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Establishment and Empirical Analysis of Logistics Transportation Cost Optimization System for Dangerous Chemicals

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The prediction and optimization of transportation cost of hazardous chemicals is the key to improve the profit and competitiveness of chemical enterprises. Based on the cost optimization theory, this paper establishes the logistics cost control and optimization system of chemical enterprises, calculates and optimizes the logistics cost of chemical enterprises by using the method of quota analysis, and takes a chemical enterprise in Jiangsu Province as an example. The results show that the productive idle capacity of the delivery center is the highest in this chemical enterprise. The difference between the rated cost and the actual cost of the warehouse center is RMB 0.813, and the difference between the rated cost and the cost of the delivery center is RMB1.54. The logistics cost optimization of hazardous chemicals in warehouse center and delivery center is the key to control the logistics cost of the chemical enterprise. The study of logistics cost control has important guiding significance for chemical enterprises to tap logistics cost profit.

1. Introduction

Logistics cost is the key factor affecting the operating profit of enterprises, because of the particularity and higher requirements of the transportation of hazardous chemicals in chemical enterprises, the control and prediction of logistics cost of hazardous chemicals is the key to improve the operating cost and competitiveness of chemical enterprises (Gao et al., 2008). Logistics cost control has become an important component of improving resource utilization and carrying out sustainable development strategy, and is gradually recognized and studied in China (Turkensteenabb, 2011).

The control and application of logistics transportation cost abroad is more mature: from the perspective of reverse logistics cost management, a two-level multi-project decision-making framework is established to reduce logistics cost (Ramírez and Morales, 2014), and a nonlinear mixed integer programming model is proposed to reduce logistics cost (Ko and Chang, 2008); domestic scholars have also made corresponding researches on the basis of foreign theory and application: improve the load rate of transport means from aspects of transport mode and route selection (He et al., 2015); and optimize transport inventory management with CPRF (collaborative planning, forecasting and replenishment) methods (Carneiro and Ferrarini, 2010). However, there are few researches on the transportation of hazardous chemicals and the optimization of lean logistics cost control based on cost control in domestic logistics cost research (Wang et al., 2009).

This paper studies the transportation cost control and prediction of hazardous chemicals. Firstly, the paper briefly introduces the research background and related theoretical knowledge, and summarizes the influencing factors of logistics transportation of hazardous chemicals; establishes logistics optimization system based on unit field energy quota cost; finally, the applicability of the optimization system is verified with an example of a chemical plant in Jiangsu Province. The research is very important to control the logistics cost of chemical enterprises.

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2. Current Situation and Influencing Factors of Logistics Transportation of Hazardous Chemicals

2.1 Current situation of logistics cost of hazardous chemicals

With the development of international economy and trade and the increasing tonnage of domestic freight transportation, China's logistics industry is facing unprecedented challenges and opportunities. Due to the late start of logistics management in China, there are many problems in practice, especially in logistics cost management (Liu and Ma, 2016). An important indicator of the logistics development level is the proportion of logistics cost in national GDP. Figure 1 shows the ratio of logistics costs to GDP of each country in 2016:

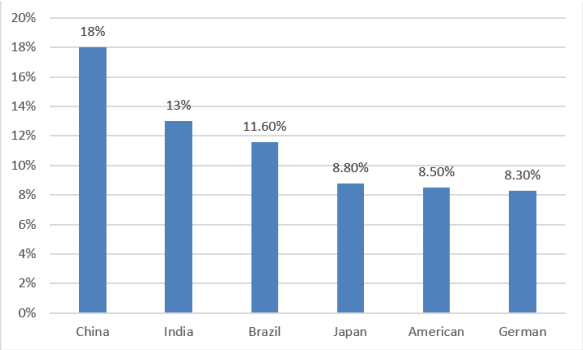

Figure 1: The ratio of total logistics costs to GDP in 2016

From the figure, we can see that the logistics management cost of China is much higher than that of developed countries, and still 5% higher than that of India, and China has a large management and control interval in the logistics cost (Tsubouchi et al., 2010).

Hazardous chemicals are an important part of the products produced by chemical enterprises. The logistics of hazardous chemicals has many problems, such as flammability, explosion, radioactivity, corrosion, personnel safety, transportation, warehouse, and loading and unloading safety, so the logistics cost of hazardous chemicals is higher than the common logistics cost, and the prediction and control of the logistics cost of hazardous chemicals can effectively improve the profits of chemical enterprises.

2.2 Influencing factors of hazardous chemicals logistics

The influencing factors of logistics cost of hazardous chemicals mainly include transportation and delivery cost, storage cost and information management cost.

(1) The transportation cost and delivery cost are the sum of the costs of hazardous chemicals incurred from the production plant to the delivery center or the distributor's warehouse. Due to the flammability, explosiveness, corrosion, radioactivity and other characteristics of hazardous chemicals, the packaging and safety protection in the transportation process is an important component of transportation costs. In addition, the transportation distance of hazardous chemicals and the load of transportation vehicles also affect the transportation cost, in which the transportation distance is positively correlated with the transportation cost, and the load is negatively correlated with the transportation cost (Wang and Zhang, 2011).

(2) The storage cost is the sum of the costs of storing hazardous chemicals. Hazardous chemicals storage needs to meet the fire-proof, explosion-proof, lightning-proof, ventilation, anti-static and other measures. In addition, the warehouse needs to have regular patrol and testing. The control of storage cost needs to increase the turnover rate of hazardous chemicals and reduce the storage time of products produced by chemical enterprises (Jiang and Ying, 2014).

(3) Information management cost is to control customer order, production inventory, order status and transportation status tracking by establishing logistics management system. The cost of updating and maintaining an information management system is a component of the cost of information management (Angels, 2013).

3. Prediction and Control of Logistics Transportation Cost of Hazardous Chemicals

3.1 Construction of logistics cost and optimization system of hazardous chemicals based on cost control theory

Based on the idea of cost control of logistics influencing factors in chemical enterprises, the control and optimization system as shown in Figure 2 is proposed.

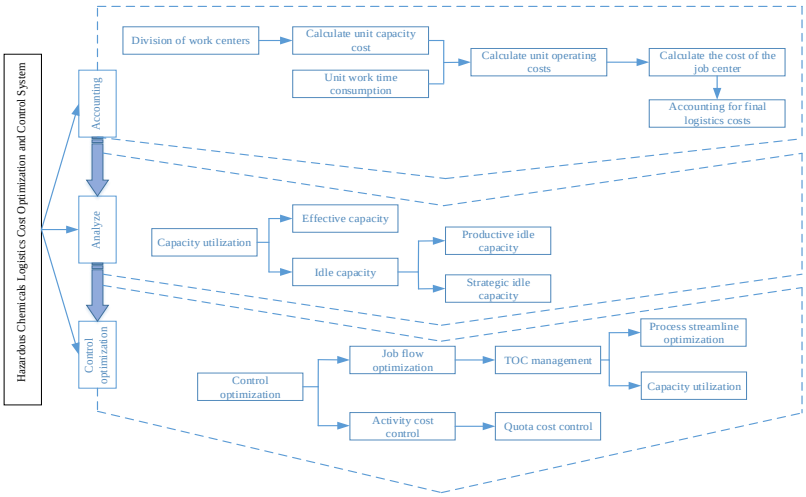

Figure 2: Logistics cost optimization and control system

As can be seen from the figure, the optimization and control of logistics transportation cost of hazardous chemicals based on cost control method is mainly divided into three parts: the first part is to calculate the logistics cost of the production activity center of the chemical enterprise, and get the cost per unit time and the time per unit activity, and the product of the two is the unit activity cost of the activity center, and is accumulated to get the total logistics cost of the chemical enterprise (Cao et al., 2013); the second part is the scientific analysis of the accounting to grasp the enterprise's capacity utilization, and eliminate the productive idle capacity; the third part is to optimize the logistics cost in each process through the cost control thought and the constraint theory, use the quota cost method to control the logistics cost, take the total cost of logistics transportation of hazardous chemicals as the optimization object, and carry on the process optimization control to each level of the logistics (Jing, 2006).

3.2 Logistics cost optimization analysis

Quota cost method is to establish a quota cost standard and compare it with the quota cost of the current month based on historical data, and to analyze the differences between the two to obtain the reasons and thus control logistics costs (Zhao et al., 2012). The standard system of logistics quota cost of chemical enterprises is shown in Figure 3:

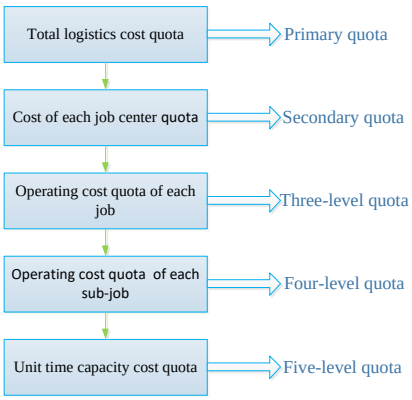

Figure 3: Logistics cost control quota standard system diagram

The method of calculating unit capacity cost quota of each activity is shown in Equation 1:

$$V^i = \frac{W}{Q_0}\frac{W}{A \times T_0 \times \gamma} \quad (1)$$

V^i is the unit capacity cost quota incurred by the department, W is the indirect cost incurred by the department, Q_0 is the actual capacity quota of part i, A is the number of employees in the department; T_0 is quota capacity for employees; γ is the efficiency of the staff.
The calculation method of each sub-activity cost quota is shown in Equation 2:

$$\mathrm{C} = t \times V^i \quad (2)$$

Where C is the cost quota of each sub-activity and t is the time-consuming quota of the sub-activity.
According to Equations 1 and 2, the cost quota F_i of the whole activity center is obtained as Equation 3:

$$\mathrm{F}_i = C_1 + \sum_{i=1}^{n} M_i \quad (3)$$

Finally, the logistics cost of transportation and delivery center, warehouse center and information management center of chemical enterprises is calculated to get the total logistics cost TC of chemical enterprises, as shown in Equation 4.

$$\mathrm{TC} = \sum_{i=1}^{n} F_i \quad (4)$$

The calculation of quota cost starts from the lowest level quota and is summed up level by level to ensure the accuracy and applicability of the quota calculation, so as to achieve the optimization and control of the logistics transportation cost of hazardous chemicals.

3.3 Application based on cost control theory

3.3.1 Background of chemical enterprises

Taking a chemical enterprise in Jiangsu province as the research object of practical application case, main customers of the chemical enterprise are chemical plants or retail stores of chemical products in the neighboring provinces and cities. More than 90% of the chemicals in the logistics transportation of the chemical enterprise are transported by truck and 10% by train. Through investigation and analysis and management investigation, the main problems are weak management consciousness, complicated transportation link, weak storage capacity and low level of logistics informatization.
The warehouse center and transportation and delivery center of the chemical enterprise are selected as the research objects, and the warehouse center mainly has three activities: warehouse-in, warehousing and warehouse-out, 6 sub-activities: acceptance, warehouse-in, inventory, stock-taking, measuring and preparing goods, and loading goods; the transportation and delivery center mainly has three activities: dispatch, delivery and return, and six sub-activities: planning, transportation, unloading, signing, vehicle maintenance and special situation reporting. Taking September 2017 as the survey month of the chemical enterprise, the unit production capacity cost and unit operation cost are calculated statistically to obtain the production capacity utilization of the chemical enterprise as shown in Table 1:

Table 1: Chemical enterprise capacity utilization

Job center	Actual total cost of consumption (Yuan)	Total cost of input (Yuan)	Idle production capacity (Yuan)	Resource utilization
Warehouse center	586528	765875	179347	76.58%
Delivery center	868950	1067000	198050	81.43%

In order to better analyze the idle production capacity of the chemical enterprise, the productive idle capacity and the overall idle capacity are shown in Figure 3:
The resource utilization rate of warehouse center of the chemical enterprise is higher than the delivery center, and the idle production capacity of the delivery center is higher. Therefore, it is more potential to improve the resource utilization rate of the delivery center. There is less space for information management optimization, which will not be introduced here in detail.

3.3.2 Optimization of logistics cost in chemical enterprises

(1) Logistics process optimization
In addition to special circumstances such as return in the delivery in the chemical enterprises due to customer questions about product quality and delivery errors, other logistics flow is relatively streamlined and doesn't

need to be optimized. In combination with the actual situation of chemical enterprises, the problems such as low turnover efficiency, poor work efficiency and long stock time of chemical warehouse are optimized, and the statistical incentive system may reward the staff and improve the work efficiency of the staff, thus promoting the smoothness of the warehousing and delivery processes and obtaining the optimized results shown in Table 2.

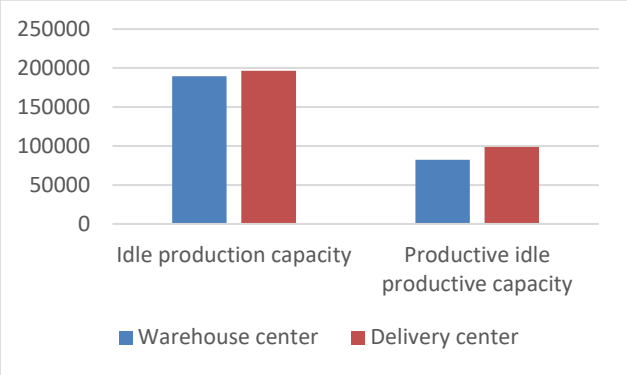

Figure 3: The idle capacity analysis chart of each operation center

Table 2: Cost optimization results for each job center

Job center	Time spent after optimization (minutes)	Optimized operating cost (yuan)	Cost savings (yuan)
Warehouse center	129909.67	141718.46	30702.53
Delivery center	655079.81	391934.21	8061.46

(2) Logistics cost optimization

The logistics cost optimization method based on the quota cost is to continuously reduce the gap between the actual cost and the quota cost. Table 3 shows the difference between the quota cost and the actual cost.

Table 3: The difference between the fixed cost and the actual cost

Job center	Actual cost	Fixed cost	Spread (yuan)
Warehouse center	1.7240	0.9110	0.813
Delivery center	4.1000	2.5600	1.54

The quota of warehouse center is RMB0.813. The main idea of control optimization is to improve the enterprise's ability to predict the market, reduce the inventory and increase the turnover rate of capital. The ration of the delivery and transportation center reaches RMB1.54, which is higher than that of the warehouse center, and the main idea of its control and optimization is to rationally plan the delivery route to realize multi-party common delivery. For different customers on the same route, the delivery can be carried out when the distribution capacity is allowed. The logistics delivery of hazardous chemicals based on the cost control method can optimize the logistics management level and the resource utilization ratio of each logistics link, and improve the market competitiveness of chemical enterprises.

4. Conclusions

In order to realize the control and prediction of logistics cost in chemical enterprises by exploiting the profits in logistics transportation, this paper studies the cost control and optimization of hazardous chemicals in chemical enterprises. Based on the cost control method and the quota analysis method, this paper takes a chemical enterprise in Jiangsu province as the actual research object to carry out the theoretical and practical research. The main research contents and significance are as follows:

This paper analyzes the current situation of logistics transportation in chemical enterprises, summarizes the main influencing factors of logistics transportation, and establishes the optimization system of logistics transportation.

This paper analyzes the production capacity of a chemical enterprise in Jiangsu province, optimizes the logistics transportation of the enterprise with quota analysis method and the logistics optimization system, and puts forward optimization measures.
The study is of guiding significance to the transportation cost optimization of hazardous chemicals in chemical enterprises.

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