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The Impact of Bike Sharing on Cities -- takes the Development of Shared Bicycles in New York City as an Example

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Abstract: The development of Shared bicycles has a strong impact on all aspects of the city. This paper takes the development of Shared bicycles in New York City as an example, and constructs different evaluation and prediction models by using descriptive analysis method, entropy method, MNL and other theories. By comprehensive use of MATLAB, SPSS, EXCEL and other software programming solutions, the influences of Shared bicycles on different aspects of urban economy, transportation, society and environment are obtained, and their weights are calculated through modeling. Quantitative evaluation paper Shared cycling influence on urban traffic, as well as relevant economic, social and environmental impact, this article first by using MATLAB software to get four factors after the normalization of data, by use of EXCEL to make trend diagram, entropy value method model quantitative calculation of the Shared cycling for transportation, economic, social and environmental impact weight, through the contrast analysis shows that Shared cycling influence on traffic, environment, society and economy are diminishing. The characteristic of this paper is using the mathematical statistics analysis method to analyze Shared cycling for the influence of the different aspects in different cities, and on the basis of the problem background and model problem processing, some suggestions are put forward for the development of Shared bicycle.

Keywords: Bike-sharing; Software application; New York city

1. Introduction

The rapid development of Internet technology and third-party payment technology provides a good opportunity for the development of Shared bicycle. The characteristics of Shared bikes are as follows: As a new form of sharing economy, bike-sharing provides recycling travel services for the vast consumer groups by integrating offline idle bikes and relying on Internet platforms (APP, qr code, etc.).Due to the sharing and cycling of Shared bikes, the industry can meet users' "last mile" travel needs at a lower cost, and its high degree of freedom and convenience maximizes users' utility. For example, OFO charges teachers and students 1 yuan/hour and 0.5 yuan/hour for using a bicycle, and they only need to acquire the decoding lock to use it, and then put it in the neighborhood[1]. Shared cycling through the rational allocation of resources, the digestion of bicycle industry overcapacity, the realization of the whole industry chain light capitalization and customer service network, in the maximization of utility allows users at the same time, also the sunset industry successful transformation for bicycle industry provides a feasible channel, so as to realize the ascension of the whole industry economic utility. Taking China's little blue car as an example, it not only makes different user groups accept differentiated prices, but also makes user groups not only limited to the original service objects and service scope (i.e., campus) by setting different prices for Shared bikes for teachers and students and non-teachers and students[2]. At present, bike-sharing has covered 35 cities in China, and expanded the market to third-tier cities by the end of 2016, expanding the depth and breadth of the market. In this paper, the development of cities bike-sharing system in New York City is modeled and analyzed, and some Suggestions are put forward.

Therefore, this paper quantitatively evaluate the impact of bike sharing on urban traffic, as well as the related economic, social and environmental impacts. Four indicators are selected, which are: the number of trips of Shared bicycle, the income of Shared bicycle industry, the number of maintenance of Shared bicycle, and the carbon emissions offset by Shared bicycle. The number of trips, the income of the bike sharing industry and the carbon emissions offset by bike sharing are used to reflect the impacts on transportation, economy, society and environment, respectively. In Shared cycling this indica-

tor, the number of maintenance due to the influence of Shared cycling to repair industries mainly reflects the transformation of identity, in the garage in a shared bike before the impression we get from car industry is the side of the road with car brand stores or the stalls, namely individual entrepreneurs, and share the bike, the bike company are a large number of recruitment car salesman, and the treatment given are not low[3]. Therefore, the influence of bicycle sharing on the vehicle repair industry creates employment opportunities in this aspect from a macro perspective, and improves the employment rate to a certain extent, which can basically reflect the impact on the society. In order to combine subjective factors with objective factors, entropy method is used to get the weights of each index. And use the multiplication normalization method to carry on the empowerment. At last, EXCEL and MATLAB software are used to quantify the problem.

2. The Establishment and Solution of the Bicycle Model

2.1. Model selection and data processing

Entropy method is a mathematical method used to judge the dispersion degree of an index. The greater the degree of dispersion, the greater the influence of the index on the comprehensive evaluation. In information theory, entropy is a measure of uncertainty. The more information there is, the less uncertainty there is and the less entropy there is[4]. The smaller the amount of information, the greater the uncertainty and the higher the entropy. According to the characteristics of entropy, we can judge the randomness and disorder degree of an event by calculating the entropy value, or we can judge the dispersion degree of an index by the entropy value. The greater the dispersion degree of the index, the greater the influence of the index on the comprehensive evaluation.

Therefore, the weight of each index can be calculated according to the variation degree of each index by using the tool of information entropy, which provides a basis for the comprehensive evaluation of multiple indexes[5].

Before modeling the problem, descriptive statistics of the processed New York City data can provide a clearer and complete view of the overall situation of the data. Figure 1 shows the trend of different modes of transport in recent years.

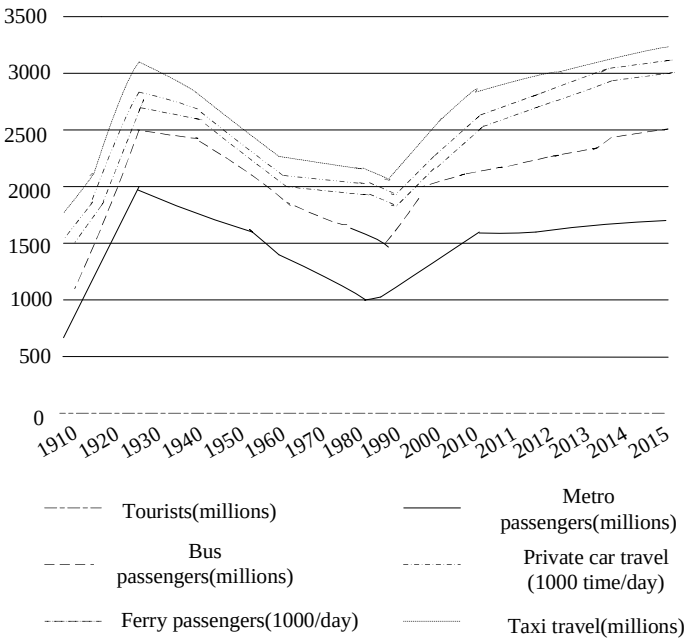

Figure 1. Change trend of different modes of transportation in recent years

2.2. Model establishment

Entropy method is an objective weighting method, which determines the weight of indicators according to the information provided by the observed values of various indicators. The greater the gap between the index value x_{ij} of an index x_j, and the larger the role of the index in the comprehensive evaluation is. If all the index values of an index are equal, the index has no effect in the comprehensive evaluation. The general model of the entropy method is:

Data matrix $= \begin{bmatrix} X11 & \mathbf{L} & X1m \\ \mathbb{M} & \mathbf{O} & \mathbb{M} \\ Xn1 & \mathbf{L} & Xnm \end{bmatrix}$, x_{ij} is the value of the j index of the i scheme

Non-negative data processing, because the entropy method is used to calculate the ratio of a certain index of each scheme to the sum of the same index value, there is no dimensional effect, do not need to be standardized processing, if there is a negative number in the data, the data need to be non-negative processing. In addition, in order to avoid the meaninglessness of logarithms in entropy calculation, data translation is required.

The efficiency index can be calculated by the formula(1)

$$x_{ij}^{'} = \frac{x_{ij} - \min\{x_{ij},...,x_{nj}\}}{\max\{x_{1j},...,x_{nj}\} - \min\{x_{1j},...,x_{nj}\}} \quad (1)$$

In the formula, i=1,2,…n ,j=1,2,…,m.

The cost type indicators can be calculated by the formula(2)

$$x_{ij}^{'} = \frac{\max\{x_{1j},...,x_{nj}\} - x_{ij}}{\max\{x_{1j},...,x_{nj}\} - \min\{x_{ij},...,x_{nj}\}} \quad (2)$$

In the formula, i=1,2,…n ,j=1,2,…,m.

For convenience, it is still recorded that the data after non-negation processing is x_{ij} to calculate the proportion of the i scheme in the index of item j :

$$p_{ij} - \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \quad (3)$$

Calculate the entropy value of the J Index:

$$e_j = -k\sum_{i=1}^{n} p_{ij}\ln(p_{ij}) \quad (4)$$

In the formula, $k = 1/\ln(n) > 0$, $e_j \geqslant 0$

Calculate the information entropy redundancy:

$$d_j = 1 - e_j \quad (5)$$

Calculate the weight of each index:

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j} \quad (6)$$

According to the above content, the bicycle model is established.

2.3. Model processing and solution

Through the sorting of bike data in New York City, a total of 4 impact indicators were selected. MATLAB software is used to conduct normalization processing of the data, and then EXCEL is used to image the normalized data. MATLAB is used to get the normalized maximum, minimum and range. By inverse normalization, the weight, entropy and information entropy redundancy of the i scheme in the index j are calculated by returning to the original data, and the required weight is finally obtained.

2.3.1. Normalization of data

In the multi-index evaluation system, due to the different nature of each evaluation index, there are usually different dimensions and orders of magnitude. When the level of each index varies greatly, if the original index value is directly used for analysis, the role of the index with higher value will be highlighted in the comprehensive analysis, such as travel times, industry income and offset carbon emissions[6]. Weaken the role of indicators with lower value level, such as the number of maintenance of Shared bikes. Therefore, in order to ensure the reliability of the results, the original index data needs to be standardized. In order to maintain the reliability of the results, the original data were standardized and the impact indicators were mapped to the range of 0-1.By using the method of normalization, the dimensionless expressions are transformed into dimensionless expressions and become scalar. After the above standardized processing, the original data are converted into dimensionless index evaluation values, that is, all index values are at the same quantitative level, which can be used for comprehensive evaluation and analysis[7].

Table 1. Data after normalization

The traffic	Economic	Social	The environment
0.2321	0.1743	0.1731	0.3443
0.4208	0.1295	0.2044	0.8591
……	……	……	……
0.9960	0.1359	0.9858	0.9275
0.9405	0.1970	0.8944	0.9044

Through the table 1, we can intuitively see that Shared bikes have a greater impact on traffic, environment and society, but a smaller impact on the economy. The impact of the four indicators is quantified below.

2.3.2. Calculate the entropy value and entropy redundancy of each index

Entropy is a measure of uncertainty. The more information there is, the less uncertainty there is and the less entropy there is. The smaller the amount of information, the greater the uncertainty and the higher the entropy. According to the characteristics of entropy, we can judge the randomness and disorder degree of an event by calculating the entropy value, or we can judge the dispersion degree of an index by the entropy value. The greater the

dispersion degree of the index, the greater the influence of the index on the comprehensive evaluation. In the model, what is considered is not the uncertainty of the occurrence of a single indicator, but the average uncertainty of all possible occurrences of this indicator. If the index has n cases: Ui...Un, the corresponding probability is: P1...Pi...Pn, and the signs appear independently of each other. At this time, the average uncertainty of indicators should be the statistical average value (E) of the single indicator uncertainty -logpi, which can be called information entropy, i.e

$$H(U) = E[-\log p_i] = -\sum_{i=1}^{n} p_i \log p_i \qquad (7)$$

In the formula, logarithm is generally base 2 and the units are bits. However, we can also take the base of other logarithms and use other corresponding units.

Therefore, the weight of each index can be calculated according to the variation degree of each index by using the tool of entropy, which provides a basis for the comprehensive evaluation of multiple indexes. Entropy redundancy refers to the difference between the maximum amount of information that a certain number of indicators may have and the actual amount of information they contain. It's usually R. The entropy and entropy redundancy can be used to objectively reflect the influence of Shared bicycle on traffic, economy, society and environment.

According to the above conclusions, the weight of the above indicators can be obtained, and the results are as follows.

Table 2. Entropy value of each index (e)

The traffic	Economic	Social	The environment
0.9596	0.8937	0.9288	0.9385

Table 3. Entropy redundancy of each index (d)

The traffic	Economic	Social	The environment
0.0404	0.1063	0.0712	0.0615

Table 4. Weight of each index (w)

The traffic	Economic	Social	The environment
0.3805	0.1447	0.2202	0.2547

According to the weight, the influence of Shared bicycle on traffic is the highest, reaching 0.3805.Secondly, the impact on the environment and society is 0.2547 and 0.2202 respectively .The impact on the economy is smaller than the other three indicators, at 0.1447.And that's pretty much the same intuition that you get from the picture.

Based on the above empirical analysis, I think we can start from the following aspects:

First, the government. All local governments should formulate and improve the guidance on bike-sharing as soon as possible, strengthen the supervision and maintenance of bike-sharing, and create a better operating environment for bike-sharing. First of all, in terms of market access, strictly in accordance with the procedures, fully assess the market capacity, to avoid excessive investment in local bicycles. Secondly, citizens' uncivilized use of Shared bicycles should be incorporated into the society's integrity system. For citizens who violate rules or maliciously destroy Shared bicycles, they can be included in the list of broken promises. In the long run, the government should give policy support to the site selection of the Shared bicycle parking space from the aspects of land and planning, and also plan the urban single lane, so that the bicycle can enjoy the basic right of way, and ensure the safety and accessibility of bicycle travel.

Second, technology. Bikesharing enterprises should strengthen technology research and development to make cycling more convenient and labor-saving. They should actively implement the responsibility of vehicle parking management, advocate citizens' standard and civilized use of vehicles, and jointly maintain the public space of the city with relevant government departments. For example, we can use encouragement mechanism, big data and intelligent development to score users. When the score reaches a certain value, we can offer certain discounts. Of course, if the value is less than a certain value, the next ride will be charged a higher fee. In addition, enterprises should also improve the bike online management system, to give users a better experience.

Third, users should regulate their own behavior, improve their own quality, mutual supervision report uncivilized use behavior.

3. Conclusion

Considering the reality of life, the economic level of sample cities has reached a certain level. Shared bicycle is the inevitable product of rental industry and mobile payment development to a certain extent, and it has a positive impact on all aspects of the city. Firstly, the impact on transportation is mainly reflected in large cities with high density of bus network and high quality of ser-

vice. Shared bicycle provides a more efficient, economical and direct way to travel for short trips that can be reached by walking or bus. Although public bikes compete with traditional bus services, they can also ease traffic congestion during rush hour. In suburban bus service scarce or small and medium-sized cities, Shared cycling supplement to public transport, is one of the important transportation link "the last kilometer" way, enhance the transportation accessibility, reduce the demand for Shared cycling members take rail transit is beneficial to relieve pressure peak of the center of urban rail transit, especially in Washington, d.c., and so on big city traffic volume. In fact, one of the reasons for starting bike-sharing inWashington, d.c.. In addition, in large cities with high rail network density and service quality, Shared bikes can provide users with more direct trips, save them time, exercise and reduce travel costs.

Furthermore, on the environment, sharing bicycles is of constructive significance to environmental protection. With the rapid development of economy today, the air pollution index is soaring day by day, among which automobile exhaust emission has become one of the main sources of air pollution. Although reduce the use of private cars, encourage the use of public transport, subway and other measures, has played a certain role in promoting the reduction of vehicle exhaust emissions. But the emergence of Shared bikes has undoubtedly improved air pollution at its source. If everyone chooses to travel by bike, then the phenomenon of car exhaust emissions will be greatly improved.

Sharing bicycles relieves the urban traffic congestion. Although underground traffic alleviates urban traffic congestion to a certain extent, overgroundtraffic is still indispensable. The emergence of Shared bicycles not only saves a lot of space occupied by cars, but also brings great convenience to people's travel due to its small size and convenient use. The use of Shared bikes is beneficial to the physical and mental health of citizens.

In today's society, people's life rhythm is accelerated, the proportion of indoor time is larger, there are few outdoor activities. Even if travel, also mostly use transport tools. Due to lack of exercise for a long time, physical health is a great hidden danger. The emergence of Shared bikes can not only bring a certain amount of momentum, but also enjoy the outdoor scenery, which is of great benefit to users' physical and mental health. Although the use of Shared bikes has certain positive values in environmental protection, transportation, and citizens' physical and mental health, such positive effects cannot be well played due to the unsound rules and regulations. Therefore, local governments should actively explore management schemes and optimize facilities to maximize the social effect of Shared bikes.

References

[1] Kim K. Investigation on the effects of weather and calendar events on bike-sharing according to the trip patterns of bike rentals of station. Journal of Transport Geography. 2018, 66, 309-320.

[2] Campbell K B, Brakewood C. Sharing riders: How bikesharing impacts bus ridership in New York City. Transportation Research Part A Policy & Practice. 2017, 100, 264-282.

[3] Kaspi M, Raviv T, Tzur M. Bike-sharing systems: User dissatisfaction in the presence of unusable bicycles. A I I E Transactions. 2017, 49(2), 15.

[4] Adhisuwignjo S, Siradjuddin I, Rifa'I M, et al. Development of a solar-powered electric bicycle in bike sharing transportation system. Iop Conference. 2017, 70(1), 012025.

[5] El-Assi W, Mahmoud M S, Habib K N. Effects of built environment and weather on bike sharing demand: a station level analysis of commercial bike sharing in Toronto. Transportation. 2017, 44(3), 589-613.

[6] Kaviti S, Venigalla M M, Zhu S, et al. Impact of pricing and transit disruptions on bikeshare ridership and revenue. Transportation. 2018(5), 1-22.

[7] Bullock C, Brereton F, Bailey S. The economic contribution of public bike-share to the sustainability and efficient functioning of cities. Sustainable Cities & Society. 2017, 28, 76-87.