Controlling Factors and Strategies of the Shared Bicycles in Jersey City, USA

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Abstract. The emergence of shared bicycles provides a convenient low-carbon transportation option, which helps to reduce carbon emissions and traffic congestion, while promoting the development of low-carbon cities and the realization of sustainable mobility. This paper takes Jersey City in the United States as an example. Through the statistical analysis, it is concluded that Grove St RATH is the site with the largest number of shared bicycles, and the site is also located in the densely populated area, commercial center and public transportation hub of Jersey City. It indicates that the most used stations of shared bicycles in the city are related to the intensity of public transportation. The Grove Street stop is one of the busiest stops in Jersey City, located in the Grove Street area of downtown and also on the main thoroughfare to Manhattan in New York City. Jersey City's Hoboken Terminal station is an important transportation hub, serving NJ Transit trains, light rail, and the Hudson River Ferry. Located on the Hudson River, it offers a variety of transportation options for residents and visitors of Jersey City and the surrounding area. The delivery station of shared bicycles is near the transportation hub, which meets the travel needs of passengers going to or from the transportation hub by providing a convenient way to travel, so the station is used more. This location choice makes bike-sharing a convenient and fast alternative mode of transportation, enabling users to easily reach their destinations, especially in cases of traffic congestion or poor public transportation. However, shared bicycle parking spots in high-traffic areas may lead to parking congestion, affecting the convenience of users to park and borrow and return their cars. Therefore, it is necessary to increase the number of parking points and optimize the layout of parking points to ensure that the distribution of parking points is balanced and enough to accommodate the demand.

Keywords: Factors, shared bicycles, low-carbon transportation, Jersey City.

1. Introduction

In a world facing environmental issues and the need for sustainable urban development, finding low-carbon transport solutions has become critical. Bike-sharing, as an innovative and convenient mode of transportation, came into being to meet the needs of these pressing issues. With a focus on reducing carbon emissions and promoting low-carbon cities, bike-sharing offers an accessible and environmentally friendly way to get around. Bike-sharing as a popular urban transportation solution has many advantages, including convenience, sustainability and economics. In recent years, some cities, including China, have adopted strategies to promote and develop bike-sharing systems. For example, in cities such as Beijing and Shanghai, large-scale bike-sharing programs have been established, providing a large number of bicycles to residents and tourists across the city. These schemes are supported by bike lanes, bike-friendly infrastructure and combined with the public transport system to create a seamless and efficient transport network. However, in addition to these benefits, bike-sharing also faces some challenges. A major problem is the improper parking of bicycles, which can lead to confusion on sidewalks and impede pedestrian access. To address the problem, the government has implemented parking regulations and adopted technological solutions such as GPS-based positioning and parking posts to ensure proper parking and prevent the random abandonment of bicycles. In addition, concerns have been raised about the sustainability and economic viability of bike-sharing systems. Several bike-sharing companies have run into financial difficulties in the face of oversupply, theft and vandalism, and have struggled to maintain profitability. Finding a sustainable business model and striking a balance between supply and demand is critical to the long-term success of bike-sharing schemes.

In recent years, the influence factors of traffic passenger flow have been analyzed abroad. In 2014, a research report in the United States adopted a spatial delay analysis method for land use, built environment, population and other factors [1]. In 2015, the French research group analyzed the impact of different user types, built environment characteristics and other factors on the bicycle flow in and out of the station level, and found that the bicycle network density, parking capacity and other factors were positively correlated with the bicycle usage at each station [2]. In 2016, a study of New York City's bike-sharing system evaluated a spatiotemporal error and spatiotemporal delay pattern to accommodate spatiotemporal interaction effects; On the basis of previous studies, this project intends to take Toronto, Canada as an example, through statistical analysis of public bicycle travel data in Toronto within a year, and based on the assumption of using bicycle collision structure and following the shortest path, a bicycle path is proposed to analyze the station to the origin destination [3].

The relationship between the placement of shared bicycles and traffic. Foreign scholars discuss how Uber has changed the traditional taxi industry in New York. To do so, they used a time-series regression model to control for various factors that could affect taxi travel. The results show that taxi drivers actively respond to the threat of Uber's entry, and consumers are better served by competition with each other. So, ride-sharing has changed the existing market in a positive, welfare-enhancing way [4]. Based on the data of the 2017 US Resident Travel Survey, the correlation between the frequency of public transportation trips and the probability of bike-sharing trips in the United States was studied. Using zero expansion negative binomial regression analysis method, the relationship between bus trip frequency and shared bicycle trip probability is discussed. The study found a strong correlation between the number of public trips and the use of shared bikes, shared bikes and shared bikes. In addition, the relationship between public transit system and rail transit passenger flow is explored, and the influence of public transit system on rail transit passenger flow is analyzed by taking Washington, USA as an example [5]. Based on the bus travel data of Lyon, a bus travel group model based on a time-space relationship is constructed, and the social characteristics of bus travel groups are analyzed [6]. Based on the data on bus stops, the travel mode of bus users was studied [7]. Through the analysis of 11.6 million cases of bicycle travel data in Lyon city, it is obtained that in the center of Lyon, the average speed of the bicycle during peak hours is 13.5 km/h, which is not much different from the speed of motor vehicles, which explains why the number of bicycle users in Lyon city is double after the implementation of the bicycle program. The analysis of bicycle traffic characteristics can provide guidance for the planning and construction of bicycle lanes [8]. Patrick Vogel [9] analyzed a large number of borrowing and returning data of the public bicycle system, counted the borrowing and returning frequency of each station in different working days and weekends, and based on this, divided the stations into five categories by cluster analysis, and studied the activity patterns of different types of stations by combining the spatial distribution of the stations. At the level of combining with rail transit, each rail transit station is regarded as a demand community, and the double-layer planning model based on delivery and travel is used to lay the public bicycles with piles. There are also scholars who conduct a small-range investigation to study the layout planning of vehicle delivery specifically for each vehicle. At the level of combining with urban facility points, scholars use a genetic algorithm based on weight coefficient transformation to solve and forecast, provide decision support for relevant departments, and classify public bicycle rental points into five categories: bus points, public construction points, residential points, recreational points and campus points, and put forward some corresponding suggestions according to the characteristics of each category point. Robert Cervero [10] also took Bogota as an example and pointed out that facility design and layout are one of the main factors affecting public bicycle travel. Some scholars summarized the experience of shared bicycles in France and believed that the practice of arranging 50% of the total amount first and then arranging the remaining 50% after a period of operation is worth learning. Because the shared bike does not have the characteristics of fixed pile points, its layout planning covers a wider area. At the level of combining with public transportation, Jin uses the histogram displacement method to judge the relationship between cooperation and competition

between public bicycles and public transportation and proposes to consider independent travel of shared bicycles within three kilometers.

This paper takes Jersey City in the United States (next to New York City) as an example. Through statistical analysis, it is concluded that Grove St RATH is the site with the largest number of shared bicycles, and it is also the commercial center and transportation hub of Jersey City.

2. Jersey City Background

Jersey City, located in Hudson County, New Jersey, west of New York City, is the second largest city in the state and one of the most densely populated cities in the United States. It is only about 2.4 km away from Manhattan in New York City, and can be connected to New York City by multiple modes of transportation such as Bridges, tunnels, and ferries (Figure 1). It is an important part of the metropolitan area, the geographical location is very convenient, is a convenient transportation hub. According to 2023 estimates, the population of Jersey City is approximately 250,000. The city has a rich and diverse population structure, where a variety of different cultures and communities meet. Many immigrant groups, including people from Asia, Latin America, Europe, Africa and the Caribbean, add diversity and vitality to the city. Jersey City's economy is dominated by the service sector, with rapid growth in finance, insurance, real estate, and information technology. Due to its location and convenient transportation connections, Jersey City has attracted numerous financial institutions, multinational corporations and start-ups to set up offices here. Jersey City is also one of the largest commercial centers in New Jersey, with multiple shopping centers, dining options, and entertainment facilities. The city is also rich in cultural resources, including art institutions, museums and music venues, providing residents and visitors with diverse cultural and entertainment options. In short, Jersey City has a great location, a diverse population, and a strong economic vitality. As one of the most important cities in New Jersey, it is attractive in terms of economy, culture and living environment, providing residents and businesses with abundant opportunities and convenient living conditions.

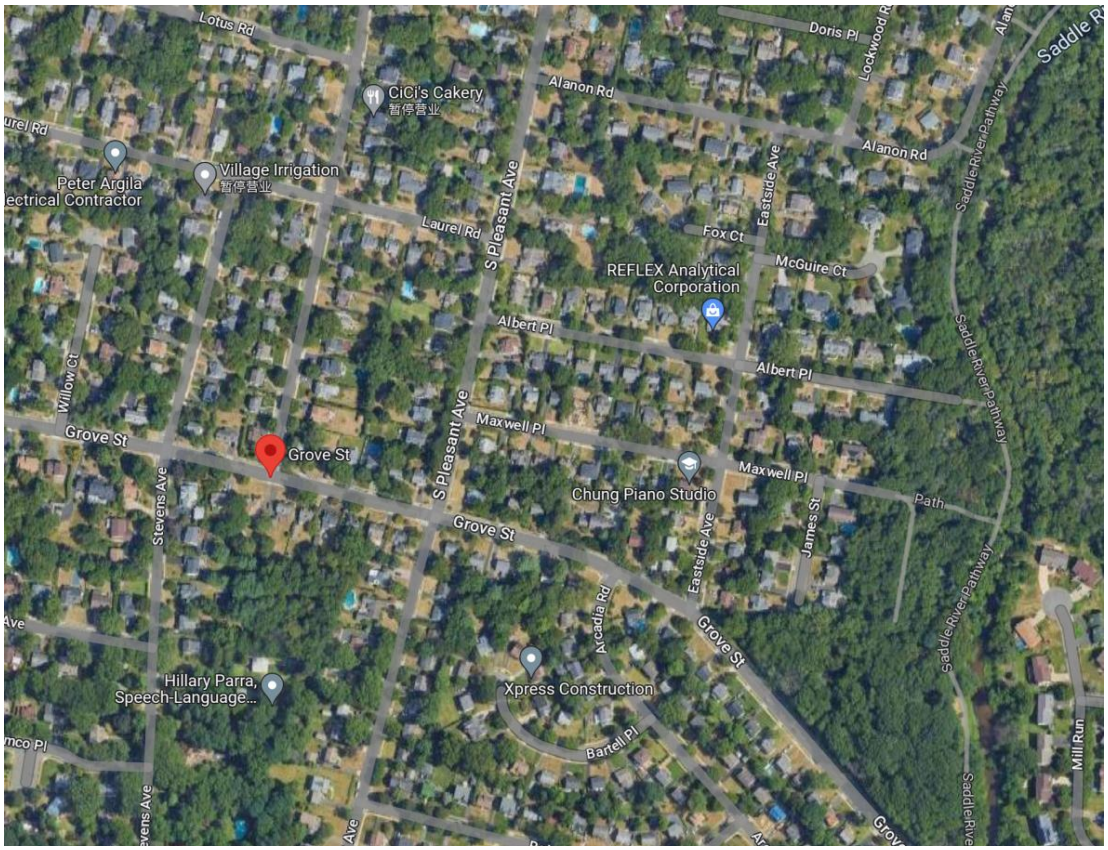


Figure 1. Location of Jersey City

3. Methods

This paper collects 7 months 'data on the usage of shared bicycles in Jersey City, and provides the starting stations for Jersey City people to use shared bicycles and the stopping stations for returning bicycles from January to July 2023 provided by Citi. In addition, this paper uses python for visual analysis, and makes use of statistics on the usage data of each station. The column diagram and thermal point diagram are obtained.

A key aspect focused on the spatial distribution of ride starts within Jersey City, and a comprehensive spatial analysis was conducted to visualize this distribution and gain insight into the density of ride starts. The location analysis method can explain the relationship between shared bicycles and traffic by observing the location relationship between the stations and transportation hubs where shared bicycles are used a lot. This analysis method provides an intuitive perspective to better understand the role and impact of bike-sharing in the transportation system.

4. Results

4.1. Distribution diagram of starting point of riding

In Figure 2a, each point represents a ride starting station, and the size of that point represents the number of rides that started at that location. The color scale, from yellow to red, illustrates riding density, with darker shades indicating higher riding activity. On the map, certain areas of Jersey City become hot spots for bike launches, characterized by a concentration of launch locations. These areas represent popular starting points for bike-sharing trips. Color intensity provides a visual representation of ride density, with darker shadows indicating larger areas of riding. It can be seen that Jersey City is more frequently used near transportation hubs and main roads.

In Figure 2b, each point represents a ride end station, and the size of that point reflects the number of rides that ended at that location. Specific geographic areas within Jersey City are hot spots for cycling finishes, characterized by clustered cycling finish locations. These hotspots represent common endpoints for bike-sharing trips. The color intensity on the map provides a visual representation of ride density, with darker shadows indicating areas that end at specific locations, which is consistent with the conclusions drawn above.

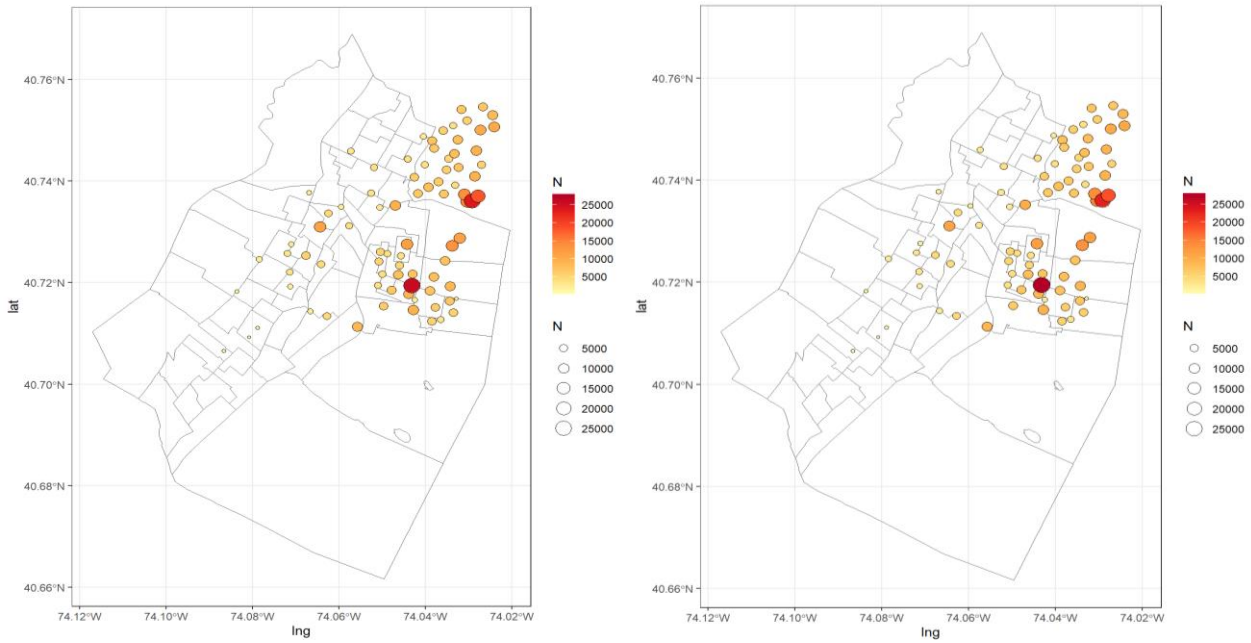


Figure 2. (a) Spatial distribution of starting stations; (b) Spatial distribution of cycling terminal stations

4.2. The most popular site distribution

By analyzing the usage of bike sharing sites in Jersey City in a given week, it's clear that in this city, the top four daily bike-sharing sites were Grove St RATH, Hoboken Terminal River ST & Hudson PI, and South Waterfront Walkway - Sinatra DR & 1 St and Hoboken Terminal - Hudson ST & Hudson PI, as shown in Figure 3. By analyzing the city's shared bike users' favorite sites. The importance and popularity of these sites can be found, perhaps because of their location near busy areas, transportation hubs, or popular destinations in the city. It also reflects the key role that bike-sharing systems play in meeting the travel needs of urban residents and tourists. The data can help city planners better understand travel patterns and optimize bike-sharing services to meet users' needs.

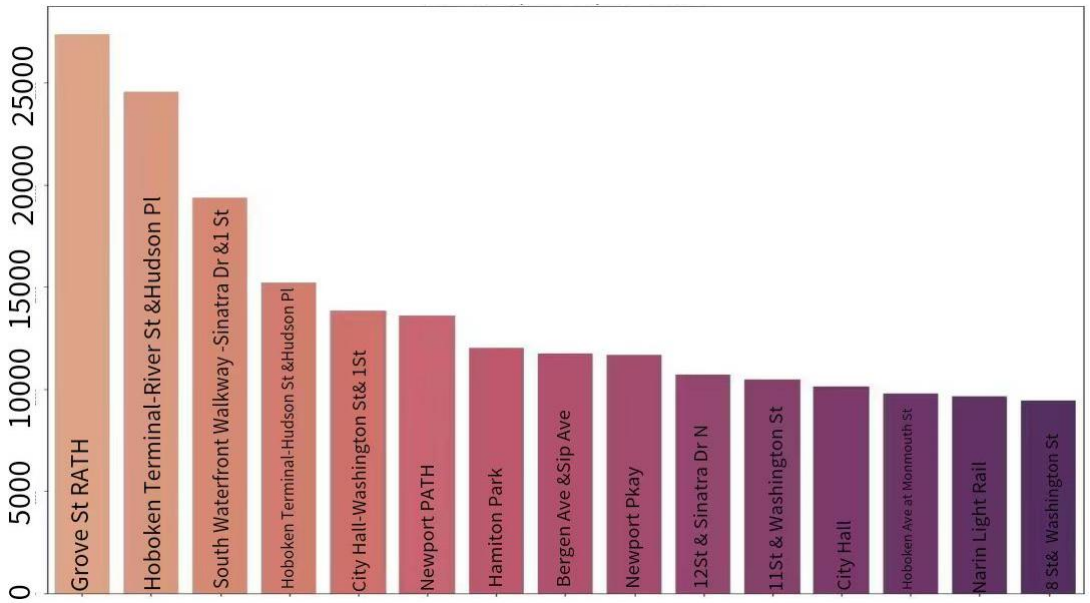


Figure 3. Jersey City's most used bike-sharing sites in the first seven months of 2023

5. Discussion

5.1. The relationship between location and traffic

5.1.1. Transportation hub station

Grove Street Station in Jersey City's PATH (Port Authority Trans-Hudson) subway system is one of the busiest subway stations in Jersey City, as shown in Figure 1. Located in the downtown Grove Street area, it provides convenient transportation connections for passengers heading to Manhattan in New York City. Jersey City's Hoboken Terminal station is also an important transportation hub, serving NJ Transit trains, light rail, and the Hudson River Ferry. Located on the Hudson River, it offers a variety of transportation options for residents and visitors of Jersey City and the surrounding area. These are three of the top four sites used in Jersey City, mainly because transportation hubs usually gather a large number of vehicles and transit lines, including subways, trains, light rail, buses, and surrounding parking lots or parking facilities. The collection of these vehicles and facilities makes the periphery of the transportation hub a popular area for people to travel. The delivery station of shared bicycles is near the transportation hub, which meets the travel needs of passengers going to or from the transportation hub by providing a convenient way to travel, so the station is used more. At the same time, transportation hubs are usually the starting point or end point for people, or for passengers to switch between different modes of transportation. After passengers arrive at the transport hub, they may need to complete the last leg of their journey, such as a long walk from the station to the destination. The drop-off stations of shared bikes near transportation hubs provide a convenient and fast solution where passengers can easily ride to their destinations, thus increasing the usage of the stations. Finally, there are usually many commercial areas, office areas, residential

areas around the transportation hub, and the flow of people is high. Bike-sharing has been welcomed by a large number of users because it provides a flexible, economical and environmentally friendly travel option in these areas. Setting up a shared bicycle delivery station at the intersection of the transportation hub and the surrounding area can better meet people's travel needs, so the use of the station is higher.

5.1.2. Main road

The South Waterfront Walkway - Sinatra DR & 1 St is an area in Jersey City's South Waterfront scenic area that offers walkways and bike paths along the edge of the Hudson River. Although it is not a transportation hub in the traditional sense, it provides an important transit path that connects different areas of Jersey City and provides a place for pedestrians and cyclists to pass through. This is the third most used site for shared bikes for a long time, mainly because city residents or visitors may need to travel from one area to another, and shared bikes can serve as a flexible travel option. The installation of shared bike stations on important traffic paths allows users to make short trips between different areas, thus easily and quickly connecting various parts of the city, and the area itself is a coastal area, which will attract a lot of traffic.

Just as the traffic flow of Chengdu is concentrated on the main road, the taxi passenger volume of Chengdu's main road will exceed 190,843 million in 2020. Moreover, some research and investigation preliminarily determined that the areas with large use of shared bicycles are mainly concentrated in downtown Chengdu and the southern area from the Second Ring Road to the Third Ring Road of Chengdu [11-13]

5.2. There may be problems and strategies

(1) Lack of sufficient bicycle parking Spaces: If the stations with large use of shared bicycles coincide with transportation hubs, it may lead to insufficient parking Spaces. This can result in users not being able to easily borrow and return bikes because there are no available parking Spaces. For example; Users went to the bike-sharing parking area near the train station and found that all the parking Spaces were full and they could not park their bikes. The strategy to solve this problem is to increase the number of parking Spaces, for example, by setting up more bicycle parking areas around transportation hubs or placing more shared bikes to meet user demand.

(2) Unbalanced vehicle scheduling: When the number of shared bicycles is too much concentrated in the transportation hub, it may lead to a lack of supply of shared bicycles in other surrounding areas. For example, in a busy subway station, there are too many shared bikes, but the supply of shared bikes in other nearby areas is seriously insufficient, and users cannot find available bikes to borrow. This can make it difficult for users to find available bikes when they need them. To solve this problem, bike-sharing operators can adopt a proactive vehicle scheduling strategy to reallocate excess bikes from busy stations to areas with relatively high demand, so as to achieve rational use of resources and fairer service.

(3) User education and guidance: Transportation hubs are usually where new users come into contact with shared bicycles. In order to provide a better user experience and avoid potential problems, users can be helped to familiarize themselves with the process and rules of using shared bicycles through user education and guidance. Mitigation measures include the provision of information boards, signs or help functions of mobile apps at transportation hubs to guide users on how to properly borrow and return bicycles and provide relevant safety tips.

(4) User flow management: Traffic hubs usually have a large flow of people, which may produce peak and trough periods. During peak periods, if a large number of users arrive or leave the transportation hub at the same time, shared bikes may not be able to meet the needs of all users, leading to congestion and chaos. For example, during the morning rush hour, a large number of passengers crowded into the train station, resulting in a shortage of bicycles at shared bike stations, and users had to queue up, causing inconvenience and delays. In order to alleviate this situation, we can consider increasing the number of shared bicycles, predicting the arrival of the peak season in advance, and dispatching more vehicles to the site to meet the needs of users.

6. Conclusion

This paper takes Jersey City as an example, obtains the station with the most bicycle usage through statistics, discusses the location and traffic relationship, and puts forward the possible problems and strategies.

The most used stations in Jersey City are Grove St RATH, Hoboken Terminal River ST & Hudson PI, and South Waterfront Walkway - Sinatra DR & 1 St and Hoboken Terminal - Hudson ST & Hudson PI.

Through the analysis, it is found that the surrounding area of the transportation hub has become a popular area for people to travel, and the delivery station of shared bicycles is located near the transportation hub, meeting the travel needs of passengers going to or from the transportation hub, and providing a convenient and quick last-kilometer solution. In addition, the commercial, office and residential areas around the transportation hub have a large flow of people, and shared bicycles provide a flexible, economical and environmentally friendly travel option. Set up shared bike stations on important traffic paths to facilitate short trips between different areas and connect various parts of the city. Especially for urban residents or visitors who need to get from one area to another, bike-sharing is a flexible travel option. In addition, if the area is located on the waterfront, it will attract more traffic. Therefore, transportation hubs and surrounding areas have become important sites with high use of shared bicycles.

Through the analysis, it is concluded that there may be a lack of sufficient bicycle parking Spaces, and the number of bicycle parking Spaces can be increased, such as adding more bicycle parking racks or parking slots around the transportation hub to meet the needs of users. There may also be an unbalanced vehicle scheduling problem, which can be balanced by optimizing the vehicle scheduling algorithm, by real-time monitoring and forecasting the demand and distribution of shared bicycles, and targeted scheduling to reallocate excess bicycles to areas with high demand. There may also be a user flow management issue, which can predict the demand for shared bikes during peak periods and take measures to increase supply, such as increasing bicycle inventory, pushing information to users in advance to encourage off-peak use, and guiding users to use shared bikes during off-peak hours through preferential measures or incentive mechanisms. Finally, there may be user education and guidance issues. User education and guidance can be strengthened by providing clear user guidelines and operation instructions, such as showing users the correct use process and rules through mobile applications, electronic screens or signs. At the same time, it provides necessary prompts and feedbacks to help users operate correctly. Publicity campaigns can also be carried out to increase users' awareness of and compliance with the guidelines for the use of shared bikes.

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