Optimization Design of Reverse Logistics Network of Power Grid Company Based on Double Carbon

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Abstract. China has attached great importance to energy conservation and environmental protection. President Xi Jinping made a solemn commitment at the 75th UN General Assembly that China will increase its national independent contribution, peak its carbon dioxide emissions by 2030, and strive to achieve carbon neutrality by 2060". At present, logistics has become an essential link in the healthy operation process of electric power enterprises. As the goal of sustainable development increases, the recycling, re-manufacturing and revalue generation of waste products and equipment have become the focus of attention. In order to better improve the operation efficiency of logistics and save the cost of power reverse logistics, this paper chooses to optimize the logistics distribution service of power enterprises, so it is necessary to use reasonable methods to study and choose the appropriate distribution strategy. It mainly analyzes the reasonable selection of the existing distribution mode of electric power enterprises and sets up a new reverse logistics network according to the current problem of waste materials recycling and re-manufacturing in electric power enterprises. The qualitative analysis method is used to analyze the choice of the reverse logistics distribution mode, and to solve the reverse logistics network optimization accordingly, so as to make the most optimal cost.

Keywords: Double-carbon · green logistics · logistics alliance · reverse logistics

1 Introduction

With the reform of the new power market, the distribution optimization and logistics management of power enterprises at home and abroad. Literature [1] proposes that with the rapid development of social and economic level, people's demand for electricity is also increasing. In order to better meet needs, electric power enterprises must strengthen the logistics management of material storage, effectively reduce logistics costs, and improve the economic benefits of electric power enterprises. Literature [2, 3] research discusses

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the intensive management mode of power materials, analyzes how the application of this management mode can help power logistics to realize the effect of material intensification. Intensive logistics management is a very important business management activity in the contemporary electric power enterprises, In the whole electric power material management, there are still deficiencies in the material storage management of electric power enterprises. The main reason is the influence of the system and personnel. The current situation has brought a lot of trouble to the intensive logistics management of electric power materials. Document [4] proposes that in the power material enterprises, good logistics management can not only ensure the better use of China's power resources, but also effectively improve the operation efficiency of the power system. Through the analysis of the logistics management mode, it can help the relevant staff to better understand the operation of the logistics system, and take corresponding solutions. In view of this analysis of power material enterprises logistics management mode, so as to ensure that the development of Chinese power material enterprises can be better. Document [5] proposes that power material logistics distribution is a very important part of the operation link of China's power system in China, so the operation efficiency and quality of this link will be of great significance to the overall link of the power system. In the operation process of the logistics system, the last link of the whole system during distribution is also an important proof to ensure the completion of the logistics work. At present, there are still many problems in the management of power material transportation in China, which makes the development of China's power material logistics and distribution industry seriously restricted, and also hinder the improvement of the work level of China's power industry. The problems existing in the logistics and distribution management of electric power materials will be analyzed to promote the optimization of the work system. Literature [6] introduces the characteristics and meanings of electric power material logistics, analyzes the current material logistics management mode and the current situation of domestic electric power companies, and puts forward relevant improvement measures for the problems existing in the management mode.

1.1 Reverse Logistics Mode Analysis

Logistics alliance distribution mode refers to the logistics network distribution mode jointly built by enterprises themselves and other cooperative enterprises. Enterprises can simultaneously share warehouses, distribution points, recycling points, distribution personnel and vehicles, etc.; such distribution mode can save the initial investment cost of the new recycling center, and make the enterprise itself does not lose the initiative of management, and effectively play the value of integrated logistics. And for the logistics distribution mode of electric power enterprises, because of its and multiple material manufacturers reached long-term manufacturing processing and maintenance agreement, take reverse logistics distribution mode selection, can choose to reach effective cooperation between suppliers, for multiple suppliers and power grid companies about recycling center of joint investment, both save investment cost synergy secondary manufacturing and maintenance fast, also can achieve mutual benefit and win-win results.

1.2 Reverse Logistics Mode Selection of Electric Power Enterprises

Combined with the advantages and disadvantages of power enterprises and market opportunities and risks, only the choice of logistics alliance distribution mode will be more in line with their own development strategy. This logistics alliance distribution method mainly involves the logistics alliance between the enterprise itself and the suppliers. Power enterprises can jointly build the corresponding reverse logistics intermediate node (such as the defective product recycling center) with multiple suppliers, and then carry out the corresponding intermediate distribution by the enterprises themselves. This way can not only effectively save the early investment cost of enterprises and suppliers, but also make the power enterprises with sufficient transportation resources without unnecessary waste of resources. At the same time, it can give full play to the concept of "mutual benefit and win-win" among partners to achieve the common development of various parties. After continuously improving the overall quality management of the logistics participants, the integrated management of the supply chain can be effectively realized. For electric power enterprises, while reducing investment risks, they can also fully realize the control of logistics information, making the logistics operation process more standardized. At the same time, it can also prevent the leakage of internal information of enterprises, but also be conducive to the continuous optimization of the long-term logistics network, which can improve the efficiency of logistics distribution and reduce the advance period. Truly realize the integration of production and marketing cooperation, and to provide an effective guarantee for the interests of all parties.

2 Optimization Design of Reverse Logistics Network Based on Logistics Alliance Distribution Mode

2.1 Problem Description

Facing the problem of resource shortage faced by the current development, how to reduce the waste of resources and the reuse of waste materials is the general direction of the current development. Through the combination with the forward supply chain, it maximizes the reuse of waste materials and reduces the unnecessary waste of materials. Moreover, it is through the reuse of waste materials, while reducing the environmental pollution, in line with the production concept of energy conservation and emission reduction. At present, the material warehouse of China's power grid company implements hierarchical management, and adopts the hierarchical mode of "primary warehouse and secondary warehouse and first aid package", with a total of three levels. The first level warehouse refers to the warehouse that is responsible for unified material storage and delivers supplies to the emergency repair site, the second level warehouse and the first aid package that it supports. It is the central hub of logistics services. The second level warehouse is the warehouse responsible for storing the materials delivered by the first level warehouse and delivering supplies to the emergency repair site and the first aid package it supports. It is mainly to extend the distribution service scope of the first level warehouse, and is the intermediate node of logistics service. First-aid package refers to the storage point of the materials needed for daily production and emergency repair, responsible for storing the materials needed for daily production, operation and maintenance, so as to solve the

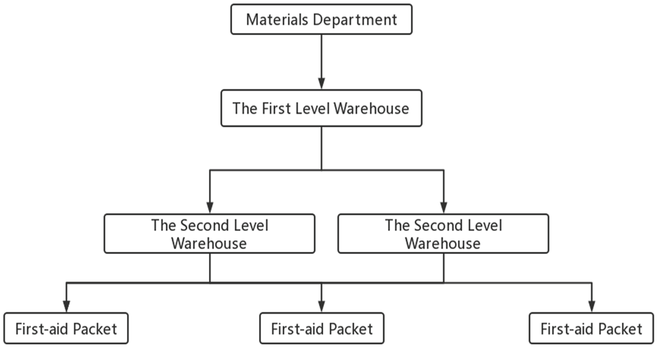

Fig. 1. Material management level structure chart of electric power enterprises.

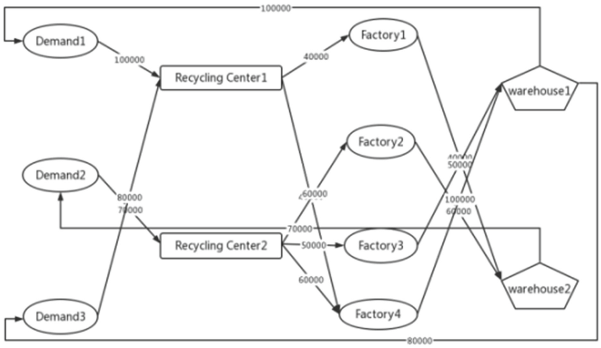

Fig. 2. Reverse logistics path plan diagram of the power grid company.

supply problem of accessories for the daily power grid maintenance of the district and county power supply bureau (Fig. 1).

In order to actively respond to the call of the national sustainable development strategy, enterprises can transport the waste materials back to the waste products recycling center and processing factory under the premise of the original logistics and transportation network, so that the waste products can be processed and utilized twice. When planning and designing a logistics network in a certain area, the power grid companies should consider the construction of warehouses, demand points, waste recycling centers and waste reprocessing centers (material processing factories) locally. Among them, regarding the construction of the waste recycling center, the enterprise and multiple suppliers have decided to adopt the joint construction method, effectively saving the investment cost of all parties (Fig. 2).

2.2 Establishment of the Network Model

In this paper, the objective linear programming method is used to solve the optimization problem of power network reverse logistics system. It mainly solves or plans the optimal linear objective function of an object under various interrelated multi-variable constraints. Details are as follows:

1) Model hypothesis.

- The quantity of supplies, the fixed cost and the variable cost between the alternative places are determined.
- Only one cycle is considered.
- The model is only optimized for the grid company's own cost.
- The fixed cost for the waste recycling center is the amount of cost invested by the power grid company.
- Suppose that after the secondary processing of the factory, all the processed waste products are intact and can participate in the secondary utilization and transportation to the warehouse.

2) Parametric description

- P--Collection of all optional warehouses, $\forall p \epsilon P$.
- Q--A collection of all optional demand points.
- S--Collection of All Waste Recycling Centers.
- J--A collection of all waste reprocessing centers.
- FCp --Fixed costs (including construction, operations, management, etc.).
- FCq --Fixed costs required at the demand point q.
- FCs --Fixed costs required at the waste recycling center s.
- FCj --Fixed costs required at the waste reprocessing center j.
- VCpq --Transportation costs required to transport waste from warehouse p to demand point q.
- VCqs --Transportation costs required to transport waste to s from recovery center.
- VCsj --Transportation costs required to transport the waste from the recycling center s to the reprocessing center j.
- VCjp --Transportation costs required for transporting waste goods from reprocessing center j to warehouse p.
- Bq --The ability of the demand points to store and handle the materials.
- Bs --The material processing capacity of the waste product recycling center.
- Bj --The material reprocessing capacity of the waste material reprocessing center.
- Bp --Storage capacity of the warehouse for materials.
- Ap --Number of potential waste items in the warehouse p.
- Xpq --Total number of supplies shipped from warehouse p to demand point q.
- Xqs --Total number of supplies transported from demand point q to waste recycling center s.
- Xsj --Total number of materials transported from waste recycling Center s to waste reprocessing Center j.
- Xjp --Total number of supplies transported from waste product reprocessing center j to warehouse p.
- Zq --0–1 Variable, when the demand point in q is selected, $Zq = 1$,otherwise $Zq = 0$.
- Zs --0–1 Variable, when the waste recycling center s is selected, $Zs = 1$, otherwise $Zs = 0$.

- Zj --0–1 Variable, when the waste reprocessing center j, Zj = 1, otherwise Zj = 0.

3) Modelling
Objective function:

$$\min TC = \sum_p FC_p Z_p + \sum_q FC_q Z_q + \sum_s FC_s Z_s + \sum_p VC_{pq} \sum_q X_{pq} + \sum_q VC_{qs} \sum_s X_{qs} + \sum_s VC_{sj} \sum_j X_{sj} + \sum_j VC_{jp} \sum_p X_{jp}$$

$$\begin{cases} \sum_j X_{jp} = A_p, \forall p \\ \sum_s X_{qs} = \sum_p X_{pq}, \forall q \\ \sum_s X_{sj} = \sum_p X_{jp}, \forall j \\ \sum_p X_{pq} \le B_p, \forall p \\ \sum_q X_{qs} \le B_s Z_s, \forall s \\ \sum_s X_{sj} \le B_j Z_j, \forall j \\ \sum_p X_{pq} \le B_q Z_q, \forall q \\ Zq, Zs, Zj = 0 or 1, \forall p, q, s, j \\ Xpq, Xqs, Xsj, Xjp \ge 0, \forall p, q, s, j \end{cases} \quad (1)$$

3 Example Analysis

3.1 Example Introduction

A city power grid company plans to build a new reverse logistics network for secondary recycling, processing and reuse of waste materials. In the process of planning the reverse logistics network, the company plans to cooperate with five suppliers to establish two recycling centers to store the corresponding waste materials. Select the more reasonable areas for each region, and thus choose the most reasonable transportation lines for the 4 demand points, so as to obtain the lowest cost of the city's power grid company. As shown in the table below: (unit: 100 pieces, yuan) (Tables 1, 2, 3, 4 and 5):

Table 1. Warehouse-related data sheet.

Warehouse	Ap	Bp	FCp
1	1537	2170	1917653
2	1123	2175	15007639

Table 2. Demand point and r Recycling Center elated data sheet.

Demand	1	2	3	Recycling center	1	2
B_q	1328	947	1062	B_s	1760	1937
FC_q	1256874	1073691	1457629	FC_s	657611	8294753

Table 3. Factory related data sheet.

Factory	1	2	3	4	5
B_j	420	673	527	833	419

Table 4. Unit transportation cost from warehouse to demand point and the recovery center to factory.

	q1	q2	q3	p1	p2	p3	p4	p5
1	33561	58237	35297	22000	34000	37000	27000	35000
2	45393	42513	62014	25000	27000	35000	29000	44000

Table 5. Unit transportation cost table from demand point to recovery center and Plant to warehouse.

	s1	s2	p1	p2	p3	p4	*p5*
1	38152	27000	57032	56067	60102	32137	35310
2	35219	47563	63044	40000	53000	50127	60128

3.2 Example Results Analysis

According to the results of LINGO solution, all the three alternatives of the demand center can be selected, both the two alternatives of the recovery center can be selected, and the factory can choose the first four alternatives.in addition, The transportation volume transported from warehouse 1 to demand center 1 is 105,000 units; The transportation volume transported from warehouse 1 to demand center 3 is 78,000 units; The transportation volume transported from warehouse 2 to demand center 2 is 67,000 units; The transport volume from Demand Center 1 to Recycling Center 2 is 96,000 units; The transport volume transported from demand center 2 to recovery center 2 is 73,000 units; The transportation volume transported from demand center 3 to recovery center 1 is 82,000 units; The transportation volume transported from recycling center 1 to plant 1 is 405000 units; The transportation volume from recycling center 1 to plant 4 is 42,100 units; The transportation volume transported from Recycling Center 2 to Plant 2 is 62,300 units; The transport volume transported from Recycling Center 2 to Plant 3 is 53,00 units; The transportation volume from recycling center 2 to plant 4 is 61,700 units; The transportation volume transported from factory 1 to warehouse 2 is 309000 units; The transportation volume transported from factory 2 to warehouse 2 is 49,100 units; The transportation volume transported from factory 3 to warehouse 1 is 48,400 units; The shipment from Plant 4 to Warehouse 1 is 12,160 units.

4 Conclusion

This paper takes the power grid company as the research object, combined with the own situation of the company and the market environment, analyzes the existing distribution mode of the materials of the power grid company and studies to create a new reverse logistics network, so that under the sustainable development strategy and dual-carbon goal, the power grid company and the suppliers can achieve long-term and mutually beneficial development. Through the research, the following conclusions are obtained: Power grid companies have a unified management mode in material distribution, transportation, storage and other aspects, which can effectively improve customer satisfaction and the development of enterprises themselves, in line with the market development process. At the same time, in the choice of logistics distribution mode, the distribution mode of logistics alliance can be selected. As the power grid company needs to consider the recycling of waste materials, the company can decide to build a reverse logistics network after consultation with multiple suppliers. In response to the national two-carbon goals and sustainable development strategies, the overall operating costs are saved. In the process of reverse logistics network optimization design, we aim at the optimal cost and use LINGO to solve the optimal location and reverse logistics distribution strategy of each key node.

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