method, linear weighting method and main objective method to transform the multi-objective programming problem into single objective programming problem for solution. In this paper, the main objective method is selected to solve the multi-objective programming model. For example, customer satisfaction and freshness of fresh agricultural products are considered as constraints when total distribution cost is the minimum. The specific conversion method is shown in formula 9 and formula 10.

\[ M_i \geq \alpha_i \]  

\[ M_i \geq \beta_i \]  

\( \alpha \) represents the minimum threshold of customer satisfaction and \( \beta \) represents the minimum threshold of fresh agricultural products freshness, and the value is determined by fresh e-commerce enterprises according to their own actual conditions, and at the same time, it needs to meet the
requirements of fresh e-commerce enterprises for customer satisfaction and fresh agricultural products freshness.

4.2. Genetic algorithm design

Considering the characteristics of the problems studied in this paper, this paper chooses to use genetic algorithm to solve the vehicle path planning problem of fresh e-commerce enterprises[8]. The specific algorithm design is as follows:

4.2.1. Chromosome coding. Coding is the first and very important step in the design of genetic algorithm. The design of coding affects the realization of the whole algorithm and the degree of the algorithm. According to the characteristics of one distribution center and multiple demand points, this paper adopts the coding method of natural number coding.

4.2.2. Create initial population. After coding the chromosome, the initial population must be generated as the initial solution. Considering the space position of each node and the constraints of vehicle load, time window, freshness and satisfaction, the paper chooses the best individual based on the principle of the lowest cost of the objective function, and designs a distribution center with time window constraints.

4.2.3. Creation of fitness function. For the constrained multi-objective path planning problem, the objective function is used to express the fitness function. Firstly, the constrained problem is transformed into unconstrained problem by punishing the infeasible solution, then the multi-objective is decomposed, each sub-objective is added to the adaptive function, and then the reciprocal of each sub-objective is taken to generate the adaptive value, and the individual fitness value of each group is calculated respectively. The smaller the fitness value, the better the individual is, the easier it is to be saved to the next generation.

4.2.4. Select. Selection operation is to select individuals from the old population with a certain probability and inherit them to the new population. The probability of individuals being selected is related to the fitness value. Individuals with larger fitness values are more likely to be saved to the next generation. Individual selection by Roulette.

4.2.5. Cross. Crossover is the most important genetic operation in genetic algorithm. After crossover, a new generation of individuals will be obtained. For individuals with high fitness value, the method of directly retaining the original population is adopted. According to the research characteristics of this paper, the sequential crossover method is selected.

4.2.6. Variation. In order to maintain the diversity of population and avoid the algorithm falling into the local optimal solution, this paper adopts the method of reverse mutation. A chromosome is randomly selected in the population, then two points are randomly selected in the chromosome, and the genes in the two points are inserted into the original position in reverse order. Finally, two points are randomly selected in this chromosome, and the position of their genes is exchanged, and the mutation operation is completed.

4.2.7. Evolutionary reversal operation. In order to improve the limitation of local search of genetic algorithm, continuous multiple evolutionary reversals are introduced after selection, crossover and mutation. "Evolution" refers to the unidirectionality of reversals, that is, after reversals, only the operators guaranteed by fitness value are retained, otherwise reversals will not be accepted. Each individual was cross mutated, and then the fitness function was used to evaluate. The individuals with high fitness value were selected for the next generation of cross mutation and evolutionary reversal.

4.2.8. Termination conditions. Set the maximum evolution algebra Gen of the algorithm.

5. Case study

It is known that there are 20 demand points of a fresh e-commerce enterprise that need fresh agricultural products. The fresh enterprise location (8, 10), 1-15 customers are distributed by the fresh e-commerce enterprise, and 16-20 customers are distributed by the third party logistics service provider. The service time of each customer point is 10 minutes, the maximum load of vehicles is 100kg, the departure cost of self delivery vehicles is 100 yuan / vehicle, the delivery speed of all vehicles is 15km / h, the unit price of fresh products is 5 yuan / kg, the unit distance cost of self delivery is 5 yuan / km, the unit price of third-party outsourcing delivery is 10 yuan / km, the warranty
period is 48 hours, the penalty for early delivery is 20 yuan / h, the penalty for late delivery is 40 yuan / h, and the freshness of fresh products by customers is the lowest. The minimum requirement for customer satisfaction is 0.8, the price discount factor is 0.3, and the minimum discount is 0.65.

| Customer demand information | Customer demand information | Customer demand information | Customer demand information |
|----------------------------|----------------------------|----------------------------|----------------------------|
| Customer Requirement (kg)  | Location (km)              | Time window                |                             |
| 0                          | 0                          | (8,10)                     |                             |
| 1                          | 23                         | (4,18)                     | 8:00                       |
| 2                          | 26                         | (2,15)                     | 8:00                       |
| 3                          | 30                         | (4,7)                      | 8:00                       |
| 4                          | 17                         | (8,8)                      | 8:00                       |
| 5                          | 25                         | (3,10)                     | 8:00                       |
| 6                          | 18                         | (8,18)                     | 8:00                       |
| 7                          | 24                         | (12,14)                    | 8:00                       |
| 8                          | 32                         | (9,13)                     | 8:00                       |
| 9                          | 31                         | (13,17)                    | 8:00                       |
| 10                         | 25                         | (5,11)                     | 8:00                       |
| 11                         | 12                         | (14,5)                     | 8:00                       |
| 12                         | 30                         | (18,6)                     | 9:00                       |
| 13                         | 25                         | (11,12)                    | 8:00                       |
| 14                         | 18                         | (16,10)                    | 9:00                       |
| 15                         | 23                         | (11,5)                     | 8:00                       |
| 16                         | 24                         | (20,16)                    | 8:00                       |
| 17                         | 18                         | (19,18)                    | 8:00                       |
| 18                         | 18                         | (17,25)                    | 8:30                       |
| 19                         | 20                         | (18,20)                    | 9:00                       |
| 20                         | 11                         | (15,25)                    | 8:00                       |

5.1. Parametric design

According to the distribution characteristics of fresh agricultural products of fresh e-commerce, based on the data in Table 2, the changes of cost, freshness and customer satisfaction of fresh agricultural products are solved. Using MATLAB 2014a to run, the parameters of genetic algorithm are set to k=2,pc=0.9,pm=0.1,gap=0.9, and the maximum number of iterations is set to 300.

5.2. Results

In order to verify the model, this paper compares and analyzes the results of collaborative distribution with different objectives, taking one of the minimum total cost, the maximum customer satisfaction, and the maximum freshness of fresh agricultural products as the objectives, and the other two as constraints to optimize the analysis.
According to Table 2, by comparing the results under different main objectives, when taking the minimum total cost as the objective, the distribution vehicles will be reduced, the distribution time will increase, the distribution timeliness will become poor, the freshness of fresh agricultural products will be reduced, and the customer satisfaction will be reduced; when taking the maximum freshness of fresh agricultural products as the objective, the points with large demand will be preferentially distributed, resulting in the distribution cost. With the increase, the profit of fresh e-commerce enterprises will decrease; with the maximum satisfaction as the goal, the customer satisfaction will be guaranteed and the distribution cost will be increased by increasing distribution vehicles. The results show that there are conflicts and incommensurability among the three sub-objects, and fresh e-commerce enterprises can choose the main objectives suitable for their own enterprises according to their own reality to carry out distribution path planning.

Taking the minimum total cost as the objective, customer satisfaction and fresh agricultural products freshness as the constraint conditions, the vehicle path planning model of self-distribution and collaborative distribution of the third party under different price discounts is solved to study the coordinated distribution path planning scheme with different price discounts. The path planning diagram is shown in Figure 1.

When the price discount proportion is 0.25, the route is Vehicle1: 0 → 16 → 17 → 19 → 18 → 2 0 → 0; Vehicle2: 0 → 10 → 2 → 1 → 6 → 0; Vehicle3: 0 → 9 → 7 → 13 → 0; Vehicle4: 0 → 11 → 12 → 14 → 8 → 0; Vehicle5: 0 → 5 → 3 → 15 → 4 → 0, the cost is 2495.2546.

When the price discount proportion is 0.3, the route is Vehicle1: 0 → 20 → 18 → 19 → 17 → 16 → 0; Vehicle2: 0 → 5 → 10 → 3 → 0; Vehicle3: 0 → 9 → 7 → 11 → 4 → 0; Vehicle4: 0 → 2 → 1 → 6 → 8 → 0; Vehicle5: 0 → 15 → 13 → 12 → 14 → 0, the cost is 2460.8420.

When the price discount proportion is 0.35, the route is Vehicle1: 0 → 20 → 18 → 19 → 17 → 16 → 0; Vehicle2: 0 → 3 → 5 → 8 → 0; Vehicle3: 0 → 9 → 7 → 13 → 0; Vehicle4: 0 → 10 → 2 → 1 → 6 → 0; Vehicle5: 0 → 14 → 12 → 11 → 15 → 4 → 0, the cost is 2402.7642.

The numerical results show that, with the increase of price discount proportion, the distribution cost of fresh e-commerce enterprises decreases, indicating that the greater the price discount proportion given by the third party, the greater the impact on the collaborative distribution path planning results. The increase rate of collaborative distribution cost is 2.42% and 1.40% respectively. The increase rate of collaborative distribution cost is small, which shows that the collaborative distribution path planning model established in this paper has strong applicability.
Figure 1. Path planning of collaborative distribution with different price discount proportion

(a) Price discount ratio is 0.25.

(b) Price discount ratio is 0.3.

(c) Price discount ratio is 0.35.
Considering the impact of different price discount ratio on the distribution and distribution path planning results, it can help fresh e-commerce enterprises to determine the cooperative distribution strategy suitable for their own enterprises. When the cooperation degree between fresh e-commerce enterprises and the third party logistics is high, the third party logistics can not only give fresh e-commerce enterprises a high discount on the distribution price, but also help fresh e-commerce enterprises save the investment of logistics infrastructure, maintain the stability of the supply chain, make the use of funds of fresh e-commerce enterprises and the supply chain more flexible, at the same time, ensure the satisfaction of customers, and ensure that the quality of fresh agricultural products.

6. Conclusion

In view of the fact that the distribution distance of fresh e-commerce varies greatly, considering the cost, satisfaction and freshness constraints of fresh e-commerce, this paper studies the vehicle route planning problem of a distribution center and a single vehicle, constructs the route planning model of fresh e-commerce self distribution and third-party collaborative distribution with price discount, and analyzes the impact of price discount on fresh e-commerce distribution results in detail. For a specific example, the corresponding genetic algorithm is designed for simulation analysis. The experimental results show that: (1) according to the real situation of price discount, freshness and satisfaction given by the third party, fresh e-commerce enterprises should reasonably plan the vehicle route, which can not only effectively reduce the driving distance, reduce the total cost, but also ensure customer satisfaction and fresh agricultural products freshness; (2) the improved genetic algorithm can reasonably plan the vehicle route and reduce the cost of distribution and ensure the freshness of fresh agricultural products and customer satisfaction; (3) price discount has a great impact on the selection of distribution results, fresh e-commerce enterprises should strengthen cooperation with third-party logistics.

Based on the model, this paper compares the impact of price discount on self delivery and collaborative delivery, which is of great theoretical and practical significance for the deep study of the impact of price on delivery. This paper only discusses the path planning problem under the contract mode of collaborative distribution with price discount, and does not study other modes of coordinated distribution. Therefore, the next step is to study and compare different modes of coordinated distribution with price discount.

7. Acknowledgments

This work was financially supported by research on external intervention model and mechanism of diffusion of advanced manufacturing mode (71371173), NSFC project fund.

References

[1] Martin N, Verdoneck L, An C, et al., Horizontal collaboration in logistics: decision framework and typology, Operations Management Research, 2018(1):1-19.
[2] Brito J, Martinez F J, Moreno J A, An ACO hybrid metaheuristic for close-open vehicle routing problems with time windows and fuzzy constraints, Applied Soft Computing, 2015, 32, pp. 154-163.
[3] Amorim P, Almada-Lobo B, The impact of food perishability issues in the vehicle routing problem, Computer & Industrial Engineering, 2014, 67(1):223-233.
[4] Xu Zhao, Yong Wang, Bin Hu, Research on Cooperative Distribution Mechanism between Self-Built Logistics and Third Party Logistics Enterprises in E-commerce Platform, Systems Engineering, 2019, 37(2):82-90.
[5] Qingkui Cao, Yanbang Li, Nan Lu, Research on the path optimization of collaborative distribution based on genetic algorithm, Logistics Technology, 2014, 4, pp. 24-27.
[6] Yuhui Xiao, Zhenkai Lou, Xiaozhen Dai, Research on collaborative distribution of multidistribution centers with time window, Mathematics in Practice and Theory, 2018, 48(14):172-177
[7] Youshi He, Tengfei Ma, Research on the optimization of logistics distribution path of fresh agricultural products in B2C environment, Journal of Commercial Economics, 2017, 5, pp. 93-95.
[8] Peili QIAO, Na WANG, Considering reverse logistics and third party distribution of location routing problem research, Computer Engineering and Applications, 2017, 53(10) 55-60.