

Research Progress on Complexity of Public Bicycle Trip Behavior

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Abstract. With the rapid development of public bicycle systems, it has taken only half a century since the development of the first generation of bicycles in the Netherlands to the fourth generation of bicycle sharing systems supported by information technology. By combing relevant literatures on public bicycle systems both at home and abroad, this paper systematically introduces the research progress and insufficiencies of the public bicycle system's user characteristics, the use of influencing factors, route selection and other public transport modes. Based on literature surveys, we judged: (1) Deepening the sharing of operating model innovations in fixed-site public bicycle systems, (2) Improving public bicycle system-related laws and regulations, (3) Supporting, managing, and monitoring public bicycle systems in an overall strategy. Development, (4) to achieve intelligent, standardized management, will become the main research direction and key areas of public bicycle cycling behavior in the next few years.

Keywords: Public bicycles system, user characteristics, use of influencing factors, development hindrance, Future direction.

FOREWORD

Research Background

With the development of the global economy, the increase in vehicle ownership has made the greenhouse effect, traffic congestion, environmental pollution, noise pollution and energy shortage more serious. With the acceleration of urbanization, a large number of populations, such as central cities and central cities, radiate, making the road traffic contradiction worse. In many parts of the world, many cities encourage residents to use green and low-carbon travel modes instead of private cars. Local governments are also vigorously promoting the bicycle sharing system (BSS), which is commonly referred to as the public bicycle system. The bicycle sharing system is particularly useful in short-distance travel in big cities and effectively solves the "last mile" problem of travel. In recent years, in some small and medium-sized cities, bicycle sharing systems have gradually begun to be implemented.

Meaning

Although bicycle sharing systems have a history of more than 50 years, they have received more attention in recent years because they play an important role in reducing the impact of traffic on the environment. The bicycle sharing system provides several important benefits to the city, including improving traffic choices and flexibility, increasing physical activity levels, reducing congestion, transportation costs and air pollution [1], reducing road congestion [2], and reducing carbon emissions. Public bicycles are part of public transportation and can effectively alleviate the "last mile" problem of urban transportation, integrate with public transportation, subway and BRT, and realize "door-to-door" services for public transportation. Second, providing short-distance travel solutions for cities can effectively alleviate the growing pressure on public transportation.

HISTORY AND DEVELOPMENT STATUS

Development History

The concept of "bicycle share" first originated in Europe. The first generation of public bicycle systems began to appear in the Netherlands in 1965. In 1995, Copenhagen, the capital of Denmark, launched the second-generation public self-planning system. At the end of the 1990s, a third-generation public bicycle system appeared in Europe. The public bike rental industry in Europe used computers, unlimited communications, and Internet technologies to achieve digital management and operations. In recent years, many cities have developed a fourth-generation public bicycle system, adopting a modular and mobile service point, and using the solar energy to provide service points, using wireless transmission technology to achieve system information transmission, and making public bicycle systems more Tends to improve.

2.2 Development Status
Hangzhou is one of the first cities in China to implement BSS and currently operates the world's largest public bicycle sharing project. [3].

Bicycle sharing is becoming a prominent strategy for solving issues such as the use of clean fuel [4], traffic demand management, land use and transportation links [5].

Since 2010, bicycles have shared more than 88 million bicycles on bike-sharing bikes in the United States. In 2016 alone, riders attracted more than 28 million trips and were higher than the number of visitors to Walt Disney World every year.

USER CHARACTERISTICS

Although there have been many discussions on feature analysis of bicycle sharing users, vertical research activities seem to lack research on the influence of specific social groups or potential users and actual users. In this context, Ricci M recommends the use of innovative research methods, taking the historical travel behavior of the user as the research object, supporting bicycle sharing data and socio-economic data, and better understanding the changes in user and non-user travel behavior [6].

Sex

The phenomenon of gender inequality in the use of bicycles is widespread. Because women have a high degree of aversion to risk [7], there are some deficiencies in bicycle infrastructure and poor road conditions that can reduce the comfort of use. During the use of bicycle [8], women showed stronger route preference [9][10].

After analyzing the data of all trips in New York in August 2017, males accounted for 65.2% of bicycle users.

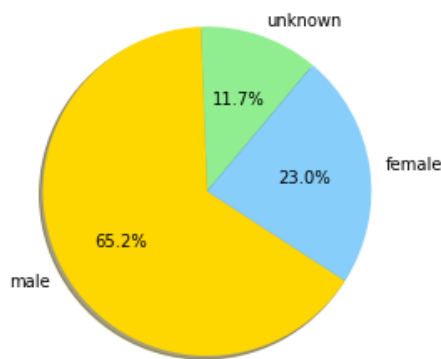


FIGURE 1. User Sex Ratio in the New York.

Age

The frequency of use of bicycles also shows a difference with age. In a survey of bicycle users, we found that young people use bicycles more frequently than older people[11].

After analyzing all travel data in New York, USA in August 2017, it was found that people around the age of 30 used bicycles most frequently.

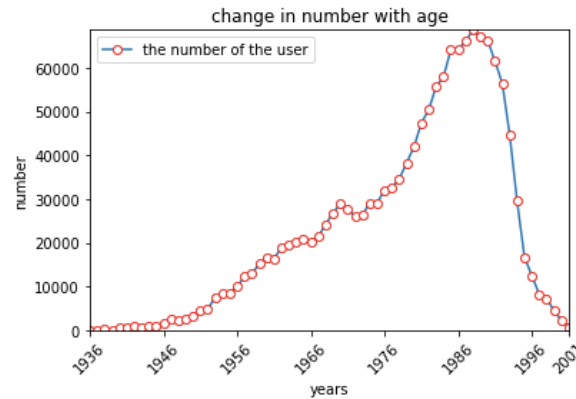


FIGURE 2. Change in Number with Age of the Users

Income

Users' income will also affect their use behavior to a certain extent. Research in the United States shows that the use of bicycles is negatively correlated with income levels and ownership of vehicles, and the utilization rate of people with lower income is higher [12]. The results of the research in the Netherlands and China are contrary to the fact that the user's income is positively related to the frequency of bicycle use Krygsman [13]and Murphy [14]made similar conclusions on the analysis of bicycle sharing systems in France and Ireland respectively.

Distance of Travel

Travelers will determine their travel method based on travel distance. In some cities in China where there are less developed public transportation systems and, in some cities, abroad, the travel distance is very short. When walking within 1 km, walks are often used. More people between 2 and 5 km will prefer to go on bicycles, and more than 5 km will choose bus transit. And other public travel modes.

In some cities with relatively complete public transportation systems such as Shanghai, most bicycles travel between 0.8 and 1.5 km dx, less than 0.8 km walk, and more than 1.5 km, they choose public transport and other means of travel.

Purpose of Travel

Different travel destinations will have different choices of transportation methods. When traveling to work, the requirements for time are relatively high. They will use a variety of means of transport in a comprehensive manner. At the end of the trip, they will choose public bicycles to travel. When they visit relatives and friends or travel, they will travel. The time requirement is not high, and the requirements for travel comfort are relatively high. Generally, buses, rail transportation, or taxis are used. Bike train combinations are more popular than other uses for travel for work and education purposes [15].

INFLUENCING FACTORS

Bicycle trips have a certain relationship with system properties, station density, weather, geography, and transportation infrastructure.

Toll

The bicycle sharing system charges are mainly divided into two aspects: rent and deposit.

Caggiani L recommends using the revenue collected by the congestion charging policy to implement a free BSS as a strategy for relieving urban traffic congestion by charging or interfering with links during peak hours [16].

Zhao J used the fare-related variables to explain the use of public bicycles and used the deposit income per capita ratio (DIR) and rent per capita income ratio (PIR) to explain the daily use of PBS in China and the conversion rate [17].

Lin J J took Taipei PBS and Ubiak as examples. The empirical data shows that whether commuters use PBS is highly dependent on basic charges and basic terms rather than variable costs after the basic period [18].

Climate and Weather

Another important influencing factor that affects public bicycle rental needs is weather and climate.

Some studies have shown that adverse weather conditions and calendar attributes (working days, weekends, and holidays) have an impact on system use[19], and passenger reduction is related to low temperatures, rainfall, and high humidity.

The results of the study also show that the weather has an impact on the amount of use. Under better weather conditions, long-distance travel is more likely [20].

Other Transportation Methods

Public bicycles not only need to attract users through their own environmental protection and free features, but also need to take into account the effective connection between ground transportation and rail transit. The purpose of setting up a bicycle sharing system in some cities is to solve the problem of the last kilometer. Its purpose is to connect public transport modes such as public rail transit. Therefore, the convenience of transfer of bicycles and other modes of transportation is an important factor influencing leasing demand. There are mainly the following relationships:

Alternative

A number of studies have shown that public estimates of CO2 emission reductions are often exaggerated because only a small percentage of car travel has been replaced by BSS[21]. At the same time, research shows that there is no direct evidence that bicycle sharing significantly reduces traffic congestion, carbon emissions or pollution [22].

Supplementary

In New York City, the bicycle sharing stations near the subway stations, especially the stations where the average number of subways per month is more, have higher bicycle utilization rates [23]. These findings suggest that there may be a complementary relationship between bicycles and other forms of transportation.

Relevance

Using a regression analysis, a 10% increase in bicycle travel was associated with a 2.8% increase in subway passengers [24].

DEVELOPMENT HINDRANCE

Public bicycles play an important role in alleviating traffic congestion and reducing carbon emissions, but public bicycle systems also face numerous criticisms.

Safety or security is the biggest obstacle preventing more people from riding in the United States [25]. In many cases, accessibility and safety related obstacles restrict the use of bike sharing systems [26, 27].

Even those bicycles sharing systems that are considered to be successful, such as the BIXI service in Montreal, can suffer serious financial difficulties [28].

With the increase in the use of PBS, planners began to notice some deficiencies: there was no customer service hotline, there was no stop sign, and there were not enough bicycles during peak hours [29].

Some of the reasons for the low usage rates in Melbourne and Brisbane include mandatory helmet legislation, a limited network of protected bicycle infrastructure, small watershed scale, poor marketing and promotion, and contracts that do not motivate operators to maximize their use [30] [31].

FUTURE DIRECTIONS

Based on literature surveys, we judged: (1) Deepening the sharing of operating model innovations in non-stationary public bicycle systems; (2) Improving public bicycle system-related laws and regulations; (3) Supporting, managing, and supervising public bicycle systems in an overall strategy Development and (4) Intelligent and standardized management will become the main research directions and key areas for the study of the complexity of public cycling behavior in the coming years.

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