Research on the Control Method of Reverse Logistics Inventory in Ocean Shipping E-commerce-- Based on improved mufti-objective particle swarm optimization

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Abstract

When the traditional method controls the reverse logistics inventory of ocean shipping e-commerce, it is impossible to determine the time and inventory of replenishment inventory, and it is not effective to control the e-commerce reverse logistics inventory. Based on the improved mufti-objective particle swarm optimization algorithm, an ocean freight e-commerce reverse logistics inventory control method is proposed. The mufti-objective particle swarm optimization algorithm is used to make the e-commerce inventory distribution uniform, and the heuristic algorithm is used to obtain the optimal inventory control parameters. The solution is to control the reverse logistics inventory of marine shipping e-commerce. The experimental results show that the method can effectively control the reverse logistics inventory of marine shipping e-commerce, thereby improving the profitability of shipping e-commerce enterprises.

Keywords

Ocean shipping; E-commerce; mufti-objective particle swarm optimization; Reverse logistics; Inventory control method.

1. Introduction

The Council of Logistics Management believes that reverse logistics is the planning, implementation and control of high-efficiency, low-cost flows of raw materials, processed inventory, finished goods, and related information from the place of consumption to the starting point [1]. The goal is to restore the value of the product or to properly handle the product [2]. The standard for reverse logistics management is how to reduce the inventory of reflow products as soon as possible and restore the recirculated product inventory to reusable products [3]. By reducing the capital used in recirculating product inventory and obtaining product value from reflow products as quickly as possible, more profits can be earned each year [4]. At the same time, effective reverse logistics inventory systems and inventory management processes can save costs, increase profits, and improve customer service [5].

2. Research background and objectives

The reverse logistics technology in the emerging field of this century began in the last century. Foreign science and technology workers have recognized the importance of reverse logistics technology and have done in-depth research. They believe that reverse logistics control technology has huge advantages in inventory management and control. The role is unmatched by the traditional logistics industry [6]. It has the advantage of being able to quickly replenish stocks and add time in stock replenishment.

In recent years, shipping technology has developed rapidly. Many shipping customers have more requirements and higher service levels. As a result, shipping profits have fallen sharply, the profit model is not very clear, and operational differences will change, increasing the risk of shipping. Aiming at the problem of reduced shipping profits [7]. This paper proposes a mufti-objective particle swarm optimization algorithm. Analysis of the shipping profit model. Passing multiple factor targets in the shipping model. Bring into the particle swarm for calculation, and converge the algorithm through simulation analysis, and put forward how to apply reverse logistics inventory technology in the electronic shipping business field to improve the profitability of shipping e-commerce enterprises [8].

3. Methods

3.1 Mufti-objective particle swarm optimization

The mufti-objective particle swarm method is a commonly used method in recent years. The idea of the algorithm is that the guided particles can be selected from the population from the derived algorithm. At the same time, the solution that has been generated is saved. When the subtraction ends, the output of the extraction algorithm can be obtained from the external file, so that the particle swarm optimization algorithm solves the problem that the mufti-objective problem of the reverse logistics is not the only solution. The result is the optimal solution set, namely the Pareto optimal solution set [9].

The mufti-objective particle swarm algorithm needs to satisfy:

(1) The method of satisfying the maximum and optimization through Pareto.

(2) Make the distance between the Pareto optimal frontier obtained by the algorithm and the real Pareto optimal front edge as small as possible.

The mufti-objective particle swarm optimization algorithm is characterized by the introduction of the objective function to find the optimal solution, and the "elite set" strategy is selected from the iterative process.

In the method of temporarily solving the solution set, through the process of particle iteration, continuous optimization, and finally find the Pareto non-inferior solution set; Second, without losing the convergence performance of the algorithm, introduce a new mutation strategy, the particle distribution The region is mutated and the particles in the elite concentration are screened to maintain the distribution and diversity of the resulting non-inferior solution set[10].

The maintenance of the external archive of the mufti-objective particle swarm algorithm selects the best global position and defines it accurately. Its own location to find the location space of the ship, under mufti-target conditions [11]. Find multiple global optimal locations and do not affect individual solutions at the same time.

In the process of calculation through the external cluster, the status of the policy update of the non-dominated individual and the external can be found [12]. As shown in Figure 1. Let the generation external population At have m1 individuals, and the maximum number of external population individuals is M (m1≤M) [13]. After the evolution of the internal particle group P, the non-dominant individuals are extracted to the external population to form the population at'. In the first step, the repeated individuals in At' are removed, and the target value is checked to make sure that the same individual is a repeating individual and then only one individual is left [14]. In the second step, after marking, the non-dominated individuals in at' are deleted, and the number of non-inferior individuals included in At' is determined to be m2 (m2≤m1+n1). At this time, the crowds in at' are crowded and arranged in descending order, and are recorded as the population At’. Judging the numerical relationship between m2 and M, if m2≤M, as shown in case 1 in Fig. 1, At" is recorded as the new external population At+1, and the latter M-m2 individuals of At+1 are identified as Empty, or you can see that as shown in Figure 1, as shown in Figure 2, showing the process of gradually reducing the external population, then save the M individuals in the head of At", remove the m2-M most dense individuals, A reduced external population At+1 is formed.

The update strategy keeps the number of individuals in the external population within the maximum value M, avoiding the infinite increase of the number of non-dominated individuals and reducing the efficiency of the algorithm as the evolutionary operation progresses; while the external population is reduced, the most intensive redundant individuals are deleted while retaining A large number of scattered individuals ensure an even distribution of the Pareto front[15].

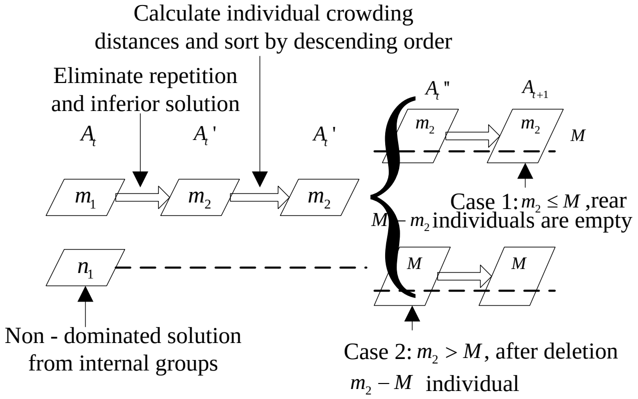

Fig. 1 External population update strategy

3.2 Reverse logistics inventory control method

The management of the recovery inventory problem is faced with a lot of reverse logistics activities such as the renovation and repair of the returned old products. The cost of the logistics activities that add value to the products is obviously much higher than the autonomous inventory problem, so it must be re flowed [16]. The handling of old products is well controlled, it is more economical to store these products, and they are repaired or modified when they are really needed. The purpose of the product after retrofitting is to re-use the reflow product as much as possible, as shown in Figure 2.

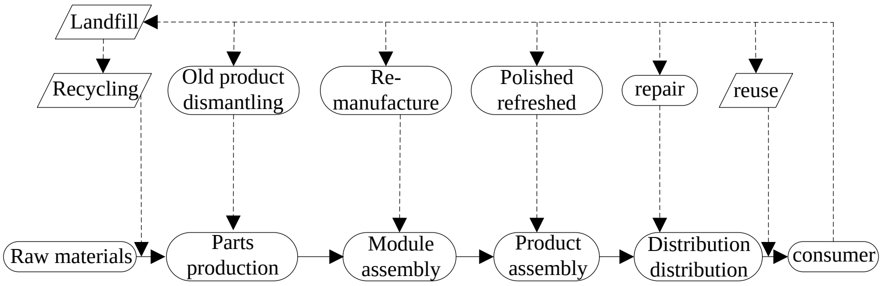

Fig. 2 multiple forms of product recovery

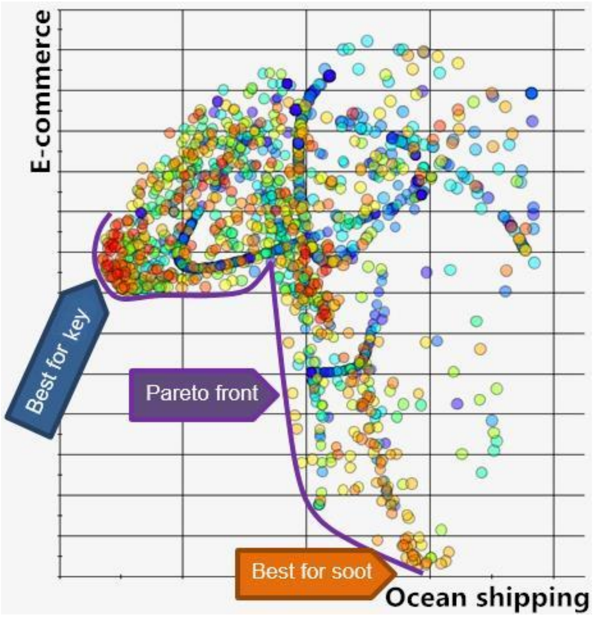

Fig. 3 Multi-objective particle swarm optimization algorithm for ocean shipping

The amount of product reflow is uncertain, so two decisions need to be made: First, whether the reflow products that have been returned to the hand should be remanufactured, and if these reflow products need to be remanufactured, when should they be reinvested. Go to the remanufactured production line. Second, because there are fewer finished products in stock and fewer products are reflowed, new products need to be produced to replenish stocks. If new products are needed to replenish stocks, what is the quantity of products to be produced [17].

We use a factory to manufacture repair products for verification. We can think that these products meet the Poisson distribution and the factory maintains these. When the stock product returns. These products can be reworked and manufactured[18]. These inventory products fall into two broad categories. One type of sales that can be sold to reduce inventory is the cost of holding. Their cost can be expressed by Chr and Chs respectively. These two kinds of costs, one called the pre-product period is Lr. If it is made with new products, its pre-term is Lm. Usually we think these two The time period is constant[19].

In the process of detecting random variables, this is consistent with the Poisson distribution, and usually we set the parameter to λd. In a production cycle, if it cannot be shipped at the agreed time, a cost will be generated. This cost is usually expressed in Cb yuan/unit. Or we use another benchmark Cb yuan / unit / day. Whether the product is the same when the product is newly produced or stocked, they are a single product flow to the consumer[20].

At this time, we analyze the inventory management system and propose the corresponding inventory control strategy for restoring inventory problems. The strategy is shown in Figure 3.

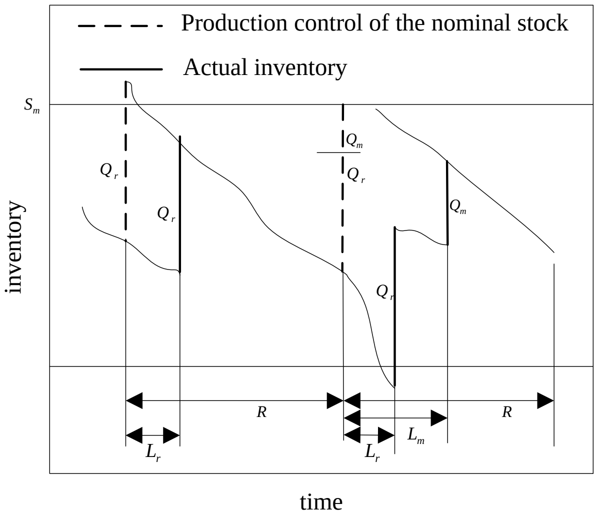

Fig. 4 inventory control strategy map

We observe this picture. Every R days, the inventory management system will re-stock all the inventory products recovered through the circulation market to the processing line. This is a random number. Usually we use Qr to represent[21]. We use IRThis represents the amount of inventory per day, which is a meaningful amount of inventory, by reprogramming product traffic. Estimate. From the amount of product recycled to the stock in the market, accurate calculations are made. The inventory of the product is automatically checked every R days[22]. Check that the IR is less than the set stock amount Sm, this time will produce new product Qm from the production workshop, which will restore the inventory quantity to Sm.

3.3 Calculation of Sm

In order to find the optimal solution of the inventory control parameters, first find the upper and lower limits of the inventory control parameter Sm, and then determine the optimal solution of Sm, the purpose is to provide an intuitive overview of the inventory system operation, and narrow the search using heuristic algorithm The range of the optimal solution, and finally the Sm optimal solution[23].

3.3.1 Calculation of Sm upper limit value

The time ratios used in the calculations during the lead period and the check interval can usually be defined as follows:

$$\lambda_d = \lambda_d \max(R+L_m, R+L_r) \tag{1}$$

The Poisson distribution can be used in the calculation of the demand distribution, with high accuracy for the standard deviation, and the variance and standard deviation can be obtained:

$$D(X) = \lambda \tag{2}$$

$$\sigma = \sqrt{D(X)} \tag{3}$$

Then you can get the standard deviation of the average demand, usually during the lead period:

$$\sigma' = \sqrt{D(X)'} \tag{4}$$

Sm shall meet the demand requirements during the period of the inspection during the inspection process, and the fluctuation values shall also meet the given conditions.

The calculation formula for the upper limit value of the order control stock quantity Sm is:

$$S_{\mathrm{mup}} = \sigma_d^{'} + \lambda_d^{'} \tag{5}$$

3.3.2 Calculation of Sm lower limit value

In the process of testing the pre-stage and production of the reflow product [25], the average interval of the inspection interval plus the lead period can be calculated by reducing the demand rate and the minimum value of the lead period:

$$\lambda_d' = \max(\lambda_d - \lambda_r)\left[\min(R+L_r, R+L_m)\right] \tag{6}$$

The standard deviation can be obtained as follows:

$$\sigma_d'' = \sqrt{D(X)''} \tag{7}$$

The calculation method of the stock Sm lower limit is as follows:

$$S_{\mathrm{mlow}} = \sigma_d^{''} + \lambda_d^{''} \tag{8}$$

By calculating the upper and lower limits of Sm, the range of the Sm optimal solution is controlled to obtain the optimal solution of Sm.

4. Results

The experimental environment is Visual C++ 6.0. The computer platform used in the experiment is Intel Core i5, CPU 2.28GHz, and Figure 4 is the experimental environment [26].

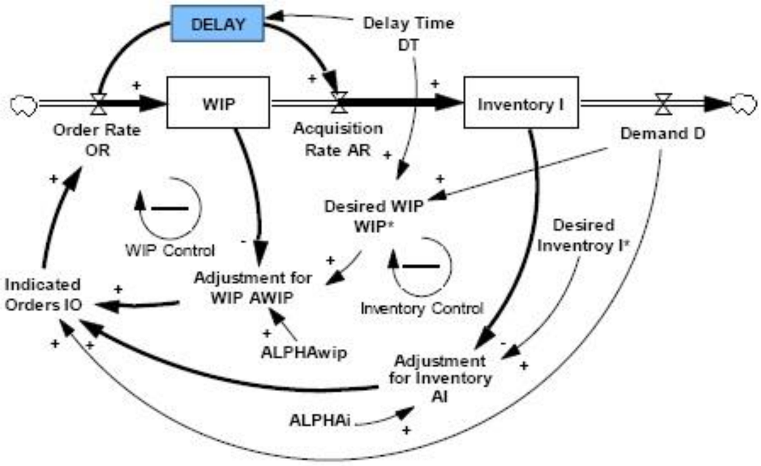

Fig. 5 Shipping inventory control

Figure 4 experimental environment

In the actual verification analysis in the assembly enterprise, the conclusion can be drawn as follows: Through the rational allocation of resources to the enterprise, the enterprise inventory inspection cycle T, the saleable product safety inventory R, the production batch Q and the recycled product processing batch Qr, δi are determined. The ratio of recyclable parts i for recycling products; pi is the purchase price of raw materials; csc is the unit out-of-stock cost; cr is the unit cost of the saleable product; Cr is the unit cost of the remanufactured product; cst is the unit of the recyclable product Cost; cm is the unit manufacturing cost; crm is the remanufactured cost of the recycled product unit; λ is the average demand; L is the pre-stage; α is the reusable ratio of the recycled product, and the test results are shown in Table 1 to Table 3.

Table 1. inventory control related parameter

parameter	λ_{out}	λ_{in}	α	L_r	L_m	Q	Q_r
Parameter value	11	6	0.6	3	6	460	40

Table 2. inventory control unit cost

parameter	c_s	c_{sc}	c_r	c_m	c_{st}	c_{rm}
Parameter value	0.3	0.6	0.2	2.2	0.3	0.2

Table 3. Reusable price and recovery ratio

Variable name	Part number		
	1	2	3
δ_i	0.4	0.5	0.7
p_i	0.7	0.5	0.3

Table 1, Table 2 and Table 3 show that the marine freight e-commerce reverse logistics inventory control method based on the improved mufti-objective particle swarm optimization algorithm reduces the enterprise inventory cost and optimizes the enterprise's ocean shipping e-commerce reverse logistics control. The resource allocation of the enterprise verifies the effectiveness of the method.

In the target inventory testing process, it can be analyzed from multiple factors, including annual shortage of stocks, annual shortage rate, etc. We use the improved particle swarm optimization algorithm to test in the reverse logistics inventory control system of Ocean Shipping E-commerce. By substituting the iterative method above. Two sets of reference groups are set. See Figures 5 and 6 below. The corresponding running time is 48.38s and 18.704s respectively.

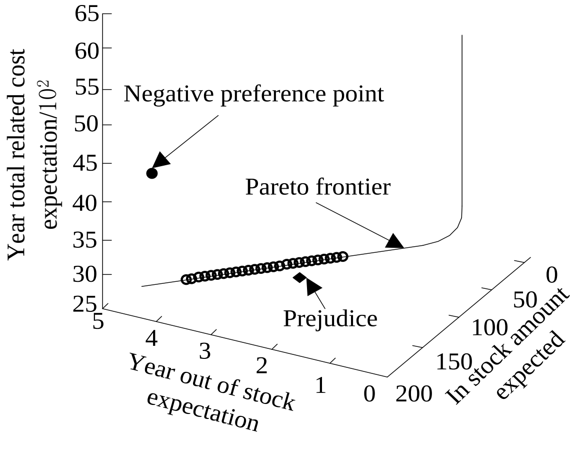

Fig. 6 shows the distribution of the solution of group 1

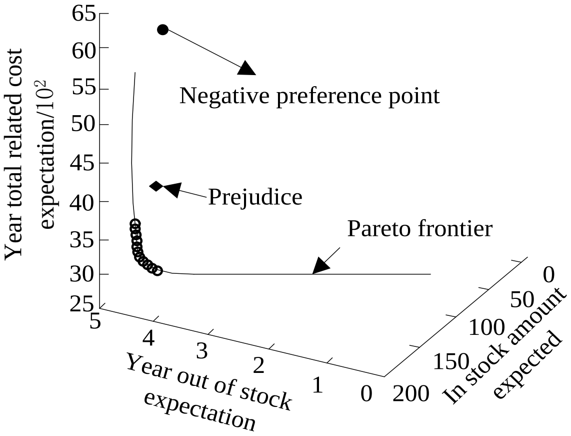

Fig. 7 shows the distribution of the solution of group 2

As can be seen from the above figure. Service levels are directly proportional to cost. Increasing the level of service will result in corresponding cost increases, especially inventory costs. If you want to reduce costs, you can reduce the service level. The marine logistics e-commerce reverse logistics inventory control method by improving the mufti-objective particle swarm optimization algorithm can effectively find the balance between the two. Improve the inventory of reverse logistics control of ocean commerce, thus achieving good cost control.

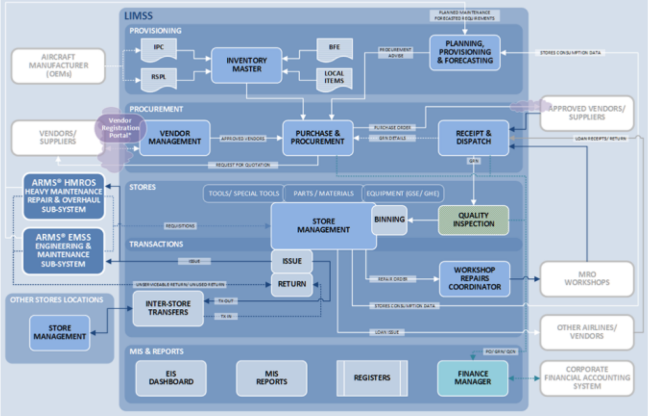

Fig. 8 Logistics inventory control system

5. Discussion

According to the parameters of the marine shipping e-commerce reverse logistics inventory control method based on the improved mufti-objective particle swarm optimization algorithm, combined with Table 1, Table 2 and Table 3, Figure 7 can be obtained.

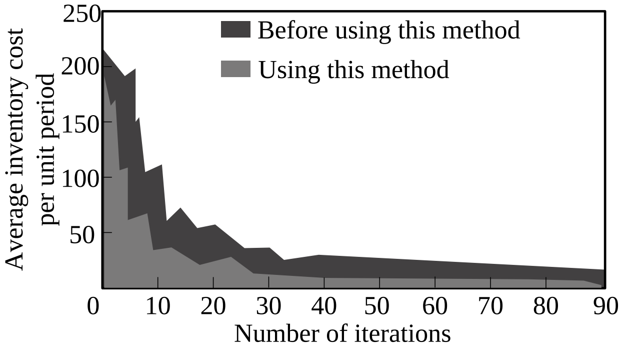

Fig. 9 Test results using the method of this paper

The research proves that the proposed mufti-objective particle swarm optimization algorithm for ocean shipping e-commerce reverse logistics inventory control method transforms the existing shipping e-commerce. It can effectively reduce inventory and reduce service costs. Add more cash flow to the company and facilitate the company to purchase materials. Let the business work normally.

We compared product inventory, service levels, and inventory costs. Then find the optimal global solution, and calculate the corresponding weight distribution, (0.7,0.4,0.2), (0.6,0.4,0.3), (0.4,0.6,0.3) and then substituting into the formula to iterate, you can find the optimal decision. Ideas. Then find the optimal global solution. At this value, product inventory and cost can be reduced to a minimum level, thereby obtaining more profits for shipping e-commerce companies.

Table 4. The evaluated with reference to the representative program of Group 1.

Serial number	Representative solution			Utility evaluation		
	cost	Out of stock rate	Out of stock	cost	Out of stock rate	Out of stock
A_1	3002	6.30	323.15	0.00	0.00	0.00
A_2	3155	4.64	228.01	0.37	0.72	1.08
A_3	3201	4.15	206.41	0.76	1.10	0.91
A_4	3223	3.95	107.68	0.95	1.06	0.71
A_5	3255	3.66	93.99	1.10	0.81	0.41

Table 5. The evaluated with reference to the representative program of Group 2

Serial number	Representative solution			Utility evaluation		
	cost	Out of stock rate	Out of stock	cost	Out of stock rate	Out of stock
B_1	3747	0.36	6.07	0.00	0.00	0.00
B_2	3794	0.29	4.61	0.00	0.28	0.36
B_3	3912	0.18	2.47	0.25	0.39	0.28
B_4	3944	0.17	2.14	0.41	0.19	0.16
B_5	3962	0.16	1.98	0.52	0.15	0.13

Analysis can be performed in these two tables to find the optimal solution. First, the inventory cost is obtained by calculation. From the Pareto optimal solution, we can find that several numerical sort relations are found by calling the function: A4>A3>A5>A2>A1 to determine that the optimal solution of reference group 1 is A4. In the second group of control groups, the application relationship of several solutions can be found as B5>B3>B4>B2>B1, and the optimal solution of the second control group can be considered as B5. Based on the above algorithm, based on the improved mufti-objective particle swarm the algorithm of the ocean shipping e-commerce reverse logistics inventory control method runs, you can find the optimal global solution set, and then develop the latest route. Found a balance between the organic logistics of reverse logistics inventory and ocean shipping e-commerce.

6. Conclusion

Reverse logistics technology is widely used in ocean shipping, and can be classified in every aspect of the control chain, which greatly improves production efficiency, reduces enterprise costs, and reduces the cost of shipping logistics. At the same time, this paper proposes An improved particle swarm algorithm. Combining the control methods of ocean shipping reverse logistics inventory has played a very important role in improving the economics of ocean shipping companies.

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