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Retraction

Retracted: Production-Distribution of Perishable Food considering Customer Time Window

Discrete Dynamics in Nature and Society

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] W. Feng, S. Du, Y. Xiao, and X. Ren, "Production-Distribution of Perishable Food considering Customer Time Window," *Discrete Dynamics in Nature and Society*, vol. 2021, Article ID 5476220, 9 pages, 2021.

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Research Article

Production-Distribution of Perishable Food considering Customer Time Window

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Aiming at the production-distribution problem of perishable food, considering the interference caused by the change of the customer's time window in actual distribution process, using the ideas of disruption management, analyzing the disturbance of the interference event to the production-distribution system, and constructing the perishable food production-distribution problem disturbance identification and disturbance measurement, and with the minimum deviation between the new scheme and the original scheme as the goal, a mathematical model of disturbance recovery is established. An improved ant colony algorithm-mixed ant colony algorithm based on the change of customer time window for perishable food production-distribution problem was designed to solve the problem. Finally, the simulation experiments are carried out by examples, and compared with the rescheduling results, the effectiveness of the disruption management model and the algorithm-mixed ant colony algorithm are also verified. The research results show that the disruption management can effectively reduce the degree of program deviation and control the cost reasonably.

1. Introduction

In the process of shopping, the freshness of perishable food is the key factor in customer satisfaction. Perishable food has the characteristics of strong seasonality and many kinds and is easy to be affected by the environment and has high requirements for transportation. The lifespan of these products declines from the moment they are manufactured and their value declines as the time after completion increases. For such products, most businesses adopt zero inventory production, that is, according to the customer's order requirements for production and distribution in order to minimize the loss of products in the production and distribution. However, in practice, some uncertain factors often occur when the production and distribution activities are carried out, which leads to the original production and distribution scheme being not feasible, thus causing disturbance to the whole system. Changes in customer time windows are often unexpected and improvised and have a knock-on effect on subsequent distribution or production processes. Therefore, how to deal with the disturbance events quickly and effectively and minimize the disturbance to the whole production-distribution system has great practical significance. The research on the integrated production and distribution scheduling problem of perishable products based on the change of customer time window can promote the development of disruption management and production scheduling, vehicle routing optimization, and other disciplines. This paper provides a new idea to solve the production-distribution integrated scheduling problem in theory and provides key decision support for enterprises to achieve efficient and quality production-distribution in practice. This paper firstly analyzes the customer time window changes in the perishable food production-distribution system and studies the disturbance from four aspects of enterprise production time, distribution cost, distribution path, and customers based on the idea of disruption management. Then, the disruption management for production-distribution of perishable food with the smallest total deviation and improved algorithm-mixed ant colony algorithm are constructed to solve the problem, and a satisfactory adjustment scheme is generated quickly. It can provide decision support for the related enterprises of production and distribution integration to solve the interference problem of time window change.

2. Problem Statement and Preliminaries

This paper applies disruption management to studying the problem of integrated production-distribution scheduling for perishable goods with changes in customer time windows. Present research on perishable products mainly focuses on three main areas: pricing, siting, and inventory of perishable products. In the work of [1], the problem of pricing of perishable products was analyzed. In terms of research on the location of perishable products, the work of [2] analyzed from the aspects of vehicle dispatching and location selection of distribution centers. In the work of [3], the retailer management strategy selection problem was investigated by Yu et al. and combined with the buy-give promotion strategy, the inventory problem of perishable products was analyzed. For more results on this topic, we refer readers to [4–6]. In recent years, many scholars have conducted related research on the production and distribution of perishable products, namely, the integrated scheduling of production and delivery problem (ISPDP), the main research results are concentrated in the work of [7, 8]. Chen [7] studied the consideration of customer time. Production scheduling and distribution scheduling of perishable products were based on customer time window. Wu and Ma [9] designed a hybrid genetic algorithm to solve ISPDP with time window under time-varying road networks. Somashekhara et al. and Wang et al. [10, 11] analyzed the integrated single-machine scheduling and multivehicle routing problems, considering the situation that the machine is allowed to switch between adjacent jobs. Subsequently, a mathematical programming model with minimizing total carbon emission is established, and a hybrid taboo search algorithm was proposed to solve this problem. The advantage of the model is proved by studying enterprise cases and 20 simulation cases. Based on the interference problem in practical problems, many scholars have conducted research in the fields of aviation, production scheduling, and supply chain management by introducing the idea of disruption management, which can be found from the work of [12–15]. Marinaki and Marinakis [14] designed a hybrid firefly optimization algorithm to solve the vehicle routing problem with random demand. Ning et al. [15] designed a logistics distribution interference management and user sensitivity decision model based on prospect theory. The prospect theory is used to measure the user's psychological perception, and an improved bacterial foraging algorithm is proposed to test the Solomon case and verify the effectiveness of the proposed method. Domestic and foreign scholars have done a lot of research on the two major issues of production planning and distribution route optimization of perishable products. Some scholars have begun to put the two relatively independent links of production and distribution of perishable products together for research. The work of [16, 17] respectively proposed the MILP modeling method and the adaptive large neighborhood search algorithm to optimize the production-distribution plan of perishable products, which solved the two problems of production and distribution. For more results on disruption management, we refer readers to [18]. By analyzing the occurrence state of interference events and considering local adjustment and optimization on the basis of the initial scheme, disruption management can ensure the freshness of products as much as possible and improve customer satisfaction.

3. Disturbance Measurement Strategy Based on Prospect Theory

Considering the perishable food production-distribution system includes four actors, customer, distribution center, distribution salesman, and manufacturer, the primary objectives of different actors are also different. This paper proposes different measurement methods for four actors through value function based on prospect theory, which refers from the work of [19]. As a behavioral decision-making theory, prospect theory applies psychology to it, which is more in line with people's decision-making behavior under uncertain conditions. Therefore, based on the prospect theory, this paper proposes different measurement methods for the four actors through the value function.

3.1. Value Function. Prospect theory is a decision model that describes the sensitivity of users to results under uncertain conditions. Based on prospect theory, the value function of each objective is expressed as follows. The value i function of $V^i_{(x)}$ can be expressed as follows:

$$V^i_{(x)} = \begin{cases} x^{\alpha^i} & x \geq 0 \\ -\lambda^i(-x)^{\beta^i} & x < 0 \end{cases}, \quad i = 1, \ldots, n. \tag{1}$$

The value function is used as the theoretical basis for people's decision-making, and the decision is made with a reference point with zero value. In practical problems, people choose to maintain the status quo, which means that they have no choice. The value of the decision-making problem itself is 0. Therefore, this paper chooses the status quo as the reference point.

3.2. Unsatisfactory Membership Function. Suppose the unsatisfied membership function of x^i is $\mu^i(x^i)$, when $\mu^i(R^i) = 1$, it means loss and shows risk pursuit.

$$\mu^i(R^i) = -V^i(-R^i + O^i) = -\left[-\lambda^i\left(-\left(-R^i + O^i\right)\right)^{\beta^i}\right] = \lambda^i\left(R^i - O^i\right)^{\beta^i}. \tag{2}$$

In formula (2), we can get $R^i = O^i + (1/\lambda^i)^{1/\beta^i}$ from $\mu^i(R^i) = 1$ (O^i is the reference point of target i). Therefore, unsatisfactory membership function of x^i can be expressed by the following piecewise function:

$$\mu^i\left(x^i\right)=\begin{cases}0, & 0\le x^i<O^i,\\ \lambda^i\left(x^i-O^i\right)^{\beta^i}, & O^i\le x^i<R^i,\\ 1, & x^i\ge R^i.\end{cases} \tag{3}$$

R^i is determined by β^i and λ^i, for different subjects; β^i and λ^i are different, so R^i is also different. Empirical research method can be used to determine the above parameters through questionnaire survey of each subject.

3.3. Construction of Disturbance Measure Function. Using unsatisfactory membership degrees to measure different goals shows that the less the dissatisfaction of the goal, the less disturbing the subject i. Therefore, the disturbance metric function of target i is

$$d_i\left(x_i\right)=\min\mu_i\left(x_i\right),\quad i=1,2,\ldots,n. \tag{4}$$

4. Production-Distribution Interference Management Model of Perishable Food with Changing Customer Time Window

4.1. Mathematical Model of the Initial Plan

4.1.1. Problem Description and Assumptions. This paper considers the production-distribution plan under the situation that a single processing and distribution center accepts multiple customer orders and takes fresh pastry production-distribution as an example. The main factors affecting production-distribution include the value loss in the process of product production and distribution and the cost of logistics distribution. This article analyzed the disturbance events of the customer time window change and makes the following assumptions of this study as follows:

The initial plan is calculated by the perishable food production-distribution model with the lowest total cost, which meets the requirements of customer time window and is the optimal route

The perishable food processing and distribution center has only one production line and can only produce one product

The delivery vehicles have the same model and the loading capacity is known

Customer points and service time windows are known

Each customer's delivery task can only be completed by one vehicle

Notation 1. Let $P=\{0,1,2,3,\ldots,n\}$, where 0 is the plant and $P'=P\backslash\{0\}$ represents a collection of n customers. The production time window of the manufacturer is $[e_0, l_0]$; the value loss per unit product in unit time is ω; q_i represents the needs of customer i; the service window of customer i is $[e_i, l_i]$; V is the collection of the same type distribution vehicles with capacity Q. The other notations for initial model are as follows:

f: fixed cost of each truck hired; ε: cost per unit journey of vehicle

k: the number of order distribution batches is consistent with the distribution vehicle number, $k\in V$; t_k^s: production start time of k batch order products

t_k^0: production completion time of k batch order products

t_k^d: the time when vehicle k (that is, k batch order) departs from the processing distribution center; a_i: distribution vehicle arrival time at customer i

t_i: the start time of customer i order delivery

s_i: service time when customer i order is delivered

θ_i: how much is the value of the product lost when the product of customer i is delivered; M: big positive number

$$\begin{aligned}x_{ik}&=\begin{cases}1, & \text{customer } i \text{ is delivered by vehicle } k,\\ 0, & \text{otherwise},\end{cases}\\ x_{ijk}&=\begin{cases}1, & \text{vehicle } k \text{ from customer } i \text{ to customer } j,\\ 0, & \text{otherwise},\end{cases}\\ y_{kk'}&=\begin{cases}1, & \text{batch } k \text{ is earlier than batch } k',\\ 0, & \text{otherwise},\end{cases}\\ y_{k0}&=\begin{cases}1, & \text{Batch } k \text{ is the last processing batch},\\ 0, & \text{otherwise}.\end{cases}\end{aligned} \tag{5}$$

4.1.2. Mathematical Model. The model of the initial plan for perishable food production-distribution is

$$\min Z=\sum_{i\in P'}\theta_i q_i+\varepsilon\sum_{i\in P'}\sum_{j\in P'}\sum_{k\in V}d_i x_{ijk}+f\sum_{j\in P'}\sum_{k\in V}x_{0jk}, \tag{6}$$

$$\text{s.t. } t_k^0=t_k^s+\sum_{i\in P'}x_{ik}q_i,\quad \forall k\in V, \tag{7}$$

$$t_k^s=t_{k-1}^0,\quad \forall k\in V, \tag{8}$$

$$t_{k,1}^s\ge e_0,\quad \forall k\in V, \tag{9}$$

$$t_{k,1}^0\le l_0,\quad \forall k\in V, \tag{10}$$

$$t_k^0\le t_k^d,\quad \forall k\in V, \tag{11}$$

$$\sum_{k'\in V\cup\{0\}}y_{kk'}=1,\quad \forall k,k'\in V, \tag{12}$$

$$\sum_{i\in P}\sum_{k\in V}x_{ijk}=1,\quad \forall i\in P', \tag{13}$$

$$\sum_{j\in P}\sum_{k\in V}x_{ijk}=1,\quad \forall i\in P', \tag{14}$$

$$\sum_{i\in P} x_{ijk} - \sum_{i\in P} x_{jik} = 0, \quad \forall j \in P', \forall k \in V, \tag{15}$$

$$\sum_{i\in P'} q_i x_{ik} \le Q, \quad \forall k \in V, \tag{16}$$

$$\sum_{j\in P'} x_{0jk} \le V, \quad \forall k \in V, \tag{17}$$

$$\sum_{k\in V} t_k^d x_{ik} < t_i \le l_i, \quad \forall i \in P', \tag{18}$$

$$t_i = \max\{a_i, e_i\}, \quad \forall i \in P', \tag{19}$$

$$t_i + s_i - a_i \le M\left(1 - \sum_{k\in V} x_{ijk}\right), \quad \forall i, j \in P', \tag{20}$$

$$\theta_i = \omega\left[t_i - \frac{1}{2}\sum_{k\in V}\left(t_k^s + t_k^0\right)x_{ik}\right], \quad \forall i, j \in P', \tag{21}$$

$$x_{ik}, x_{ijk}, y_{kk'}, y_{k0} \in \{0, 1\}, \quad \forall i, j \in P', \forall k, k' \in V. \tag{22}$$

The objective function (6) indicates the minimum total cost of production and distribution, including three aspects: product value loss, vehicle driving cost, and fixed cost.

Constraints (7)–(12) are constraints in the production process; equation (7) represents the time consumed for continuous production of the same batch of products; equation (8) indicates that there is no interval production for the same batch of products; equations (9) and (10) indicate that the production time meets the production time window of the processing and distribution center; equation (11) indicates that vehicles can only be delivered after the current batch of products is completed; equation (12) indicates the sequence relationship of consecutive batches.

Constraints (13)–(20) are constraints in the distribution process, where equations (13) and (14) indicate that all customer needs are met; equation (15) indicates that the vehicle must leave the customer after completing the distribution task; equation (16) indicates that the number of products delivered by the vehicle does not exceed the vehicle capacity; equation (17) indicates that the number of distribution vehicles does not exceed the total number of vehicles; equation (18) represents the start time of the customer order delivery is no earlier than the start time of the customer's time window; equation (19) indicates that the start time of order delivery is greater than the start time of customer time window; equation (20) represents the time when the vehicle arrives at the customer and eliminates the subloop in distribution; equation (21) represents the value loss of order delivery at the time of product delivery; equation (22) represents the variable value.

4.2. Mathematical Model of the Interference Management

4.2.1. Problem Description and Assumptions. When a customer's time window changes, the location of each distribution vehicle is taken as the virtual distribution center, which is the starting point of distribution after disturbance. The initial production-distribution center is the distribution terminal point, that is, after the vehicle has served customers, it returns to the initial production-distribution center. In this paper, we only consider the surplus vehicle distribution plan when we make the emergency distribution plan.

Notation 2

m: the total number of customers who have not completed the delivery task

P: customer point collection, $P = \{0, p_1, p_2, \ldots, p_{m+k}\}$; 0 is the initial processing distribution center

$p_1, p_2, \ldots, p_m$: the customer who has not completed the delivery task

$p_{m+1}, p_{m+2}, \ldots p_{m+k}$: the location of the current distribution vehicle, the virtual distribution center

μ_i^1: the dissatisfaction with the arrival time of the goods of p_i

μ^2: the distribution operators are not satisfied with the distribution cost

μ^3: dissatisfaction of distribution salesman on the number of new distribution road sections

μ^4: dissatisfaction of production center on waiting for start time of production

Other parameters and variables are the same as above.

4.2.2. Measure Function of Disturbance. The interference of four participants in the production-distribution system is separately measured by formula (3) [17].

(1) Customer dissatisfaction membership

$$\mu_i^1(t_i)\begin{cases} 0 & 0 \le t_i < t_i^0 \\ \lambda^1\left(t_i - t_i^0\right)^{\beta^1} & t_i^0 \le t_i < R_i^1, \quad i = 1, \ldots, n. \\ 1 & t_i \ge R_i^1 \end{cases} \tag{23}$$

In formula (23), λ^1 and β^1 are the parameters, t_i^0 is the initial arrival time, and $R_i^1 = t_i^0 + (1/\lambda^1)^{1/\beta^1}$. If $t_i > t_i^0$, it means $i$is in loss $(x < 0)$.

(2) Dissatisfaction degree of distribution center

$$ {}^{2}(c)=\begin{cases} 0, & 0c<c^{0}, \\ {}^{2}\left(c-c^{0}\right)^{2}, & c^{0}c<R^{2}, \\ 1, & cR^{2}. \end{cases} \qquad (24)$$

In formula (24), λ^2 and β^2 are the parameters, c^0 is the initial cost, and $R^2 = c^0 + (1/\lambda^2)^{1/\beta^2}$. If the distribution cost $c > c^0$, it means the distribution center is in loss $(x < 0)$;

According to this article, after the customer time window is changed, the amount of disturbance will usually exceed the existing metric value and become 1; at this time, the algorithm will stagnate in the optimization process. Therefore, this article improves the disturbance measurement method based on the original formula [20].

$$ {}^{2}(c)=\begin{cases} 0, & 0c<c^{0} \\ {}^{2}\left(c-c^{0}\right)^{2}, & c^{0}c<R^{2}, \\ 1, & cR^{2}. \end{cases} \qquad (25)$$

In formula (25), λ^2 and β^2 are the parameters and $R^2 = 1.3c^0$.

(3) Dissatisfaction degree of distribution clerk

$$\mu^{3}(g)=\begin{cases} \lambda^{3}g^{\beta^{3}}, & 0\le g<R^{3}, \\ 1, & g\ge R^{3}. \end{cases} \qquad (26)$$

In formula (26), λ^3 and β^3 are the parameters and $R^3 = (1/\lambda^3)^{1/\beta^3}$. If the number of new road sections $g > 0$, it means that the distribution salesman has a loss $(x < 0)$.

(4) Dissatisfaction degree of manufacturer

$$ {}^{4}(T)=\begin{cases} 0, & 0T<T^{0}, \\ {}^{4}\left(T-T^{0}\right)^{4}, & T^{0}T<R^{2}, \\ 1, & TR^{2}. \end{cases} \qquad (27)$$

In formula (27), λ^4 and β^4 are the parameters and $R^4 = T^0 + (1/\lambda^4)^{1/\beta^4}$. If the time when production starts in the adjustment plan $T > 0$, it means that the manufacturer is losing money $(x < 0)$.

4.2.3. Disruption Management Model. Taking into account the different disturbance measurement functions of the actors, we adopt the lexic-order multiobjective programming method to construct the following disturbance management model:

$$\min \mathrm{Lex} = Z_1 \sum_{i=1}^{m} \mu_i^1 \colon Z_2\mu^2(c)\colon Z_{3:}\ \mu^3(g) Z_4\colon \mu^4(T), \qquad (28)$$

$$Z_1 \gg Z_2 \gg Z_3 \gg Z_4, \qquad (29)$$

$$\sum_{i=1}^{m} q_i x_{ik} \le Q, \quad \forall k \in V, \qquad (30)$$

$$\sum_{i=1}^{m+k} x_{i0k} = 1, \quad \forall k \in V, \qquad (31)$$

$$\sum_{k=1}^{K}\sum_{i=1}^{m+k} x_{ijk}\left(t_i + s_i + t_{ij}\right) = t_j, \quad j = 1, 2, \ldots, m, \qquad (32)$$

$$e_i \le t_i + s_i \le l_i, \quad i = 1, 2, \ldots, m. \qquad (33)$$

Equation (28) is the objective function, which means that the deviation between the adjustment scheme and the initial scheme is the minimum, that is, the disturbance degree of the system is the minimum. In this model, the target level is customer ≥ distribution center ≥ distribution operator disturbance ≥ manufacturer. Equation (29) is the priority of different goals; the decision maker can adjust the sequence according to the actual situation; equation (30) means the total vehicle load does not exceed the vehicle loading capacity; equation (31) returns to the initial production and distribution center after the vehicle serves the customer; equations (32) and (33) represent the time window to meet customer requirements.

5. Solution Procedure of Disruption Management Model

This paper proposes algorithm-mixed ant colony algorithm to solve the disruption management model by improving the ant colony algorithm. In the algorithm, this paper applies the advantages of genetic algorithm to ant colony algorithm, such as rapidity, randomness, and global convergence. The initial pheromone distribution of relevant problems can be quickly generated at the initial stage of search, so as to improve the current situation of pheromone shortage in the initial stage of ant colony algorithm and improve the solving speed.

Construct a pheromone constant τ_C, through initial conditions, use genetic algorithm to solve the conversion pheromone value τ_G, get the new pheromone initial value $\tau_S = \tau_C + \tau_G$, which represents the persistence of the trajectory, then compare all paths in the ant colony algorithm, and use the path to update the trajectory equation to the path pheromone is updated; the formula is as follows:

$$\tau_{ij}(t+1) = \rho \cdot \tau_{ij}(t) + \sum \tau_{ij}^{k}(t). \qquad (34)$$

The specific steps are as follows:

Step 1: genetic algorithm is used to generate a better solution, and pheromone is left in this path

Step 2: select X and Yaccording to the fitness function and perform crossover and mutation operations on X and Y to generate several new solutions

Step 3: initialize the parameters, generate the initial distribution of pheromone based on the solution

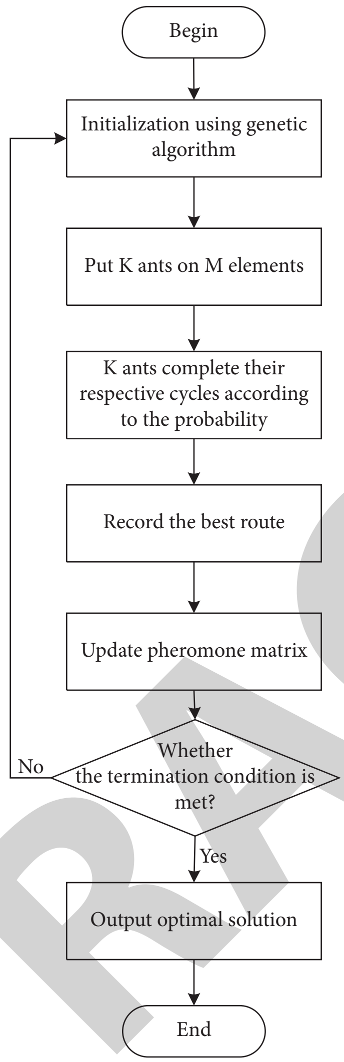

Figure 1: Flowchart of the improved ant colony algorithm.

optimized by the genetic algorithm, and place m ants on n nodes

Step 4: calculate the probability P_{ij}^{k} of each ant moving to the next node and move each ant to the next node according to the selection probability

Step 5: after m ants traverse n nodes, the optimal path increases pheromone by $\Delta\tau_{ij}^{k} = (Q/Z_k)$

Step 6: all path pheromones are updated by $\tau_{ij}(t+1) = \rho\tau_{ij}(t) + \sum \Delta\tau_{ij}^{k}(t)$

Step 7: if the number of cycles is less than the predetermined iteration number and the solutions obtained are the same, then turn to step 4

Step 8: output the optimal solution

The improved ant colony algorithm is shown in Figure 1.

6. Main Results

6.1. Algorithm Validation. In this paper, eight classic datasets from TSPLIB standard library are used to test the algorithm through MATLAB 2016b. The traditional ant colony algorithm (ACO), improved ant colony algorithm [21, 22], and HACO algorithm are used to solve the problem for 20 times, and the optimal solution and average solution of the test are obtained, as shown in Table 1.

In the classical dataset, according to the experimental results in Table 1, the optimal solution and average solution obtained by HACO are 100% better than the traditional ant colony algorithm. Compared with the hybrid ant colony algorithm (SAACO and ACSPSO), HACO can jump out of local optimum and has better optimization ability.

The analysis results show that the results of HACO are better than the best results in some literatures, especially in Eil101, and other test results are also very close to the optimal solution. Therefore, HACO is very competitive in solving NP-hard problems. Because the parameter selection in HACO is determined by many experiments, there is still room for further improvement from the final solution.

6.2. Computational Experiments. The coordinates of the production-distribution center are (20.5, 20.5), its time window is [7:00, 17:00], there are 10 vehicles of the same

Table 1: Table of customer order information.

TSP problem	Optimal solution	Tested optimal solution				The average value of the tests			
		ACO	SAACO	ACSPSO	HACO	ACO	SAACO	ACSPSO	HACO
Berlin52	7542	7664	7589	7560	7549	7708	7619	7600	7589
Rat99	1211	1301	1295	1287	1282	1317	1308	1306	1300
D657	48912	56627	56021	55976	55360	57143	56592	56397	55783
Nrw1379	56638	66961	65475	65210	60508	68093	66163	66232	63130
Ch150	6528	6677	6604	6591	6579	6704	6728	6629	6610
Eil101	629	683	654	649	633	696	665	653	651
Eil51	426	446	440	439	436	450	445	445	439
St70	657	700	692	691	683	712	703	698	691

Table 2: Table of customer order information.

Number	Coordinate	Requirement	Time window	Number	Coordinate	Requirement	Time window
1	(23, 27)	10	9:00–14:00	11	(25, 13)	8	7:30–8:10
2	(20, 11)	12	9:40–15:10	12	(25, 18)	11	9:20–13:00
3	(30, 25)	15	9:40–10:40	13	(20, 23)	16	8:30–11:20
4	(30, 13)	8	8:30–9:50	14	(23, 21)	13	10:10–14:30
5	(10, 18)	4	8:00–11:00	15	(18, 29)	15	9:00–10:00
6	(15, 18)	13	8:20–9:20	16	(29, 29)	10	8:10–9:30
7	(13, 28)	11	9:50–14:20	17	(23, 15)	7	10:20–12:20
8	(28, 20)	21	10:00–11:10	18	(15, 9)	9	8:00–8:40
9	(18, 15)	25	9:10–10:50	19	(9, 29)	10	8:40–12:45
10	(13, 23)	15	8:20–11:10	20	(26, 26)	14	7:40–8:20

Table 3: Table of the initial production-distribution plan.

Batch	Distribution route	The start time of production (min)	The start time of distribution (min)
1	0⟶11⟶18⟶5⟶10⟶1⟶0	440.0	456.6
2	0⟶15⟶3⟶8⟶17⟶0	532.2	553.1
3	0⟶20⟶16⟶19⟶12⟶2⟶0	456.6	477.1
4	0⟶4⟶9⟶7⟶14⟶0	493.9	514.4
5	0⟶6⟶13⟶0	477.4	487.8

Table 4: Solution results of different methods.

Method	Customer's disturbance	Distribution center's disturbance	Distributor's disturbance	Manufacturer's disturbance
1	0.92	3.04	1	0.32
2	4.39	0.35	2	2

type, each vehicle has a capacity of 60 units, the speed of the vehicle is 30 km/h, the driving cost is RMB 1 yuan/km, the fixed cost of vehicle is RMB 150 yuan/vehicle, the production time of unit product is 0.006 h, and the loss coefficient of unit product value is RMB 0.5 yuan/h. For the convenience of calculation, the service time is 0. The customer order information table is shown as Table 2.

According to the above conditions, the final objective function value is RMB 1113 yuan; the product value loss value is RMB 131.4 yuan. The scheme is shown in Table 3.

6.3. Experimental Result. When the delivery is carried out to customer 20, the time window of customer 9 changes from [9:10–10:50] to [10:10–13:30]. According to reference [19], take = 0.88 = 2.25, respectively, and use the method in this paper and the rescheduling method to solve the problem. The results are shown in Table 4; 1 represents the proposed method and 2 represents the rescheduling method.

It can be seen from Table 3, for customer disturbance, the disturbance of this method to customers is significantly lower than that of rescheduling, which is very effective in dealing with customer satisfaction to products; the cost of this method is higher than that of rescheduling method, but the difference is not significant; the disturbance management model is better than the rescheduling method in restraining the deviation of distribution routes; the disturbance of production center is relatively small after meeting the change of customer time window, which shows that the disturbance management model is effective for production center.

7. Conclusions

Aiming at the problem of customer time window changes, this paper uses prospect theory, with minimum system disturbance as the priority goal, and constructs a perishable food production-distribution disruption management model with customer time window changes. Based on simulation experiments, the algorithm-mixed ant colony algorithm for perishable food production-distribution problems based on customer time window changes is designed to solve the problem. The analysis results show that the disruption management model constructed in this paper can quickly and effectively produce adjustment schemes with less disturbance; it can also better balance the four goals of customer waiting time, distribution costs, distribution routes, and production waiting time. It can provide new ideas for the company of production-distribution integration to solve the disruption problem. In the actual production and distribution process, we may face other interference problems such as machine failure and address change. This requires further research.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References

[1] R. E. Chatwin, "Optimal dynamic pricing of perishable products with stochastic demand and a finite set of prices," *European Journal of Operational Research*, vol. 125, no. 1, pp. 149–174, 2000.

[2] Z. Dai, F. Aqlan, X. Zheng, and K. Gao, "A location-inventory supply chain network model using two heuristic algorithms for perishable products with fuzzy constraints," *Computers & Industrial Engineering*, vol. 119, no. 8, pp. 338–352, 2018.

[3] W. Yu, J. Tao, and Q. Lei, "Optimal ordering and extra-product promotion policy for deteriorating items with expiration date," *Industrial Engineering and Management*, vol. 22, no. 3, pp. 99–105, 2017.

[4] K. Li, D. Li, and D. Wu, "Multi-objective optimization for location-routing-inventory problem in cold chain logistics network with soft time window constraint," *Journal Européen des Systèmes Automatisés*, vol. 53, no. 6, pp. 803–809, 2020.

[5] P. Amorim, D. Alem, and B. Almada-Lobo, "Risk management in production planning of perishable goods," *Industrial & Engineering Chemistry Research*, vol. 52, no. 49, pp. 17538–17553, 2013.

[6] Y. Zhu, J. Wang, and M. Li, "Collaborative distribution in the soft time window of agricultural-means supply chain based on simulated annealing-genetic algorithm," *Journal Européen des Systèmes Automatisés*, vol. 53, no. 6, pp. 835–844, 2020.

[7] H.-K. Chen, C.-F. Hsueh, and M.-S. Chang, "Production scheduling and vehicle routing with time windows for perishable food products," *Computers & Operations Research*, vol. 36, no. 7, pp. 2311–2319, 2009.

[8] J. Ren, C. Ye, and Y. Li, "A two-stage optimization algorithm for multi-objective job-shop scheduling problem considering job transport," *Journal Européen des Systèmes Automatisés*, vol. 53, no. 6, pp. 915–924, 2020.

[9] Y. Wu and Z. Ma, "Time-dependent production-delivery problem with time windows for perishable foods," *Systems Engineering-Theory and Practice*, vol. 37, no. 1, pp. 172–181, 2017.

[10] S. Somashekhara, A. Setty, S. Sridharmurthy, P. Adiga, U. Mahabaleshwar, and G. Lorenzini, "Makespan reduction using dynamic job sequencing combined with buffer optimization applying genetic algorithm in a manufacturing system," *Mathematical Modelling of Engineering Problems*, vol. 6, no. 1, pp. 29–37, 2019.

[11] J. Wang, S. Yao, J. Sheng, and H. Yang, "Minimizing total carbon emissions in an integrated machine scheduling and vehicle routing problem," *Journal of Cleaner Production*, vol. 229, no. 20, pp. 1004–1017, 2019.

[12] D. Qiulei and J. Yang, "A model of disruption management based on behavioral operations research in production scheduling," *Systems Engineering-Theory and Practice*, vol. 36, no. 3, pp. 664–673, 2016.

[13] H. Mu, "Disruption management of flexible job shop scheduling considering behavior perception and machine fault based on improved NSGA-II algorithm," *Journal Européen des Systèmes Automatisés*, vol. 52, no. 2, pp. 149–156, 2019.

[14] M. Marinaki and Y. Marinakis, "A glowworm swarm optimization algorithm for the vehicle routing problem with stochastic demands," *Expert Systems with Applications*, vol. 46, no. 15, pp. 145–163, 2016.

[15] T. Ning, X. Wang, X. Hu, and X. Jiao, "Disruption management optimal scheduling for logistics distribution based on prospect theory," *Control and Decision*, vol. 33, no. 11, pp. 147–151, 2018.

[16] P. Farahani, M. Grunow, and H.-O. Günther, "Integrated production and distribution planning for perishable food products," *Flexible Services and Manufacturing Journal*, vol. 24, no. 1, pp. 28–51, 2012.

[17] F. Belo-Filho, P. Amorim, and B. Almada-Lobo, "An adaptive large neighbour hood search for the operational integrated production and distribution problem of perishable products," *International Journal of Production Research*, vol. 53, no. 11, pp. 1–19, 2015.

[18] T. Ning, X. Wang, and X. Hu, "Study on disruption management strategy of terminal logistics based on prospect theory," *Systems Engineering-Theory and Practice*, vol. 39, no. 3, pp. 673–681, 2019.

[19] Q. Ding, "Model of disruption management for the change of time window based on human behavior in logistic distribution," *Chinese Journal of Management Science*, vol. 23, no. 5, pp. 89–97, 2015.

[20] J. Zheng and Z. Cai, "Discrete differential evolution algorithm of MDOVRPSTW," *Information Tech- nology and Informatization*, vol. 12, p. 81, 2016.

[21] X. Z. Jiang, S. Gao, and J. Z. Chen, "Hybrid algorithm combining ant colony optimization algorithm with simulated

annealing algorithm optimization," *Computer Engineering and Design*, vol. 29, no. 6, pp. 1491–1493, 2008.

[22] B. J. Chai and D. W. Liu, "Application of an ant colony algorithm in TSP based on particle swarm," *Computer Simulation*, vol. 26, no. 8, pp. 89–91, 2009.