

## The social benefit analysis of the public bicycle

Tianjun Feng<sup>1, 2,a</sup>, Chunyan Liang<sup>1,b\*</sup>

<sup>1</sup>College of Traffic Science & Engineering, Jilin Jianzhu University, Changchun, 130118, China

<sup>2</sup>Transportation College, Jilin University, Changchun, 130022, China

<sup>a</sup>fengtianjun2009@sina.com, <sup>b</sup>lcy9716@sohu.com

\* Chunyan Liang

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**Abstract.** Public bicycle social benefits are complex and difficult to quantitative expression, the model of social benefit is established, and the factors of public bicycle social benefits and composition is expounded, and the fuzzy comprehensive evaluation method is used to evaluate the model, obtained the quantitative index of social benefit.

### Introduction

The public bicycle traffic construction is a national project, its goal is to realize the green environmental protection and unimpeded traffic, plays an important role in the whole city traffic. Public bicycle can replace walking in public transportation, light rail, subway ends, is connected to public transport, services for short distance transport and main application in scenic area. Development of public bicycle system, construction of public transit, bicycle transfer (B+R) and park and ride (P+R) combination mode of transport, is an extension of bus service, an improve of the city public traffic mobility and accessibility, prompting the car users to change travel mode, saving road resources, reduce environmental pollution, an important measure to alleviate the "travel difficult" problems<sup>[1,2]</sup>.

Apart from the user's point of view to consider the travel time, travel costs, and considering the operating costs and expenses from the operator's view, social benefits are considered from the social angle. Public transportation should undertake the business and social responsibility, through all the expected benefit comparison of various alternatives and all the current value of the expected cost assessment selected scheme, as a basis for decision making<sup>[3,4]</sup>. In China, Hangzhou public bicycle traffic system is successful, and its station can be seen in Fig.1.

### Social benefit connotations

Public bicycle is a human powered tool, its social benefit is to increase road capacity, reduce traffic congestion, reduce environmental pollution, improve the living environment of residents, improve business, communication convenience, and enhance social vitality to obtain benefits[5]. Social benefits and the state of economy conditions, social and cultural environment, the living standards of residents are linked. The Lyon bicycle station can be seen in Fig.2.

Social benefit analysis can determine the main effected project and distinguish the stakeholders, and evaluate the implementation effect before, in and after the project implementation. For the construction project benefit analysis, some scholars have done a lot of fruitful research<sup>6</sup>. Jenn-Rong Lin[7]set up the minimum cost model, trying to determine the location and number of rental point through the optimization of existing schemes, determine the connection path between the right bike rental point ; Tang Wenqian[8]compared the generated economic benefits, social benefits, environmental benefits and traffic benefits of public bicycle system, and given an example to make a simple analysis. Public bicycle users pursue different interests by the effect of applicable subject, so their goals are different. System builders, managers, users, the surrounding residents, ecological environment and the local government are the impact subject of public bicycle construction, use, management. From the point of view of different subjects can be affected by the traffic impact, public bicycle traffic benefit is divided

into traffic benefit, economic benefit and social benefit. The road traffic users pursue traffic benefits and road operators pursue economic benefits. Surrounding residents in the construction projects and local governments pursue social benefits. The social benefits include congestion benefits, energy benefits, environment benefits, the road resources benefits and social vitality benefits.



Fig.1 Hangzhou public bicycle station



Fig.2 Paris public bicycle station

Low carbon environmental protection effect is remarkable. According to statistics, Hangzhou public bicycle now, the daily average is 30 million passengers ride, people ride every time average by 15 minutes 3 kilometers from the calculation, monthly cumulative riding 90 million kilometers, to ride a bike instead of driving a car to travel, to city 100 kilometers consumption 10 liters of oil to calculate, the monthly saving fuel 9 million liters, calculated according to the international carbon emission targets, 1 liter of fuel = 2.3 kg "carbon dioxide", the public bike run monthly reducing emissions of carbon dioxide about 205 tons, a year can reduce carbon dioxide emissions of 2460 tons. Ease traffic congestion significantly. Public bicycle traffic can effectively ease the traffic congestion in our county. With the increase in the amount of cards, most people will choose to travel by bike; sharing traffic congestion will become more obvious role.

Reduce the cost of public travel. The public bicycle transportation system is a very successful project that can effectively reduce the cost of travel.

The popularization of the public bicycle system, gradually increasing, the proportion of the city, improve the overall image of the city.

### Social benefit models

Social benefit evaluation of public bicycle transport is mainly based on two points. First, there is the nature of change in the project selection and strategy, by the mere pursuit of material into economic, social, environmental comprehensive coordinated development, therefore, the traffic development, policy adjustment and evaluation of benefit should adapt to this change; Second, public bicycle transport is a quasi public product, its benefit is mainly reflected in the external social income, therefore research on social benefits of traffic project is conducive to the objective evaluation of the project.

#### 3.1 Traffic congestion benefits

Public bicycle mainly be caused by private cars, buses and other modes of transfer, and the travel efficiency of various modes of transportation has a big gap.

The congestion benefits of the public bicycle is a macro issues, involving many factors, and the concrete value of traffic congestion benefits are determined through expert scoring method.

#### 3.2 Energy benefits

Energy benefits are defined as public bicycle put into use to replace the other way that the benefits of reducing energy consumption.

$$B_{31} = L_2 \times G_2 \times V_{G2} + L_3 \times G_3 \times V_{G3} \quad (1)$$

$G_2$ 、 $G_3$  - Fuel consumption of the bus and the car unit mileage,  $L / km$  ;

$V_G$  -The unit fuel cost,  $yuan / L$  .

### 3.3 Environmental benefits

Environmental benefits means compared with other modes of transportation, public bicycle benefits than other modes of transportation to reduce exhaust emissions. Environmental benefits are mainly embodied in the exhaust governance cost savings. Environmental benefit model is as follows:

$$B_{32} = 365 \sum_{i=1}^k \left( \frac{N_{P2}}{N_b} \times m_{bi} \times l_{12} + \frac{N_{P2}}{N_c} \times m_{ci} \times l_{13} \right) \times C_i \quad (2)$$

$N_b$ 、 $N_c$ —The average passenger number of each bus and each car,  $yuan / vehicle$  ;

$m_{bi}$ 、 $m_{ci}$ —The quantity of pollutant  $i$  generated by bus and car respectively,  $L / km$  ;

$C_i$ —The cost pollutant  $i$  treatment,  $yuan / L$  .

### 3.4 Road resources benefits

After the implementation of public bicycle transport, increased capacity unit road, leaving road resources conservation and benefit. Public bicycle rental point is generally located in the street sidewalk and the open corner space, makes the traffic models the way crowds turned out passenger buses and cars, saves the occupation of the land area, the benefits are expressed as:

$$B_{33} = (A_b + A_c) \times P_s \quad (3)$$

$A_b$ —The occupied land area by bus,  $m^2$  ;

$A_c$ —The occupied land area by car,  $m^2$  ;

$P_s$ —City land opportunity cost,  $10000yuan / m^2$  .

### 3.5 City vitality benefits

The relationship between travel degree of convenience (including the distance, travel time, traffic mode, travel cost etc.) and travel time is related, when conditions are good, people will like to travel. Therefore, the addition of travel activity will make the exchanges more active, and promote social development and progress, and further enhance the vitality of the city. This benefit is very difficult to use quantitative indicators to measure, so expert scoring evaluation is usually adopted.

## The fuzzy comprehensive evaluation method

Fuzzy comprehensive evaluation method based on the membership degree of fuzzy mathematics theory to qualitative evaluation into quantitative evaluation, namely to have things or objects, many factors make an overall evaluation by fuzzy mathematics.

The fuzzy comprehensive evaluation method has the characteristics that the result is clear and the system is strong, it can solve the fuzzy, difficult to quantify the problem, solve for all non deterministic problem. The basic principle of fuzzy comprehensive evaluation is to first determine each factor set and evaluation the evaluation object set, and then determine the weight of each factor and the membership vector, determining the evaluation matrix, finally the evaluation matrix and weight vector of fuzzy arithmetic, normalization, and the final results evaluation.

The fuzzy comprehensive evaluation is based on fuzzy mathematics. The principle of fuzzy relation synthesis will be hard to be clear and not easy.

Quantitative factors, a method of comprehensive evaluation.

In the comprehensive evaluation of the campus environmental quality, the interaction of a large number of complex phenomena and many factors is involved, and there are a lot of fuzzy phenomena and fuzzy concepts in the evaluation.. Therefore, in the comprehensive evaluation, the method of fuzzy comprehensive evaluation is used for quantitative treatment, and the quality grade of the campus

environment is evaluated, and good results are obtained. But the weight of the need for expert knowledge and experience has a certain defect, for this, this paper uses the analytic hierarchy process to determine the weight of each indicator. It makes it more reasonable, more consistent with the objective reality and easy to quantitative, thus improving the accuracy of the results of fuzzy comprehensive evaluation. In addition, the fuzzy comprehensive evaluation of the large take the small algorithm, the information is lost a lot, often results are not easy to distinguish that the failure of the model.

So, this paper presents an improved model for fuzzy comprehensive evaluation. In addition, this paper makes an improvement on the principle of maximum membership degree, and puts forward the weighted average principle method when analyzing the results of fuzzy comprehensive evaluation.

The boundary of many things is not obvious, and it is difficult to be attributed to a certain category, so we have to single factor.

The evaluation is carried out and the comprehensive fuzzy evaluation is carried out to prevent the loss of any statistical information and information.

This can help to solve the problem of the objective reality from the objective reality caused by the deterministic evaluation of "yes" or "no".

## Summary

This paper provides some references for the planning and layout of the public bicycle system and provides some experiences and theoretical guidance for the implementation of public bicycle transport system of the government departments, so as to make reasonable financing scheme.

If you follow the "checklist" your paper will conform to the requirements of the publisher and facilitate a problem-free publication process.

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