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DHL Logistics Distribution Path Optimization Analysis

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Abstract. With the continuous development of the market economy, logistics as the "third source of profit" continues to promote economic development, but how to maximize profits has become the top priority of enterprises. Logistics distribution is one of the most important links in logistics, so it is very important to optimize the logistics distribution path. This paper first analyzes the current situation of DHL logistics distribution, Through the current situation of its management system and vehicle scheduling, we find that there are too many DHL logistics distribution path loops, low full load rate and unreasonable path selection. Taking the distribution problem of DHL Wuchang service center as an example, the VRP mathematical model is established, and the optimal distribution route is obtained by using the mileage saving method, it is confirmed that the optimized route is better.

Keywords. DHL logistics; VRP; Distribution path.

1. Introduction

With the continuous development of science and technology of the times, China's economic strength has been greatly improved, and its various industries have also been affected and developed rapidly. Among them, the logistics and distribution industry is particularly prominent. However, while complying with the development, it is often the most serious problem. At present, the domestic logistics distribution industry is in chaos, the distribution environment is characterized by many, scattered, disorderly, weak and other large but incomplete phenomena. The service level of logistics distribution industry is uneven, internal management is low and chaotic, and there is no stable and balanced price system, and so on, which gives the impression that the industry is a kind of overall chaos. In addition, in the post epidemic era, in order to prevent the epidemic from spreading again, the logistics and distribution industry is facing a rapid expansion of problems, More advocate non-contact distribution, which will increase the logistics distribution of higher challenges [1-2].

The cost of logistics distribution accounts for nearly half of the cost of logistics enterprises. Therefore, reasonable and effective control of logistics distribution costs is the most important thing for logistics enterprises to survive. How to optimize the distribution path and grasp the efficiency of distribution is one of the core businesses. It can also greatly reduce the total transportation cost, complete the logistics service with the least money and the fastest speed, and improve the economic benefits, Provide better service for customers. The identification of key proteins has become an important

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research task. In particular, the discovery of key proteins based on fuzzy ant colony clustering is a reference in exploring disease mechanisms and drug development [3-5].

2. Current Situation and Problem Analysis of DHL Logistics Distribution

2.1. DHL Company Profile

Up to now, DHL has more than one hundred and twenty-five employees of DHL, which is one of the world's largest logistics companies in the world, Customers in more than 1000 destinations provide fast and reliable service.

2.2. Current Situation of DHL Logistics Distribution Path

2.2.1. Composition of DHL Logistics Distribution Business

According to the different customs policies at the place of origin / destination, DHL's distribution business is mainly divided into document logistics distribution and non-document logistics distribution.

At the same time, document and non-document distribution can be divided into three categories according to the different transit time: products of the same day (SDI), products with limited time (TDI) and products with limited daily production (DDI). Among them, time limited products (TDI) are the core of DHL [6-8].

2.2.2. DHL Logistics Distribution Mode

The common logistics distribution mode in domestic logistics is three-level distribution mode, which goes from region to branch and then to subordinate stores. DHL mainly focuses on international logistics, which is not developed in China and has few logistics centers, and some regional systems will not be involved. In a simple point, take a county or city in Hubei Province as an example, foreign parts are loaded to Wuhan logistics service center after arriving at the domestic transfer center, When Wuhan logistics service center goes to the county and city, it needs the cooperation of other domestic logistics, such as SF, EMS, etc. to place an order to deliver the goods to customers. But it is also a ladder from the whole to the local.

As far as central China is concerned, the ports of Beijing, Shanghai and Guangzhou are the regional logistics centers, which can share the logistics inventory of the whole central China area. The export near the ports is convenient, which can reduce the logistics cost; As a branch logistics center, seven provinces in Central China (Hubei, Hunan, Hubei, Henan, Shanxi, Anhui and Jiangxi) have the same functions as regional logistics centers in controlling the logistics inventory of the province, These seven provinces have the main functions of logistics warehousing and distribution. For Hubei Province, Hankou, Hanyang and Wuchang three logistics service centers are the distribution points of branch logistics centers. Other logistics companies are required to assist in the distribution in areas not covered by the distribution scope [9-10].

This paper mainly discusses the problem of route optimization for the distribution and transportation of customers in the provincial branch logistics center. There are few logistics centers in the province, the route is complex and unstable, and the cost saving

after optimization is relatively obvious. Figure 1 is flow chart of DHL logistics distribution mode.

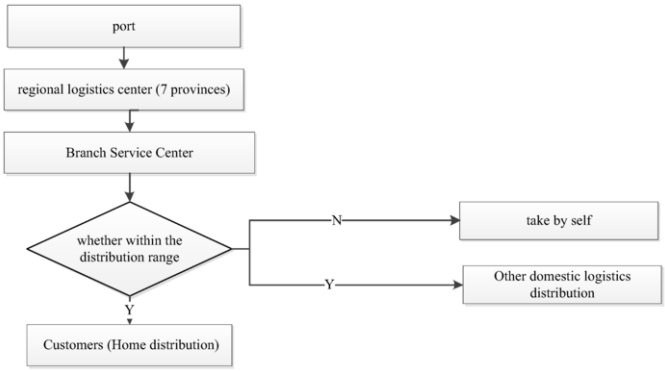

Figure1. Flow chart of DHL logistics distribution mode

2.2.3. DHL Logistics Distribution Grid Layout

DHL express delivery logistics network is mainly composed of regional logistics center, branch logistics center and distribution point. The regional logistics center is located in Beijing、Shanghai and Guangzhou port, the branch logistics center is located in all provinces of the country, and the distribution point is located in the cities under each province. Taking central China as an example, the branch logistics centers are located in Hubei, Hunan, Hubei, Henan, Shanxi, Anhui and Jiangxi provinces, The distribution points of branch logistics centers in Hubei Province are located in Hankou, Hanyang and Wuchang.

2.3. Problems in DHL Logistics Distribution Path

2.3.1. There are Too Many Circuits

DHL express delivery is different from domestic logistics distribution in terms of the number of packages, which is less than that of domestic logistics. In terms of service scope, it adopts door-to-door service, but does not cooperate with other logistics in the service scope. In the area of door-to-door service, each DHL customer has multiple addresses, and there are uncertain factors for customers, this delivery complexity to several customers will result in different needs. The point-to-point distribution mode will result in a long distribution route. At the same time, DHL will rearrange the responsible Road area for a period of time according to the quantity of pieces and divide the road area continuously. The distribution personnel need time to adapt to the new road area, which deepens the multi loop route.

2.3.2. The Load Factor is Unstable

After arriving at the port, the express will be transported in different regions and arrive at the Branch Logistics Center at a fixed time every day. According to the normal operation, sometimes a foreign piece will arrive at the port in three or four days, but sometimes, due to the export policy of the sender's country and the lack of customs declaration materials, the service personnel at the delivery point start to work at a fixed time every day, it is possible that the full load rate of distribution vehicles on the same

day is not high, and sometimes there is empty car distribution in the morning. The main reason is that the point-to-point distribution mode reduces the overall full load rate, thus reducing the enthusiasm and sense of responsibility of the distribution personnel. Therefore, it is necessary to stabilize the vehicle load rate and optimize the distribution path.

2.3.3. The Choice of Distribution Route is Lack of Planning

The branch logistics center mainly manages the vehicles, personnel and goods warehouse. There is no perfect distribution management system, no one-to-one planning for the distribution route. It only has the allocation of the road area. Then the distribution personnel can only arrange the distribution path according to their own driving experience, which is not reasonable in many aspects, as a result, it is difficult to guarantee the stability of distribution service if the self-selected distribution path is not scientifically planned and perfected. In this way, convection and circuitous transportation are often easy to occur, which greatly increases the distribution cost, and it is difficult to reduce the delivery time, so that the customer satisfaction is not easy to improve, and then the company's operating costs will be increased.

3. Establish DHL Logistics Distribution Path Model

3.1. VRP Mathematical Model

At the algorithm level, vehicle routing problem (VRP) can be abstractly solved in digraph, undirected graph, connected graph and network graph. The cities and warehouses arriving in the logistics distribution route are represented by points, and the connection between the points represents the water, land and air routes between the two cities, which can clearly reflect the connection between each point and point. The research models of vehicle routing problem (VRP) mainly include mathematical model and network graph model. The mathematical model has the advantages of large capacity, high flexibility and strong versatility than network graph model, so the mathematical model is often used.

The mathematical model of VRP is to start from a distribution center, distribute goods to multiple demand points, and then vehicles return to the distribution center on the same day, and require to arrange a suitable driving route to meet the demand points. For the known conditions of VRP Problem, including the number of vehicles, the weight of each vehicle, the demand point, the quantity of goods required per demand point, etc, Suppose that the number of vehicles owned by the distribution center is m, the number of each vehicle is k, and the carrying capacity of each vehicle is $Wk\ (k=1,2,...,m)$. The number of distribution demand points p is n, distribution demand point Pi, and the quantity of goods required is, $Ri\ (i=1,2,...,n)$. Then the cost from the distribution center to each demand point and the cost between each demand point is C_{ij} , $(i=1,2,...,n-1;\ j=1,2,...,n;i<j,i-0)$. The constraints include that the total weight of the goods carried by each vehicle should not exceed the maximum carrying capacity of the vehicle itself, that each demand point can only be delivered by one vehicle, and that the starting and ending points of each route must be the distribution center [11-13].

$$min_z = \sum_{i=0}^{n} \sum_{j=1}^{n} \sum_{k=1}^{n} c_{ij} x_{ijk} \tag{1}$$

$$s.t.\sum_{i=1}^{n} R_i Y_{ki} \le W_K, K = 1,2,\ldots,m \quad (2)$$

$$\sum_{k=1}^{k} Y_{ki} = 1, \ i = 1,2,\ldots,n \quad (3)$$

$$\sum_{i=0}^{n} X_{ijk} = Y_{kj}, \ j=0,1,2,\ldots,n;k=1,2,\ldots,m \quad (4)$$

$$\sum_{j=0}^{n} X_{ijk} = Y_{ki}, \ i = 1,2,\ldots,n; k = 1,2,\ldots,m \quad (5)$$

$$Y_{ki} = 1or0, \ i = 1,2,\ldots,n \ ; k = 1,2,\ldots,m \quad (6)$$

$$X_{\mathrm{ijk}} = 1or0, \ i \neq j \ ; i, \ i = 1,2,\ldots,n; k = 1,2,\ldots,m \quad (7)$$

In the above model:

(1) Expression is expressed as objective function

(2) The formula indicates that the quantity of goods transported by each vehicle does not exceed its carrying capacity

(3) Each demand point is delivered by and only one vehicle

(4) From K to the distribution point

(5) The formula shows that vehicle K delivers goods to demand point I, and vehicle K will arrive at another point J after delivering the goods at that point

(6) The formula indicates that the distribution task of demand point I is completed by vehicle K. when the distribution task occurs, it is taken as 1; if it does not occur, it is taken as 0

(7) The formula indicates that vehicle K is from demand point I to demand point J. when time occurs, it is taken as 1; if it does not occur, it is taken as 0.

3.2.VRP Problem Description

Vehicle routing problem (VRP) refers to the fact that a certain number of customers have different requirements for receiving and delivering goods. Under certain constraints, the distribution center distributes goods to customers, and organizes appropriate driving routes to make vehicles pass through these customers orderly, so as to achieve the goals of shortest distance, less time and minimum cost, The constraints include the demand and delivery of goods, delivery time, time limit, vehicle capacity limit, etc. The VRP Problem is extended to consider that the demand point has some requirements on the vehicle arrival time, so the time window problem is added to the vehicle path (the waiting time caused by early arrival of a customer and the service time required by the customer), it extends to the vehicle routing problem with time windows (VRPTW). Most DHL delivery customers are for companies, and there will be no time window problem. If it is a single person, the customer will not deliver next time or Honeycomb will temporarily release. Therefore, this paper chooses VRP.

The components of VRP model mainly include road, demand point, distribution center and vehicle. Road is one of the core elements of vehicle routing problem, which connects distribution center with demand point and forms a network route map of distribution center demand point distribution center; Obviously speaking, demand is the object that needs to be served, which promotes vehicle transportation, At the same time,

because of the different demand, the transportation time is also different; The distribution center plays the role of goods storage and the starting or ending point of each vehicle route; The vehicle is a tool to transport goods between points. The most important thing to consider when using a vehicle is the load capacity and volume, as well as the unit distance, cost and time of the vehicle [14-15].

3.3. Establishment of VRP Model for DHL Logistics Distribution Path

Multi loop transportation problem is a very common vehicle allocation problem in real transportation [16-17]. Especially for entities with a big number of service objects, VRP model can successfully solve most of the multi loop problems. Therefore, VRP model is established for DHL logistics distribution.

Known conditions: DHL Wuchang service center will fix a batch of wooden box goods every week, and now they need to be delivered to the regional customers involved, including Wuchang District, Hongshan District, Jiangxia District and Qingshan District. This paper assumes that there are 2 demand points in Wuchang District, 3 in Hongshan District, 2 in Jiangxia District and 1 in Qingshan District. The number of vehicles used in the distribution center is 8 golden cups, The rear of the vehicle is 3 meters*1.3 meters*1.6 meters, which can hold 6 cubic meters of goods. The average fuel consumption per 100 kilometers is 12 ltr, and 92 gasoline is 8.06 yuan per liter. In addition to the basic salary, the salary of distribution personnel also includes mileage salary, which is 1.5 yuan per kilometer within 50 kilometers, and 1.8 yuan per kilometer for parts exceeding 50 kilometers.

The goal of the model is to determine the number of vehicles to be arranged N and the distribution path of each vehicle, and arrange these vehicles to a loop (routing and scheduling of the loop), so as to maximize the benefit of the total transportation cost.

Restrictions:

Jinbei can hold 12 wooden cases of goods, not exceeding the vehicle volume limit.

Each vehicle will be returned to the Service Center w after delivery.

4. Logistics Route Optimization Based on DHL

4.1. DHL Logistics Distribution Optimization Data Source

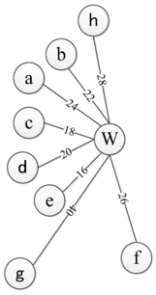

Figure 2. Original distribution route of DHL Wuchang Service Center

At present, the distribution route of DHL Wuchang service center is shown in Figure 2 (W is Wuchang Service Center).

The distribution volume of wooden box goods in a certain week at each demand point is shown in table 1.

Table 1. Distribution of goods at demand point

Demand point	Wuchang a	Wuchang b	Hongshan c	Hongshan d	Hongshan e	JiangXia f	JiangXia g	Qinshan h
Distribution volume	4	3	2	4	3	2	4	3

4.2. DHL Logistics Distribution Path Optimization Calculation

This paper uses the parallel method of saving mileage to optimize the distribution route.

Table 2. Transport distance of each demand point (unit: km)

Demand point	Center w	Wuchang a	Wuchang b	Hongshan c	Hongshan d	Hongshan e	Jiangxia f	Jiangxia g	Qinshan h
Center w	0	24	22	18	20	16	26	40	28
Wuchang a		0	6	8	10	9	18	36	13
Wuchang b			0	7	9	8	20	34	11
Hongshan c				0	5	4	9	14	21
Hongshan d					0	7	10	11	31
Hongshan e						0	8	7	29
Jiangxia f							0	17	27
Jiangxia g								0	7
Qinshan h									0

The best distribution route is calculated to make the running distance of the vehicle the shortest. According to the restriction conditions, the vehicle can carry 5 wooden boxes of goods, which cannot exceed the carrying capacity of the vehicle in the process of optimization.

According to the distance between Wuchang service centre to each demand point and each demand point to the point in table 2, the shortest distance between each other is calculated and the shortest distribution route matrix is obtained as shown in table 3.

From the shortest distribution route matrix, calculate the saving mileage of distribution route between each demand point, as shown in the table 4.

Table 3. Shortest distribution route matrix

	W								
a	24	a							
b	22	6	b						
c	18	8	7	c					
d	20	10	9	5	d				
e	16	9	8	4	7	e			
f	26	18	20	9	10	8	f		
g	40	36	34	14	11	7	17	g	
h	28	13	11	21	31	29	27	48	h

According to the distribution route saving odometer, the mileage saving is sorted from large to small. The sorting table of distribution route mileage is shown in table 5.

According to the table 5 distribution route mileage sorting table, the distribution route map is formed.

Case 1: Initial solution.

As shown in Figure 3, there are 8 distribution lines from Wuchang Service Center w to demand point, and the total vehicle running distance is 388 km.

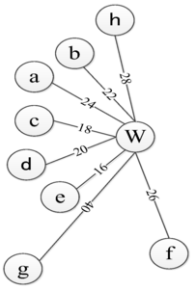

Figure 3. Initial solution

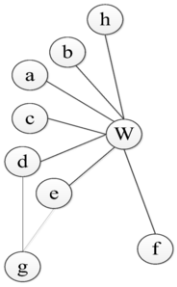

Figure 4. Quadratic solution

Table 4. Saving mileage of distribution route

	a							
b	40	b						
c	34	33	c					
d	34	33	33	d				
e	31	30	30	29	e			
f	32	28	35	36	34	f		
g	28	28	44	49	49	49	g	
h	39	393	25	17	15	15	20	h

Case 2: Quadratic solution.

According to the order of saving mileage, d-g is connected and combined into distribution line 1. As shown in Figure 4, there are 7 distribution lines with a total running distance of 339 km. Because the total number of wooden boxes required by demand points d and g is 8, which is less than the carrying capacity of one golden cup, it can require 7 vehicles. After connecting e-g into distribution route 1, the total demand of demand points d, e and g is 11 boxes, the carrying capacity of a golden cup is less than 12 boxes, so it can be incorporated into distribution line 1. The optimized operation distance of distribution line 1 is 54 km, which is 98 km less than that of 152 km before optimization, and two distribution personnel are reduced.

Case 3: Cubic solution.

Then, according to the order of saving mileage, d-f, a-d, e-f, etc. may be incorporated into the distribution route 1 of the secondary solution. As a golden cup can only carry 12 cases of wooden box goods, and other demand points need more than one wooden box goods, so the distribution line 1 can't add more demand points, so connect a-b to form distribution line 2, as shown in Figure 5, the total demand of wooden boxes at demand points a and b is 7. Then connect a-h. the total demand of wooden boxes at demand points a, b and h is 10 cases, which is less than 12 boxes of a golden cup. Therefore, b-h is incorporated into distribution line 2, and then connected to b-c. the total demand of wooden boxes at demand points a, b, c and h is 12 cases, which is equal to the carrying capacity of a gold cup. Therefore, b-c is incorporated into distribution line 2, and

distribution line 2 can't increase the demand point. There are 3 distribution lines with a total running distance of 178 km, and the operation distance of distribution line 2 is 72 km, which saves 112 km compared with 290 km of secondary solution.

Table 5. Sorting table of saving mileage of distribution route

Number	Connection	Saving algorithm	Number	Connection	Saving algorithm
1	d-g	49	15	c-d	33
2	e-g	49	16	a-f	32
3	f-g	49	17	a-e	31
4	c-g	44	18	b-e	30
5	a-b	40	19	c-e	30
6	a-h	39	20	d-e	29
7	b-h	39	21	a-g	28
8	d-f	36	22	b-f	28
9	c-f	35	23	b-g	28
10	a-c	34	24	f-h	27
11	a-d	34	25	c-h	25
12	e-f	34	26	g-h	20
13	b-c	33	27	d-h	17
14	b-d	33	28	e-h	15

Case 4: Final solution.

Through the above three-step solution, we can optimize the distribution route, leaving the demand point jiangxia f not incorporated into the optimized distribution route. Because the distribution route one and distribution route two in front can't be merged, we choose separate distribution for the demand point.

4.3. Analysis of DHL Distribution Route Optimization Results

4.3.1. Optimization Results

To sum up, the vehicle distribution route planning and design of Wuchang service center has been completed, as shown in Figure 6. There are three distribution routes, and three Jinbei minibuses are required, and the total running distance is 178 km. Among them, the operation distance of distribution line 1 is 54 km, that of distribution line 2 is 72 km, and that of distribution line 3 is 52 km. Compared with the optimized route of 38km, the total distance of the optimized distribution is 8 km, which is 8 km for the first and 8 km for the former.

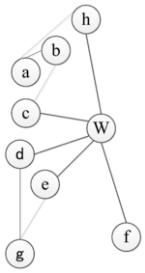

Figure 5. Cubic solution

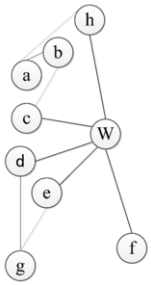

Figure 6. Logistics distribution of DHL Wuchang service center after optimization

To sum up, the vehicle distribution route planning and design of Wuchang service center has been completed, as shown in Figure 6. There are three distribution routes, and three Jinbei minibuses are required, and the total running distance is 178 km. Among them, the operation distance of distribution line 1 is 54 km, that of distribution line 2 is 72 km, and that of distribution line 3 is 52 km. Compared with the optimized route of 38km, the total distance of the optimized distribution is 8 km, which is 8 km for the first and 8 km for the former.

4.3.2. Comparative Analysis of Distribution Route Optimization Results

This paper uses the mileage saving method to optimize the distribution route, and obtains the final optimization scheme. Now, through a series of indicators such as the number of vehicles required, the total mileage of vehicle operation, the total fuel consumption, human resources and total cost, the optimized distribution route is evaluated and analyzed, as shown in table 6.

According to the comparison of the optimization results in table 6, from the perspective of vehicle demand, the optimized vehicle scheduling saves 37.5 percent vehicle demand and reduces the use of vehicles in Wuchang service center, which makes DHL Wuchang service center more flexible in vehicle scheduling arrangement; In terms of the total operating mileage of the vehicle, the total mileage after optimization is 178 km, Compared with the total mileage of 388 km before optimization, the mileage of 210 km is greatly reduced, which greatly reduces the loss of vehicle use and improves the utilization rate of resources; In terms of gasoline consumption, the gasoline consumption before optimization can reach 46.56 ltr, and the fuel consumption after optimization is reduced by 25.2 ltr compared with that before optimization, nearly half of the gasoline cost is reduced, and the utilization of social resources is protected; From the point of view of distribution personnel consumption, before the optimization, the distribution personnel need 8 people, but after optimization, only 3 people are needed, which reduces the cost and increases the flexibility of distribution personnel arrangement; Finally, it is obvious from the total additional cost that the optimized cost greatly saves more than half of the expenditure. To sum up, five vehicle routing optimization results are compared.

Table 6. Comparison of optimization results

Index	Before saving algorithm		After saving algorithm
The number of Jinbei cars	8		3
The number of cars reduction		5	
Car movement (Km)	388		178
The number of miles reduction (Km)		210	
Oil consumption (L)	46.56		21.36
Oil saving（L）		25.2	
The number of delivery persons	8		8
The number of saving manpower		5	
Total additional charges (CNY)	1058.67		477.58
Charge saving（CNT）		581.11	

4.3.3. Result Analysis

The results of Wuchang Service Center's distribution route optimization to customers at demand points are shown in Figure 7.

Figure 7. Route optimization

Wuchang Service Center w - Hongshan District d - Jiangxia District g - Hongshan e - Wuchang Service Center w is the first distribution route;

Wuchang Service Center w - Hongshan c - Wuchang b - Wuchang a - Qingshan District h - Wuchang Service Center w is the second distribution line;

If Jiangxia District f is incorporated into the above two distribution routes, its distribution cost will be increased. Therefore, Wuchang Service Center w-jiangxia District f will be taken as the third distribution route.

As an international logistics, it is difficult for DHL to achieve all aspects of domestic logistics after arriving at the distribution area. In this paper, according to the nine demand points of Wuchang service center, the route planning is carried out, and the calculation and analysis are carried out by using the mileage saving method. Through the benefit analysis of each index, it is proved that the optimized distribution mileage is shortened by 210 km, and the gasoline is saved by 25.2 ltr, so as to reduce the logistics distribution cost, Improve its enterprise efficiency.

5. Conclusion

In recent years, with the development of e-commerce, the business volume of the logistics industry has gradually increased. With the increase of business volume, the logistics cost will be higher and higher. The transportation cost accounts for half of the logistics cost, and the distribution cost is the primary expenditure item in the transportation cost. In the era of rapid development of Internet big data, enterprises need to keep up with the times, which is also necessary to improve the quality of development and strive to make the enterprise have a more refined operation, which can provide better services and meet the needs of the market. Based on the mileage saving method, this paper takes the DHL terminal distribution path as the goal optimization, combined with the case analysis, constructs the optimal distribution route from the service center to the customers at the demand point, and evaluates the optimized distribution route by comparing various indicators, Carry out the optimization work effectively and scientifically.

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