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Study on Evaluation Index System of Urban Public Transport Development Level

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Abstract: ***This paper summarizes the principles and methods of establishing the comprehensive evaluation index system of urban public transport development level, and analyzes how to establish the evaluation index system by using the analytic hierarchy process. Then, using the fuzzy comprehensive evaluation method to develop the public transportation in Xi'an Shaanxi China, and to find out the shortcomings in the development process and to test the rationality and scientificity of the evaluation index system, and to provide support for the development of public transport in other cities.***

Keywords: public transport, development level, evaluation index system, fuzzy comprehensive evaluation

1. Introduction

Urban public transport is the key to urban modernization and an indispensable part of urban infrastructure construction. It is also an important link in building a harmonious society and improving the living standards of residents. Good public transport can curb the excessive development of individual traffic, effectively use road resources, protect the urban natural environment, and promote the sustainable development of urban social economy. Urban public transport has been widely used in major cities abroad, such as railways, subways and buses in cities such as London, Tokyo and Singapore. Urban residents who choose public transport travel account for more than two thirds of the total number of residents. Public transport Is the main tool for these urban transport, and the bus operating expenses are largely borne by the government.

Therefore, in the next 15-20 years, the structure and mode of city traffic in a critical period of great historical change, how to improve the share of public transport, public transport priority, will attract more residents to public transit way of traffic field. The analysis and evaluation of the existing level of urban public transport is the basic analysis technology, which is closely related to the planning and management of urban public transport system, and is the basic prerequisite for further promoting the development of urban public transport. The analysis and evaluation results of the correct, reasonable and reliable public transport development level can provide effective support and assistance for the planning, implementation, evaluation and improvement of urban public transport system.

2. The principle and method of establishing index system

2.1 Index Selection Principle

(1)Systematic principle

The selected indicators should reflect the characteristics and status of all aspects of urban public transport system development. Therefore, the systematic principle must be followed in the construction of the index system.

(2) Objectivity principle

The evaluation system should be objective and impartial, and the data source should be reliable.

(3) Scientific principle

Construction of the index system should have a scientific basis, the selection of indicators, data and weights are determined on the basis of scientific theory.

(4) Pragmatic principle

The establishment of urban public transport system evaluation index system is to help the city to identify the current development status, find problems, better provide guidance, so the data selection should be intuitive and simple to explain the problem.

(5) Comparable principle

The selection of indexes should be applied not only to the vertical comparison in different periods of the same city, but also to the horizontal comparison of different cities.

(6) Quantitative principle

Quantitative indicators can accurately and clearly reflect the problem, while facilitating the establishment of mathematical models, scientific calculations.

2.2 Method of Establishing the Index System

There are many aspects and contents in the evaluation of urban public transport. There are many factors to consider in choosing indexes. Therefore, it is difficult to describe the internal relations of indexes with a simple linear structure.

The AHP tree diagram is often used for the comprehensive evaluation of multi factors, the evaluation target classification according to the logical start down for several points on the target, and each target were spread down into sub goals, and so on, until the quantitative or qualitative analysis to check. The selected evaluation index is directly related to the target, and is hierarchical, and expands with the increase of the target.

Therefore, on the basis of clarifying the connotation and goal of the development level of public transportation, this paper makes a comparative analysis of the relevant indicators at home and abroad. Combining with the requirements of sustainable development of transportation and the development characteristics and current situation of local public transport, Screening effective indicators.

3. The Construction of Evaluation Index System

3.1 Selection of indicators

The elements of urban public transport system mainly include people, vehicles and roads. The system is very complicated. The system has as many as dozens of indicators. In this paper, through the research on the literatures after the discovery, because the national conditions are different, so the selected indicators have different emphases, but follow the unified the indicators selected in the principle of sustainable transportation strategy, therefore, the indicators are classified and analyzed, that evaluation system can reflect the overall development level from the construction of input level, operation service level, service level of comprehensive benefit.

3.1.1 Construction Investment Level

Infrastructure construction related to public transport is the basis of public transport development, and is an important manifestation of the development level of public transport. With a good infrastructure, we can play a high level of service. The index of line network includes several indexes, such as the density of line network, the coefficient of non linear and the repetition coefficient.

The density of public traffic network refers to the length of the road center line which has public transit lines on the urban land area per square kilometer, and the value reflects the extent of the residents' proximity to the bus routes. The non linear coefficient of the public traffic line is the ratio between the actual distance and the linear distance between the first and the last stations of the bus line, which reflects the degree of tortuosity of the bus line. The repetition coefficient of public transport lines is the ratio of total length of public transit to the length of line network, which reflects the density of bus lines on the main roads of the city. These indicators can explain the rationality of bus network structure, to a certain extent reflects the passengers on the bus convenience, comfort, but for the city road network shape, different criteria should be different.

Station construction indicators include site coverage, average parking, maintenance area, vehicle approach rate,

etc.. The bus station coverage rate is the percentage of the service area of the bus station to the urban land area, and it is also an important index to reflect the residents' proximity to the bus transportation level. The average parking and maintenance area is the total area of the parking lot and the maintenance area divided by the amount of vehicle ownership. The vehicle entry rate is the proportion of the total number of vehicles parked and the total number of public transport vehicles. These indicators reflect whether the construction scale of the bus station matches the vehicle and the room for further development.

Vehicle allocation index includes ten thousand people own the number of vehicles, vehicle update rate, integrity rate, ownership rate of high-end cars, etc. Ten thousand people have a standard unit, which means the number of bus vehicles owned by every ten thousand people in a certain space of a city. It is an important index to reflect the actual passenger transport capacity of the bus. The vehicle update rate, intact rate, high-end car ownership rate from different sides reflects the vehicle allocation situation, update rate reflects the bus input speed, the actual capacity of the intact rate, high-end car ownership rate reflects the model configuration, also from another side that the ride comfortably.

Bus priority measures indicators include harbor style bus stops, and the rate of priority section ratio, priority intersection ratio, these indicators are useful for examining the level of implementation of bus priority development, bus priority measures of the strategy.

The index of public transport investment plan is the annual infrastructure investment, reflecting the importance of the government and enterprises in the construction of public transport and the potential development of public transport in the future.

3.2.2 Operation Service Level

Closely related to public transit service level and satisfaction of residents of the bus, each index respectively from the operating conditions, safety, rapidity, comfort and punctuality in many aspects of the service level of public transit was evaluated at different levels, which is an important manifestation of public transportation development level and management level of the enterprise.

The operation status is mainly reflected by the total passenger volume, the operating vehicle, the vehicle to vehicle ratio and the mileage traveled. Traffic safety is reflected by safe travel intervals. Convenience indicators include bus travel ratio, transfer coefficient, average station distance, departure frequency and other basic characteristics of the bus operation index. Rapidity is reflected by travel time consumption and bus operation speed index. The punctuality rate of public transport is also another important aspect of bus service. Traffic punctuality is related to enterprise scheduling management, operation organization, road condition and so on. The higher the punctuality rate is , the higher the level of public transport development is. Comfort reflects mainly through the full peak and non peak rate, with the improvement of living standards, people have higher requirements on bus travel, which requires the crowded compartment cannot exceed a certain limit, in vehicle configuration such as air conditioning vehicle proportion and car service levels can reflect the degree of comfort.

3.2.3 Comprehensive Benefit Level

The comprehensive benefit level is generally described from the two aspects of economic benefits and social benefits, which is also an important part of the evaluation of public transport level.

However, due to the environmental protection and energy saving problem was mentioned several times, for the transportation system, energy consumption and environmental output is higher, so this paper adds the environment and energy consumption, reasonable control of energy consumption and environmental output is also very important.

The economy is very important as the power system of the sustainable development system, so the economic benefit of public transportation development level is very necessary, economic benefits mainly through thousands of kilometers, thousands of car passenger car cost income, operating vehicle car ratio and other indicators to reflect.

Public transportation is a public welfare undertaking, and

social benefit is an important aspect of measuring the development level of public transportation. Social benefit is closely related to social equity and people's livelihood security. Therefore, we can select the satisfaction degree of residents for bus and the benefit of travel time to reflect the social benefits of public transportation. A sustainable public transport system must be environmentally sustainable and low consumption, so this paper evaluates the use of waste emissions and fuel consumption as indicators of environmental and energy consumption.

3.2 The Construction of Evaluation Index System

On the basis of domestic and international research, combined with the above mentioned from the construction investment level, operation and service level and the overall efficiency of the three aspects of index selection, based on the goal and meaning of evaluation, the establishment of evaluation system for tower structure. As shown in figure 1.

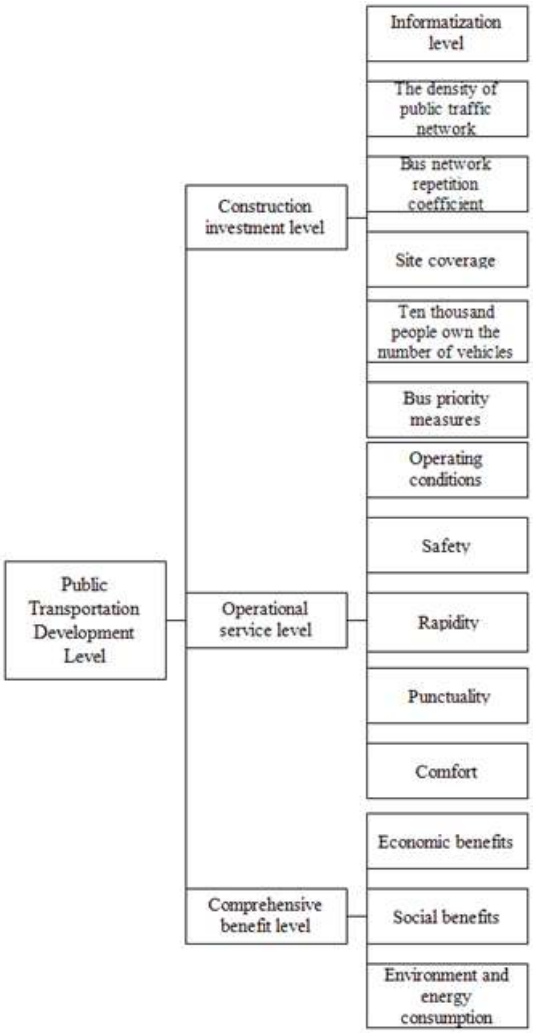

Figure 1: Evaluation System

1.fuzzy comprehensive evaluation of the development level of urban public transport system-taking Xi'an city as an example

In this paper, the evaluation index system is established by analytic hierarchy process (AHP), and then the fuzzy comprehensive evaluation method is used to evaluate the development level of public transport.

The first public transportation development level is divided into 5 grades (see Table 1), membership degree of each index by the corresponding rank, can use the fraction of Xi'an city public traffic system development directly, the results expressed in percent form.

Table 1: Public Transport Development Level Rating Table

Public transport system development level	Public transport development level score
Level 1	90-100
Level 2	80-90
Level 3	70-80
Level 4	60-70
Level 5	0-60

The data of 2016 public transport system in xi'an were collected and analyzed. The results were as follows:

(1) Comprehensive Evaluation Result

The comprehensive evaluation results of the development level of public transport in Xi'an are shown in figure 2. Analysis shows that the development level of public transport in Xi'an is three, belonging to medium level. Construction investment level and operational service level, two indicators score well, but the overall efficiency is poor, mainly due to poor social benefits, higher fuel consumption density.

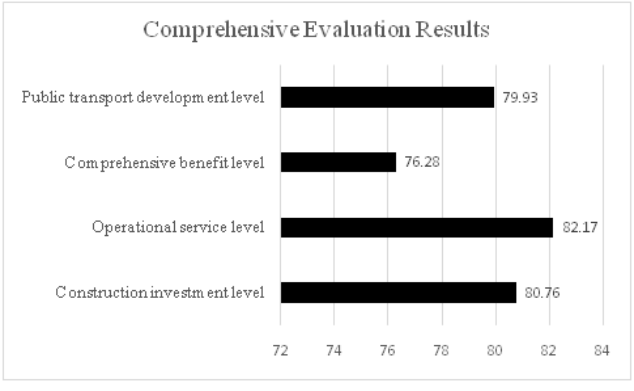

Figure 2: Comprehensive Evaluation Results

(2) Evaluation results of each layer index

The construction investment level, operation service level and comprehensive benefit level of Xi'an are evaluated respectively. The results are shown in figures 3, 4, and 5 below.

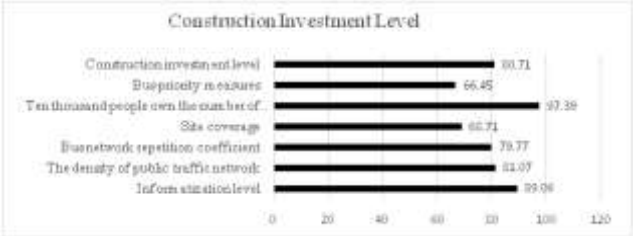

Figure 3: Construction Investment Level

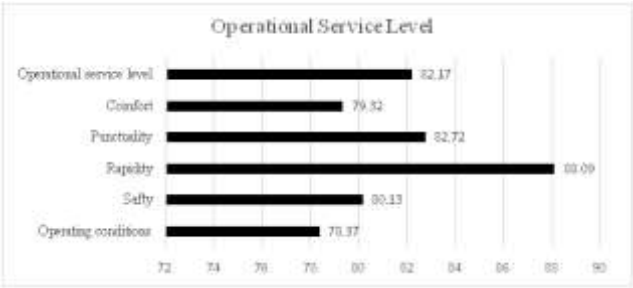

Figure 4: Operational Service Level

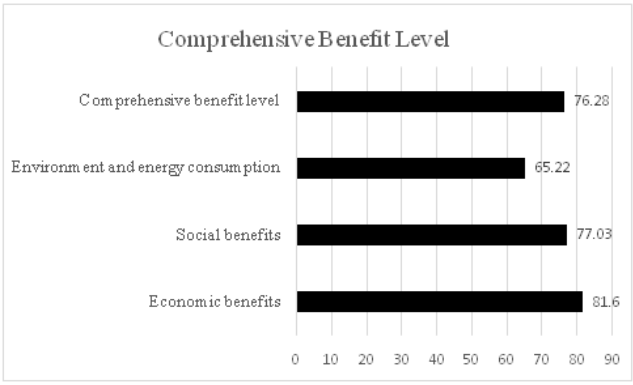

Figure 5: Comprehensive Benefit Level

The result shows that investment in the construction level of Xi'an city is 80.76 points, operation and service level of 82.17 points, is two levels, a good assessment, but can be seen from the chart, the construction investment, the bus priority measures for the development of investment is not enough, in the operation of the service level, operation and comfort the lower score, the need to improve. The comprehensive benefit level of Xi'an public transport system is 76.28, which is the three levels and the level is low. The main reason is that it is badly needed in the environment and energy consumption, so it needs to be strengthened. In addition, attention should be paid to the social benefits associated with passenger satisfaction.

4. Conclusions and Recommendations

According to the above evaluation process and results, this paper puts forward the following suggestions for the sustainable development of urban traffic in Xi'an:

1. To strengthen the government's investment in public transport, and adopt measures to ensure the priority development of public transport, so as to ensure the social fairness of the transportation system and highlight the social benefits of public transport.
2. Improving the service level of public transport, and giving priority to the development of public transport as the principle to improve the market share of public transport.
3. The development of urban public transport should be based on the protection of the environment and the reduction of energy consumption.

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