Risk hierarchy analysis of international railway container transportation

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Abstract: The implementation of the "the Belt and Road" strategy has deepened the ex change of goods between countries and regions along the “Silk road economic belt”. Until April 2019, China launched more than 15,000 trains of the international container trains. Because there are many kinds of transportation goods, many transportation segment, the whole transport process has to face multiple risk threats. According to the "5M" theory, this paper constructs a trans- portation risk indicator system with 5 first-level indicators and 28 second-level indicators, app- licate AHP to calculate the weights of all indicators, selected 17 indicators. Using ISM, the risk hierarchy structure is determined and a three-level interpretative structure model is estab- lished. The first level is the surface factor, which including three indicators, if the surface risk factors are identified, it means that the entire transportation system is facing a serious risk crisis. The second level is the middle level factor, which including 11 indicators. The middle factors are risk factors for releasing the crisis signal which is usually closely related to the macro policy changes and the organizational capabilities and resilience of each link. The third level is the deep-seated factor, including three indicators, which requires risk managers to take counter- measures of risk warning and prevention.

1. Introduction
With the expansion of the "the Belt and Road" initiative, the exchanges between countries and regions along "the Belt and Road" have been deepened. Since the opening of the international railway container transportation lines in 2011 to April 2019, more than 60 cities in China have opened international railway express trains, of which the number has exceeded 15,000. The transported cargo includes mechanical equipment, complete automobiles and spare parts, daily necessities, household appliances, tires, electronic products, luggage and stationery, agricultural products, integrated circuits and so on.

The international railway transportation spans the Asian-European continent, and there are many countries with many transportation links. The transportation process faces multiple risk threats. The risk factors from different channels have different impacts and influences on the whole process of transportation. However, there are complex causal logical relationships between these risk factors. In other words, the changes that occur during the transportation of cargo are a complex system process that is a combination of multiple risk variables. Therefore, under the premise of clarifying the basic relationship between various risk factors, this paper uses the explanatory structure model to analyze the multi-level hierarchical structure of international container freight transport risks, which is highly intuitive and can understand the risks at a glance through the hierarchical chart.
2. Literature review
Ma, X.L. et al. based on risk source analysis, establish an accident probability model based on the ordered Logit model and a diamond-based accident consequence evaluation model to obtain the comprehensive risk level of each section of the transportation route [1]. Wang, Z. et al. established a dynamic risk assessment model for dangerous cargo transportation on urban expressway, focusing on the impact of traffic flow parameters on the probability of dangerous cargo accidents and the quantity of population exposure [2]. Wu, J.Z. et al. analyzed the risk factors of road transportation of dangerous cargo, and uses fuzzy comprehensive evaluation method to establish a risk evaluation model to reflect the weak points of safety management [3]. Su, J.X. constructed a four-layer explanatory structure model to study the influencing factors of the inland river dry bulk shipping freight rate and the relationship between various factors [4]. Sadeh, Garkaz. analyzed the impact of various factors of medical services and hospitality services on perceived value, satisfaction and loyalty according to ISM [5]. Guo, D. et al. selected nine risk factors, constructed an explanatory structure model and analyzed the hierarchical relationship between the risk factors of fresh cold chain logistics [6]. Lei, K. et al. constructed a multi-level hierarchical analytical structure model to explore the structure and hierarchical relationship of risk factors in multimodal transport networks [7]. As can be seen from the above literature, using the ISM model to analyze the risk of container transportation is a relatively new attempt.

3. Screening risk evaluation indicators
4M theory pointed out that the occurrence of accidents is mainly related to four factors: human, environment, management and Facility equipment. Once an accident happens, it is a multi-faceted combination utility of the above four factors. However, the cargo on the international railway transportation transport has a wide variety, different structure and the required transport conditions. Therefore, the occurrence of transportation accidents is also highly correlated with the cargo factors. When considering the factors of transportation accidents, not only the four factors of human, environment, management, and Facility equipment should be considered, but also the nature of the cargo should be considered. Therefore, the cause of the accident is extended from "4M theory" to "5M theory".

![Causality diagram of international railway transportation accidents.](image)

*Fig.1* can be shown that:
- Changes in any of the five factors can cause an accident.
- The five factors are interrelated and unified. For example, an inappropriate behavior of a person may cause the vehicle to be in an unsafe state, increasing the probability of an accident;
external environmental factors may affect the safety status of the cargo, and may increase the probability of an accident and slow the speed of rescue.

Based on Fig.1, an international railway transportation risk evaluation indicators system with 5 first-level indicators and 28 second-level indicators can be constructed. We call this the “initial indicator system”. Although this indicator system comprehensively covers the factors affecting the risk of cargo transportation, too many indicators are not only easy to repeat, but also weaken the importance of important indicators, so it must be deleted.

We select AHP to conduct this research and carry out a questionnaire survey. The questionnaire was distributed to universities and research institutes, as well as middle and high-level personnel engaged in international freight transportation. The measures of questionnaire distribution mainly includes mailing questionnaires, field research, and intercept interviews. The scale of the importance of the indicator is judged to be 5 levels, that is, “very important”, “important”, “general”, “unimportant” and “very unimportant”, and their corresponding values are 5, 4, 3, 2, 1 respectively.

We distributed 46 questionnaires and collected 34 copies, of which 32 were valid questionnaires. Using spss 22.0, performed the Cronbach reliability analysis. The Cronbach coefficient value was 0.829, which was highly reliable.

Calculating questionnaire scores, making a risk evaluation score table, and constructing each element comparison matrix. This paper calculates the weight of each indicator and the consistency ratio of each element matrix by using the AHP. The calculation results are shown in the table1).

| First-level Indicators | Weights | Consistency ratios |
|------------------------|---------|--------------------|
| A₁ (Human factors)     | 0.3785  | 0.056              |
| A₂ (Facility equipment factors) | 0.1177 | 0.019              |
| A₃ (Environmental factors) | 0.2364 | 0.041              |
| A₄ (Management factors) | 0.2345 | 0.03               |
| A₅ (Cargo factors)     | 0.0737  | 0.0077             |

Figure 2. Second-level indicators weight.

By calculation, all indicators $CR \leq 0.1$, accord with the consistency test. Because the number of indicators below a certain criterion layer more than nine indexes, the critical point of the index weight can be taken as 0.1. Therefore, according to the index weight value of Fig.2, deleting the indicators.
with weights less than 0.1 and retaining the indicators with weights greater than 0.1 and screening out 17 indicators that avoid the risk concentration and index repeatability.

Table 2. Risk indicator screening result.

| Deleted risk indicators | age, technical query capability, line accessibility, the integrity of the monitoring and management system, employee training, vehicle routine management, coordinating and organizational capabilities, strength of financial support, sealing tightness of packaging, rehabilitation disposal capacity, packaging logo and logo comprehensive |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Retained risk indicators | physical quality, safety awareness, law awareness, business proficiency, station layout, reliability of loading and unloading machinery, transportation tools, information systems, economic environment, political environment, legal environment, natural environment, prevention management, rescue management, the nature of the goods, rationality of packaging |

4. Application of Interpretative Structural Model

4.1. Establish a binary relationship of risk indicators

Eight experts were invited to compare 17 risk indicators in pairs and analyze whether each indicator has a direct impact on other indicators. Usually $V$, $A$, $O$ are used to indicate the relationship between the factors, $V$ means that $S_i$ affects $S_j$, $A$ means that $S_i$ affects $S_j$; and $O$ means $S_i$ and $S_j$ do not affect each other.

Table 3. Binary relationship of risk indicators in international railway transportation.

| $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | $S_7$ | $S_8$ | $S_9$ | $S_{10}$ | $S_{11}$ | $S_{12}$ | $S_{13}$ |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 6     | 5     | 3     | 2     | 1     | 0     | 7     | 5     |

4.2. Establish adjacency matrix

The set of elements is defined as $S = \{S_i \mid i = 1, 2, \cdots, n\}$, and the matrix of the basic binary relationship between the elements in the set $S$ is the adjacency matrix $C = (c_{ij})_{mn}$. According to formula (1),
\[ C = \{c_{ij} | S, \bar{R}S_j = 1 \Rightarrow c_{ij} = 1, S, \bar{R}S_j = 0 \Rightarrow c_{ij} = 0, i, j = 1, 2, ..., n; i \neq j \} \quad (1) \]

"1" stands for relationship, and "0" stands for no relationship, establishing adjacency matrix \( C \) for risk factors of international railway cargo transportation.

\[
C = \begin{bmatrix}
S_1 & S_2 & S_3 & S_4 & S_5 & S_6 & S_7 & S_8 & S_9 & S_{10} & S_{11} & S_{12} & S_{13} & S_{14} & S_{15} & S_{16} & S_{17} \\
S_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
S_3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
S_4 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
S_5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
S_6 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_7 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_8 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_9 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{10} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{12} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{13} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{14} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{15} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{16} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{17} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\]

4.3. Solve reachable matrix

The reachable matrix is used to describe the extent to which a certain path can be reached between different nodes in a directed connection graph.

The reachable matrix \( Q \) is calculated according to the formula (2).

\[
Q = (C + I)^{-1} = (C + I)^{-1} \times (C + I)^{-1} \times \ldots \times (C + I), i = 1, 2, ..., n. \quad (2)
\]

\( I \) is a \( C \)-order unit matrix.

\[
Q = \begin{bmatrix}
S_1 & S_2 & S_3 & S_4 & S_5 & S_6 & S_7 & S_8 & S_9 & S_{10} & S_{11} & S_{12} & S_{13} & S_{14} & S_{15} & S_{16} & S_{17} \\
S_1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_2 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_3 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_4 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_5 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_6 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_7 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_8 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_9 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{10} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
S_{12} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
S_{13} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
S_{14} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
S_{15} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
S_{16} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
S_{17} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\]

4.4. Hierarchical division of influence factors

According to formulas (3), (4), (5), the reachable set \( R \), the premise set \( H \), and the common set \( G \) required for structural interpretation are filtered in the reachable matrix \( Q \), and then the hierarchical relationship of elements are decomposed according to the following process.

\[
R = R(S_i) = \{R(S_i) = \{S_i | q_{ij} = 1, j = 1, 2, ..., n\} | i = 1, 2, ..., n\} \quad (3)
\]

\[
H = H(S_i) = \{H(S_i) = \{S_i | q_{ij} = 1, i = 1, 2, ..., n\} | j = 1, 2, ..., n\} \quad (4)
\]

\[
G = G(S_i) = \{G(S_i) = R(S_i) \cap H(S_i) | i = j = 1, 2, ..., n\} \quad (5)
\]

- Take the intersection of \( R(S_i) \) and \( H(S_i) \) to get the highest level element set \( L_1 \), which is the termination set:
\[
L_{i} = \{ S_{i} | R(S_{K}) \cap H(S_{K}) = R(S_{K}) \} \quad K = 1, 2, \ldots, n, \quad i = 1, 2, \ldots, n
\] 

- The elements in the set \( L_{i} \) are eliminated in \( R(S_{i}) \) and \( H(S_{i}) \), and the set \( L_{2} \) is continuously searched in the remaining sets.
- This loops until you get the set \( L_{n} \) of the lowest level.

In this order, a collection of elements at each level is obtained:
\[
L_{1} = \{ S_{6}, S_{14}, S_{15} \} \\
L_{2} = \{ S_{2}, S_{3}, S_{7}, S_{8}, S_{9}, S_{11}, S_{12}, S_{13}, S_{16}, S_{17} \} \\
L_{3} = \{ S_{1}, S_{4}, S_{10} \}
\]

4.5. Determine the hierarchy diagram
According to the obtained various factor levels, the reachable matrix \( Q \) is reordered to obtain a standard form hierarchical structure matrix \( Q' \).

\[
Q' = \begin{bmatrix}
S_{6} & S_{4} & S_{10} & S_{3} & S_{2} & S_{8} & S_{1} & S_{12} & S_{5} & S_{9} & S_{11} & S_{13} & S_{16} & S_{17} & S_{1} & S_{4} & S_{10} \\
S_{6} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{4} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{10} & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{3} & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{2} & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{8} & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{1} & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{12} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{5} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{9} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{11} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
S_{13} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
S_{16} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
S_{17} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
S_{1} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
S_{4} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
S_{10} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\]

Remove the transfer relationship between elements in the standard form hierarchy matrix \( Q' \) and its relationship to obtain the level matrix \( Q^{*} \).

\[
Q^{*} = \begin{bmatrix}
S_{6} & S_{4} & S_{10} & S_{3} & S_{2} & S_{8} & S_{1} & S_{12} & S_{5} & S_{9} & S_{11} & S_{13} & S_{16} & S_{17} & S_{1} & S_{4} & S_{10} \\
S_{6} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{4} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{10} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{8} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{12} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{5} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{9} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{13} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{16} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{17} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{4} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
S_{10} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\]

4.6. Construction Interpretative Structural Model
The logical structure relationship between the various factors is clarified, and the explanatory structure model of each risk indicator is obtained, as shown in the Fig.3.
Figure 3. Hierarchical structure diagram of the risk

5. Conclusions

Fig. 3 shows that the hierarchical structure model of the correlation coupling of the factors of the international railway cargo transportation risk. Using ISM to analyze the hierarchical relationship of cargo transportation risk factors can help to clarify the complex relationship between risk factors.

The first level is the surface factor, including the station layout, prevention management and rescue management, directly acting on the operating system. If the surface risk factors are identified, it means that the entire transportation system is facing a serious risk crisis, and corrective measures must be taken immediately.

The second level is the middle factors, including the economic environment, policy environment, safety awareness, legal awareness, reliability of loading and unloading machinery, information systems, transportation vehicles, legal environment, packaging of goods, natural environment and the nature of goods, that indirectly act on the operating system. The middle factors are risk factors for releasing the crisis signal which is usually closely related to the macro policy changes and the organizational capabilities and resilience of each link. That is the key and difficult point to control the risk of the overall transportation system.

The third level is a deep factor, including political environment, physical quality and business proficiency. Risk managers need to continuously strengthen themselves and take countermeasures in the aspect of risk warning and prevention. The deep factors transmit energy through the middle layer to the surface layer under the stimulation of uncertainty and induce the risk crisis of the international railway transportation at different levels, it brings a lot of negative energy to the organizational operation. Therefore, international railway cargo transportation related enterprises need to do well in risk prevention and control measures at all levels to ensure the safe and efficient transportation of goods.

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References

[1] Ma, X.L., Liu, Y.J., Lu, J. (2018) Risk assessment of dangerous cargo transportation on urban roads, Chinese Journal of Safety Science (05): pp.179-184.
[2] Wang, Z., Tao, J., Wang, W.J. (2018) Dynamic risk assessment of dangerous cargo transportation on urban expressway, Journal of Chongqing Jiaotong University (Natural Science) (07): pp.6.
[3] Wu, J.Z., Fan, W.J. (2015) Research on risk assessment system for dangerous cargo road transport, Highway transportation technology (12): pp.6-11.
[4] Su, J.X. (2019) Research on influencing factors of Inland river dry bulk water transportation price based on explanatory structural model, Logistics Technology (05); pp.6-9.
[5] Sadeh, Garkaz. (2019) Interpretive structural modeling of quality factors in both medical and hospitality services in the medical tourism industry, Journal of Travel & Tourism Marketing, Taylor journal (02):pp.253-267.
[6] Guo, D., Pan, C.H., Lee, H.Y., Fu, M. (2018) Logistics risk factors of intelligent fresh cold chain based on ISM, Chinese Business Theory (32): pp.16-17.
[7] Lei, K., Zhu, X.N., Hou, J.F. (2015) Structural analysis of risk factors in multimodal transportation network based on ISM model, Journal of Safety & Environment (06): pp.162-165.