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Carbon Emission Potential Evaluation from China's Airlines

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Abstract: ***The take-away business model is highly complex, and there is a lack of research on the issue of order allocation optimization in the existing literature. In view of the fact that this paper builds a take-out order allocation model based on the overall satisfaction of merchants and ordering customers, customer satisfaction is defined by the function of arrival time and ordering customer time, and an improved particle swarm optimization algorithm that can quickly and effectively solve the model is designed. The simulation experiment was carried out by using a region in Hexi District of Tianjin as an example to obtain the actual data, and the scientific validity of the model was verified.***

Keywords: Take-out order allocation; Particle swarm algorithm; Satisfaction.

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1. Introduction

The take-away industry has gradually become more formalized after extensive and rapid development, and now has a large consumer group. However, at this stage, due to the lack of scientific guidance on the distribution of take-out orders, the timeliness of distribution is poor [1], which greatly reduces the user's consumption experience. However, users' demands for high-quality take-out service are constantly improving, and efficient and fast delivery has become a bottleneck restricting the high-quality development of the take-away industry. Therefore, how to achieve efficient and fast take-out delivery, improve consumer service satisfaction, has become the top priority of the US group take-out, hungry and many other take-out platforms.

The rapid development of the take-away industry has attracted the attention of many scholars and has carried out fruitful research. Aiming at the problem of take-out delivery path optimization, Chen Ping and Li Hang [2] constructed the optimization model of O2O take-out distribution path with customer time satisfaction as the objective function, and solved it with an improved genetic algorithm. Sex and the effectiveness of the algorithm. Li Taoying [3] attributed the problem of take-away delivery to the VRPPSTDST problem, and considered the influence of multi-fuzzy and random parameters. The minimum distribution cost was used as the objective function, and the stochastic simulation algorithm was used to solve the model. Zhao Daozhi was asked about the delivery time of the delivery. And Yang Jie [4] introduced the Stackelberg game to separate the platform, third-party distribution agencies, and business self-employment perspectives, and constructed the decision-making model for the estimated delivery time of the take-away delivery; in addition, some scholars sold the white garbage problem [5] and food. The security issue [6] has also been studied.

In summary, the current research on the issue of external sales mainly focuses on the problems of white garbage disposal, food safety, distribution path optimization, expected meal delivery time, etc., and lack of research on the order allocation of the external sales platform, but the high quality take-out order. The distribution model determines the efficiency of the take-away delivery and directly affects the satisfaction of the take-away platform customers. The purpose of the take-out service industry is to provide high-quality service customers. For the take-out platform, both merchants and order-order customers belong to customers. Therefore, this paper takes the overall satisfaction of merchants and order-order customers as the optimization goal, and builds an optimization model for take-out order allocation, in order to build efficient take-away distribution system provides support.

2. Methodology

2.1 Problem Description

The take-out order allocation problem studied in this paper can be represented by the directed graph $G=(V,A)$, where V is the set of vertices, including the set of starter positions of the take-outs, the set of merchants M in the R take-out orders, and the set N^+ of the ordering customers, representing the set of all sides. $N^-$and A each edge contains a non-negative weight representing the distance d_{mi} , d_{mi} between nodes m , i and j .

Both merchants and ordering customers have a certain service time window. Based on the relationship between the actual take-time of the seller and the delivery time and the service time window, the customer and merchant service satisfaction functions are defined. Assume that the merchant has a meal time of T_a , the time window for the merchant to take the meal is $\left(0,T_a\right]$, the latest time is acceptable T_b , and the time satisfaction of the merchant for the seller is $S_i(0\leq S_i\leq 1)$. The time window for the customer to deliver the meal is $\left(T_a,T_c\right]$, the latest time T_d is acceptable, and the customer satisfaction with the customer is $S_j(0\leq S_j\leq 1)$.

This paper uses the linear continuous time satisfaction function [4] under the service time window to quantify the time satisfaction of merchants and customers. Assume that the take-out time of the take-out meal is T_o , the leave time after taking the meal is T_l , and the arrival time of the meal is T_q . The relationship between the merchant's time satisfaction and the time of arrival of the takeaway meal is shown in Figure 1. The relationship between the customer's time satisfaction and the delivery time of the delivery staff is shown in Figure 2.

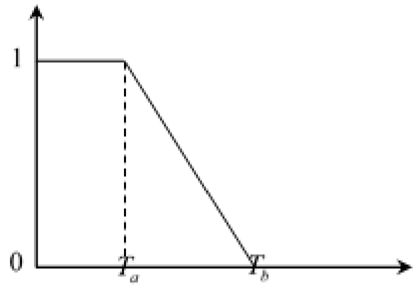

Figure 1: Merchant's time satisfaction function

The time satisfaction function of the merchant is as shown in formula (1):

$$S_i=\begin{cases}1 & 0\leq T_o\leq T_a\\ \dfrac{T_b-T_o}{T_b-T_a} & T_a\leq T_o\leq T_b\\ 0 & T_o\geq T_b\end{cases} \tag{1}$$

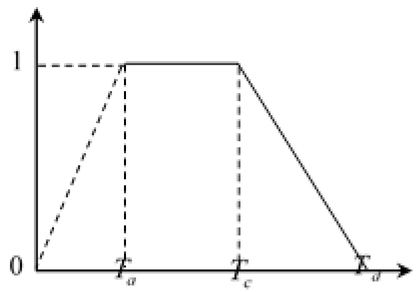

Figure 2: Customer's time satisfaction function

The customer's time satisfaction function is as shown in equation (2):

(2)

$$S_j = \begin{cases} 1 & T_a \le T_o \le T_c \\ \dfrac{T_d - T_q}{T_d - T_c} & T_c \le T_o \le T_d \\ 0 & T_o \ge T_d \end{cases} \tag{2}$$

Formula (1) indicates that the seller has arrived at the merchant service time window to receive the meal, the satisfaction of the merchant is 1, and if the merchant's latest acceptable time is exceeded, the satisfaction is 0, and the merchant satisfaction is with the time between the two. Linear decrement; formula (2) indicates that the delivery agent arrives at the customer service time window, the customer satisfaction is 1, if the customer's latest acceptable time satisfaction is 0, the customer satisfaction between the two Linearly decreasing with time. To simplify the solution, the following assumptions are given:

(1) The salesman is driving at a constant speed, and the driving speed is v;
(2) The delivery vehicle of the delivery agent is an electric vehicle, and does not consider the difference between the delivery person and the distribution electric vehicle;
(3) The endurance of the distribution electric vehicle can meet the needs of the delivery;
(4) There is a precedence constraint between the node where the takeaway visitor visits the merchant and the customer;
(5) In an order allocation, the merchant and the corresponding customer can only be served once by one seller;
(6) Disregarding the bearing capacity constraints of the distributed electric vehicle;
(7) The delivery agent does not need to return to the starting point after completing the delivery;

2.2 Symbol Description

(1) Parameters
T_a : Prepare meal time for the merchant;
T_i : The moment when the seller arrives at the merchant;
T_l : The time for the seller to leave the business;
T_j : The moment when the takeaway arrives at the customer;
T_b : The latest arrival time acceptable to the merchant;
T_c : The critical moment for the best meal delivery time for customers;
T_d : The latest arrival time acceptable to the customer;
d_{mi} : The distance between the slave nodes m and i ;
d_{ij} : The distance between the slave nodes i and j ;
v : a uniform speed for the seller;
S_i : Time satisfaction of the merchant's salesperson;
S_j : Customer satisfaction with the time of the seller;
(2) Decision variables
x_{mij} : The takeout is 1 when node m travels through node i to node j , otherwise it is 0;
k_{rm} : It is 1 when the order r is delivered by the delivery; agent m , otherwise 0.

2.3 Model

Based on the above problem description and hypothesis, aiming at the optimal time satisfaction of merchants and customers, the order allocation optimization model of the takeaway delivery platform is constructed:

$$MaxS = \sum_{i \in N^+} S_i + \sum_{j \in N^-} S_j \tag{3}$$

$$\sum_{m\in M} k_{rm} = 1, \forall r \in R \tag{4}$$

$$\sum_{m\in M} \sum_{j\in N^-} x_{mij} = 1, \forall i \in N^+ \tag{5}$$

$$\sum_{i\in N^+} x_{mih} - \sum_{j\in N^-} x_{mhj} = 0, \forall m \in M, h \in N \tag{6}$$

$$T_{lm} + \frac{d_{ij}}{v} = T_j, x_{mij} = 1, \forall i, j \in N, m \in M \tag{7}$$

$$T_j > T_i, \forall i, j \in N \tag{8}$$

$$T_l > T_a \tag{9}$$

The objective function (3) represents maximizing the time satisfaction of the merchant and the customer; the constraint (4) ensures that there is one and only one delivery of the order for each order; the constraint (5) ensures that each node can only be accessed once by a single taker Constraint (6) ensures that the takeaway must leave the node after arriving at a merchant node; constraints (7) and (8) ensure the time and order of delivery; constraints (9) ensure that the takeaway person leaves the merchant no earlier than the merchant Preparation time.

3. Algorithmic Solution

In 1995, Kennedy and Eberhart proposed the Particle Swarm Optimization (PSO), whose core is based on the random optimization technique of particle population [7]. Each particle represents a solution, each particle has a specific direction vector and position vector, and the fitness is determined by the objective function. All particles move at a certain speed within the search space, finding the optimal position to determine the global optimal solution.

3.1 Improved Particle Swarm Optimization

For example, in an d -dimensional search space, the position vector X_n of the n -th particle, the velocity vector V_n. In each iterative calculation, the fitness of each particle is evaluated according to the objective function, and the optimal position $Pbest$ of each particle at t time and the optimal position $gbest$ found by the entire particle group are determined, by equations (10) and (11). Update the velocity and position of the particles separately to track the optimal positions $gbest$ and $gbest$.

$$v_{i.j}(t+1) = v_{i.j}(t) + c_1 r_1 \left[p_{i.j} - x_{i.j}(t) \right] + c_2 r_2 \left[p_{g.j} - x_{i.j}(t) \right] \tag{10}$$

$$x_{i.j}(t+1) = x_{i.j}(t) + v_{i.j}(t+1), j = 1, \ldots d \tag{11}$$

In the formula (10), c_1 and c_2 are acceleration constants, and r_1 and r_2 are random numbers uniformly distributed between 0 and 1. Since the basic particle swarm optimization algorithm is prone to fall into the local optimal solution, this paper introduces the linear decreasing inertia weight to improve the basic particle swarm algorithm (10):

$$v_{i.j}(t+1) = \omega v_{i.j}(t) + c_1 r_1 \left[p_{i.j} - x_{i.j}(t) \right] + c_2 r_2 \left[p_{g.j} - x_{i.j}(t) \right] \tag{12}$$

$$\omega = \omega_{\max} - \frac{t(\omega_{\max} - \omega_{\min})}{t_{\max}} \tag{13}$$

Where $\omega_{\max}$ represents the maximum value of ω, the larger inertia weight is beneficial to the global search, avoiding falling into the local optimal solution; $\omega_{\min}$ represents the minimum value of ω, and the smaller inertia weight is beneficial to improve the accuracy of local search; t represents the calculation Iteration number of steps; $t_{\max}$ represents the maximum number of iteration steps.

3.2 Solution Structure

Determining the expression of particles and solutions is one of the key steps to achieve the success of the algorithm. This paper constructs an $2L$-dimensional space corresponding to the VRP problem of L customer point tasks. Each customer point task corresponds to two dimensions: the merchant number K corresponding to the customer point, and the take-out number Q of the customer point. For the sake of calculation and expression, the $2L$-dimensional vector X corresponding to each particle is divided into two L-dimensional vectors: X_v (representing the merchant number corresponding to the customer point) and X_r (representing the salesperson number of the customer point), The particle velocity vector V corresponds to V_v and V_r. For example, let the number of customer points in the VRP problem be 5, if the position vector V_r of a particle is:

Customer point task number: 1 2 3 4 5

X_v : 6 7 8 9 10

X_r : 12 11 13 15 14

Then, the distribution scheme of the corresponding solution of the particle is: 12-6-1, 11-7-2, 13-8-3, 14-9-4, 15-10-5.

3.3 Fitness function

Design the fitness function as $Eval$ according to the objective function and constraints.

if $\frac{d_{mi}}{v} < T_a$

$$Eval = 1 + S_j\left(T_a + \frac{d_{ij}}{v}\right);$$

else

$$Eval = S_i\left(\frac{d_{mi}}{v}\right) + S_j\left(\frac{d_{mi} + d_{ij}}{v}\right);$$

end

3.4 Algorithm Flow

The process of improving the PSO algorithm is as follows:

*Step*1: Initialize the position and velocity of each particle in the population, set the current historical optimal position *Pbest* of each particle as the initial position, and take the global optimal position of the particle group as the optimal value in *gbest*.

*Step*2: Calculate the fitness *Eval* of each particle according to the above fitness function, and store the optimal position and fitness of each particle, and select the particle position with the best fitness in the particle group as the *gbest* of the population.

*Step*3: Adjusting the position and velocity of the particles according to equations (11), (12), and (13).

*Step*4: Calculate the fitness of the updated particle, compare it with the fitness corresponding to the optimal position *Pbest* that has been experienced before. If it is better, set the current position to the optimal position *Pbest* of the particle.

*Step*5: Comparing the fitness of each particle with the optimal position *gbest* experienced by the population particles, and if so, updating the value of *gbest*.

*Step*6: Determine the termination condition, if the maximum number of iterations is set, output the optimal optimization result, otherwise return *Step*3.

4. Study Simulation

In order to verify the rationality of the order allocation optimization model of the take-away delivery platform and improve the effectiveness of the PSO algorithm, this paper takes a region in Hexi District of Tianjin as an example to obtain the starting location information, merchant location information and customer location information of the delivery agent. Construct test examples and perform simulation experiments.

4.1 Study Construction

Assume that there are 5 take-out orders in the area at a certain time (the details of the order are shown in Table 1), and the five foreigners are now located in the 7-day hotel, Guotou Building, Huangpuli Community, Hongxiang Real Estate, Seven built buildings. The locations of the sellers, merchants, and customer nodes are numbered as shown in Table 2. The distance information between the nodes is obtained through Baidu map. Assume that the uniform speed v=0.18*km/*min of the delivery staff, the average meal time T_a=15min of the merchant, the latest meal time T_a=15min acceptable to the merchant, the critical time T_c=30min of the customer's most ideal meal delivery time, and the latest meal delivery time T_d=40min acceptable to the customer.

Table 1: Take-out order information

Order number	*Merchant*	*Customer location*
1	Shaoxing old dishes	Tianxin Building
2	Sihuali beef rice	Wanhai Business Office Building
3	Zhang Liang Mala Tang	Peace Apartment
4	Xiangjiang Tower	Xiangrongli Community
5	Ordinary family seafood home cooking restaurant	Northern Financial Building

Table 2 Node serial number and location information

Node number	*Node location*
1	Tianxin Building
2	Wanhai Business Office Building
3	Peace Apartment
4	Xiangrongli Community
5	Northern Financial Building
6	Shaoxing old dishes
7	Sihuali beef rice
8	Zhang Liang Mala Tang
9	Xiangjiang Tower
10	Ordinary family seafood home cooking restaurant
11	7 days hotel
12	Guotou Building
13	Huangpuli Community
14	Hongxiang Real Estate
15	Seven Buildings

4.2 Simulation Results

Combined with the example, the parameters of the improved algorithm are set as follows: acceleration constant $c_1 = c_2 = 1.65$, maximum inertia weight $\omega_{\max} = 0.9$, minimum inertia weight $\omega_{\min} = 0.2$, particle size of 40, and maximum number of iterations of the particle is 100. The improved PSO algorithm was run using Matlab R2017a encoding.

The simulation results show that the node numbers of the optimal delivery scheme are 11-8-3, 12-7-2, 13-9-4, 14-

10-5, 15-6-1 (the detailed order allocation is shown in Table 2). Show), the optimal overall satisfaction of merchants and customers at this time is 9.4.

5. Conclusion

Based on the overall satisfaction of merchants and ordering customers, this paper constructs an optimization model of order allocation for take-out platform, and designs an improved particle swarm optimization algorithm. A case study in Hexi District of Tianjin is taken as an example to verify and verify the example. The scientific validity of the model. The order allocation model constructed in this paper can be used to determine the optimal distribution plan for take-out orders and take-outs at a certain time in the specified delivery area. The designed algorithm can solve the problem better and can provide new and efficient delivery system. The perspective provides assistance for the decision-making of the order allocation of the take-out platform. The focus of the next step is to build a dynamic take-out order allocation model based on the uncertainties of merchants and ordering customers and the sellers, and to study various heuristic algorithms in depth to solve more complex and varied practical problems.

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