Evaluation Method of Public Transportation System Based on Fuzzy Cloud Model

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ABSTRACT

This article describes how the public traffic system evaluation is an important measure to strengthen the management of urban transportation. Many scholars have evaluated the public transportation system, but lack research on different index weights of it. In past models, although the fuzzy assessment method was integrated into an evaluation methodology, its randomness was reflected unclearly. To solve the problems, a fuzzy evaluation of a cloud model is researched. Firstly, the corresponding weights of all indexes are calculated by analytic hierarchy process (AHP) and a clustering method. Then, the principal component of the indexes is extracted by the principal component analysis. According to the distribution of a principal component and processed with the cloud model, a subordinate degree function was established. Finally, scoring cities by combining the principal component weight and membership cloud matrix and evaluating the public transportation system. Comparing the matter-element analysis and the AHP gray model method, this proposed model in this article can evaluate the performance of different urban traffic systems more practically.

KEYWORDS
Analytic Hierarchy Process, Cloud Model, K-Mean Value Cluster, Public Transportation System

INTRODUCTION

Public transportation system is bound up with various aspects of cities’ development, and it has a direct impact on people’s travelling. Moreover, public transportation system evaluation is the basis for designing the distribution of urban public transportation, and the evaluation is also an important guide for the development of cities’ transportation.

A method called fuzzy comprehensive evaluation based on DEA model (Fu & Jin, 2010), in which the fuzzy evaluation and data envelopment analysis was combined. Fu tried to indicate the fuzziness by fuzzy evaluation. As people judging the qualitative things. However, the accuracy of fuzzy evaluation’s discriminant function itself is contrary to human mind. Evaluation model of urban public transportation based on structural equation (Liu & You, 2013), which has made use of the data from a questionnaire to modify model. It has analyzed the relation and influence between the different indexes with strong explanatory, which can offer support for decision. However, it is obvious that questionnaires which use accurate figure to represent evaluation result fail to demonstrate the fuzzy evaluation as how we human beings judge the fuzzy things. Then, with the congestion intensity index acting as the breakthrough of high speed congestion (Lee J.,2014), the paper uses fuzzy logic to evaluate transportation system comprehensively, and the design has set up microscopic traffic flow

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model based on the control theory firstly. Research on congestion characteristics based on velocity distribution (Ko & Guensler, 2005) by statistical method of gauss mixture distribution has two kinds of traffic conditions: Identify congestion and non-congestion by, it has indicated the practical traffic application of this model. Then the current situation and trend of congestion in American cities has been introduced (Hallenbeck, 2005). In another literature, the cloud model is used to make the real-time judgment of the traffic jam (Gao & Xu, 2013), they have taken various factors into consideration and made use of the cloud model to evaluate different indexes, it failed to consider the concrete proportion of different indexes.

This paper firstly gains the proportions of the indexes by comprehensive evaluation and analysis based on analytic hierarchy process (AHP). Then, it extracts the index principal component and obtains the membership function by fuzzy evaluation. Thirdly, it absorbs the main idea of importing membership function into cloud to construct the non-uniform unilateral cloud model (Wei, 2005). Finally, the principal component of different cities is analyzed according to membership function to achieve evaluation result. The evaluation process is showed in Figure1:

SELECTION OF EVALUATION INDEX

The system of evaluation index in urban public transportation system should be representative, practical and measurable. This paper refers to the current situation of public transportation system in small and medium sized cities, in which the public transportation system evaluation index is distinguished into two kinds. According to the evaluation index level established in Figure 1, a hierarchical set of factors is founded = \{U_1', U_2\} and \(U_1 = \{U_{1r}, U_{1s}, U_{1t}, U_{1d}\}\), \(U_2 = \{U_{2r}, U_{2s}, U_{2t}, U_{2d}\}\) (\(U_1\): Wire mesh rationality index set; \(U_2\): Service level indicator set).

A. The Index to Evaluate Rationality of Wire Mesh Layout -- \(U_1\):
   1. **Wire Mesh Density**-- \(U_{1r}\) The length of the centerline of the road in the area of urban land per square kilometer.
   2. **Site Coverage**-- \(U_{1s}\) The ratio of bus station service area to urban used land area.
   3. **Non-Linear Coefficient**-- \(U_{1t}\) The ratio of the distance between the actual length of the bus line to the distance between the starting and ending sites.
   4. **Wire Mesh Repetition Coefficient**-- \(U_{1d}\) The ratio of total length of bus transit line to the total length of the center line of the road with buses.

B. The Index to Evaluate the Service Level of Public Transportation -- \(U_2\):
   1. **Operating Speed**-- \(U_{2r}\) The average value of the one-way travel speed of the operating line.
   2. **Average Transfer Coefficient**-- \(U_{2s}\) The ratio of bus passengers to the whole travelers.
   3. **Peak Load Rate**-- \(U_{2t}\) The ratio of the actual passenger capacity to the rated capacity of the vehicle during the peak period.
   4. **Bus Ownership Rate**-- \(U_{2d}\) The number of public buses per million people in the city.

ENSURE THE WEIGHT OF EVALUATION INDEX AND EXTRACT PRINCIPAL COMPONENTS BY AHP

**Determination of Weight of Evaluation Index**

This paper tries to ensure the weight coefficient of evaluation index, that is to make sure the comparative importance of each index and construct the judgment matrix \(A\), whose elements has the following property: \(a_{ij} > 0; a_{ii} = 1; a_{ji} = 1/a_{ij}\). In another word, after the calculation of the characteristic root, you can get the weight of each index.