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# Research on e-commerce supply chain inventory optimization and multi-objective planning method based on hierarchical analysis method

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**Abstract** With the continuous expansion of e-commerce business scale as well as the increasing variety, its supply chain inventory management is facing the complex multi-objective decision-making problem of balancing the total cost and total distribution time. Based on the ultimate goal of inventory management control and optimization, this paper constructs a set of e-commerce supply chain inventory performance evaluation system consisting of three primary indicators and 17 secondary indicators. Fuzzy hierarchical analysis is chosen as the calculation method of indicator weights, and the application steps of fuzzy hierarchical analysis are analyzed. Then the triangular fuzzy number method is used to convert fuzzy uncertain linguistic variables into definite values and accurately quantify the performance of the evaluation object. Combining the fuzzy hierarchical analysis method with the triangular fuzzy number operation method, the weights of the indicators of the performance evaluation system and the performance evaluation scores of P e-commerce supply chain inventory are calculated. Subsequently, fuzzy numbers are utilized to describe the product market price with ambiguity and target weights, and a fuzzy multi-objective decision-making model involving multi-level supply chain inventory is proposed. A genetic algorithm is introduced to solve the optimal solution set of the multi-objective optimization model. In the multi-objective optimization model solution for P supply chain inventory, the solution algorithm designed in this paper achieves a total cost lower than 450,000 yuan and a total delivery time lower than 57.5 hours after 60 iterations, and it is more stable.

**Index Terms** e-commerce supply chain inventory, performance evaluation, multi-objective optimization model, genetic algorithm, fuzzy hierarchy analysis

## I. Introduction

With the updating of the Internet and information technology, the pattern of the consumer market has undergone great changes, mainly manifested in the impact of mobile shopping and cross-border e-commerce on traditional brick-and-mortar enterprises. With the rise of e-commerce technology in the use of enterprises, invariably increase the pressure of enterprises in the market competition, resulting in the current stage of market competition from the independent competition between enterprises, to the supply chain between the integrated ability to the core of the competition. Supply chain management has become the preferred management mode of enterprises in the information technology era and new competitive conditions, and has been favored by many business decision makers [1], [2]. As a highly advanced management model, logistics, capital flow and information flow are the aspects that need to be emphasized in its operation and management [3]. Among them, inventory management, as one of the key links in supply chain management, plays a balancing role in maintaining customer stability and satisfaction, production operations and transportation of goods and other activities, and the level of inventory costs and levels can be visualized to show the operational status of enterprises [4]-[6]. The current supply chain inventory management model used by e-commerce enterprises is slightly outdated, and the problems of multiple sources of data and inconsistent standardization between data from different systems are increasingly apparent, which increases the difficulty of subsequent integration and analysis of data, and reduces the value of data use [7]-[10]. Therefore, by analyzing the inventory model under demand determination and using multi-objective planning to establish a multilevel inventory mathematical model, the supply chain management efficiency will be effectively improved [11], [12]. This will further coordinate and organize the operation process among the enterprises in the supply chain nodes, thus cutting the cost of our company, making mutual benefits for ourselves and our suppliers, and gaining an advantage in the competition among the supply chain [13], [14].

This paper combines the needs and objectives of e-commerce supply chain inventory management, and establishes a set of e-commerce supply chain inventory management performance evaluation index system from three different dimensions. Secondly, it elaborates the analysis steps of fuzzy hierarchy method and the operation process of triangular fuzzy number, and integrates the two as the assignment of indicator system and performance evaluation method. Taking P e-commerce supply chain as the experimental object, the weights of the designed performance evaluation index system are assigned to the indexes, and the performance of P e-commerce supply chain inventory is evaluated. Finally, the multi-objective optimization model (F) of e-commerce supply chain is designed to illustrate the solution principle of multi-objective optimization genetic algorithm. Compare the algorithm of this paper with similar algorithms in solving the multi-objective optimization model and the solving results.

## II. Evaluation methods of e-commerce supply chain inventory management

### *II. A.Establishment of a system of performance assessment indicators*

There should be corresponding technical specifications for supply chain inventory control performance assessment, but due to the differences in the industries in which the supply chains are located and the different strategic orientations, the process of establishing the supply chain inventory control performance assessment system is quite complicated, and it is an exploratory and innovative work. In this paper, we will assess the inventory control status among enterprises in the supply chain nodes through financial indicators, internal and external process indicators. The goal of general inventory control is: to maximize the service level and minimize the total cost as much as possible. Then, when assessing the performance of inventory control, inventory service level and inventory control cost are two essential indicators, and financial indicators refer to inventory control cost. In summary, for the analysis of factors affecting the supply chain inventory control performance, and following the design principles of the indicator system, through analysis, comparison, screening to establish the supply chain inventory control performance evaluation system is shown in Table 1.

Table 1: The index sign system of performance evaluation in inventory control

| First-level evaluation indicators | Secondary evaluation indicators |
|---|---|
| (A)Inventory control cost | (A1)storage cost |
| | (A2)ordering cost |
| | (A3)shortage cost |
| | (A4)Cost of lost orders |
| | (A5)Handling and loading costs |
| | (A6)transportation cost |
| | (A7)Inventory information transmission cost |
| (B)customer service level | (B1)On-time delivery rate |
| | (B2)Order completion time |
| | (B3)Delivery accuracy rate |
| | (B4)Supply rate of inventory materials |
| | (B5)order fill rate |
| (C)Inventory control quality | (C1)Damage rate of inventory materials |
| | (C2)Inventory material recycling rate |
| | (C3)Warehouse capacity utilization rate |

### *II. B.Fuzzy Hierarchical Analysis*

#### II. B. 1) Presentation of the Fuzzy Hierarchy Analysis methodology

Fuzzy hierarchical analysis (FAHP), which appeared in the mid-1980s, is a decision analysis method based on the hierarchical analysis method (AHP). The method successfully introduces fuzzy mathematics into hierarchical analysis.

The traditional hierarchical analysis method is to decompose the complex decision-making problem level by level by judging the importance between the factors, using the multi-level structure, and calculating the weights in each level to arrive at the final decision-making conclusion, and the weight values use the exact numerical values, while the fuzzy hierarchical analysis method expresses the importance of the elements with fuzzy numerical values by introducing the concepts of fuzzy sets, affiliation functions, and so on, and by the function attached to the fuzzy set to describe, combining the fuzzified importance factors with the hierarchical structure, and calculating the weights of each factor by establishing a mathematical model, so as to arrive at the final decision-making conclusion.

### II. B. 2) General analytical steps

(1) Constructing a hierarchical model

Decompose the decision-making problem into goal, criterion and program layers, which are the desired goals, the criteria for evaluating these programs, and the available options, respectively.

(2) Constructing a fuzzy judgment matrix

For each criterion within the criterion layer and each set of elements between the criterion layer and the solution layer, expert judgment is expressed using fuzzy numerical values by evaluating their relative importance, such as triangular fuzzy number, trapezoidal fuzzy number, etc., and then a fuzzy judgment matrix is formed.

(3) Calculation of fuzzy weight vector

In order to determine the fuzzy weight of each factor and establish the fuzzy judgment matrix, this process can be used to solve the fuzzy weight vector by using fuzzy geometric mean method, fuzzy arithmetic mean method and other methods.

(4) Synthesis of weight vector

According to the principle of hierarchical single ordering, the fuzzy weight vector is synthesized into global priority weights.

(5) Defuzzification

Converting the fuzzy weights into clear numerical weights can be achieved by defuzzification techniques such as the center of mass method, area method, and maximum affiliation.

(6) Sorting and selecting programs

After defuzzification, the weights are sorted according to size, so as to select one or more optimal solutions as the result of decision-making.

## *II. C. Triangular fuzzy number operations*

Before the specific operation, the following theorem is introduced without proof:

(1) If $M_1=(l_1,m_1,u_1)$ and $M_2=(l_2,m_2,u_2)$ are two fuzzy numbers, then we have equations (1)-(4):

$$M_1 \oplus M_2=(l_1,m_1,u_1)\oplus(l_2,m_2,u_2)=(l_1+l_2,m_1+m_2,u_1+u_2) \tag{1}$$

$$M_1 \otimes M_2=(l_1,m_1,u_1)\otimes(l_2,m_2,u_2)=(l_1l_2,m_1m_2,u_1u_2) \tag{2}$$

For any $\lambda$, there exists $R$.

$$\lambda M=\lambda(l,m,u)=(\lambda l,\lambda m,\lambda u) \tag{3}$$

$$\frac{1}{M}=(\frac{1}{u},\frac{1}{m},\frac{1}{l}) \tag{4}$$

(2) Let $M_{Ei}^1,M_{Ei}^2,\cdots,M_{Ei}^n$ be the degree analysis value of the $i$ th program on $m$ objectives, and the fuzzy synthesis value of the “weight value” type is shown in equation (5):

$$S_i=\sum_{j=1}^{m}M_{Ei}^j\cdot w_i^j\otimes\left[\sum_{i=1}^{n}\sum_{j=1}^{n}M_{Ei}^j\cdot w_i^j\right]^{-1} \tag{5}$$

$(i=1,2,\cdots,n)$, where $w$ is the weight and $\sum_{j=1}^{m}w_i^j=1$, which holds for everything $i$, is referred to as $S_i$ as the degree of synthesis of the $i$ th scheme.

(3) The pure measure of program $X_i$ superior to other programs is as in equation (6):

$$d=(x_i)\min V(S_i\geq S_k) \tag{6}$$

$k=1,2,\cdots,n$, $k\neq I$. and $V(S_i\geq S_k)=1$.

## *II. D. Calculation of indicator weights and application of examples*

### II. D. 1) Calculation of weights

Assuming that P is an e-commerce supply chain inventory, the overall performance of its inventory management is unfolded. The relative importance of inventory performance indicators is investigated in the form of expert scoring, and then the statistical results of the indicator relative importance questionnaire are calculated by using the arithmetic mean to obtain the judgment matrix of the weights of the first-level indicators of this supply chain in Figure 1.

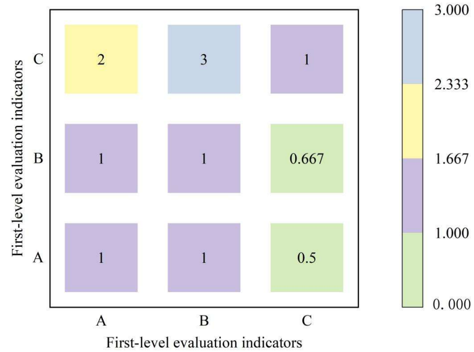


Figure 1: Deterministic matrix of the First-level evaluation indicators

The judgment matrix of the weights of the secondary indicators for this supply chain is shown in Figure 2.

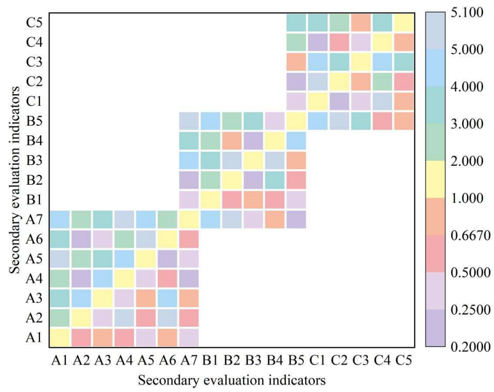


Figure 2: Deterministic matrix of the Secondary evaluation indicators

Based on the above judgment matrix, the weights of the indicators at the first and second levels were calculated and consistency tests were conducted. The weights of the indicators at each level are shown in Table 2.

Table 2: The index weight of all indexes

| First-level indicator | Weight | Secondary indicator | Weight |
|---|---|---|---|
| A | 0.2 | A1 | 0.08 |
| | | A2 | 0.08 |
| | | A3 | 0.18 |
| | | A4 | 0.15 |
| | | A5 | 0.15 |
| | | A6 | 0.21 |
| | | A7 | 0.15 |
| B | 0.3 | B1 | 0.28 |
| | | B2 | 0.19 |
| | | B3 | 0.15 |
| | | B4 | 0.19 |
| | | B5 | 0.19 |
| C | 0.5 | C1 | 0.29 |
| | | C2 | 0.14 |
| | | C3 | 0.57 |

#### II. D. 2) Calculating the fuzzy matrix

The performance appraisal grade V = [excellent, good, average, poor] = [90,80,70,50], the hiring of experts on the scoring of the relevant experts on the grade of the second-level indicators, the summary of the evaluation results, the calculation of the fuzzy matrix of the second-level indicators is shown in Table 3.

Table 3: Secondary index fuzzy matrix

| Index | Excellent | Good | Average | Poor |
|---|---|---|---|---|
| R1 | 0.3 | 0.4 | 0.2 | 0.1 |
| R2 | 0.1 | 0.2 | 0.4 | 0.3 |
| R3 | 0.1 | 0.3 | 0.4 | 0.2 |

The fuzzy evaluation vector of the first level indicators was calculated as equation (7):

$$V = \begin{bmatrix} 0.14 & 0.29 & 0.36 & 0.21 \end{bmatrix} \tag{7}$$

Then the performance evaluation score of Supply Chain Inventory Management performance under the set of performance appraisal ratings is 71.5, and the performance of Supply Chain Inventory Management is between good and fair according to the performance rating V=[Excellent, Good, Fair, Poor]=[90,80,70,50].

## III. Multi-objective planning for e-commerce supply chain inventory

### *III. A. Multi-objective optimization model*

In reality, a supply chain is composed of a large number of inter-collaborating firms and involves the whole process of supply, production and distribution of each member firm. In this paper, we are going to consider a three-level series supply chain model for a single product and it consists of three firms, i.e., suppliers, producers and sellers. It can be easily extended to obtain more levels of series supply chain model or mesh supply chain model.

#### III. A. 1) Model assumptions

(1) Each business has its own safety stock level.

(2) Stock-outs are allowed, but they are minimal compared to the average inventory and there are no simultaneous stock-outs.

(3) Continuous inventory type $(Q,r)$ inventory control strategy is used to check the inventory position of each enterprise.

(4) The firm's lead time demand is an independent random variable and obeys a normal distribution $N(\mu_{Di},\delta_{Di}^2)$, with $i=1,2,3$ denoting each node firm.

(5) The order lead time $L$ is an uncertain quantity obeying the standard normal distribution $N(\mu_{Li},\delta_{Li}^2)$ with $i=1,2,3$.

#### III. A. 2) Objective functions in the model

Inventory management is based on two considerations: one is ordering cost, inventory holding cost and ordering cost, and the other is customer service level and safety stock level. The general objective of inventory management is to minimize inventory costs in the supply chain and improve the efficiency of supply chain logistics to strengthen the competitiveness of enterprises under the precondition of achieving a satisfactory customer service level. Therefore, this paper mainly focuses on the optimization calculation from the three objectives of minimizing inventory cost, maximizing safety stock level and customer service level as the objective function.

(1) Supply chain inventory cost

It mainly includes inventory holding cost $HC$, ordering cost $OC$ and ordering cost $PC$ as in equation (8):

$$\sum_{i=1}^{3}(PC_i + OC_i + HC_i) \tag{8}$$

Since the order lead time and product market demand are random and obey normal distribution: $N(\mu_L,\delta_L^2)$ and $N(\mu_D,\delta_D^2)$ respectively, the average in-stock inventory of the enterprise at the $i$ th level can be obtained as Eq. (9):

$$\frac{Q_i}{2} + k_i\sqrt{\delta_{Li}^2\mu_{Li} + \mu_{Di}\delta_{Di}^2} \tag{9}$$

where $k_i$ is the safety stock factor.

The minimization supply chain inventory cost function is equation (10):

$$f_1 = \sum_{i=1}^{3}\left(\tilde{p}_i \times Q_i + T_i \times \frac{D}{Q_i} + U_i \times \left(\frac{Q_i}{2} + k_i\sqrt{\delta_{Li}^2\mu_{Li} + \mu_{Di}\delta_{Di}^2}\right)\right) \tag{10}$$

where $T_i$ is the ordering cost incurred at each replenishment, $D$ is the annual forecasted customer demand, $U_i$ is the unit in-stock inventory holding cost, and $\tilde{p}_i$ is the product price, a fuzzy variable.

(2) Safety stock level

Safety stock is a part of inventory that is mainly set up to cope with short-term random changes in demand or order points. By establishing an appropriate level of safety stock, the likelihood of running out of stock is reduced and the cost of inventory shortage is reduced to some extent. However, the increase in safety stock will in turn increase the inventory holding cost, so it is difficult to accurately predict the safety stock. The supply chain safety stock level is equation (11):

$$\sum_{i=1}^{3}\left(1 - \frac{S_i}{k_i\sqrt{\delta_{Li}^2\mu_{Li} + \mu_{Di}\delta_{Di}^2}}\right) \times 100 \tag{11}$$

$S_i$ is the shortage inventory level.

Maximize the safety stock level, i.e., minimize the function as in equation (12):

$$f_2 = \sum_{i=1}^{3}\frac{S_i}{k_i\sqrt{\delta_{Li}^2\mu_{Li} + \mu_{Di}\delta_{Di}^2}} \times 100 \tag{12}$$

(3) Customer service level

This refers to the degree of fulfillment of customer demand situations. The higher the customer service level, the less out-of-stock occurs, and thus the cost of out-of-stock is smaller, but thus the amount of safety stock is increased, resulting in a higher cost of inventory holding. A lower level of customer service indicates that out-of-stocks occur more often, the cost of out-of-stocks is higher, and the level of safety stock is lower. The supply chain customer service level formula is equation (13):

$$\frac{1}{\sqrt{2\pi}}\sum_{i=1}^{3}\left[\int_0^{k_i} e^{-\frac{x^2}{2}}dx\right] \times 100 \tag{13}$$

Maximize the customer service level, i.e., minimize the function as in equation (14):

$$f_3 = \sum_{i=1}^{3}\int_{k_i}^{\infty} e^{-\frac{x^2}{2}}dx \times 100 \tag{14}$$

The purpose of this paper is to integrate several of the above objectives simultaneously, making it possible to: ensure that inventory control costs are minimized for all participating firms in the supply chain. Improve the level of customer service and safety stock levels throughout the supply chain. Let $f_j^{\max}$ and $f_j^{\min}$ be the maximum and minimum values $j = 1,2,3$ of the objective $f_j$, respectively, and the objective function is obtained as Eq. (15) for the above three objectives:

$$v_j(Q_i, k_i) = \frac{f_j - f_j^{\max}}{f_j^{\min} - f_j^{\max}} \tag{15}$$

The weight factor $\tilde{w}_j$ for each objective is given by the decision maker, and the multi-objective function with feasible solution $x_i = (Q_i, k_i)$ is transformed into a single objective function as in equation (16):

$$f(x_i) = \sum_{j=1}^{3}\tilde{w}_j v_j(x_i) \tag{16}$$

Then only the optimal solutions $Q_i^*$ and $k_i^*$ of the single-objective function (16) are found, i.e., they are the optimal reconciliation solutions of the supply chain inventory multi-objective optimization problems Eqs. (10), (11), and (13).

### III. B. Genetic algorithm for multi-objective optimization

Genetic algorithm is a powerful tool for solving multi-objective optimization problems, it covers a large search area, can simultaneously evaluate multiple solutions in the search space in parallel, which is conducive to the realization of global optimization, the fitness function is not subject to continuous differentiable constraints and its defining domain can be arbitrarily set, and the search can be organized by itself, which are the advantages that make genetic algorithm an effective algorithm to deal with the multi-objective optimization problems. The basic steps of genetic algorithm for multi-objective optimization in this paper are as follows:

(1) Coding

Since the constructed multi-objective optimization problem requires a large search range and high search accuracy, thus the real number coding is more appropriate than other coding methods, and the population can be obtained as in equation (17):

$$P_{1,2,\cdots,NN}=\left[Q_1,Q_2,\cdots,Q_t,Q_1,Q_2,\cdots,Q_x\right] \tag{17}$$

Based on the constraints of the model, the feasible domain of the model is obtained as equation (18):

$$\begin{cases} Q_i\in\left[0,\min\left(\sum_{i=1}^{m}Q_{0i},W_m/SA\right)\right] \\ Q_x\in\left[0,\min\left(\sum_{x=1}^{X}Q_{0x},W_x/SA\right)\right] \end{cases} \tag{18}$$

(2) Fitness function

The fitness function is generally designed according to the objective function, in order to be able to directly relate the fitness function to the individual strengths and weaknesses in the population, the genetic algorithm will specify the fitness value as non-negative, according to the size of the individual's fitness to determine the probability of the individual selected in the selection operation, the larger the individual's fitness, the greater the probability that it will be hereditary to the next generation, and thus always hope that the fitness is as big as possible under any circumstances. The model constructed in this paper is processed and transformed into an optimization problem with the minimum of the objective function, which requires certain changes in the objective function, combined with the multi-objective evaluation function constructed previously by the evaluation function method, it can be seen that with $F(Q_i,Q_x)$ to represent the fitness function, there is equation (19):

$$F(Q_i,Q_x)=0.3255\times\frac{2+OC}{y_1^*}+0.0701\times\frac{2+OP}{y_2^*}+0.6044\times\frac{2-OS}{y_3^*} \tag{19}$$

(3) Generation of initial population

Genetic algorithm is a genetic operation on the population, which needs to prepare some initial population data indicating the starting search point, and also needs to initialize the parameters population size $NN$, crossover probability $P_c$ and variation probability $P_b$. The population size $NN$ specifies how many individuals there are in each generation, and one individual is randomly generated in the feasible domain, and stochastic simulation is applied to test whether the requirements are met, and if they are not met, a new individual is generated until a feasible and compliant $NN$ individuals are generated to form the initial population $(P_1,P_2,\cdots,P_{NN})$. By using a large population size, the genetic algorithm searches the solution space more thoroughly and also reduces the probability of returning a local minimum, but a large population scale will make the genetic algorithm run more slowly.

(4) Selection operation

The selection parameter specifies how the genetic algorithm selects two parents for the next generation. According to the fitness function, the fitness value of each individual is obtained, sorted by size $(P_1,P_2,\cdots,P_{NN})$, and the roulette method is used to select $NN$ times, and $NN$ individuals are copied to the matching pool to wait for the crossover operation. In order to overcome the phenomenon of prematurity and enhance the ability of continuous global optimization search, a strategy of protecting outstanding individuals is adopted, i.e., the $BESTMAX$ optimal individuals in the parent generation are put back into the matching pool to replace the worst $BESTMAX$ individuals in order to maintain the existence of outstanding individuals in the population. According to the principle of optimal individual retention, the best individual is $P_0$, which is replaced when a better individual is found later, so that the final $P_0$ is the optimal solution.

(5) Crossover operation

The crossover operation in the genetic algorithm imitates the mating and recombination process in the natural evolution of organisms to produce new individuals, which plays a key role in the genetic algorithm and is the main method to produce new individuals. The crossover probability specifies the parts of the next generation that are different from the original population, which are produced by crossover, and is set to 0.6 in this paper. The crossover parameter describes how the genetic algorithm combines two individuals or two parents to form crossover subindividuals for the next generation. Using sequential arithmetic crossover, if two parents are feasible, then their children are also feasible, therefore, for the solution near the edge that the crossover operator may not be able to search, the mutation operation should be used.

(6) Mutation operation

Mutation operation can generate new individuals, mutation has two main purposes, one purpose is to improve the local search ability of the genetic algorithm, the other purpose is to maintain the diversity of the population. Randomly generate a mutation direction as in equation (20):

$$c = (c_1, c_2, \cdots, c_N) \tag{20}$$

$c_i$ is the allowed variation of $Q_i$ and $Q_x$, which is then compiled to produce the offspring population as in equation (21):

$$child_p = parent_p + c \tag{21}$$

Then test whether the offspring meet the requirements, if not then regenerate the individual until the generation of feasible individuals that meet the requirements.

(7) Loop until termination

Repeat the operation steps from (3) to (5) until the termination condition is satisfied, thus obtaining the optimal solution $P_0$. Where the termination condition is the maximum number of iterations $MAXGEN$, when the evolution of the algorithm reaches $MAXGEN$, the algorithm ends and outputs the optimized value, in this paper, the number of iterations is taken as 300 times.

### *III. C. Analysis of the model's solution results*

In this paper, Python language is used for programming to construct the multi-objective optimization model (P, P1) of e-commerce supply chain inventory successively. The algorithm is implemented in PyCharmProfessional Edition2020.3 platform, and the experimental environment is 24GRAMIntel(R)Core(TM)i5- 9400FCPU@2.9GHz. Firstly, the relevant parameters are set, and the population size N is 100, the maximum crossover probability is 1, the maximum variation probability is 0.8, and the iteration number is 60 times.

Firstly, the multi-objective model P before optimization is solved, that is, the multi-objective model that only considers the total cost (f1) and the total delivery time (f3), which are 2 objectives, and then the model is solved by (H1) NSGA-IIII algorithm and (H2) the algorithm in this paper. And the search efficiency as well as the search accuracy of the two algorithms are compared. The Pareto-optimal solution set of the total cost objective obtained after iteration of the two algorithms is shown in Fig. 3, and the Pareto-optimal solution set of the total delivery time is shown in Fig. 4.

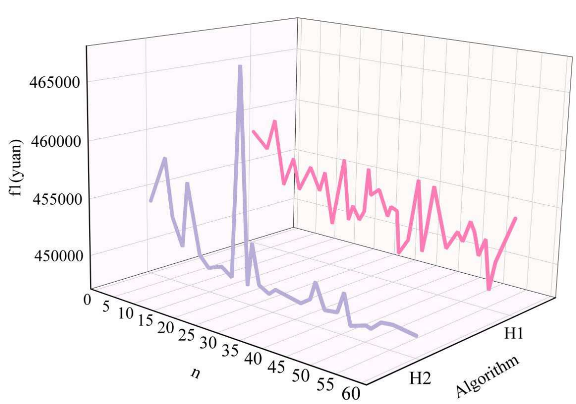


Figure 3: The changing trend of the total cost target

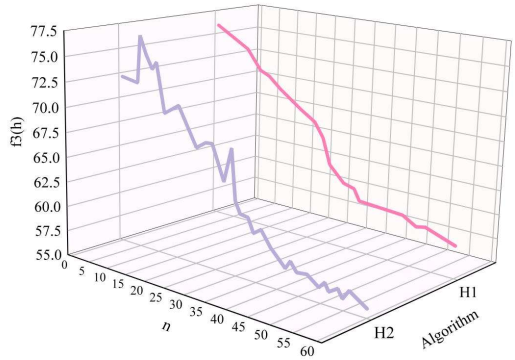


Figure 4: The changing trend of the total delivery time target

Comparing the search efficiency of the two algorithms, it can be seen that (H2) this paper's algorithm is faster than (H1) NSGA-IIII algorithm in terms of search efficiency and convergence speed, in which (H2) this paper's algorithm has a total cost of less than 450,000 yuan and a total delivery time of less than 57.5 hours after 60 iterations. From the trend of the 2 objective function values, (H2) this paper's algorithm obtains a better set of Pareto optimal solutions than (H1) NSGA-IIII algorithm, and the computational results obtained from (H2) this paper's algorithm are better than (H1) NSGA-IIII algorithm in terms of the total cost objective and total distribution time.

Next, the optimized multi-objective model P1 is solved, that is, based on the original multi-objective model plus the system synergistic effect objective, and the model is also solved using (H1)NSGA-IIII algorithm and (H2)this paper's algorithm.The trend of the mean value of the total cost objective function corresponding to the optimal solution set of the two algorithms obtained after each iteration of Pareto is shown in Fig. 5, and the trend of the mean value of the total delivery time objective function is shown in Fig. 6. The trend change of the mean value of the total delivery time objective function is shown in Fig. 6.

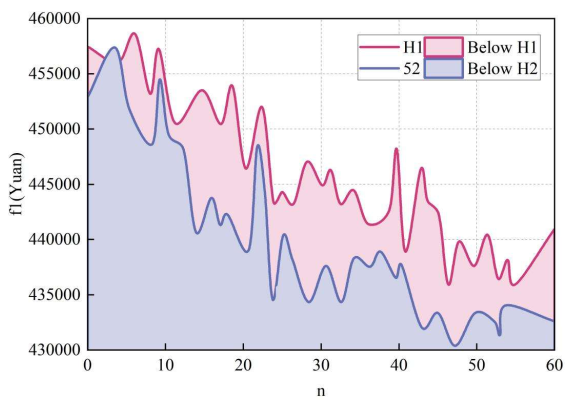


Figure 5: Optimize the changing trend of the total cost target of the model

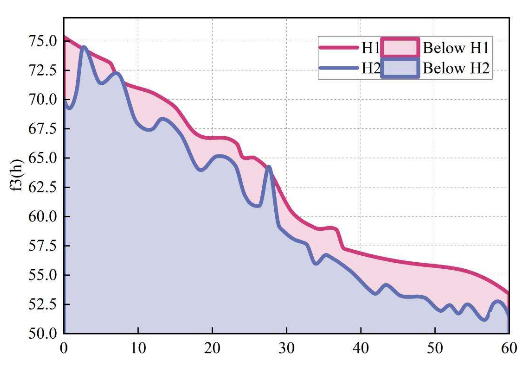


Figure 6: Optimize the changing trend of the total delivery time target of the model

Comparing the trends of the two algorithms on the average of the 2 objective functions of the optimized multi-objective model, on the total cost objective (H2) this paper's algorithm solving result is much better than (H1) NSGA-IIII algorithm, controlling the total cost between 430,000-435,000 yuan. In terms of total distribution time (H2) this paper's algorithm solution results are slightly better, the total distribution time is less than 54 hours.

In addition, from the experimental results, it can also be seen that the algorithm in this paper has the following advantages:

First, the algorithm can ensure the population stability. For the problem of population instability, the population prediction strategy based on reference points is designed, which fully utilizes the historical information of the population. It increases the possibility of producing good individuals, and the good individuals will be retained with a greater probability, while the bad individuals will be given a larger crossover rate and mutation rate to produce good individuals, so that the population will maintain diversity as well as stability after each selection generation.

Second, the algorithm can improve the convergence and accuracy of the algorithm. The multi-segmented integer coding method is adopted to feedback the results of each iteration to the algorithm to adjust the parameters dynamically, which can accelerate the convergence of the algorithm.

## IV. Conclusion

In this paper, the optimization of e-commerce supply chain inventory management is divided into two parts: performance evaluation and multi-objective planning, and the performance performance performance of e-commerce supply chain inventory management is obtained by constructing a performance evaluation index system whose structure and content meet the needs of inventory management. On the basis of this data, the multi-objective optimization model of e-commerce supply chain inventory is established, and the genetic algorithm is designed to solve the optimal solution set of total cost and total delivery time.

The performance evaluation index system under the set of performance evaluation levels has a performance evaluation score of 71.5, which is between good and average. The proposed multi-objective optimization genetic algorithm in solving the multi-objective optimization model of e-commerce supply chain inventory has faster search efficiency and convergence speed compared with similar algorithms, and the total cost is lower than 450,000 yuan and the total delivery time is lower than 57.5 hours after 60 iterations. And on the average of the 2 objectives, after 60 iterations, the total cost is controlled to be between 430,000-435,000 yuan and the total distribution time is lower than 54 hours. The performance evaluation index system proposed in this paper has reliability, and the solution algorithm is stable and efficient, which is a practical e-commerce supply chain inventory management optimization scheme.

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