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Analysis of Transport Operation Situation of Express Railroad based on Improved TOPSIS Method

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Abstract: Currently, there is no relevant analysis method for the intelligent scheduling of high-speed rail for global traffic organization situation evaluation. Therefore, the study combines the original order preference technology that utilizes the similarity of ideal solutions with the grey correlation analysis method to construct a combination model and verify its effectiveness. The relative fit at 11:00 o'clock was the highest at 0.796. At this point, the values of indicators A, B, and C are all high, and the values of indicators D and E are both small, but there are trains that are 7.5 minutes late. 15: The evaluation result value of 30 is only 0.204. Overall, the range of evaluation results of the combined model was obtained at the peak of indicators D and E, indicating the correctness and effectiveness of the model, which can be effectively applied in the analysis of actual high-speed railway transportation organization situation.

Keywords: GCA-TOPSIS; High speed railway; Transportation organization situation; Evaluation level; Validity

1. Introduction

Accompanied by the improvement of the level of state science and technical and the gradual improvement of the railroad structure, the railroad traffic system also presents a prosperous situation. The organization of high-speed rail transportation continues to innovate, and the overall service level continues to improve [1,2]. As the actual high-speed rail transport system is relatively complex, timely and highly efficient mastery of the real situation of high-railway traffic, particularly the real situation of high-railway traffic management, is of great value to the regular functioning of the railroad system and the guarantee of traffic security [3]. Although existing research has made certain achievements in achieving intelligent scheduling and command of rail transit, there are still many important fundamental theoretical issues that need to be broken through. At present, the recognition and judgment of the organizational situation of high-speed rail transportation is of great significance for high-speed rail transportation organization, especially for dispatch and command. However, most of the researches are focused on train operation adjustment, and the research on the smart scheduling theory and method of express railways oriented to the evaluation of the whole bureau's transport tissue posture has not been reported yet. Based on this, the study proposes a real traffic behavior evaluation model for express railways by combining Grey correlation analysis (GCA) with the original Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS). GCA and the original Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) are combined to propose a model for evaluating the actual transportation organization posture of high-speed rail. The purpose is to grasp the actual working condition of express rail transit operation situation from a macroscopic point of view and expand the related contents, so as to provide theoretical support for guaranteeing the safety of express rail operation.

2. Construction of a TOPSIS based High-Speed Rail Transportation Organization Situation Evaluation Model

2.1. Analysis of the basic principles of situation evaluation methods

For the current overall momentum evaluation of traffic organization status of express train intelligent scheduling theory and related methods of research is still relatively small problem, the study improved TOPSIS and proposed an evaluation model for the actual transportation organization situation of high-speed rail based on it. TOPSIS method is a method of ranking a certain number of evaluations based on their similarity to the ideal target. The rationale is that by examining the evaluation objective's distress to the best and poorest alternative simultaneously, if the evaluation objective is nearest to the best possible solution but nearest to the poorest possible solution, then it is the best; and vice versa, it is not. However, in practical evaluation using the traditional TOPSIS me-

thod, if the actual closeness between two schemes and the ideal scheme is equal, it is difficult to rank them accordingly.

On the basis of fully mining the explicit and implicit information in limited data, GCA represents the correlation between relevant information from the changes and development trends of indicators. In the actual situation of high-speed rail transportation organization, it is mainly quantified through correlation analysis. However, it is undeniable that GCA simply analyzes the connection between the same indicator in each evaluated scenario and an ideal scenario, and its application in the analytical study of express train transit planning is prone to make the decision-making of multi-attribute deficient, which in turn affects the final analysis results. Therefore, by combining the two, it is theoretically expected to realize complementary advantages.

2.2. Construction of situation evaluation model

Simply using both TOPSIS and GCA methods can lead to low accuracy in actual situation analysis results. Therefore, the study combined the two to construct a GCA-TOPSIS model. The specific process of this model first involves constructing the corresponding initial evaluation matrix and constructing a standardized matrix. Secondly, to carry out powering processing on the normalized matrix after obtaining it, and calculate the matrix proper and ideal solutions after powering processing, as well as calculate the Euclidean distance from the positive and negative ideal solutions to the actual evaluation strategies. Next, the gray association matrix and gross association degree between the ideal matrix of positive and negative solutions and each strategy are calculated, and the Euclidean district and gray association degree obtained from the actual calculation are dimensionless accordingly. Then, the dimensionless Euclidean distance and grey correlation degree are merged to calculate the relative closeness of the research model. Finally, the actual size of the relative closeness is used to rank the advantages and disadvantages of the solutions.

After the completion of the structure of the assessment model of express train transit system, it is necessary to grade the actual evaluation results, consider the actual situation of high-speed rail in a certain province in eastern China, and combine the relative closeness value obtained from the model construction to classify the situation evaluation level. Among them, 0.2 is used as the gradient value in actual classification, which is divided into 5 levels, namely excellent (0.8-1.0), good (0.6-0.8), average (0.4-0.6), poor (0.2-0.4), and extremely poor (0-0.2).

3. Performance Analysis of Situation Evaluation Model

To verify the effectiveness of the constructed model, the study analyzed a high-speed railway line in a certain province in eastern China. The actual operating length of the line is 1070km, with a total of 17 stations, and the maximum allowable operating speed is 350km/h. The study period was selected from 9:00 am to 9:00 pm on October 15, 2022. At the same time, the analysis indicators in the experiment include benefit based and cost based, with the former including the probability of actual train operation on schedule, the actual reliability of high-speed train connection, and the actual recovery degree of train delay. The latter includes the total delay time of trains, the actual total number of delayed trains, and the maximum delay time of trains. The six indicators are represented by A~F, and the results are shown in Figure 1.

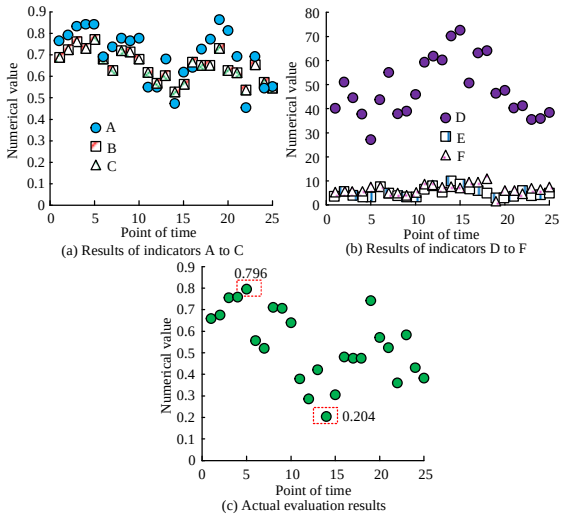

Figure 1. Evaluation results - index information analysis content

In Figure 1, 1-25 represent the time points from 9am to 9pm, with a time interval set at 30 minutes. From Figure 1, it can be seen that the highest and lowest results at 25 time points are 0.796 and 0.204 respectively. Overall, the transportation organization of the high-speed rail maintains a stable state, with the highest relative fit at 11am. At this time, the values of indicators A, B, and C are all high, and the values of indicators D and E are both small. However, there are trains that are 7.5 minutes late. In addition, the evaluation result value at 3:30 pm was only 0.204, at which point the value of indicator A was only 0.474, and the value of indicator B also reached the lowest value, which was 0.526. The overall evaluation results of the proposed model were obtained at the peak values of indicators D and E, which to some extent verifies the correctness of the model's results and also indicates the effectiveness of the research model.

4. Conclusion

In response to the lack of research on the intelligent scheduling theory and related methods for high-speed rail in the current global traffic organization situation evaluation, a GCA-TOPSIS model was constructed using a high-speed rail in a certain province in eastern China as an example, and its effectiveness was verified. The experimental results show that the highest result at 25 time points is 0.796, and at this time, the highest and lowest relative fit degree is 0.204. The total stability of the traffic pattern of the express train has been maintained. Overall, the evaluation results of the GCA-TOPSIS model are correct, indicating its high effectiveness. However, the study only analyzed the operation posture in the analyzing of high-speed train traffic tissue posture, and did not conduct the demand posture analysis, which can be added in the future to the analysis of visitors' traffic requirement posture.

5. Acknowledgment

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References

[1] Wang B., Ersoy A., van Bueren E., et al. Rules for the governance of transport and land use integration in high-speed railway station areas in China: the case of lanzhou. Urban Policy and Research. 2022, 40(2), 122-141.

[2] Esposito G., Terlizzi A., Crutzen N. Policy narratives and megaprojects: the case of the lyon-turin high-speed railway. Public Management Review. 2022, 24(1), 55-79.

[3] Cavallaro F., Bruzzone F., Nocera S. Effects of high-speed rail on regional accessibility. Transportation. 2023, 50(5), 1685-1721.