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Discussion on Safety Management System of Dangerous Chemicals Based on Analytic Hierarchy Process

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ABSTRACT. *With the development and application of science and technology, chemicals have become indispensable means of production and consumer goods in the current social and economic production. However, chemicals not only bring us good news, but also bring some physical, health and environmental hazards. In this process, for hazardous chemicals enterprises, it is urgent to solve how to standardize the construction of safety standardization and perfect the safety management system. The analytic hierarchy process is used to determine the weight of the evaluation index to the overall goal, and the evaluation matrix is constructed by expert evaluation. Finally, the fuzzy comprehensive evaluation method is applied to the safety evaluation of dangerous chemicals transportation enterprises, and the safety grade of dangerous chemicals transportation enterprises is obtained. Using 1 ~ 9 scale method to determine the weight of each level content index, it provides the basis for building the safety management system of hazardous chemicals.*

KEYWORDS: *Analytic hierarchy process; Hazardous chemicals; Safety management*

1. Introduction

With the increase of transportation volume of dangerous chemicals year by year, the number of operators, transport vehicles and employees in the transportation of dangerous chemicals is increasing year by year. There are great potential safety hazards in road transportation of dangerous chemicals, and transportation accidents often occur. Because there are many enterprises in the hazardous chemicals industry, involving a wide range of knowledge and contents, the safety management system of hazardous chemicals is not perfect, with many redundant contents and poor scientificity, which leads to poor training effect [1]. The accompanying traffic accidents of dangerous chemicals have attracted the attention of the world. The traffic accidents of dangerous chemicals have a great impact, many casualties, serious environmental hazards and great difficulty in rescue, which need multi-department joint disposal and seriously affect the safety of expressway

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operation.

Frequent accidents of dangerous chemicals have caused huge losses to people's lives and property and public property. People pay more and more attention to the transportation safety of dangerous chemicals [2]. In order to improve the safety of transportation of dangerous chemicals, the author establishes an index system that affects the operation safety of transportation enterprises of dangerous chemicals in combination with the factors of vehicles, personnel, environment and management, and evaluates the safety of transportation of dangerous chemicals by AHP and fuzzy comprehensive evaluation [3]. This paper intends to analyze the transportation of dangerous chemicals by chromatography, and evaluate and study the safety risks of dangerous chemicals in transportation operations, which has important practical significance.

2. Present situation and existing problems of hazardous chemicals management in China

Many government functional departments in China, such as quality and technical supervision, environmental protection, public security and transportation, have formulated relevant regulations and standards for the management of hazardous chemicals, resulting in the lack of authoritative classification standards recognized by multiple departments in the classification management of hazardous chemicals, which leads to the phenomenon of overlapping or blank supervision objects in various departments. The registration of hazardous chemicals lags behind, and the national database of hazardous chemicals and enterprises has not been established yet [4]. Lack of safety information on hazardous chemicals; A large number of chemicals and mixtures with unknown hazards are in urgent need of hazard identification and classification to determine their hazards. On the whole, enterprises unilaterally emphasize the maximization of their own benefits, and then the investment in safety production management is insufficient. Safety first is too formal to some extent, and has not yet been standardized and institutionalized.

The construction of emergency rescue system for hazardous chemical accidents in China started late, and the emergency rescue standard was weak. China's current laws and regulations on safety in production and Regulations on Safety Management of Chemical Dangerous Goods are mostly formulated under the planned economy system, and many details of them can no longer meet the development needs of market economy, resulting in some blind spots in safety supervision and management. These uncoordinated and even contradictory problems make law enforcers have no rules to follow, and enterprises are at a loss. On the whole, due to the heavy historical burden, its economic benefits are relatively low, the pace of updating production technology and equipment is slow, and the overall safety production capacity is insufficient.

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3. Application of analytic hierarchy process to the construction of hazardous chemicals safety management system

3.1 Establish a hierarchical structure model

The highest level of the model, i.e. the target level, represents the problems to be solved, that is, the total goal to be achieved by AHP. The decision-making goal of this paper is to build a safety management system for hazardous chemicals. The main idea of this method is to compare and judge the importance of every two indicators by decomposing the complex problem into several levels and factors, and to establish a judgment matrix. By calculating the maximum eigenvalue and the corresponding eigenvector of the judgment matrix, the weight of each indicator can be determined. By sequentially constructing hierarchical model, inputting judgment matrix data, collecting and inputting expert judgment data, Yaahp software calculates the ranking weight. Avoid duplication of management elements and clarify management priorities, so as to lay the foundation for improving the quality and efficiency of safety management [5].

The amount of dangerous chemicals transported depends on the approved load capacity of transport vehicles and the maximum load capacity specified by relevant enterprises or governments. In case of mixed transportation of multiple dangerous chemicals, the transportation volume should be less than the approved load capacity of transport vehicles and the maximum mixed load weight specified in transportation. If it is greater than the specified loading capacity, the transportation will be regarded as extremely dangerous and not transportable. The transportation quantity weight F_Q of hazardous chemicals conforms to the following expression [6].

$$F_Q = \sum_{i=1}^{r} \left(P \times M_i \right) (1)$$

In which P represents the relative weight of transportation modes of hazardous chemicals, M_i represents the transportation volume of the i th hazardous chemicals, and r represents the variety of goods transported.

The transport risk index R_I of hazardous chemicals is determined by the characteristics of hazardous chemicals and the loading capacity of hazardous chemicals, and its expression is as follows:

$$R_I == N \times F_Q (2)$$

For hazardous chemicals enterprises, it is necessary to define the scope and standard of risk assessment, clarify the management responsibilities and realize the scientific choice of safety assessment methods. When selecting the evaluation index, it should be as comprehensive as possible, and it should be focused. If too many

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indicators are considered too detailed, the weight of each indicator may be too small or even zero, so necessary screening is needed. The factors related to the transportation, collection and transportation of dangerous chemicals are divided into four categories: people, environment, management and dangerous chemicals. There are four evaluation methods in the scheme layer of this paper, so the final weight of the evaluation methods can also be used as the confidence of the evaluation results of each method. Corresponding to the specific contents related to dangerous chemicals knowledge training under the branch contents of the scheme layer.

3.2 Risk assessment index system

Safety evaluation is a vague concept, and its boundary is uncertain. Under the influence of the diversity of human thinking modes, different evaluators have different hobbies and focuses, and often come to different evaluation conclusions. In this process, the corresponding evaluation method needs to be simple and feasible, and can meet the needs of this type of enterprise security risk evaluation. At the same time, the government should invest funds and staff to carry out safety-related research such as basic safety research, accident investigation, inspection and testing. In the same group, according to the importance degree of each index, the discriminant matrix of each second-level index in the same group is obtained. Three basic index elements are put forward: hazardous chemicals, external environment and supervision of relevant personnel. Focusing on these factors, the risk assessment index system of hazardous chemicals transportation collection and transportation is established, which includes one first-level index, three second-level indexes and nine third-level indexes, as shown in Figure 1 [7].

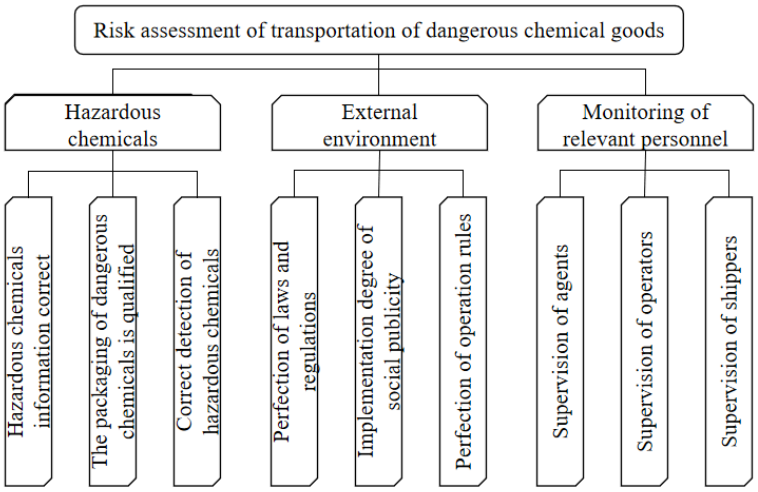

Figure 1 Risk assessment index system of hazardous chemicals transportation collection and transportation

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3.3 Determination of index weight by analytic hierarchy process

Determining the weight of evaluation index is an important step to establish the whole safety evaluation system. In this paper, AHP is used to analyze and determine the weight of each evaluation index. Three experienced experts engaged in training in hazardous chemicals industry and related fields are invited to set the index weights of each layer. After discussion, the experts compare and assign values according to the scale method of 1 ~ 9. According to the set index weights, the corresponding judgment matrix is constructed, and the consistency test is carried out. If the CI value is greater than 0.1, the comparative value between the two indexes needs to be discussed again, and the consistency test is carried out again. If the CI value is less than 0.1, the matrix composed of the set index weights is relatively consistent and does not need to be modified.

The paired comparison matrix of each layer to each factor of the previous layer is constructed respectively, and the weight is calculated and the consistency test is carried out. Taking the safety management of hazardous chemicals as an example, the process is listed in Table 1.

Table 1 The weight of the layer to the target layer

Content	regulations related to hazardous chemicals and related technical standards and specifications	Safety technology of hazardous chemicals	Safety management of hazardous chemicals	On-site emergency treatment of hazardous chemicals accidents	Weight
Laws and regulations related to hazardous chemicals and related technical standards and specifications	2	1/6	1/6	1/6	0.0204
Safety technology of hazardous chemicals	6	1	2	1	0.3621
Safety management of hazardous chemicals	6	2	2	1	0.3368
On-site emergency treatment of hazardous chemicals accidents	6	1	2	1	0.2956

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Through the risk assessment of hazardous chemicals transportation, we can see that the packaging of hazardous chemicals is qualified and the supervision of shippers plays an important role in the transportation, which should be paid attention to [8]. In this process, under the basic requirements of regular inspection, it is necessary to realize the perfect development and implementation of the assessment work, and further strengthen the effectiveness of safety management by means of the implementation of the performance appraisal mechanism. Environmental protection, trade, public security, transportation, quality and technical supervision and other departments should strengthen ties, establish a comprehensive coordination mechanism, and realize the supervision and management of the whole process of hazardous chemicals from production, transportation to waste disposal.

3.4 Establishment of evaluation set

Evaluation set is a set of evaluation results made by evaluation objects, which can be expressed as $V=\{V_1,V_2,\cdots,V_m\}$, in which $V_j(j=1,2,\cdots,m)$ element is a number of possible evaluation results. The purpose of fuzzy comprehensive evaluation is to obtain the best evaluation result from the evaluation set V by comprehensively considering all the influencing factors of the evaluation object.

In this paper, the safety status of dangerous chemicals transportation enterprises is evaluated, and finally the safety target level of dangerous chemicals transportation is divided into five levels (see Table 2).

Table 2 Evaluation set of dangerous chemicals transportation target

Target score (out of 100)	Fuzzy evaluation language	Target evaluation grade	Goal evaluation set
≥90	Very safe	I	V = [Class I, Class II, Class III, Class IV, Class V]
90～80	Safety	II	
80～70	It's safe	III	
70～60	Unsafe	IV	
≤60	It's very unsafe	V	

Based on the uncertainty of risks, in order to effectively avoid and control risks, in the process of building this safety management system, risk identification and assessment should be implemented and operated as a separate system, so as to avoid unnecessary influence on the smooth operation of the whole system. At the same time, enterprises should independently and regularly assess the hazards of hazardous chemicals, find out problems in time and rectify potential safety hazards [9]. Strengthen communication, cooperation and coordination, establish a set of perfect emergency system for measurement, analysis, alarm and emergency measures, and timely and correctly implement on-site emergency rescue measures.

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4. Suggestions and measures

4.1 Establish an emergency rescue system for hazardous chemical accidents

It is necessary to build the main force of emergency rescue based on the fire brigade, and establish three emergency rescue teams through integration and reorganization. Secondly, it is necessary to establish a leadership mechanism. Establish a regional emergency rescue command center for hazardous chemicals, which is responsible for emergency rescue command, coordination and disposal of the construction of emergency rescue system for hazardous chemicals accidents within its jurisdiction. Relevant technical institutions may also be entrusted by the government and enterprises to carry out research on chemical safety and harmful evaluation of working conditions, and issue legally effective inspection and certification reports. Establish chemical classification benchmarks and improve the national database of hazardous chemicals and enterprises; Optimize and improve this management system to ensure that the long-term safety management mechanism system is built to realize the comprehensive avoidance and control of safety risks.

4.2 Strengthen education, training and management, and eliminate fatigue driving

We can adopt the combination of unblocking and blocking, strengthen inspection and law enforcement, seriously investigate and punish drivers for fatigue driving, and increase punishment to make drivers afraid to break the law. Packaging should have appropriate pads and adsorption materials; The weight specification and model of package shall meet the requirements of loading, unloading and handling; The appearance of the package shall have the specified package marks and labels. Integrating it with the safety management system can provide new ideas for the current hazardous chemicals enterprises to practice safety management. Relevant enterprises and government functional departments should improve the registration management system of hazardous chemicals, establish a regional statistical analysis information system and registration management database of hazardous chemicals, and monitor the dynamic situation of hazardous chemicals production, management, storage, use and abandonment in real time.

4.3 Strengthen the transportation management of hazardous chemicals

In order to better guide the healthy development of hazardous chemicals logistics industry, ensure the transportation safety of hazardous chemicals to the greatest extent, and reduce the probability of accidents of hazardous chemicals, we must do a good job in the transportation and storage management of hazardous chemicals. At the same time, for the rapid response and correct disposal of dangerous chemical accidents, the training of accident emergency disposal must be done well, including the general mobilization of the whole society. Strengthen the management of hazardous chemicals transport enterprises and vehicles, establish a normal

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cooperation and coordination mechanism between regulatory authorities, a seamless urban safety supervision platform and a cross-regional cooperation and supervision mechanism, and integrate China's hazardous chemicals safety supervision network to provide services for chemical management.

5. Conclusion

Using analytic hierarchy process to construct the safety management system of hazardous chemicals can eliminate the influence of subjective factors in the optimization process. The evaluation index system of highway transportation safety risk is established, and the weight of each index is determined by analytic hierarchy process (AHP), and two factors which have great influence on the transportation safety of highway dangerous chemicals are determined. For the training of hazardous chemicals knowledge, the analytic hierarchy process should be used throughout to make the whole training process systematic and scientific, which can effectively improve the efficiency and quality of training. Therefore, the corresponding preventive measures can be given according to the evaluation results, so as to move the safety barrier forward, which has important practical significance for improving the safety level of dangerous chemicals transportation.

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