

Retraction

Retracted: An Optimization Model for Logistics Distribution Network of Cross-Border E-Commerce Based on Personalized Recommendation Algorithm

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] Z. Zhang, "An Optimization Model for Logistics Distribution Network of Cross-Border E-Commerce Based on Personalized Recommendation Algorithm," *Security and Communication Networks*, vol. 2021, Article ID 5510481, 11 pages, 2021.

Research Article

An Optimization Model for Logistics Distribution Network of Cross-Border E-Commerce Based on Personalized Recommendation Algorithm

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Received 1 February 2021; Revised 26 March 2021; Accepted 1 April 2021; Published 15 April 2021

Academic Editor: Chi-Hua Chen

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In order to solve the problems of poor timeliness and high service cost caused by international logistics of cross-border e-commerce and to realize the localization of cross-border trade and improve consumers' shopping experience, much cross-border e-commerce has introduced overseas warehouse business. Because the optimization model for the logistics distribution network of cross-border e-commerce cannot solve the problem of high operation cost, the optimization model for the logistics distribution network of cross-border e-commerce based on a personalized recommendation algorithm is designed. Through the analysis of the logistics distribution network of cross-border e-commerce structure and the construction of logistics distribution network of cross-border e-commerce model and multiobjective optimization of logistics distribution network of cross-border e-commerce, the construction process of the logistics distribution network optimization model is completed. The simulation results verify the effectiveness of the model. By comparison, this model can effectively solve the problems that the original model cannot solve and reduce the operation cost of the logistics distribution network.

1. Introduction

With the rapid development of China's cross-border e-commerce in recent years, a large number of overseas goods are stored in the warehouse of e-commerce but also presented in front of users, resulting in "Information overload" and other phenomena. Consumers encounter great difficulties in the process of choosing the goods they like. The target customer group of cross-border e-commerce is different from that of traditional e-commerce, and its focus is more on food safety, good quality, variety of products, reasonable price, and so on. Therefore, the traditional personalized recommendation system of e-commerce is no longer applicable to the field of cross-border e-commerce. The research topic of a personalized recommendation system for cross-border e-commerce needs to be solved, and it can be applied to the field of cross-border e-commerce. In order to effectively solve the sales and inventory problems of cross-border e-commerce platforms, at

the same time, it can select suitable products from the mass of cross-border goods to recommend to customers [1, 2]. A personalized recommendation algorithm has become the main way to solve this problem and also promotes the progress and development of logistics distribution networks to a certain extent.

E-commerce logistics and distribution is to meet the customer's satisfaction, and it is the basic goal of the enterprise to find ways to minimize the transportation cost during the operation. The vehicle routing problem (VRP) [3] is a typical NP hard problem. It has a wide range of applications in computer science, operations research, and engineering optimization. The algorithms of solving VRPs mainly include precise algorithms, traditional heuristic algorithms, simulation algorithms, and artificial intelligence algorithms. The exact algorithm [4] uses the mathematical programming method to obtain the optimal path solution. The exact algorithm is suitable for solving small-scale VRPs. The traditional heuristic algorithm [5] refers to a feasible

solution to the combinatorial optimization problem to be solved under the premise of acceptable computation time and space. The simulation method [6] obtains the optimized solution of the vehicle route through computer simulation experiments. The artificial intelligence optimization algorithm [7] finds the optimal solution of the problem by revealing and simulating natural phenomena. It has global optimization performance, strong robustness, and strong versatility and is suitable for parallel processing. It is widely used to solve large-scale VRPs. According to the study [8], e-commerce is a business activity that uses modern information technology to process cash flow and logistics to achieve transactions. Under the e-commerce environment, whether an item can reach to the customer accurately is a key factor to enhance the company's image. Therefore, how to efficiently select the algorithm to solve the vehicle routing problem is an urgent problem to be solved. In this paper, the genetic algorithm and the conservation algorithm [9–11] are combined to construct the conservation genetic algorithm to study the logistics distribution path optimization problem under the e-commerce environment, and the experimental results are verified in the simulation environment.

With the rapid growth of cross-border e-commerce transaction volume, the logistics efficiency of cross-border e-commerce has become an important factor affecting enterprise efficiency. Due to the small difference in quality and price of goods traded on cross-border e-commerce platforms, cross-border e-commerce needs to seize customers with better services, so as to improve its competitive advantage and expand its brand influence. Therefore, the quality and efficiency of cross-border logistics have become one of the important considerations for cross-border e-commerce to establish core competitiveness. The excellent level of cross-border logistics will help cross-border e-commerce enterprises to occupy the market and improve sales [12, 13]. At the same time, with the rapid development of cross-border e-commerce and the increasingly stringent requirements of consumers for the overseas shopping experience, the bottleneck of export logistics development is becoming increasingly prominent. In order to solve the shortcomings of poor timeliness and high service cost caused by international logistics of cross-border e-commerce and to realize the localization of cross-border trade and improve consumers' shopping experience, much cross-border e-commerce has opened up overseas warehouse business. In this design, starting from the multidimensional international logistics network model of cross-border e-commerce shipping and air transportation under the overseas warehouse mode, the large-scale high-dimensional objective optimization problem is systematically and deeply studied in the field of logistics network optimization and applied to the optimization configuration of cross-border e-commerce shipping and overseas warehouse mode of international logistics by air transportation. Therefore, in this study, the overseas warehouse model of cross-border e-commerce shipping and

international logistics network by air transportation will be analyzed. Through in-depth mining of the structural characteristics of cross-border e-commerce shipping and international logistics network by air transportation under the overseas warehouse mode, the problem description and basic assumptions of the model will be given, and the model parameters will be set to establish the optimal model with the lowest cost, the highest timeliness, and the best 2D and 3D multiobjective models that customers satisfy.

Aiming at the multiobjective model of 2D maritime international logistics network of cross-border e-commerce based on logistics cost and customer satisfaction under the overseas warehouse mode, this paper deeply studies the large-scale multiobjective network optimization problem using weight vector adjustment strategy. Mining the associated variables in the multiobjective function found with less computational cost in the search process; this paper proposes a variable decomposition algorithm based on weight vector adjustment, establishes a logistics network optimization algorithm based on large-scale variables, and applies it to the 2D objective optimization configuration of maritime international logistics overseas warehouse mode of cross-border e-commerce. Generally speaking, the traditional method only takes one function as the optimization objective; it only focuses on one objective, but the optimization problem is usually multiple objective functions. In this paper, an optimization model for logistics distribution network of cross-border e-commerce based on the personalized recommendation algorithm is proposed, which considers the optimization model for logistics distribution network of cross-border e-commerce as a multiobjective optimization problem, and it can effectively improve the performance of logistics distribution.

The contributions of this paper are summarized as follows:

- (1) In this paper, an optimization model for logistics distribution network of cross-border e-commerce based on the personalized recommendation algorithm is proposed, which can deal with the logistics distribution problem effectively. This paper solves the cross-border e-commerce problem by a multiobjective optimization model.
- (2) We modify the existing personalized recommendation algorithm to improve its performance. This paper analyzes the logistics distribution network of cross-border e-commerce structure, firstly. Then, the construction of logistics distribution network of the cross-border e-commerce model and multiobjective optimization of logistics distribution network of cross-border e-commerce are proposed. At last, the solution of the optimization model is the solution of the logistics distribution network.

This paper is organized as follows. Section 2 presents construction of the logistics distribution network optimization model of cross-border e-commerce. In Section 3,

experimental results are also presented and analyzed. Section 4 gives the discussion. Section 5 sums up some conclusions and gives some suggestions as the future research topics.

2. Construction of Logistics Distribution Network Optimization Model of Cross-Border E-Commerce

In order to successfully complete this research, the research plan to be adopted is as follows: to fully study the timeliness, logistics cost, customer satisfaction, and other problems and difficulties of international logistics of cross-border e-commerce in the existing literature and to focus on the analysis of the network optimization problems and countermeasures of cross-border e-commerce logistics under the overseas warehouse mode. On this basis, aiming at logistics timeliness, logistics cost, and customer satisfaction, 2D and 3D multiobjective models for international logistics network of cross-border e-commerce by shipping and air transportation under the mode of the overseas warehouse are established. Various theories and methods of evolutionary multiobjective optimization are learned to seek the solution of the multiobjective network optimization model of cross-border e-commerce logistics in overseas warehouse mode. This paper studies the use of direction vector insertion and weight vector adjustment to solve the problem of high-dimensional international logistics network optimization and discusses the practical application value of logistics network optimization under the new economic model. Figure 1 shows the analysis and explanation of the main content of this study.

In the process of this study, firstly, the research background of the paper is analyzed by using literature analysis, inductive logic, and information retrieval methods; secondly, the mathematical modeling method is used to build the member selection and combination optimization model; then, the solution method of the model is proposed based on the multiobjective algorithm, and the numerical analysis and program implementation method are used to solve the model.

2.1. Analysis of Logistics Distribution Network Structure of Cross-Border E-Commerce. In this study, the preferences of users are taken as the main basis of logistics distribution, and the personalized recommendation algorithm is used to control the logistics distribution network of e-commerce. Compared with traditional e-commerce, the shopping purpose of user groups in cross-border e-commerce will be clearer, the requirements for goods will be higher, and the system will have higher accuracy when analyzing its characteristics so as to more effectively set up the user product distribution network. In order to obtain the effective analysis results of logistics distribution network of cross-border e-commerce structure, this paper first analyzes the traditional user-based multi-interest collaborative filtering algorithm [14, 15] and then proposes an improved user-based multi-interest collaborative filtering algorithm aiming at the

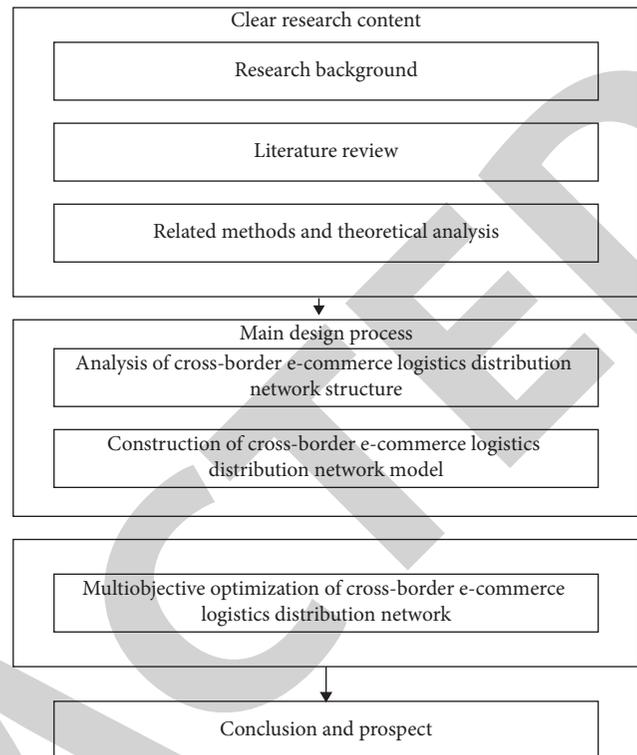


FIGURE 1: Research route to construct the optimization model for logistics distribution network of cross-border e-commerce.

problem of low accuracy of the traditional algorithm. At the same time, it makes a detailed analysis on the current customer groups of cross-border e-commerce. According to the characteristics of user groups of cross-border e-commerce, the logistics transportation network of user groups is constructed.

For judging the user's interest in goods, in addition to scoring the explicit interest, implicit interest is also a powerful supplement for measuring the user's interest in goods [16]. For the e-commerce platform, the following user behaviors can be summarized and analyzed to obtain users' implicit interests and preferences for products: the time when users browse products: for products with long product details, if the user interface stays in the interface for a long time, it can be considered that the user is interested in the product and the user is a potential product customer; the user forwards the product: for the goods that users are interested in, users often forward the goods information; and the collection behavior of users' goods: users are interested in goods and users tend to collect the goods first in order to follow-up view and purchase. In order to measure the implicit interest, we also use 1–5 levels to express, and different implicit behaviors give different levels of interest. For example, after spending a certain amount of time browsing the product details page, the user's interest in the category of the product is increased by 0.2; after forwarding the product details page, the user's interest in the commodity category is increased by 0.6; if a user has collected a commodity in a certain commodity category, then it adds 1 to the user's interest in the commodity category.

In order to effectively and accurately measure the user's interest in a product, the explicit interest and implicit interest are combined, and the combination value can represent the user's interest in a product. The calculation formula of comprehensive interest degree is as follows:

$$U_{i,j} = \alpha Ue_{i,j} + \beta Uk_{i,j}, \quad (1)$$

where $Ue_{i,j}$ is the value of explicit interest, $Uk_{i,j}$ is the value of implicit interest, α and β are the weight (proportion) of explicit interest and implicit interest in comprehensive interest, respectively, and $\alpha + \beta = 1$. The value range of $Ue_{i,j}$ and $Uk_{i,j}$ is 0–5, and the maximum value of $Ue_{i,j}$ and $Uk_{i,j}$ is 5, so the value range of the comprehensive interest of commodities $U_{i,j}$ is 0–5.

Because the modified cosine similarity calculation method does not consider the influence of time on the user's interest, in order to reduce this effect, a time attenuation factor is introduced to adjust it. The formula is as follows:

$$\text{Sim}_{\text{new}}(i, l) = \frac{\sum_{i \in r} (U_{i,j} - \bar{U}_i)(U_{i,l} - \bar{U}_l) \left(1/1 + \varphi |t_{ij} - t_{il}|\right)}{\sqrt{\sum_{i \in r} (U_{i,j} - \bar{U}_i)^2} \sqrt{\sum_{i \in r} (U_{i,l} - \bar{U}_l)^2}}, \quad (2)$$

where φ is the attenuation factor of time, and its value is different in different systems. If the user's interest changes rapidly, it should take a larger value; otherwise, it needs to take a smaller value. t_{ij} is the time point when user i scores item j , t_{il} is the time point when user i scores item l , and $|t_{ij} - t_{il}|$ is the time difference between the two scores. The larger the time interval of user i 's interest and user v 's interest in item l is, the smaller the similarity contribution of the item to users is and the smaller the interest similarity of two users is [16].

Generation Step of Recommendation Result. Firstly, it needs to determine the commodity classification A_C to which the recommended commodity belongs and then obtains all the commodities in commodity classification A_C , which can be expressed as set B_C . Then, target users are recommended through calculation. Neighbor users Nei_{ij} with the same interest similarity select top $-n$ from the neighbor users and then predict the target users. The interest in product ($j \in B_C$) (product that user i did not over rate) is as follows:

$$P_{i,j} = U_i + \sum_{i \in Nei_{ij}} v(i, j)(U_{i,j} - \bar{U}_i), \quad (3)$$

where $v(i, j)$ represents the user similarity between user i and user j , which is sorted according to the size of $P_{i,j}$ value. Finally, the products of top $-n$ are recommended to the target user v .

In formula (3), the combination of explicit interest degree and implicit interest degree is proposed to measure the interest degree; at the same time, the time attenuation factor is introduced in the calculation of user similarity [17, 18], which can effectively eliminate the influence of time on user similarity and further improve the analysis ability of the personalized recommendation algorithm for user

preferences. According to the results of user preference analysis, the e-commerce logistics distribution network is constructed, and the users who have the same preferences and live close to each other are distributed uniformly to build a new logistics network.

2.2. Construction of Logistics Distribution Network Model of Cross-Border E-Commerce. In the above, in the logistics distribution network of cross-border e-commerce, the content of user preferences has been added, which provides a basis for further research. In this part, we will build a logistics distribution network model of cross-border e-commerce to provide data and information basis for subsequent processing [19]. According to the literature research results, the logistics network concept involved in the logistics network model is divided into three dimensions, and the specific content is shown in Figure 2.

In this study, the Baumol–Wolfe method [20, 21] is used to complete the model construction process. The Baumol–Wolfe model belongs to the nonlinear programming model, which considers renting warehouse and does not include fixed investment cost. The model assumes that (1) all the freight in the distribution process is linearly related to the distribution volume; (2) the user's demand and location are known; (3) the capacity of the logistics distribution center is enough to meet the customer's demand; and (4) the candidate location of the logistics distribution center is known.

The Baumol–Wolfe model assumes that the relationship between storage cost and distribution volume is as follows:

$$H_k = o_k \sqrt{d_k}, \quad (4)$$

where H_k is the storage cost; o_k is the unit variable cost of distribution from logistics distribution center to customers; and d_k is the distribution volume from logistics distribution center to customers. Based on the above assumptions, the scale and location of the new logistics distribution center are solved with the minimum total cost as the goal. The model is as follows.

Objective function is as follows:

$$\min F = \sum_{i=1}^m \sum_{k=1}^n \sum_{j=1}^l (B_{ik} + B_{kj}) L_{ijk} + \sum_{k=1}^n s_k (G_k)^\epsilon + \sum_{k=1}^n X_k u(G_k). \quad (5)$$

Constraints are as follows:

$$\begin{aligned} \sum_{k=1}^n \sum_{j=1}^l L_{ijk} &\leq H, \\ \sum_{k=1}^n \sum_{j=1}^l L_{ijk} &\geq D_j, \\ \sum_{i=1}^m L_{ik} &= \sum_{j=1}^l L_{jk}, \quad L_{ijk} \geq 0, L_{jk} \geq 0, L_{ik} \geq 0. \end{aligned} \quad (6)$$

In formula (6), B_{ik} represents the unit freight from factory i to logistics distribution center k ; B_{kj} represents

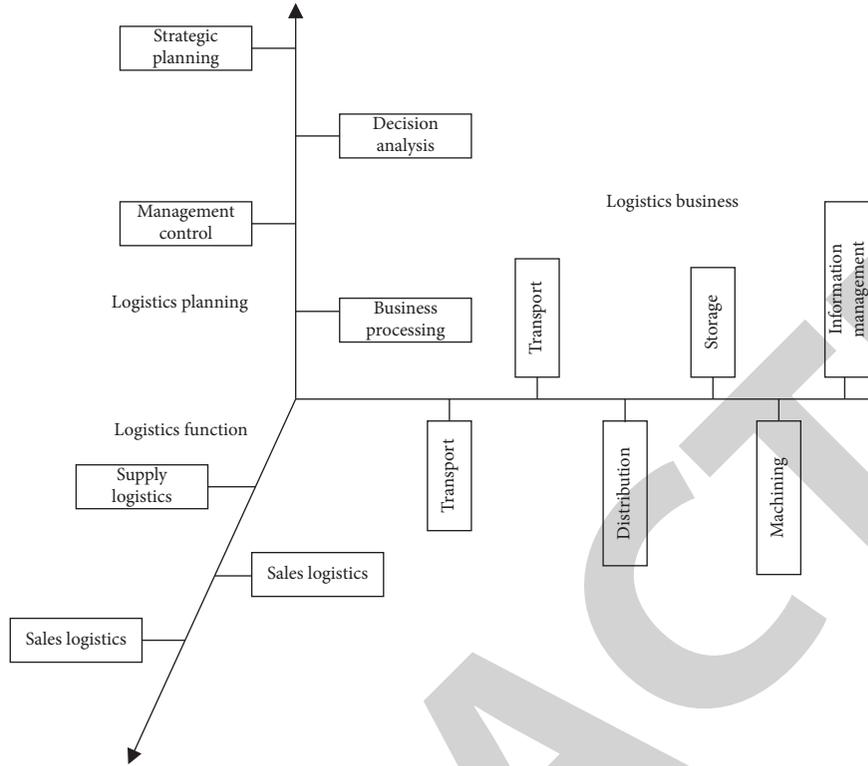


FIGURE 2: Logistics network conceptual model of cross-border e-commerce.

the unit freight from logistics distribution center k to customer j ; L_{ijk} represents the transportation volume from factory i to logistics distribution center k and then to customer j ; s_k represents the unit variable cost of distribution center k ; G_k represents the logistics volume of distribution center k ; that is, $\sum_{k=1}^n \sum_{j=1}^l L_{ijk}$; ε represents the empirical constant, and $\varepsilon \in (0, 1)$; in general, $\varepsilon = (1/2)$; X_k is the fixed cost of logistics distribution center k ; $u(G_k)$ is the decision variable; if alternative flow distribution center k is selected, it is 1; otherwise, it is 0; H_k is the supply quantity of factory k ; D_j is the demand quantity of customer j ; L_{ik} is the delivery quantity from factory i to distribution center k ; and L_{jk} is the delivery quantity from logistics distribution center k to customer j . For the logistics distribution center k , the unit storage cost B_k can be calculated as follows:

$$B_k = \frac{U_k}{2d_k} = y_k \frac{\sqrt{d_k}}{2d_k}. \quad (7)$$

The transportation planning method is used to solve the problem. The Baumol-Wolfe model is simple to calculate. This algorithm overcomes the difficulty of solving mixed integer programming and objectively evaluates the total cost of the distribution process. In addition, it can also solve the circulation of the logistics distribution center, which is convenient to plan and build a new logistics distribution center. This model is taken as the multiobjective

optimization objective of logistics distribution network of cross-border e-commerce.

2.3. Multiobjective Optimization of Logistics Distribution Network of Cross-Border E-Commerce. In order to ensure the authenticity of the research results, it is set that the vehicles used in the distribution process should not exceed their maximum load; parameter (s, v, κ) represents the vehicle parameters, which are vehicle load, driving speed, and unit transportation cost, respectively. Assuming that the vehicle load rate is 100%, the vehicle load is $s = (Y/f)$, (s_j, v_j, κ_j) represents the vehicle parameters used in the distribution and transportation between the end nodes of hub and spoke distribution network [22, 23], (s_c, v_c, κ_c) represents the vehicle parameters used in the transportation from the end node to the hub in the hub and spoke network, and (s_z, v_z, κ_z) represents the vehicle parameters used in the distribution between the hub nodes in the hub and spoke network. Assuming that the vehicle runs fast, the vehicle capacity is large, and the unit transportation cost is low, so $s_j \leq s_c \leq s_z$, $v_j \leq v_c \leq v_z$, $\kappa_j \geq \kappa_c \geq \kappa_z$. Let t_{ij} be the transportation time between the links (i, j) (the transportation time of the nonexistent links is sufficiently large). For any logistics network terminal y_{ij} , the transportation time budget is T_{ij} , so the transportation time constraint can be expressed as follows:

$$\sum t_{ij} \leq T_{ij}. \quad (8)$$

Transportation cost is one of the main cost sources of logistics network, and delivery time reflects the level of service to customers. In view of the distribution network optimization problem that generally does not consider the connection waiting time of distribution transportation in each link, distribution time only includes sorting time, transportation time, and transit time, among which sorting time and transit time are positively correlated with sorting cost and transit cost, respectively, while transportation time is often negatively correlated with transportation cost. The shorter the transportation time is, the higher the unit transportation cost is and the higher the cost is. It should be related to the mode and means of transportation; that is, the cost of the mode of transportation with long transportation time is lower, and the cost of the mode of transportation with short transportation time is higher.

The purpose of each node in the distribution network is to make profit. Therefore, cost optimization is the main factor to be considered in the e-commerce logistics distribution network. According to the basic operation process of e-commerce logistics distribution, considering the cost of sorting, transportation, and storage under the hub and spoke logistics distribution network structure, in order to facilitate the analysis, in general, the distribution cost is mainly expressed by the delivery cost $Q1$, that is, a series of expenses generated by sending goods from the terminal distribution node of the destination to the receiver. Packing cost $Q2$ refers to the packing cost incurred by packing according to the nature of the order for transportation and repackaging during transshipment. Because the impact of the delivery cost $Q1$ and packaging cost $Q2$ on the network distribution cost is small and relatively fixed, this part is not included in the calculation of the total cost. The following focuses on the analysis of storage cost, sorting cost, and transportation cost.

Sorting cost C_p^ϕ refers to the cost of sorting according to the flow direction of the goods to the destination before the goods enter the distribution process. $r(N)$ is recorded as the unit sorting cost; when there is only one direction, the goods do not need to be sorted, so $r(L) = 0$, and the sorting cost can be expressed as follows:

$$C_p^\phi = r(N) * U. \quad (9)$$

For node p , it is obvious that all the goods passing through p need to be sorted. The formula is as follows:

$$C_p^\phi = \left[u \left[\frac{m}{k} + \frac{k(k-1)}{2} \right] \left(\frac{m}{k} + k - 2 + m - \frac{m}{k} \right) + 2 \left(m - \frac{m}{k} \right) r \left(\frac{m}{k} \right) \right] h_{ij}. \quad (10)$$

According to formula (10), the corresponding sorting cost can be obtained:

$$C_S = \eta * q * d. \quad (11)$$

In formula (11), C_S represents the distribution cost, q represents the distribution volume, and d represents the

distribution kilometers. To optimize the formula, the following results are obtained:

$$C_S = \sum_{i \in N} \sum_{l \neq i} \eta_{ij} q d_{ij}. \quad (12)$$

Using the optimized formula can get more accurate transportation cost.

Storage cost C_V refers to the temporary storage cost before the goods arrive at the distribution center for distribution, which is mainly related to the storage capacity W and storage time T . If H is the unit storage cost of goods, the average arrival speed is (W/T) . Other links in hub and spoke terminal network do not store goods, so only the storage time and cost C_V of terminal goods in distribution center are considered. The specific formula is as follows:

$$C_V = \sum_{i \in m} \frac{TH}{2f_s^2} \sum_{j \neq i} w_{ij} + \sum_{i \in m} \frac{TH}{2f_n^2(k-1)} \sum_{j \neq i} w_{ij} \\ = \frac{THw_{ij}}{2} \left[\frac{m(n-1)}{f_s^2} + \frac{n}{f_n^2} \right]. \quad (13)$$

Therefore, the total cost of distribution network is shown in the following formula:

$$\min C = \min (C_V + C_S + C_P), \\ \sum t_{ij} \leq T_{ij}. \quad (14)$$

The multiobjective optimization model of e-commerce logistics terminal distribution network established by the above analysis is as follows:

$$\min C(A) = \min (C_V + C_S + C_P),$$

$$\max I(A) = \frac{1}{n(n-1)} \sum_{i \neq j} \frac{1}{d(i, j)}$$

$$\text{s.t.} \quad \begin{cases} \sum t_{ij} \leq T_{ij}, \\ s_j \leq s_c \leq s_z, \\ v_j \leq v_c \leq v_z, \\ \kappa_j \geq \kappa_c \geq \kappa_z. \end{cases} \quad (15)$$

Using the optimization method, the minimum network economic cost is set as the main goal. The calculation process is set as follows. Because the measurement value of network temporary change is related to the traffic size of nodes and distribution routes in the network, it is regarded as the secondary goal, and a expected value of network invulnerability $E(A)$ is given in advance, which is recorded as $E^1(A)$, with $E^1(A) \geq E(A)$. $\min(C)$ is set as the main objective, and the single objective problem for $\min(C)$ and $\max(E)$ can be solved, respectively, to get (A_1, A_2) . The value of the objective function corresponding to (A_1, A_2) is calculated, and the maximum value Z and minimum value z

TABLE 1: The calculation result of the maximum and minimum values of Z .

Category	$C(A)$	$E(A)$
A_1	$C(A_1)$	$E(A_1)$
A_2	$C(A_2)$	$E(A_2)$
Z	Z_1	Z_2
z	z_1	z_2

of the obtained $C(A)$ and $E(A)$ are calculated. The results are shown in Table 1.

Z and z specify the value range of $C(A)$ and $E(A)$ in the effective solution set; the calculation selects an integer $\partial > 1$ and determines ∂ different thresholds of $E^1(A)$ as follows:

$$E^1(A) = Z + \frac{t}{\partial - 1} (Z - z). \quad (16)$$

If $t = 0, 1, 2, \dots, \partial - 1$ is solved, respectively, the multiobjective optimization model is transformed into a single objective optimization model [24, 25] as follows:

$$\text{s.t.} \begin{cases} E(A) - E^1(A) \geq 0, \\ \sum t_{ij} \leq T_{ij}, \\ s_j \leq s_c \leq s_z, \\ v_j \leq v_c \leq v_z, \\ \kappa_j \geq \kappa_c \geq \kappa_z. \end{cases} \quad (17)$$

According to formula (17), the multiobjective optimization of the logistics network is completed, and the optimized network is used as the logistics distribution network of cross-border e-commerce. So far, the optimization model of logistics distribution network of cross-border e-commerce based on the personalized recommendation algorithm is completed.

3. Experiment and Analysis

3.1. Experimental Environment. In this study, a cross-border e-commerce platform is taken as an example to verify the rationality of the algorithm. In addition, based on the MATLAB language programming, it can get an optimization result, and through the analysis of the optimization results, the effectiveness of the model and algorithm is to examine, to hope to have reference value for e-commerce enterprises in logistics distribution route planning of cross-border. Due to this year's strategic adjustment of business and streamlining of business types, the customers are located in the middle- and high-end white-collar groups in the city, and the distribution products are mainly cosmetics, clothing, and daily necessities. The name, code, location coordinates, and other information of the distribution center and customers are shown in Table 2.

In this experiment, the distribution center of cross-border e-commerce platform is selected as the research object to test the rationality of the model. Through the example analysis, the scientific and applicability of the model are verified. The customers of the distribution center of the e-commerce platform are mainly individual consumers. The

online orders received on the same day will be delivered on the next day. Here, we select the distribution customers of a certain day as the sample. On a certain day, it needs to carry out product distribution for 20 customers, and 13 points including the distribution center are used as logistics nodes. Due to the difference between the actual distance and the spatial coordinate distance, the shortest distance between the distribution center and the target node is approximately calculated by the following formula:

$$d_{ij} = 1.2 \left[(x_1 - x_2)^2 + (y_1 - y_2)^2 \right]^{0.5}. \quad (18)$$

Formula (18) is used to get the actual distance of the user. In order to improve the reliability of the experimental results, the demand and service time of the target node are summarized as shown in Table 3.

Through the above-collected data, as the data source of the design model and the original model in the use process, the use effect of the design model and the original model is verified. In the process of this experiment, the total distribution distance, operation cost, and the total distribution time are taken as the experimental comparison indexes, and each index is measured five times to compare the experimental results. In the process of distribution, the cost of distribution vehicles per kilometer is 20 yuan, the speed is 60 km/h, the aircraft is used to deliver the distribution center to the cross-border distribution center, and this part of the funds is not included in the experimental results.

The performance of the proposed algorithm must be proved by experiments. So, two recently proposed methods, a simple yet effective cross-border e-commerce personalized recommendation that integrates fuzzy association rule and complex preference into a recommendation model (FACP) [26] which is also the Original model 1 and an optimization model of logistics distribution path based on IoT (LDIoT) [27] which is also the Original model 2, were employed. According to the FACP scheme, a hybrid recommendation model based on user complex preference features is constructed to mine user preference features, and personalized commodities recommendation is realized according to user behavior preference. Compared with the traditional recommendation algorithm, the improved algorithm reduces the impact of data sparsity. For the LDIoT scheme, it analyzes the current research status of Internet of Things (IoT) and the basic application of particle swarm optimization (PSO); then, according to the development needs of logistics industry, the connection and restriction of optimal path planning are analyzed. With this as a constraint, the optimization model is built with the goal of comprehensive cost and then studied how to design and implement the logistics information system based on the IoT. The paper focuses on the design of information mechanism to ensure information security and the intelligent mechanism design to improve distribution efficiency. Finally, an optimization model of logistics distribution path based on IoT is established. These performances of the logistics distribution network of cross-border e-commerce are compared with the strategy proposed in this paper. For

TABLE 2: Distribution node information.

Code	Name	Position (x, y)	Code	Name	Position (x, y)
1	Distribution center	(55, 90)	11	Target node 10	(20, 75)
2	Target node 1	(40, 110)	12	Target node 11	(80, 150)
3	Target node 2	(70, 94)	13	Target node 12	(90, 150)
4	Target node 3	(45, 87)	14	Target node 13	(120, 30)
5	Target node 4	(87, 135)	15	Target node 14	(75, 90)
6	Target node 5	(60, 120)	16	Target node 15	(80, 175)
7	Target node 6	(70, 110)	17	Target node 16	(90, 145)
8	Target node 7	(90, 25)	18	Target node 17	(92, 20)
9	Target node 8	(100, 37)	19	Target node 18	(150, 35)
10	Target node 9	(87, 22)	20	Target node 19	(30, 95)

TABLE 3: User demand table.

Node number	Cargo weight (kg)	Service time (min)	Node number	Cargo weight (kg)	Service time (min)
Target node 1	2.5	15	Target node 11	6.5	15
Target node 2	3.0	20	Target node 12	3.0	10
Target node 3	4.5	10	Target node 13	2.5	15
Target node 4	2.5	5	Target node 14	4.0	20
Target node 5	1.0	20	Target node 15	5.5	15
Target node 6	1.5	25	Target node 16	6.5	10
Target node 7	6.0	20	Target node 17	7.5	10
Target node 8	4.0	15	Target node 18	2.0	15
Target node 9	5.5	30	Target node 19	6.0	15
Target node 10	5.0	20			

a fair comparison, all these three strategies are with the same network parameters.

3.2. Analysis of Experimental Results. According to the above experimental settings, the experimental results of the total distribution distance are shown in Figure 3. The total distribution distance refers to the total length of the route selected by the distribution algorithm.

From the above experimental results, it can be seen that the route planning ability of the proposed model is better than that of the other two schemes, and the performance of FACP is much better than that of LDIoT. The results of data analysis show that in the process of many experiments, the length of the total distribution distance of the proposed model is relatively stable, the fluctuation is small, the change of node order is small, and the route order is high. In the process of using the traditional model, the route changes greatly, and the total length of the distribution route obtained each time varies greatly, so the use effect of this model is poor, and the control ability of the distribution route is poor. According to the above experimental results, in the future distribution process, we should use the designed model to complete the route planning process. According to the different route planning results in the experiment, the running cost of each model is shown in Figure 4. The logistics distribution operation cost means the money or the cost of the logistics distribution operation.

According to Figure 4, it can be seen that the logistics distribution operation cost of the proposed scheme is low and stable. The reason might be the good route planning

ability of the designed model. In the daily use process, the designed model saves the operation cost to a certain extent. Compared with the design optimization model in this paper, the traditional optimization model is less effective. In the process of using the traditional model, the operation cost of logistics distribution changes greatly. This kind of instability in the use process restricts the development of cross-border e-commerce and affects the user experience. According to the above analysis results, the use effect of the design model in this paper is better. According to the experimental results of the above two parts and the content of the experimental design, the experimental results of the total logistics distribution time are shown in Figure 5. The total logistics distribution time means the time spent on logistics distribution.

Through the above experimental results, it can be seen that the designed model in this paper has good time control ability for logistics distribution. The goods can be delivered to the user within the waiting time of the user. The performance of total logistics distribution time for FACP scheme and LDIoT scheme has the similar effect on average. This proves the route planning ability of the design model. In the process of using the original optimization model, the total time of logistics distribution is too long, resulting in the problem of long waiting time and low logistics speed, which directly affects the use effect and experience of cross-border logistics. Therefore, the application effect of the designed optimization model in this paper is better than that of the traditional optimization model. The above three parts of the experimental results fully reflect the advantages of the design model, which can

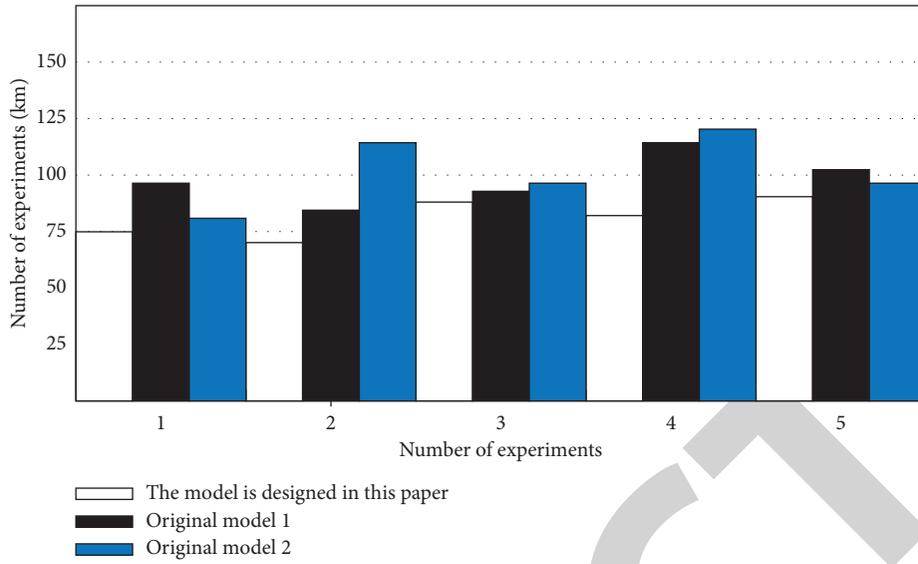


FIGURE 3: Experimental results of total distribution distance.

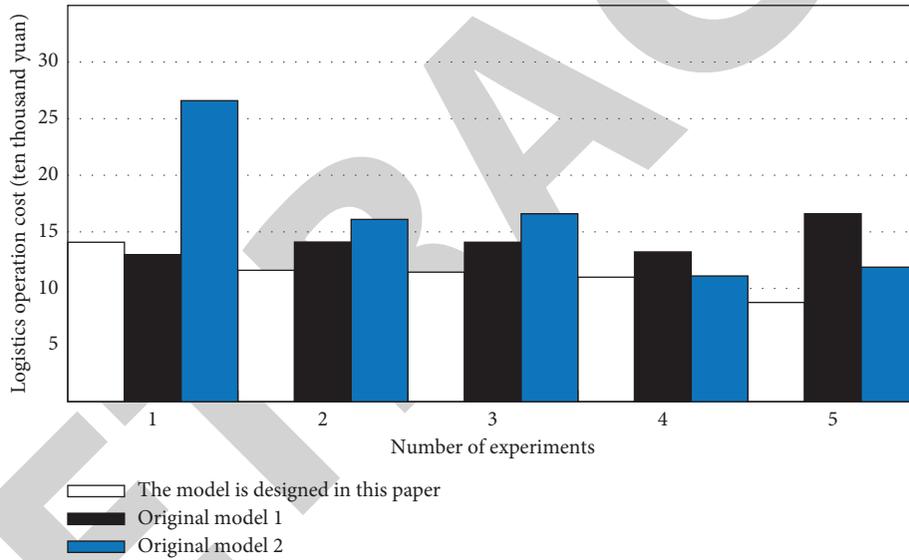


FIGURE 4: Experimental results of logistics distribution operation cost.

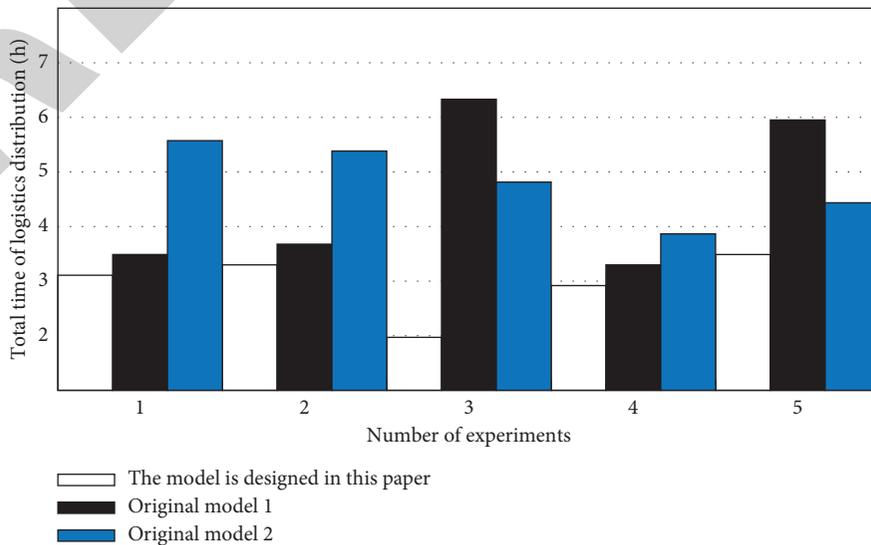


FIGURE 5: Experimental results of total logistics distribution time.

TABLE 4: Comparison of these experimental results.

Parameter	Average of total distribution distance	Average of logistics distribution operation cost	Average of total logistics distribution time
Proposed scheme	101	3	2.9
Original model 1	112	6	4.3
Original model 2	115	5	4.6

be used to improve the distribution speed of cross-border e-commerce in future research.

We use the average of the total distribution distance, logistics distribution operation cost, and total logistics distribution time to verify performance of the three schemes. The comparison of these experimental results is shown in Table 4.

Above all, we can draw the following conclusions:

- (1) With the increase in the number of experiments, the length of the total distribution distance of the proposed model is relatively stable, the fluctuation is small, the change of node order is small, and the route order is high.
- (2) Due to the good route planning ability of the designed model, the corresponding logistics distribution operation cost is low and stable. The reason might be that the designed model saves the operation cost to a certain extent in the daily use process.
- (3) The proposed scheme has good time control ability for logistics distribution. The reason might be that the total time of logistics distribution is too long in the process of using the original optimization model, and it can result in the problem of long waiting time and low logistics speed, which directly affects the use effect and experience of cross-border logistics.

4. Discussion

The layout of an overseas logistics networks involves many factors. Because of the path cost, location of the overseas warehouse, early investment cost, unsalable cost of goods, return and exchange cost, timeliness, customer satisfaction, and other factors, the overseas logistics network becomes very complex. Therefore, the optimization problem of the logistics network often contains multidimensional objectives and multiple variables, which belong to the NP problem. With the increase in the number of objective space and variables, the number of solutions will increase on a large scale, and the difficulty of the solution will increase greatly. Therefore, we must seek the multiobjective network optimization algorithm to solve the problem.

However, most of the existing methods are to optimize a single objective function. Under the overseas warehouse mode of international logistics of cross-border e-commerce, three or more objectives need to be optimized at the same time, such as total transportation cost, total time cost, and customer satisfaction. On the other hand, the multiobjective optimization problem contains multiple variables, forming multiple decision variables. Therefore, it is of great significance and value to study the optimization algorithm of

multiobjective and multidecision variables for the optimal allocation of overseas warehouse mode of the international logistics networks and bring new methods and new ideas for more reasonable planning and layout of a complex international logistics system.

This study basically defines the concept and mode characteristics of international logistics of cross-border e-commerce in the economic sense and discusses the new overseas warehouse mode of cross-border e-commerce according to the actual needs of this study. Based on the investigation and study of a large number of the relevant literature on the international logistics network model, this paper summarizes the main characteristics and modeling methods of the logistics network under the overseas warehouse mode of cross-border e-commerce; according to the commodity characteristics of cross-border transportation mode and the solution characteristics of overseas logistics network problem of cross-border e-commerce, this paper proposes an improved multiobjective evolutionary algorithm for linear insertion direction vector decomposition and compares its performance and analyzes the effectiveness and feasibility of the algorithm through case simulation; according to the commodity characteristics of transportation mode and the solution characteristics of overseas logistics network problem of cross-border e-commerce, in the case, the feasibility and effectiveness of the algorithm are verified.

5. Conclusion

In this study, the optimization model of a logistics distribution network of cross-border e-commerce based on the personalized recommendation algorithm in an e-commerce environment is preliminarily discussed and studied, and some useful conclusions are drawn. However, there are still many problems to be further studied in the collaborative network of logistics distribution in an e-commerce environment. Firstly, the construction and optimization of logistics distribution collaborative networks are studied. Through literature review, we can see that the existing research on logistics distribution collaborative networks is very few, and in the e-commerce environment, logistics distribution is an extremely important part. The research on logistics distribution collaboration is of great significance for optimizing resource allocation and integrating social forces. Secondly, we should continue to study the method of member selection and portfolio optimization. The research on member selection can provide strategic suggestions for enterprises and solve the problem of choosing partners for enterprises. Nowadays, the multiobjective optimization problems, especially the dynamic multiobjective

optimization problem, are widely used in control, decision, and many other related problems. Although this paper focuses on this issue, it only studies the multiobjective optimization model in the field of e-commerce logistics distribution, which is not mentioned in other fields. It is of far-reaching significance to study the construction of logistics networks and route selection in other fields.

Data Availability

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

Conflicts of Interest

The author declares that there are no conflicts of interest.

Acknowledgments

This research was supported by the major projects of Natural Science Research in Colleges and Universities of Jiangsu Province (no. 17KJA413002).

References

- [1] J. Mou, Y. Cui, and K. Kurcz, "Trust, risk and alternative website quality in B-buyer acceptance of cross-border E-commerce," *Journal of Global Information Management*, vol. 28, no. 1, pp. 167–188, 2020.
- [2] S. C. Wingreen, N. C. H. L. Mazey, S. L. Baglione et al., "Transfer of electronic commerce trust between physical and virtual environments: experimental effects of structural assurance and situational normality," *Electronic Commerce Research*, vol. 19, no. 2, pp. 339–371, 2019.
- [3] C. Xueli, Ma Liang, and B. Fan, "Ant colony algorithm for vehicle routing problem (VRP)," *Systems Engineering*, vol. 19, no. 4, pp. 418–422, 2004.
- [4] S. Lijun, H. Xiangpei, and W. Zheng, "Research progress on vehicle path planning problems and solving methods," *Systems Engineering*, vol. 24, pp. 31–36, 2006.
- [5] L. Yufeng and J. Li, "Dynamic programming heuristic algorithm for solving time-varying vehicle scheduling problems," *Systems Engineering Theory and Practice*, vol. 32, pp. 1712–1718, 2012.
- [6] L. Xiang and L. Yanhui, "Cross-regional VRP model for e-commerce distribution and its heuristic algorithm," *Journal of Tsinghua University*, vol. 46, no. z1, pp. 1014–1018, 2006.
- [7] H. D. Ratliff and A. S. Rosenthal, "—Order picking in a rectangular warehouse: a solvable case of the traveling salesman problem," *Operations Research*, vol. 2, no. 31, pp. 507–521, 2002.
- [8] W. Dingwei, *Modeling and Optimization in E-Commerce*, Science Press, Beijing, China, 2008.
- [9] Y. Jian, L. Jin, and L. Houqing, "||Annealing network solution for VRP in stochastic demand situation||," *Systems Engineering Theory and Practice*, vol. 22, no. 3, pp. 109–114, 2002.
- [10] L. Jiali and M. Zujun, "There are vehicle rental and sharing and there are time windows and multiple distribution centers open loop VRP," *Systems Engineering Theory and Practice*, vol. 33, no. 3, pp. 666–672, 2013.
- [11] L. Yuqin and W. Peiru, *Research on the Traditional Storage Picking Path of Logistics Center*||, Supplementary City Name, Taiwan Mingxin University of Science and Technology, Taiwan, China, 2005.
- [12] S. Chen, L. Huang, Z. Lei, and S. Wang, "Research on personalized recommendation hybrid algorithm for interactive experience equipment," *Computational Intelligence*, vol. 36, no. 3, pp. 1348–1373, 2020.
- [13] C. Yang, Q. Fan, T. Wang et al., "RepoLike: a multi-feature-based personalized recommendation approach for open-source repositories," *Frontiers of Information Technology & Electronic Engineering*, vol. 20, no. 2, pp. 222–237, 2019.
- [14] W. Zhou and W. Han, "Personalized recommendation via user preference matching," *Information Processing & Management*, vol. 56, no. 3, pp. 955–968, 2019.
- [15] P. Pourya, K. K. Oh, and H. Lim, "Integrating sustainability into the optimization of fuel logistics networks," *Korean Society of Civil Engineers*, vol. 23, no. 3, pp. 1369–1383, 2019.
- [16] Z. Dai, H. Zhou, F. Wen et al., "Efficient predictability of stock return volatility: the role of stock market implied volatility," *The North American Journal of Economics and Finance*, vol. 52, 2019.
- [17] J. J. Yu, "Average case constant factor time and distance optimal multi-robot path planning in well-connected environments," *Autonomous Robots*, vol. 44, no. 5, pp. 469–483, 2020.
- [18] d. F. R. M. Guitián and B. Casas-Méndez, "Routing problems in agricultural cooperatives: a model for optimization of transport vehicle logistics," *IMA Journal of Management Mathematics*, vol. 30, no. 4, pp. 387–412, 2019.
- [19] Z. He, F. Zhou, X. Xia, F. Wen, and Y. Huang, "Interaction between oil price and investor sentiment: nonlinear causality, time-varying influence, and asymmetric effect," *Emerging Markets Finance and Trade*, vol. 55, no. 12, pp. 2756–2773, 2019.
- [20] P. S. C. Priscila, A. K. Ricardo, L. M. R. Jorge et al., "Interactions among stakeholders in the processes of city logistics: a systematic review of the literature," *Scientometrics*, vol. 20, no. 2, pp. 567–607, 2019.
- [21] A. Abdullah and S. Suresh, *Revisiting Norm Optimization For Multi-Objective Black-Box Problems: A Finite-Time Analysis*, Springer, vol. 73, no. 3, pp. 659–673, New York, NY, USA, 2019.
- [22] D. G. Izabela, Á. G. G. Miguel, H. G. Guillermo et al., "Mineralization of cyanide originating from gold leaching effluent using electro-oxidation: multi-objective optimization and kinetic study," *Journal of Applied Electrochemistry*, vol. 50, no. 2, pp. 217–230, 2020.
- [23] K. Slawomir and P. D. Anna, "Rapid multi-objective optimization of antennas using nested kriging surrogates and single-fidelity EM simulation models," *Engineering Computations*, vol. 37, no. 4, pp. 1491–1512, 2019.
- [24] S. Es-Saidi, S. Blaize, and D. Macías, "Meta-model-based multi-objective optimization for robust color reproduction using hybrid diffraction gratings," *Optics Express*, vol. 28, no. 3, pp. 3388–3400, 2020.
- [25] N. Mcdonald, Q. Yuan, and R. Naumann, "Urban freight and road safety in the era of e-commerce," *Traffic Injury Prevention*, vol. 20, no. 7, pp. 764–770, 2019.
- [26] D. Xiang and Z. Zhang, "Cross-border E-commerce personalized recommendation based on fuzzy association specifications combined with complex preference model," *Mathematical Problems in Engineering*, vol. 2020, no. 4, pp. 1–9, 2020.
- [27] F. Liu and Y. Shi, "A study on artificial intelligence IQ and standard intelligent model," *Computer Science*, vol. 180, no. 20, pp. 118–191, 2015.