Application of Cloud Model in Operational Risk Assessment of Urban Rail Transit

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ABSTRACT

With the increasing flow of urban rail transit and the increasing scale of the road network, the operational risk of urban rail transit is also increasing. It had great significance to assess the operational safety of urban rail transit. In order to objectively evaluate the risk severity level of the urban rail transit, the author put forward a method based on combination weight and cloud model. Firstly, the risk severity evaluation index system was established. Secondly, the weight of the evaluation index was calculated by AHP method. Thirdly, the security evaluation method based on cloud model was given. Finally, the effectiveness of the method was illustrated by an example.

INTRODUCTION

Urban rail transit has the characteristics of energy saving, province, transportation, all-weather, pollution-free (or less pollution) and safety. It is a green environmental transportation system, which is the backbone of urban public transportation, especially suitable for large and medium-sized cities. With the increasing flow of urban rail transit and the increasing scale of the road network, the operational risk of urban rail transit is also increasing. It had great significance to assess the operational safety of urban rail transit.

This paper introduced the cloud model to evaluate the safety of urban rail operations. Firstly, the safety evaluation system of urban rail operation was

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established. Secondly, the method of calculating the weights of the evaluation system was introduced. Then, the security evaluation method based on cloud model was given. Finally, an example was given to show the effectiveness of the evaluation method.

**Urban rail operation safety assessment system**

There are many influence factors involved in the safety assessment of urban rail operations, and the impact of various factors are not the same degree. However, due to the restrictions of the technical level, it is difficult to consider all the influencing factors. Therefore, this article builds an urban rail operation safety evaluation index system in Figure 1. As we can see from figure 1, the system consists of three levels: target layer, project layer and indicator layer.

**SYSTEM WEIGHT CALCULATION**

AHP method is a simple, flexible and practical multi-criteria decision-making method for quantitative analysis of qualitative problems. Therefore, in this paper

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**Figure 1. Urban rail operation safety assessment system.**
AHP method were used to calculate the weight of the system weight. According to the results of expert evaluation to calculate the weight of each index, the specific process see the literature for details [1-3].

SECURITY ASSESSMENT METHOD BASED ON CLOUD MODEL

The main steps of the security assessment based on the cloud model are as follows: to determine the safety assessment level; to collect expert evaluation information and process the collected expert data; using the standard risk cloud generator to generate the standard cloud; generate the factor evaluation cloud and evaluate the various factors to obtain the weighted comprehensive evaluation cloud; the similarity calculation was performed for the standard cloud and the weighted comprehensive evaluation cloud. We took the standard cloud level with the highest similarity as the level of safety assessment.

INSTANCE VALIDATION

Take the fault of train operation control center failure of a railway bureau as an example to verify the effectiveness of the proposed method in this paper.

Establish S= {especially serious catastrophe, catastrophic accident, very serious accident, serious accident, light accident, very light accident, negligible accident}. 10 experts in railway safety were invited to evaluate the risk severity of track circuit communication failure in the train operation control center. The experts rated each evaluation attribute according to the standard of judgment criteria. The score was within the range of [0, 100], and 100 indicates the highest risk severity level, 0 indicates the lowest risk level.

Calculate the AHP weight and entropy weight, the result were [0.0553, 0.1175, 0.2622, 0.5650] and [0.0944, 0.1400, 0.3384, 0.4271]. Calculated the combined weight, and result was [0.0749, 0.1288, 0.300, 0.496].

[0, 100] was divided into 7 intervals: [0, 7.5] (negligible accident), [7.5, 20] (very light accident), [20, 37.5] (light accident) [37.5, 62.5] (serious accident), [62.5, 80] (very serious accident), [80, 92.5] (catastrophe accident), [92.5, 100] (especially serious catastrophe). Assume super entropy is 0.15: the negligible accident standard cloud C1(0,3.185,0.15), very light accident standard cloud C2(13.75,5.308,0.15), light accident standard cloud C3(28.75,7.431,0.15), serious accident standard cloud C4(50,10.62,0.15), very serious accident standard cloud C5(71.25,7.431,0.15), catastrophe accident standard cloud C6(86.25,5.308,0.15), especially serious catastrophe standard cloud C7(100,3.185,0.15). The cloud generator can be used to generate the evaluation criteria cloud in Figure 2. Calculate the comprehensive evaluation cloud, the result was (68.9,4.37,0.12).

Calculate the similarity between the comprehensive evaluation cloud and the standard cloud. The results was that the comprehensive evaluation cloud and the
very serious accident standard cloud has the biggest similarity. so the evaluation level results is a very serious accident. Draw the comprehensive evaluation cloud and the standard cloud as shown in Figure 3.

It can also be seen from Figure 3 that the comprehensive evaluation cloud and the very serious accident cloud has the highest similarity.

CONCLUSIONS

(1) This paper puts forward the evaluation model based on combination weight and cloud model to evaluate the risk severity of train operation control system.
(2) The example showed that the method can objectively reflects the risk severity of urban rail transit. It provided a more scientific method for the risk assessment and had a very good application value. At the same time, the assessment methods in this paper can also be applied to other risk assessment areas.

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