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Assessment on logistics warehouse fire risk based on analytic hierarchy process

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Abstract

In order to achieve a safe and speedy logistics, this article assessed the logistics warehouse fire risk. Firstly, based on the logistics warehouse fire accidents, the four aspects of the logistics warehouse fire risk were gained. Secondly, the model was designed to assess the logistics warehouse fire risk by means of expert investigation and using the method of AHP and fuzzy comprehensive assessment. The target layer of logistics warehouse fire risk assessment model is logistics warehouse fire risk. The criterion layers, which are 4 parts, are the warehouse building, goods, management, environment. The 14 index layers are associated with the secondary indicators. By consulting experts, the weight of each index was constructed. The assessment model is applied to evaluate and analyze the logistics warehouse fire risk. This model was exemplified in a logistics warehouse. The results show that the assessment methodology of logistics warehouse fire risk is reasonable, effective and feasible.

1. Introduction

Along with the development of our country socialist market economy, the logistics industry has developed rapidly. The rapid development of logistics expedites a batch of large scale, multifunctional, perfectly managerial, professional logistics warehouse[1-3]. This kind of logistics warehouse is not only different in the function, operation mode with the ordinary warehouse, but also characteristic in the fire character, the fire control facilities and fire safety management[4].

Currently, the research of logistics warehouse safety problems are generally goods damaged or lost, caused by human or technology error[5-6]. At present, the assessment methods of the logistics warehouse fire safety aren't enough. With the development of society and science technology, risk problems are becoming the problem which people must face. In this paper, it analyzes the logistics warehouse fire risk conditions, establishes its security assessment with the Analytic Hierarchy Process. To quantify professional's judgments with AHP improves the decision-making effectiveness and reliability.

2. Model of assessment of logistics warehouse fire risk

2.1. Comprehensive assessment factors

Based on the causes of logistics warehouse fire, the comprehensive assessment factors are shown in Fig.1.

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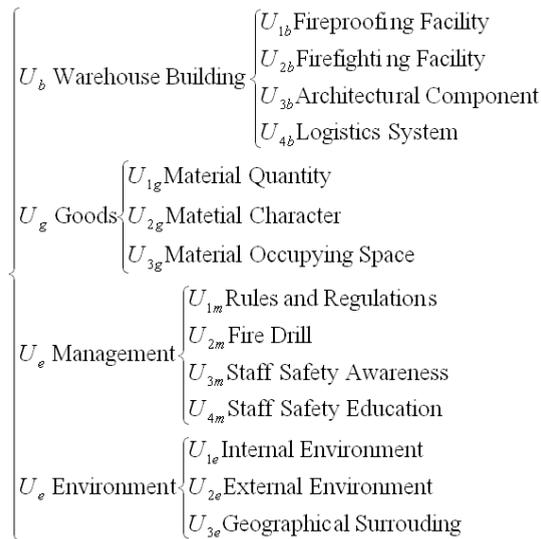*E-mail address:* renshaoyun@sohu.com

$$U_b \text{ Warehouse Building} \begin{cases} U_{1b}\text{Fireproofing Facility} \\ U_{2b}\text{Firefighting Facility} \\ U_{3b}\text{Architectural Component} \\ U_{4b}\text{Logistics System} \end{cases}$$

$$U_g \text{ Goods} \begin{cases} U_{1g}\text{Material Quantity} \\ U_{2g}\text{Matetial Character} \\ U_{3g}\text{Material Occupying Space} \end{cases}$$

$$U_e \text{ Management} \begin{cases} U_{1m}\text{Rules and Regulations} \\ U_{2m}\text{Fire Drill} \\ U_{3m}\text{Staff Safety Awareness} \\ U_{4m}\text{Staff Safety Education} \end{cases}$$

$$U_e \text{ Environment} \begin{cases} U_{1e}\text{Internal Environment} \\ U_{2e}\text{External Environment} \\ U_{3e}\text{Geographical Surrouding} \end{cases}$$

Fig. 1. Comprehensive assessment factors.

2.2. Comprehensive assessment judgments

Based on the characters of the logistics warehouse fire, each assessment factor of logistics warehouse fire risk is judged to belong to severe risk or moderate risk or low-grade risk. If one factor doesn't produce any risk, it belongs to no risk.

The comprehensive assessment judgment is shown in V.

$V\{V_1(\text{severe risk}), V_2(\text{moderate risk}), V_3(\text{low-grade risk}), V_4(\text{no risk})\}$

2.3. Single factor fuzzy assessment matrix

When the assessment object is warehouse building (U_b), four factors are used to establish a single factor assessment matrix $R_b = \{r_{ijb}\}$. Because of the fuzziness of U_{ib}, according to Delphi method, the degree of U_{ib} belongs to the comment V_j in the comprehensive assessment judgment. Then the judgment matrix is constructed[7]. For the statistical convenience, the subjection degree r_{ijb} is shown with the proportion of the experts who agree with this factor. By dealing with the expert's comments, a fuzzy judgment matrix can be gained.

In a similar way, when the assessment objects are respectively goods (U_g), management (U_m), and environment (U_e), the judgment matrix are respectively R_g, R_m and R_e.

2.4. Comprehensive judgment weights

In the assessment system, the weights should be exact and logical. This paper adopts AHP (Analytic Hierarchy Process)[8] to confirm the weights of indexes. When the factors are compared with each other, the methods shown in table 1 are used. In table 1, the factor i is compared with the factor j, and the result is written down as b_{ij}.

According to fig.1, the hierarchy structure is concluded (shown in table 2-6), and a comparison judgments matrix is constructed. Then the sum and product method[9] is used to count the eigenvector and the latent root of matrix, and the consistency of the matrix is tested. The eigenvector of judgment matrix accorded with the consistency test is the weight of each index.

2.4.1. Comprehensive judgment weights

By consulting experts, the judgment matrix of each index is constructed.

2.4.2 Consistency checking

Because of the complexity and diversity of the logistics warehouse fire safety assessment, the given judgment matrix can't keep complete consistency. So there is the need to check the consistency of the matrix. If the consistency ration