

# Collaborative Supervision Method of Third-Party Administrator for Dangerous Chemicals Based on Management Science and Technology

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Third-party administration of dangerous chemicals is a management mode which improves the performance of enterprises, it helps enterprises reduce costs and increase competitiveness. However, ineffective third-party administration will also bring huge economic losses to enterprises. From the perspective of management science and technology, this paper studies the collaborative supervision method of third-party administrator for dangerous chemicals. Taking Jinan refinery as an example, this paper constructs a BSC-based KPI third-party administrator performance evaluation indicator system and introduces the risk matrix evaluation method and the Borda sequence value method to evaluate the key risks in the third-party administration. The results show that the lack of transparency and confidentiality, and the resistance from within the company are the main risks in the administration of dangerous chemicals of this company, so the risk prevention should be carried out from the three aspects of qualification review and signing of confidentiality contracts, personnel training of both parties and popularization and promotion of third-party administration. This study is of great significance for the theoretical research and practical application of the collaborative supervision method of third-party administrator for dangerous chemicals.

## 1. Introduction

Dangerous chemicals are flammable, explosive, toxic, and corrosive. Compared with other products, during production, manufacturing, procurement, transportation, use, and other links, their restrictions are more stringent (Noh et al., 2013). Third-party administration of dangerous chemicals is a good way for enterprises to reduce production costs, improve market competitiveness, and ensure production safety in all aspects (Bluff, 1997), and with the rapid development of third-party administration of dangerous chemicals, the relationship between the enterprise and the third-party administrator is no longer a simple “transactional relationship under contract system”, but a cooperative relationship that deals with the rational distribution of risks, benefits and profits (Tolentino et al., 1990), so the third-party administration of dangerous chemicals has attracted the attention of entrepreneurs, experts and scholars from all over the world.

The third-party administration mode for dangerous chemicals originated from chemical outsourcing. This mode has a history of only more than 30 years in foreign countries (Si et al., 2012). Foreign administrators of dangerous chemicals often have advanced human resources and technological leadership. In China, the automobile manufacturing industry is the earliest industry to implement third-party administration of dangerous chemicals, but their professional technical level and management experience are not mature enough (Barrozo et al., 2018; Noyel et al., 2016; Zhai and Shen, 2018). Although domestic and foreign scholars have done a lot of research on the third-party administration of dangerous chemicals and have achieved a lot of results, the research still mainly focused on third-party logistics supplier selection, safety and performance evaluation. As for the collaborative supervision methods of third-party administrators for dangerous chemicals, the research is still very limited (Moussaoui et al., 2016; Tang et al., 2015).

Based on the above analysis and related references at home and abroad, this paper briefly introduces the concept of third-party administration of dangerous chemicals, and analyzes the advantages and risks of implementing third-party administration of dangerous chemicals in detail. In order to discover the problems

existing in the management and timely rectify them, so as to achieve collaborative supervision of dangerous chemicals between enterprises and third-party administrators, targeting on Jinan refinery, a BSC-based KPI performance management evaluation indicator system is proposed, and a third-party administration risk assessment model for dangerous chemicals based on risk matrix is constructed. This paper also analyzes the key risks existing in Jinan refinery, and at the same time, corresponding risk control measures are proposed.

## 2. Related theories of third-party administration for dangerous chemicals

### 2.1 Third-party administration for dangerous chemicals

The third-party administration for dangerous chemicals (Yu et al., 2017) refers to that, the enterprises will hand over dangerous chemicals in their non-core business parts to a third-party administrator who has scientific management concepts and professional supporting services, so that they can reduce costs, improve productivity and ensure safety of all links. Third-party administration has become a part of the development strategies for many enterprises.

### 2.2 Advantages and risks of implementing third-party administration

#### (1) Advantages of implementing third-party administration

Implementing third-party administration for dangerous chemicals can improve product quality and technical level to a certain extent, and increase flexibility of enterprises as well as the coordination degree of internal resources of enterprises. Formula (1) and Figure (1) are the ways of profit growth under traditional mode. Formula (2) and Figure (2) are the ways of profit growth under the third-party administration mode. By comparison, it can be seen that the scientific services provided by third-party administrators can reduce waste and save costs so as to obtain benefits (Er et al., 2010).

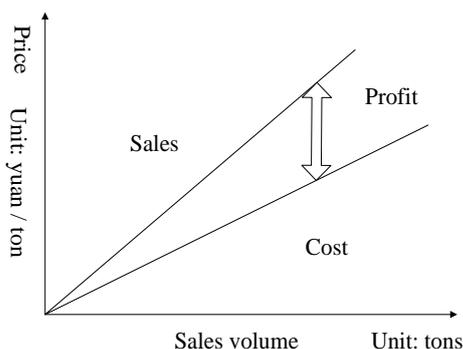


Figure 1: Profit growth under traditional mode

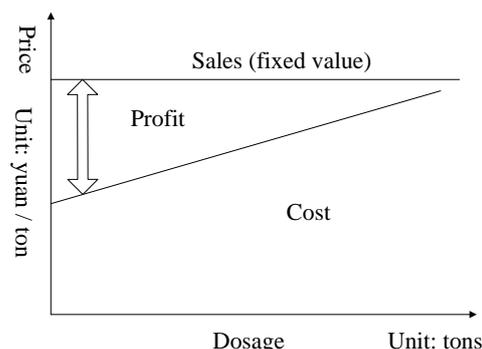


Figure 2: Profit growth under third-party administration mode

$$\begin{aligned} \text{profit} &= \text{sales} - \text{cost} \\ &= \text{price} \times \text{sales volume} - \text{unit cost} \times \text{sales volume} \end{aligned} \quad (1)$$

$$\begin{aligned} \text{profit} &= \text{fixed sales} - \text{cost} \\ &= \text{fixed sales} - \text{unit cost} \times \text{dosage} \end{aligned} \quad (2)$$

#### (2) Risks of implementing third-party administration

Figure 3 shows seven types of risk factors in the third-party administration of dangerous chemicals summarized in this paper (Campora et al., 2018):

- 1) Out of control: If an enterprise relies too much on third-party administrators and does not often participate in process management, it may lose key information sources and cause the management or technology to be out of control.
- 2) Lack of transparency: After the enterprise hands over the business to the third-party administrator, it may increase the management expenses by the business outside the so-called business scope.
- 3) Lack of cost control: In order to truly reduce costs and avoid third-party administrator not actively controlling costs or maintaining quality levels in long-term cooperation, enterprises should include appropriate incentives for price when signing agreements with third-party administrators.

4) Invalid management: Enterprises sometimes neglect to review the management capabilities and qualifications of third-party administrators, causing third-party administrators fail to complete the tasks assigned by enterprises, which not only increases the cost of the tasks, but also fails to solve the problems should be solved.

5) Lack of confidentiality: For enterprises, handing over dangerous chemicals to third-party administrator for management will inevitably involve the transfer of company-specific data. Therefore, how to effectively prevent third-party administrators from revealing information intentionally, and how does the enterprises judge whether information is leaked or not, are questions need to be concerned by both the enterprises and the third-party administrators.

6) Double outsourcing: When a third-party administrator is not capable of completing the administrative work handed over by the enterprise, it may transfer the dangerous chemicals management contract entrusted by the enterprise to other companies, thus making the enterprise unable to control the entire management process and causing potential risks.

7) Resistance from within the enterprise: For the enterprise, transferring part of its business to a third-party administrator will inevitably change the original organizational structure and business process of the enterprise, or even result in layoffs, all of these situations will affect the implementation of third-party administration of dangerous chemicals.

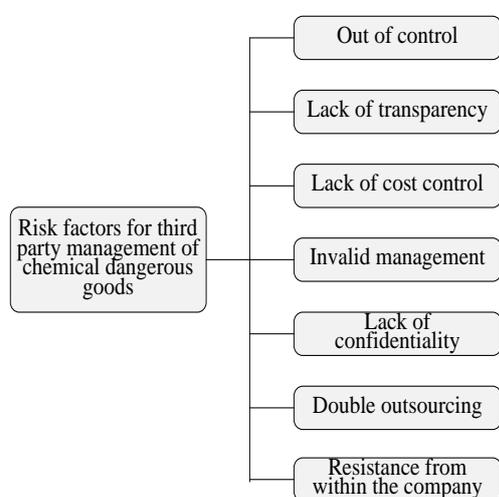


Figure 3: Risk factors for third party administration of dangerous chemicals

Therefore, in order to reduce the risks and losses brought by third-party administration to enterprises, it is necessary to realize collaborative supervision of the enterprise and the third-party administrator for dangerous chemicals.

### 3. Research on collaborative supervision methods of third-party administrator for dangerous chemicals

#### 3.1 Supervision and performance evaluation of third-party administrator for dangerous chemicals

Scientific and rational performance evaluation of third-party administrator for dangerous chemicals can find problems existing in management and timely rectify them, which is very beneficial to both the enterprises and the third-party administrators.

At present, the balanced scorecard (BSC) and the key performance indicator (KPI) are two kinds of performance management methods commonly used in management. BSC (Sargent, 1991) measures the overall goal of the enterprise through four different dimensional indicators with obvious logical relationship and causality. The four dimensions include finance, client, internal business process and learning and growing. While KPI (Vapen et al., 2016) analyzes the main performance indicators that affect the overall goal of the company, but there is a lack of logical relationship between these indicators. To explore excellent performance evaluation method, this paper takes Jinan Refinery as an example to list the four different dimensions of BSC as the main controlling factors of KPI. Different enterprises can divide key performance indicators into several levels according to their own conditions. Table 1 shows the BSC-based KPI performance management evaluation indicator system.

Table 1: BSC-based KPI performance management indicator system

BSC performance dimension	KPI master factor	First level key performance	Second level key performance
Finance	Finance	KPI (1-1)	KPI (1-2)
Client	Client	KPI (2-1)	KPI (2-2)
Internal business process	Internal business process	KPI (3-1)	KPI (3-2)
Learning and growing	Learning and growing	KPI (4-1)	KPI (4-2)

Table 2 shows the designed third-party administration service performance balance scorecard for dangerous chemicals by taking the oil chemicals in dangerous chemicals commonly used in Jinan Refinery as an example.

Table 2: Oil chemicals administration service performance balanced scorecard

KPI	Countermeasures	Control element	Measure
Customer goal	lower the cost	1. Yuan / ton	Strengthen daily management
		2. Filtration cost	Control filter cloth consumption
		3. Oil processing	Control waste oil treatment costs and emissions
		4. Oil concentration control	Control oil consumption
Client needs	Maximize value in business	Comprehensive improvement to reduce costs	Control overall cost
	Maximize value in third-party administrators	Share value with the company	Assigned to 50% of cost savings concentration
	Create value for the company through optimal control of the oil	1. Concentration of SPC 2. Saponification value of SPC 3. Iron content SPC 4. ESI SPC	Saponification value Iron content ESI
Internal process monitoring	Product evaluation	1. Oil improvement 2. Reduce the dependence of oil management on people Quarterly inspection In stock	Choose the right oil Standardized operation Satisfaction level Minimum inventory
		Safety and environmental protection	Actual value / standard value Regular review
Learning and growing	Technology Exchange	Enterprise requirements for third-party administrators	Monthly written report
	Defect resolution	Various defect analysis	Personnel learning training

### 3.2 Risk factors and control measures of third-party administrators for dangerous chemicals

Although third-party management of dangerous chemicals can achieve a win-win situation for both the enterprises and the third-party administrators, due to the existence of many uncertain risk factors, it may also cause huge losses to both parties. Therefore, for the risk factors existing in the third-party administration of dangerous chemicals, both parties should perform collaborative supervision and prevention, determine key risks, and take measures to reduce the negative consequences brought by key risks.

#### (1) Risk assessment of third-party administration of chemicals based on risk matrix

The risk matrix method (Lam et al., 1994) is to analyze the project to assess whether the project has risks, the probability of occurrence of risks and its potential impact on the enterprise. This paper introduces the risk matrix into the third-party administration of chemicals, which divides the risks that may occur into five degrees and defines them as critical, severe, general, minor, and ignorable. The risk levels are divided into three levels of high, medium and low. We invited industry experts to evaluate the probability of risk, and finally designed the third-party administration risk level comparison table as shown in Table 3 (Wolf and Nowak, 1995).

Table 3: Third-party management risk level comparison table

Risk probability	Risk impact				
	Ignorable	Minor	General	Severe	Critical
91~100%	Medium	High	High	High	High
61~90%	Medium	Medium	Medium	Medium	High
41~60%	Low	Medium	Medium	Medium	High
11~40%	Low	Low	Medium	Medium	High
0~10%	Low	Low	Low	Medium	Medium

In order to further distinguish the most critical risks, Borda sequence value method is introduced to rank the importance of the risks. The calculation method is shown as Formula (3) (Mont et al., 2010).

$$b_i = \sum (M - r_{ik})$$

(3)

Taking Jinan refinery's third-party administration of dangerous chemicals as an example, this paper evaluates the risk levels according to the proposed risk assessment method in this paper. From Table 4 we can see that the top three risks of the company's third-party administration are: lack of transparency, lack of confidentiality, and resistance from within the company.

Table 4: Chemical dangerous goods third party management risk matrix

Risk	Risk impact	Probability of risk	Level of risk	Borda
Resistance from within the company	Critical	91~100%	High	2
Lack of transparency	Critical	41~60%	High	0
Lack of confidentiality	General	61~90%	Medium	1
Double outsourcing	General	0~10%	Low	6
Lack of cost control	Severe	41~60%	Medium	2
Invalid management	Severe	11~40%	Medium	5
out of control	Critical	0~10%	Medium	4

#### (2) Risk control measures of the third-party administration for dangerous chemicals

According to the previous experience of the third-party administration for dangerous chemicals, combined with the results of risk assessment and the actual situation of enterprises, enterprises and third-party administrators should take the following measures to control the occurrence of risks (Stoughton and Votta, 2003): (1) When selecting a third-party administrator, the enterprise should review its management capabilities and qualifications, and sign a formal service agreement and confidentiality contract with the administrator. (2) Enterprise and third-party administrator should carry out relevant education and training for staffs who involved in the implementation of the third-party administration. (3) Enterprise should establish a special leading organization to promote to the staffs of the importance of third-party administration to the development of the enterprise, so as to avoid causing panic and dissatisfaction among employees or affecting the implementation of third-party administration.

## 4. Conclusion

The third-party administration mode is a double-edged sword. Although it can reduce costs and improve the competitiveness of enterprises, improper management would cause huge losses to enterprises. This paper studied the collaborative supervision methods of third-party administrators for dangerous chemicals. The conclusions are as follows:

- (1) This paper established a BSC-based KPI third-party performance administration evaluation indicator system, and designed the third-party administration service performance balance scorecard for dangerous chemicals by taking the oil chemicals of Jinan Refinery as an example.
- (2) This paper introduced the risk matrix evaluation method and the Borda sequence value method to evaluate the risk factors of the enterprise.
- (3) By adopting the proposed risk assessment method, this paper evaluated the risks existing in the third-party administration of Jinan Refinery, and proposed corresponding improvement measures.

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