Research on Internal Supply Chain Model of LG Coal Mine

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***Abstract*—This paper takes large coal companies as research objects and uses cost control as the basis for the internal supply chain of large coal companies. It is pointed out that the goal of the internal operation of the large coal enterprise supply chain is to achieve a balanced coal supply for coal end customers, achieve double satisfaction of coal supply chain enterprises and customers and ultimately maximize general utility. This paper aims to optimize the supply chain in the development of LG coal mine recycling economy. Use existing research methods to solve practical business problems, read a large number of domestic and foreign literature on internal supply chain optimization, and summarize the characteristics and common structure of the internal supply chain of coal companies. Subsequently, through field research, the structure of the internal supply chain of the coal mine was analyzed, and the production process, the selection process, the uncertainty of the transportation and sales process and the necessity of the optimization of the internal supply chain of the coal mine were qualitatively analyzed. Based on the existing theoretical results, the method of optimizing the internal supply chain is compared, and the method suitable for optimizing the internal supply chain of coal mine is selected. The questionnaire survey method was used to obtain the customer satisfaction evaluation index. Maximizing customer satisfaction and company profitability as the optimization goal, taking production capacity, washing capacity and transportation capacity as the constraints of the coal mine internal supply chain target planning optimization model. Based on the overall coordination of the internal supply chain, coal mine production and sales decisions. Finally, the optimal production and sales decisions of the coal mine were obtained, and the optimization results were evaluated.**

Keywords-LG coal mine; supply chain; target planning

I. INTRODUCTION

Internal supply chain management is to plan, coordinate and control the business and resources of orders, procurement, inventory, production, sales, capital and personnel within the enterprise [1]. The purpose is to optimize the internal logistics business process, improve the efficiency of related processes, and reduce Production costs, thereby improving the quality and efficiency of business operations. The internal supply chain management of the enterprise realizes the business and information integration among the various functional departments of the enterprise. Through the allocation of internal resources, the internal supply chain management of enterprises enables a high degree of integration, control, sharing and coordinated operation of various information and services, thereby eliminating the cumbersome phenomenon of internal business, eliminating invalid business links and affecting the operation of business processes. Unfavorable factors, indirectly reduce inventory, and effectively make comprehensive decisions on the main plans of the company's internal business processes. This kind of internal supply chain structure connects the information of each business link of the enterprise, so that various businesses and information can be integrated and shared to successfully manage the internal supply chain. It also needs to discuss the content, such as operation and organization behavior. Logistics and transportation, among which, operations can coordinate the relationship between members of the supply chain to help establish and solve model problems.

The internal supply chain integration of the enterprise optimizes the supply and demand process of the entire supply chain, and links all the links in the entire internal supply chain, so that each department can change from the starting point of pursuing its own optimization and the situation of losing one to the other. The chain system is integrated into a community of interests. For the internal supply chain of coal enterprises, the raw coal production, raw coal washing, transportation of raw coal and commercial coal, storage of warehousing, commercial coal and customer demand in the internal supply chain of coal enterprises are in a dispersed state, for example, raw coal production is not based on Customer demand forecast or customer actual order is carried out. Once the consequences of overproduction are caused, on the one hand, it will cause serious waste of inventory, on the other hand, it will disrupt the market. Because coal products belong to the state regulation resources, supply disorder will inevitably affect the whole industry. Make an impact. This is the result of each of the various links within the company's internal supply chain. By

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coordinating and interacting with each other, we can minimize the cost of the enterprise and satisfy the customers. Integrating all aspects of the internal supply chain can achieve the following goals: First, improve customer satisfaction, meet consumer demand from the quantity and quality of commercial coal, and deliver customer orders on time in delivery time, reducing order response time. Second, reduce the cost of the enterprise. For example, the close connection between transportation and warehousing can reduce the inventory cost. The close connection between the production link and the sales link can reduce the loss of customers and reduce the cost of handling customer complaints. At the same time, it can also improve customer satisfaction. At the same time, get more customer orders and increase corporate profits.

II. Select Internal Supply Chain Optimization Method For LG Coal Mine

Purpose of the use of information technology to optimize the internal supply is to improve the overall operational efficiency of enterprises, strengthen internal supply various chain transfer of information between sectors, the pursuit of Full range of information sharing for the enterprise. This optimization method requires a good information management facility as a basis, such as an ERP system [2]. The cost of information construction is high, and it is suitable for enterprises with large scale, scattered distribution of various departments and high requirements for information sharing. LG internal coal supply chain ring section than manufacturing enterprises less, coal mining area, coal preparation plant, coal blending center sales information-sharing requirements are not very high, it does not apply to the use of information technology for supply chain optimization of internal cost method. The use of business process reengineering to optimize the internal supply chain is the business process of the enterprise, the purpose is to eliminate redundant business links and integrate the disconnected business processes. The method of using business process reengineering to optimize the internal supply chain advocates shortening the operation time and speeding up the decision-making, and is suitable for enterprises with complicated production processes, many production links, and relatively high storage levels. LG coal mine products mainly include raw coal, commercial coal A and commercial coal B. The product variety is relatively small, and the corresponding production process is relatively simple. Because it is mainly order-driven production, there is almost no inventory, and the whole business process is simple, and it is not suitable for the process as a research. The internal supply chain optimization method of the object.

The Petri network has a visual description function that graphically presents the entire process of the coal internal supply chain to expose problems in the process [3]. The main role of this method is the detection of internal supply chain problems, Peng Chen is in the process of supply chain Petri nets were used for analysis, mainly for supply flow and logistics. Transportation plays an important role in the process of raw coal production, coal washing and raw coal sales throughout the coal enterprise. Transport to connect. The problem of the internal supply chain of LG coal mine is mainly because the uncertainty of each link leads to the failure of all links to make decisions. The use of Petri nets for internal supply chain optimization focuses on identifying bottlenecks in each link and does not apply to the optimization of the internal supply chain of LG Coal Mine.

The use of goal planning for internal supply chain optimization can enable all aspects of the internal supply chain to operate around a common goal, and each step of the decision will affect other links to achieve the overall optimization goal. LG coal supply chain in a variety of internal capacity of about East, trying to find an optimal production and marketing decisions to take into account in the case of customer satisfaction to achieve profit maximization. This paper chooses the goal planning method as the internal supply chain optimization method, obtains production and sales decisions, and analyzes the results [4].

III. Construction of Internal Supply Chain Optimization Model in LG Coal Mine

A. Basic Assumptions And Optimization Objectives

1) The basic assumptions include the following points:

- During the decision period, the production and washing costs of raw coal are unchanged, the transportation costs are constant, and each node technology The level has not changed. In addition to 5 fixed customers,
- LG coal mines have some individual customers, but the purchase volume of individual customers is random and the purchase amount is small, which is not considered in the decision-making.
- Assume that the demand for fixed customers of LG Coal Mine during the decision-making period is the average demand, calculated according to the previous order demand.
- During the decision period, the prices of raw coal, commercial coal A and commercial coal B did not change. LG coal mine customers are fixed and demand is stable, this decision does not consider inventory costs.

2) Optimizing the target

The goal of the company's operations is to obtain the maximum economic benefits while meeting customer needs. Corporate profits are the measure of economic benefits. Customer needs include many aspects, such as product quality, product quantity or product availability. It is necessary to determine the evaluation index of customer satisfaction through research. This article prepared according to the adjusted index Customer Satisfaction Index Model investigation questionnaire, LG business customer satisfaction issues on coal for research by telephone. There are 5 customers in LG coal mines, the number of individual passengers is random, and the amount of coal consumed by individual customers is small. Here we consider five corporate customers when considering customer satisfaction. According to the data obtained by the effective questionnaire, the paper analyzes the importance ranking of the

customer satisfaction index, and selects the customer satisfaction evaluation index according to the ranking [5].

First, data collection. Inquire about 5 corporate customers by phone and get 5 questionnaires, including 5 valid questionnaires.

Second, the questionnaire design was carried out. In the design of the questionnaire, based on the customer satisfaction index model, the paper designs from three perspectives: product quality, product service and brand image. This article tries to adopt a form of topic that has proven to be effective to ensure effectiveness. The questionnaire is divided into four parts. The first part is the basic information of the respondents, including the name, annual coal demand, the type of coal required, and the most important indicators at the time of purchase. The second part is the most concerned about the quality of the product: volatiles, sulfur, ash, calories. The third part is the most concerned about the product service indicators: the supply is sufficient, the delivery is timely, the settlement method is good, and the customer opinions are processed quickly. The fourth part is the most concerned about the brand image of the customer: the size of the company, consumer word of mouth and social contribution.

Finally, data analysis is performed. According to the collected questionnaires, the rankings of customer satisfaction evaluation indicators were obtained. Four of the five questions were selected for product service, and three of the questionnaires for selecting product services chose sufficient supply, and the supply was sufficient. The number of questionnaires has the largest proportion, so we choose sufficient supply as the evaluation index of the customer satisfaction model.

Taking into account the supply and demand situation of LG mine, the final determination of the supply quantity to reach 80% of customer demand is the minimum requirement for customer satisfaction.

B. Variable Description

1) Subscript and set

i indicates the coal mining area;

i=1, 2, 3 respectively represent three different coal mining areas;

n represents the type of coal, n=0 represents raw coal, n=1 represents commercial coal A, and n=2 represents commercial coal B;

k represents the customer, k=1, 2 is the raw coal customer; k=3, 4, 5 is the commercial coal customer.

2) Known constant

A_1, A_2, and A_3 are the maximum amount of raw coal mined in the three coal mining areas;

B is the largest washing capacity of the coal preparation plant;

T is the largest transportation capacity of LG Coal Mine;

C_i is the raw coal cost of the production unit of coal mining area i;

C_4 is the cost of raw coal for the washing unit of the coal preparation plant;

R is the transportation cost of one ton of raw coal from the coal mining area to the coal preparation plant;

R_i is the transportation cost of a ton of washed coal from the coal preparation plant to the coal distribution center;

T_k is the cost of transporting one ton of raw coal or coal to customer k;

Q_{nk} is the demand for customer k for n varieties of coal;

P_0 is the price of raw coal;

P_1 is the price of commercial coal A;

P_2 is the price of commercial coal B.

3) Decision variables

X_1 is the raw coal output of coal mining area i;

Z_i is the amount of raw coal entering the coal preparation plant in the coal mining area i;

Z_4 is the amount of coal transported from the coal preparation plant to the coal distribution center;

Y_{nk} is the sales volume of the company's k-customer n-type coal.

C. Objective Function

In the enterprise Profit is the foundation of all companies' survival. Therefore, profit maximization is the objective function of the decision model, and the profit is equal to the income minus the cost. The income is the sales income of all coals, and the cost is the funds invested by the enterprises in the production, processing and transshipment stages [6].

$$\max U = \sum_{k=1}^{2} P_0 y_{0k} + \sum_{k=3}^{4} P_1 y_{1k} + \sum_{k=4}^{5} P_2 y_{2k} - \sum_{i=1}^{3} C_i x_i - \sum_{i=1}^{3} C_4 z_i - \sum_{i=1}^{3} R_i z_i - R_4 z_4 - \sum_{k=1}^{2} T_k y_{0k} - \sum_{k=3}^{4} T_k y_{1k} - \sum_{k=4}^{5} T_k y_{2k}$$

D. Constraints

There are certain constraints on the production of coal enterprises objectively. To this end, the constraints can be established as follows:

St. $X_1 \le A_1$(Coal mining area 1 production capacity constraint)

$X_2 \le A_2$(Coal mining area 2 production capacity constraints)

$X_3 \le A_3$(Coal mining area 3 production capacity constraints)

$\sum_{i=1}^{3} z_i \le B$ (Constraining capacity of coal preparation plant)

$z_4 \le \sum_{i=1}^{3} z_i$ (The original coal is selected as the total amount of restrictions)

$\sum_{k=1}^{5}\sum_{n=1}^{2} Y_{nk} \le z_4$ (The total sales volume of commercial coal is about east)

$X_1 = \sum_{k=1}^{2} y_{nk} + z_1$ (Coal mining area 1 production and sales balance)

$x_2 = z_2$ (Coal mining area 2 production balance)

$x_3 = z_3$ (Coal mining area 3 production balance)

$\sum_{k=1}^{5}\sum_{n=0}^{2} y_{nk} + \sum_{i=1}^{3} z_i + z_4 \le T$ (Enterprise transportation capacity constraints)

$y_{nk} \ge 0.8Q_{nk}$ (Customer demand minimum constraint)

E. Optimization Model

Above objective function and the approximate condition can be used to optimize the model as follows:

$$\max U = \sum_{k=1}^{2} P_0 y_{0k} + \sum_{k=3}^{4} P_1 y_{1k} + \sum_{k=4}^{5} P_2 y_{2k} - \sum_{i=1}^{3} C_i x_i - \sum_{i=1}^{3} C_4 z_i - \sum_{i=1}^{3} R_i z_i - R_4 z_4 - \sum_{k=1}^{2} T_k y_{0k} - \sum_{k=3}^{4} T_k y_{1k} - \sum_{k=4}^{5} T_k y_{2k} \quad (1.1)$$

$X_1 \le A_1$ (Coal mining area 1 production capacity constraint)

$X_2 \le A_2$ (Coal mining area 2 production capacity constraints)

$X_3 \le A_3$ (Coal mining area 3 production capacity constraints)

$\sum_{i=1}^{3} z_i \le B$ (Constraining capacity of coal preparation plant)

$z_4 \le \sum_{i=1}^{3} z_i$ (The original coal is selected as the total amount of restrictions)

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$x_2 = z_2$ (Coal mining area 2 production balance)

$x_3 = z_3$ (Coal mining area 3 production balance)

$\sum_{k=1}^{5}\sum_{n=0}^{2} y_{nk} + \sum_{i=1}^{3} z_i + z_4 \le T$ (Enterprise transportation capacity constraints)

$y_{nk} \ge 0.8Q_{nk}$ (Customer demand minimum constraint)

1) Decision variable

LG Coal Mine has 3 coal mining areas with output of x_1, x_2 and x_3 respectively; LG Coal Mine owns 1 coal preparation plant, and the raw coal transportation volume from 3 coal mining areas to coal preparation plant is z_1, z_2, z_3 respectively; LG Coal Mine It has a coal distribution center, the coal transportation volume from the coal preparation plant to the coal distribution sales center is z_4; the LG coal mine has 2 raw coal customers, only the coal mining area 1 sells raw coal, and the coal mining area to the raw coal of 2 raw coal customers Sales and transportation volume is y_{01}, y_{02}; LG Coal Mine owns 3 commercial coal customers, customer 3 purchases commercial coal A, customer 4 purchases commercial coal A and commercial coal B, customer 5 purchases commercial coal B, coal distribution sales center 6 passengers 3, customer 4, customer 5 sales of commercial coal sales are y_{13}, y_{14}, y_{24}, y_{25}.

2) Known parameters

Due to the confidentiality of enterprise data, it is not convenient to directly use real data for model calculation. The model operation is aimed at enterprises. Provide ideas for making production and sales decisions, thus allowing adjustment of real data of W open pit mines. After adjustment, the following parameters can be obtained, such as capacity constraint parameters, production cost, washing cost, transportation cost, coal price and customer demand forecast parameters.

TABLE I. THE ABILITY OF CONSTRAINT PARAMETERS THE PROCESS OF PRODUCTION , WASHING , TRANSPORTATION(TEN THOUSAND TONS)

A_1	A_2	A_3	B	T
100	100	80	180	500

TABLE II. PRICE PARAMETER (YUAN / TON) OF ALL VARIETIES OF COAL

P_0	P_1	P_2
530	620	600

TABLE III. THE PRODUCTION COST AND WASHING PARAMETERS (YUAN / TON)

C_1	C_2	C_3	C_4
345	320	315	35

TABLE IV. TRANSPORT COST PARAMETERS (YUAN / TON)

R_1	R_2	R_3	R_4	T_1	T_2	T_3	T_4	T_5
25	30	28	6	35	30	12	15	10

TABLE V. CUSTOMER DEMAND FOR COAL (TEN THOUSAND TONS)

Q_{01}	Q_{02}	Q_{13}	Q_{14}	Q_{24}	Q_{25}
37.5	70	37.5	37.5	37.5	52.5

Substituting each parameter into the optimization model yields.

$$
\begin{aligned}
&\max U = 495y_{01} + 500y_{02} + 608y_{13} + 605y_{14} + 585y_{24} + 590y_{25} \\
&-345x_1 - 320x_2 - 315x_3 - 60z_1 - 65z_2 - 63z_3 - 6z_4 \\
&x_1 \le 100 \\
&x_2 \le 100 \\
&x_3 \le 80 \\
&z + z_2 + z_3 \le 180 \\
&z + z_2 + z_3 \le z_4 \\
&y_{31} + y_{41} + y_{42} + y_{52} \le z_4 \\
&y_{10} + y_{20} + z_1 = x_1 \\
&x_2 = z_2 \\
&x_3 = z_3 \\
&y_{10} + y_{20} + y_{31} + y_{41} + y_{42} + y_{52} + z_1 + z_2 + z_3 + z_4 \le 500 \\
&y_{01} \ge 30 \\
&y_{02} \ge 56 \\
&y_{13} \ge 30 \\
&y_{14} \ge 30
\end{aligned}
\tag{1.2}
$$

Problem solving results are as follows:

From decision results, 3 mining the amount of a coal mining area during the decision-making were 100 ten thousand tons, 53.3 ten thousand tons and 80 ten thousand tons, 3 coal mining area in the runoff during the making of f traffic coal Preparation Plant were 0 ten thousand tons, 53.3 ten thousand tons and 80 ten thousand tons of coal preparation plant during blending decisions on traffic sales center was 133.33 ten thousand tons, LG mine in decisions during the making of the customer 1 , customer 2 the amount of coal sales were 30 ten thousand tons and 70 ten thousand tons, LG mine in decisions during the making of the customer 3 sales of commercial coal a was 31.3 ten thousand tons, LG coal to customers during the decision-making 4 sales of commercial coal is 30 ten thousand tons, LG mine in decisions during the making of the customer 4 sales of commercial coal B is 30 ten thousand tons, LG coal to customers during the decision-making 5 sales of commercial coal B is 42 ten thousand tons.

Finishing get 3 Ge coal mining area of production decisions (100, 53.33, 80), 5 customer sales decisions (30, 7031.33, 30, 30, 42), 3 coal mining district to transport coal preparation plant decision For (0, 53.5, 80), the transportation decision of the coal preparation plant to the coal distribution sales center is 133.33 (the above data units are all tons). Under the above decision, LG Coal Mine has reached a maximum profit of 433, 073, 248.00 yuan in meeting the minimum number of customers.

2) Optimization results and evaluation of coal within the supply chain

From the above-described optimization results, we can find, coal area 2 there is a case of overcapacity, mining area 2 The production capacity is 1 ten thousand tons, but the annual production in the production decision is 53.33 ten thousand tons, and the mining of 46.67 ten thousand tons of raw coal does not meet the overall goal of maximizing profits. The supply of commercial coal A and commercial coal B can only meet 80% of customer demand, and there is still a large part of the profit margin. The analysis of the whole process is caused by insufficient transportation capacity, resulting in overcapacity in coal mining area 2. The existing transportation volume has exceeded the transportation capacity of LG coal mine 500, and the insufficient transportation capacity of enterprises has become the limiting factor of the production process. Therefore, LG Coal Mine should be forced to increase the capacity of the transportation vehicles or to outsource the transportation business [7].

From the solution process, we can find that when the raw coal price changes in the interval (-M, 427.67), the price of commercial coal 1 varies in the interval (313, 474), and the price of commercial coal B is in the interval (-M, 322), the production decision does not change, that is, the optimal solution does not change. Therefore, when the coal price of a coal mine is subject to state regulation or market operation changes, if the variation range is within the above range, the production decision remains unchanged. If the variation range exceeds the above interval, the price parameter of the model may be changed, and the optimal solution may be recalculated. The new maximum profit value [8].

In the construction of the whole model, we consider customer satisfaction, and 80% of the coal volume of the customer's predicted demand is used as an evaluation index of satisfaction, and is included in the constraints of the model. If the evaluation index of customer satisfaction is revised, 70% of the customer's coal demand will be used as an evaluation index of satisfaction, and the model will be recalculated to obtain the maximum profit of 435, 180, 768.00 yuan, compared with 80% of the customer demand. Under the circumstance of 70%, corporate profits have increased. Although the short-term profits of enterprises are higher in this case, they are not conducive to the long-term development of the company. The coal demand of customers is not satisfied. For a long time, they will be dissatisfied with the company. Even changing buyers, therefore, taking into account the customer satisfaction when making production and sales decisions can prevent the occurrence of customer loss and help the company's long-term development [9].

IV. SUMMARY

This paper defines the concept of internal supply chain, qualitatively describes the characteristics of internal supply chain, studies the internal supply chain structure of real coal enterprises, and summarizes several common models. Propose the goal of internal supply chain optimization, and propose and study the construction of the circular economy system and the main goals. This paper mainly studies the following contents: The internal supply chain structure of LG modern mining area is studied, and several common models are summarized. Research on the internal supply chain of LG Coal Mine and analyze the current status of the supply chain. Based on the analysis of the uncertainty of the internal supply chain of LG coal mine, the necessity of internal supply chain optimization is proposed, and the optimization method suitable for the internal supply chain of LG mine is selected. Constructed a goal

planning optimization model for the internal supply chain of LG Coal Mine. Using the questionnaire survey method to obtain the evaluation index of customer satisfaction, taking customer satisfaction and corporate profit maximization as the optimization goal, taking the production capacity, washing ability and transportation capacity as constraints, and constructing the LG coal mine internal supply chain target planning optimization model, on the basis of the overall coordination of the supply chain inside the LG conduct coal production and sales decisions. Finally, the production decision of LG Coal Mine was obtained and the optimization results were evaluated.

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