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Study on the Evaluation Index of Logistics Safety of Hazardous Chemicals

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In recent years, with the rapid development of road transport, the leakage accidents of hazardous chemicals caused by road transport are also increasing, which seriously threaten people's lives and property safety. The establishment of safety management mechanism is an urgent mission for the government departments, and accurately and reasonably evaluate the safety status of hazardous chemicals road transport system is an important basic work for ensuring smooth operation of safety management mechanism. The hazardous chemicals road transport safety is taken as a complete system. From the scientific research achievements at home and abroad, through the statistics and analysis of the road transportation accidents of hazardous chemicals in the domestic industry, this paper summarizes and establishes the safety evaluation system of hazardous chemicals road transport, makes use of combination weighting method of entropy value method and expert method to obtain the weights of each index in the index system, adopts comprehensive index method to establish the road transport of hazardous chemicals safety evaluation model, and applied to the road transportation safety evaluation of hazardous chemicals in Liaoning province. In the safety evaluation of road transportation of hazardous chemicals in Liaoning province, according to the existing problems, starting from the actual situation of Liaoning Province, this paper puts forward several suggestions for how to improve the safety level of road transport of hazardous chemicals.

1. Introduction

With the rapid development of China's economy, the demand for the hazardous goods is growing, the number and classification of hazardous goods by road transport are also increasing. According to statistics, at present, China's hazardous chemicals market volume has reached more than ten thousand, each year about a million tons of hazardous goods needing to be transported by road. Because of the serious consequences caused by the road transport accidents of hazardous chemicals, many domestic and foreign experts, scholars and research institutes have actively explored and studied hazardous chemicals (Ansari, 2013). In view of the particularity and complexity of road transport of hazardous chemicals, single safety evaluation index cannot meet the safety requirements, needing to comprehensively analyze influence factors of road transport of hazardous chemicals safety, and form a set of objective and quantitative, comprehensive and systematic safety evaluation index system, providing reference and decision-making basis for state security legislation, enterprise safety production, and government supervision and management, so as to prevent and reduce the occurrence of accidents of hazardous chemicals.

By using the systematic method, referring to relevant research results at home and abroad, this paper analyzes the actual situation of road transport safety, carries out necessary reasoning and summary, establishes practical model and method, and applies to the practice, to evaluate the safety of road transport of hazardous chemicals in Liaoning Province, which has a certain theoretical significance and practical guidance in the improvement of the security situation of road transport of hazardous chemicals. The concrete research content has the following several points (Cunha, et al., 2015): (1) specifically analyze the research status and development trend of the safety evaluation of road transportation of hazardous chemicals at home and abroad. (2) find out the characteristics and influencing factors of hazardous chemicals transportation safety itself and analyze; with reference to the relevant national laws and regulations and standards, determine the safety evaluation of road transportation of hazardous chemicals, so as to construct the evaluation index

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system of road transportation safety of hazardous chemicals, and improve the evaluation index system. (3) use the combined weighting method entropy value method and expert method to obtain the weight of each index in the index system, adopt comprehensive index method to establish a safety evaluation model of road transportation of hazardous chemicals. (4) apply the theory and model of road transport of hazardous chemicals safety evaluation for empirical evaluation of Liaoning province road transport of hazardous chemicals, thus drawing the conclusion that the established evaluation index system can effectively evaluate the safety of road transport of hazardous chemicals.

2. Construction of evaluation index system of logistics safety of hazardous chemicals

2.1 Principles of constructing safety evaluation index system

The research object of the safety evaluation of road transportation of hazardous chemicals includes many aspects, mainly involving in people, machines, environment, management and so on. It is very important to establish a reasonable and scientific evaluation index system of safety management. It can effectively improve the safety management level of the road transport of hazardous chemicals by evaluation, and the traffic accidents will be reduced. Therefore, we must proceed from China's specific conditions, according to the national production safety regulations and relevant technical standards, take a serious and responsible spirit, make the road transport of hazardous chemicals safety evaluation comprehensively, carefully and deeply, and adhere to the principle of the policy nature, scientific nature, systematic nature, operability, and highlighting.

(1) Policy nature

In setting up the index system, it is supposed to base on our country's safety laws and policies, which helps guiding transportation enterprises adhere to the principle of "safety first, prevention importance" through the evaluation, and strictly implement regulations of safe production od departments.

(2) Scientific nature

When the safety evaluation index system of road transportation of hazardous chemicals is established, the objective reality and the essence of the things must be correctly reflected. Only the adherence to the scientific principles can control the occurrence and development of major casualty accidents, and play a good role in preventing of major injuries and deaths.

(3) Systematic nature

The safety evaluation system of road transportation of hazardous chemicals is a very complicated system, which is related to each other and affects each other (Min, 2013):

Correlation - should fully consider the correlation between indicators, avoid the containing relationship between indicators, so as to eliminate the tendency of the evaluation results caused by correlation between indicators. Consistency - name determination method of evaluation index, evaluation standard and so on should be consistent with the relevant standards and industry standards, easy to be understood and operated.

Comparability - when selecting indicators, it is required to ensure the same trend so that the road transport of hazardous chemicals have comparability in all aspects of performance in the transverse and longitudinal level.

(4) Operability

It should be not difficult to collect the information that indicator quantification required, and it can be solved with the existing methods and models, so the evaluation process and the workload is not too heavy. Ensure the completion of clear, structured, simple and practical evaluation system, so as to successfully carry out the work of evaluation.

(5) Highlighting

In the selection of indicators, it requires not only to be comprehensive, but also has the primary and secondary points. The direct cause of the accident should not only be fully considered, but also carefully consider in the selection of management indicators. Only by adhering to the principle of highlighting can the evaluation work be carried out smoothly.

2.2 Primary election method of evaluation index system

The basic methods of evaluation index selection include two kinds, expert consultation and evaluation method and principal component factor analysis method. Among them, the first method usually adopts expert consultation method first of all to study the evaluation target, understand the content that the relevant evaluation involved in, fully analyze the selection of some evaluation indicators, determine the alternative indicators, make a choice through the expert groups, considering the opinions and suggestions of experts, and at last select the final index element set. There are many advantages of this method, and the most important is that the content relates to the selected indicators is more comprehensive, which can reflect the evaluated target as much as possible (Poechlauer, et al., 2012). Whereas, there are also some shortcomings, too depending on the opinions of experts group in the choice of indicators, making subjectivity become the major defect in the choice of indicators. The principal component factor analysis is a method based on the theory of linear algebra, which is to transform a large number of indicators, making them become several independent

indicators. These indicators remove the original defects of each single index, through the linear combination to form comprehensive index. The integration of various indicators into an organic whole is its unique advantage, thus the comprehensive effectiveness of the indicators can be effectively reflected. But there are obvious shortcomings, that is, to a large extent, depending on the data. Through the full analysis of factors affecting road transport safety of hazardous chemicals, and by reference to evaluation of other organization and management system model, adopt the opinions of the experts and scholars in the industry to carry out the preliminary selection of the evaluation index system.

2.3 Process of constructing safety evaluation index system

The premise and foundation to carry out safety evaluation is to establish the evaluation index system. The choice of indicators and the classification of indicator level can affect the evaluation results to a large extent. For more reasonable and procedured establishment of evaluation index system, this paper determines the index system according to the process shown, e.g. Figure 1.

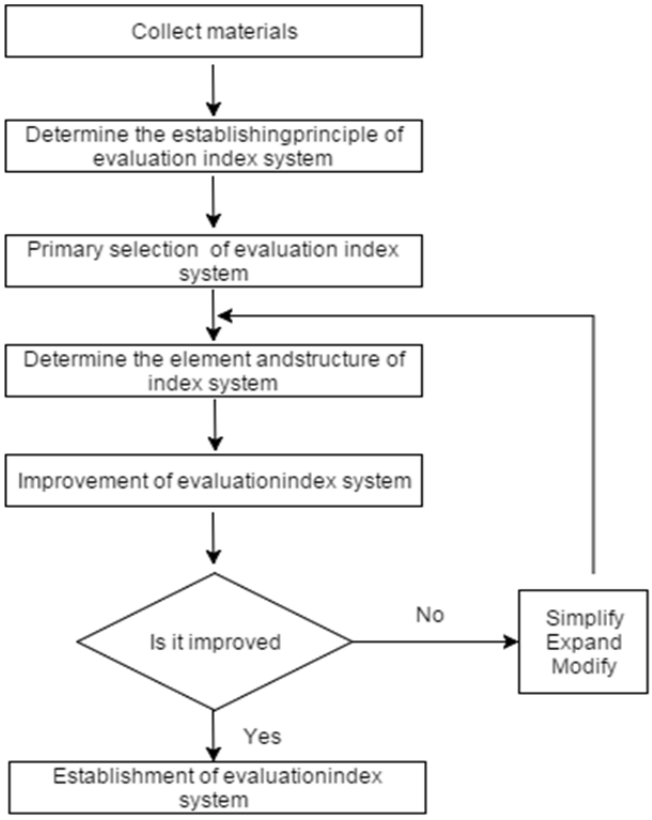

Figure 1: The process of establishing the index system for the safety evaluation of road transportation of hazardous chemicals

2.4 Structure of evaluation index system

In accordance with the principles of constructing a safety evaluation index system, the safety evaluation index system of the road transport of hazardous chemicals includes two parts, one is the accident index and the other is the hidden danger index. The safety evaluation index made according to the frequency, nature and consequences of the accidents is the index of the accident. Taking the accident index as the system safety evaluation index can effectively control the occurrence of accidents and reduce the severity of the accident consequences.

From the whole of the system, the safety evaluation index of personnel, vehicles, environment and management is the hidden danger index. The hidden danger index is to measure the system risk factors, which plays a proactive role.

The accident index and the hidden danger index complement each other, which fully examines the safety performance of the road transport system of hazardous chemicals in a certain period of time, but also considers the hidden dangers existing in the system elements, thus playing a role of avoidance of one

sidedness in a separate category index evaluation, to comprehensively and correctly reflect the security state of the system.

After determining the basic structure of the index system, the synthesis method of the indicators at all levels is determined. But this is achieved based on the characteristics of system security and that of index system. Synthetic methods can be used for safety comprehensive evaluation mainly include multiplicative synthesis, additive synthesis, addition and multiplication method and so on (Shi, et al., 2012). The necessary conditions of the accident are hidden danger, and hidden index and accident index in essence are interrelated, but they also reflect the overall level of safety system from different aspects. In this sense, the relationship between the accident index and hidden danger index is independent mutually, thus the use of additive synthesis is a synthesis method.

Hidden danger indicators include vehicle safety evaluation index, personnel safety evaluation index, safety management evaluation index, and environmental safety evaluation index these four parts. According to the statistics analysis of accident, it is seen that personnel, vehicles and environment are the direct causes of the accident, making influence on system security from different aspects. Available management appears to be the indirect cause of additive synthesis, but it is the essence from the root. As a result, it can be said that the safety management evaluation index makes influences on other three evaluation indexes at the same time. In summary, the establishment of the safety evaluation index system of road transportation of hazardous chemicals is shown, e.g. Figure 2.

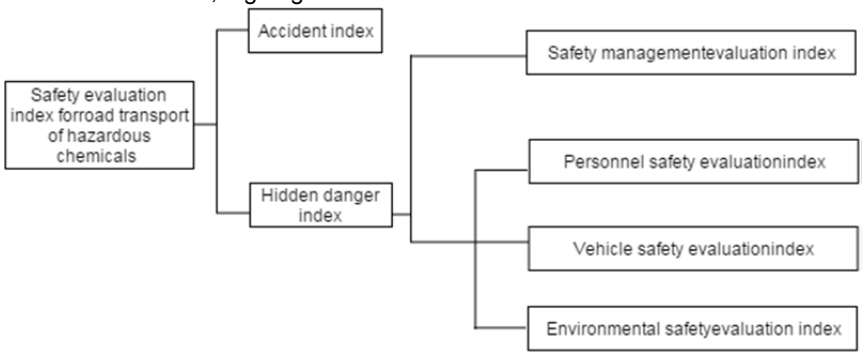

Figure 2: Safety evaluation index system for road transportation of hazardous chemicals

3. Establishment of safety evaluation model for road transportation of hazardous chemicals

The first step is to determine the evaluation index. Compare the actual value of the evaluation index and the index value, namely the standard value. After the data normalization processing, a series of non-dimensional index can be obtained. The second step is to determine the weight of the evaluation index. The non-dimensional index and the index weight of the first step are weighted and averaged, and then the comprehensive evaluation index is obtained (Terzic, et al., 2015). Finally, the composite index is divided into several grades according to certain interval, whose computational model is shown as follows.

$$DRS = \sum_{i=1}^{m} W_i^0 R_i \tag{1}$$

In the Eq (1), DRS indicates safety comprehensive evaluation index for road transport of hazardous chemicals; W_i^0 is the weight of number i index; R_i is the dimensionless index of number i index; i suggests the number of sub-system.

This method usually requires the establishment of the evaluation function curve of each factor. The first step is to determine the factor standard of each factor, then determine the upper and lower limit of the curve, which is determined by the value of upper and lower limit value.

In this paper, the safety status of road transport of hazardous chemicals is divided into five levels, as shown in Table 1.

Table 1: The safety status level of road transport of hazardous chemicals

Safety degree of road transportation of hazardous chemicals	0.0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0
Safety status level	The fifth level	The fourth level	The third level	The second level	The first level

4. Safety evaluation and analysis of road transportation of hazardous chemicals in Liaoning Province

4.1 Safety evaluation of road transportation of hazardous chemicals

There are two sources of data to be obtained, through the analysis or simple calculation of statistical data released. These data cannot be ignored, or the corresponding state level cannot be accurately reflected by the existing data, which can be obtained through investigation and expert judgment. When using this method to obtain the data, it is necessary to appropriately design the evaluation criteria and the grading experts, so as to provide guarantee for the scientific and reliability of the evaluation plan. In this paper, the qualitative indicators and quantitative indicators are selected. The basic data of these indicators are achieved through the statistical data published by the government of Liaoning province.

On the basis of determining the evaluation index system, the weight value of each index in the evaluation index system is determined by the combination weighting method. Set the weight of an index obtained by en entropy weight to W^1, and the weight obtained through expert method to W^2. W^0 refers to the combined weight of the index, R is the index value after non-dimension.

4.2 Analysis of road rransportation of hazardous chemicals

For comprehensive evaluation conclusion, according to the relevant statistical data of Liaoning Province, combined with the calculation method in this paper, the safety system of road transport of hazardous chemicals in Liaoning province is evaluated, and the safety comprehensive index is: DRS = 0.623, which belongs to the interval of [0.6, 0.8), so the road transport safety level of hazardous chemicals in Liaoning Province is the second level (Veenema, 2012).

Through the analysis of main effect indexes and evaluation results, it can find the main factors affecting road transport safety of hazardous chemicals in Liaoning Province, so as to find out the crux of the problem of road transport safety in Liaoning Province, providing basis for the formulation of strategies.

The road traffic facilities of Liaoning province are good, but the construction of traffic safety management facilities is lagging behind, and the road safety management in Liaoning province is relatively lax; although the level of hazardous chemicals transportation vehicles increased more than that in previous years, but the phenomenon of vehicles not up to the standard still exists; professional quality of staffs engaged in the transportation in Liaoning Province remained to be improved and the safety awareness remained to be strengthened; safety management of the transportation enterprises in Liaoning province of hazardous chemicals is weak, and a number of enterprises have not yet developed security plans or regulations, and the operation is not standardized; after the accident, the accident alarm information work cannot be paid attention to, thus lose the best opportunity for emergency rescue, directly leading to the expansion of the consequences of the accident.

4.3 Suggestions

Improve the traffic conditions, increase investment in road transport safety management facilities, accelerate the development of traffic monitoring equipment, improve road traffic monitoring equipment installed automatic rate, and ensure a good and safe environment for hazardous goods transport. Strengthen the safety training and assessment of the hazardous goods transport vehicle driving and personnel, improve their safety awareness and skill, regularly cooperate with safety supervision, public security, quality inspection departments to conduct safety inspections of the hazardous goods transport enterprises, focusing on monitoring whether the transport of hazardous goods transport enterpriser have business qualifications, whether employees are certified, whether tanker tank are regularly inspected, and obtain the test report and certificate of transport companies, whether practitioners are conducted with regular training and other items. Issue a rectification notice and review for the problems found in the inspection on the spot (Yao, et al., 2013). Prepare well for emergency rescue work, start from the establishment of production safety emergency rescue system, construct emergency rescue team, set up all kinds of rescue commandos, formulate emergency rescue plan according to the respective characteristics of each industry, and the industry department in charge establish emergency team records, form the network, and implement mutual aid and linkage.

5. Conclusion

Modern enterprises use more and more hazardous chemicals. Thus the safety assessment of hazardous chemicals has become more and more important. Safety evaluation can make the production process safe and preventive measures entire of hazardous chemicals of production enterprise safety management products, which is the prerequisite for the entry of hazardous chemicals into the social market. The establishment of safety evaluation index system is very important to the safety evaluation, and the rationality, the integrity and the conformity of the evaluation index system will make great contribution to the safety evaluation of the hazardous chemicals in our country.

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