

The Influence of Shared Bike Parking Space on City Environment and Citizens

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Abstract. With the popularity of low-carbon transportation, the bike-sharing industry is developing rapidly and integrating into people's lives. This paper includes the impact of bike-sharing on various aspects of cities, analyzing the current situation and recent strategies. Some opinions and optimization measures are put forward for problems related to shared bike systems. The emergence of bicycle sharing has brought many positive effects on urban operation. It can not only ease road congestion and solve the problem of "the last kilometer", but also reduce urban air pollution to a certain extent. However, it has also brought some social issues. A series of problems in the use and parking of bicycles have led to the occupation of public resources which caused people's distress. In response to the current imbalance between the rental and return of shared bicycles and the unreasonable distribution of parking spots, platforms have adopted measures such as setting up conventions and fines to restrain users. However, this could barely solve the problems of large piles of bicycles on the street. At present, for the problems of shared bicycles such as difficulty in recycling, over-aggregation of parking spots, and inconvenience of parking methods, this study proposes several methods to solve the related problems: 1) Refine the management partition and increase the recycling centers, and increase the efficiency of recycling by using manual small-scope marking of bicycles. 2) Calculate the parking spot distribution model using the distribution of facilities in the spatial unit guided by the transportation partition. Then lay out the parking spots on demand in the cities of each line. 2) Issue discounts to promote regulated behavior.

Keywords: Shared Bicycle, Built Environment, Spatial Layout, Site Selection.

1. Introduction

With the urban population increasing and the climate environment getting warmer, public transportation systems that conserve resources and reduce carbon emissions are receiving attention. Travelling by buses, subways or bicycles instead of driving cars on daily trips could improve the transportation energy structure and promote low-carbon development of society. Among them, as a green and healthy mode of transportation, shared bicycle travel has become mainstream in recent years.

Bicycle-sharing systems provide bike rental services through an internet platform, allowing users to easily travel short distances by simply scanning a code on the top. Bike sharing has been growing rapidly in China since 2016 and soon expand to other countries. In recent years, more and more cities around the world have begun to introduce bike-sharing systems. In the beginning, people used staked parking in order to facilitate management. But problems like the rental and return imbalance led to insufficient vehicles at the station or nowhere to park. Managers began to replace the staked shared bicycles with the dockless ones on a large scale, which would not limit the bicycle to a single station and promote the quick development of shared bicycles at the same time [1].

The globalization of shared bicycles has brought a lot of convenience to people. Firstly, by replacing private motorized travel, the use of shared bicycles could reduce fuel consumption and tailpipe emissions thus improving urban air quality [2]. Secondly, the relationship between shared bikes and public transportation sometimes may constitute a complementary relationship. The report shows that in solving the last-mile problem, bike-sharing can enhance connectivity with public transportation to improve the attractiveness and utilization of public transportation services. This may allow users to reach their final destinations in a smoother way [3]. Furthermore, available data shows that 54% of users use bike-sharing to connect to other modes of transportation. However, there is

insufficient research on how the urban built environment affects the parking of shared bikes, and the problem of haphazard parking of dockless bikes remains to be solved. A literature review of the impacts of various aspects of bicycle sharing recycling and placement is needed to summarize existing research findings and identify future research directions. Overall, a research review in this direction is very important for enhancing the efficiency of shared bicycle use and creating a neat parking environment.

Therefore, the purpose of this paper is to discuss the main impacts of shared bike usage and propose new ideas and solutions, analyzing existing strategies and proposing new ideas and solutions.

2. Impact of bike sharing on cities and the environment

2.1. Positive impacts

2.1.1. Addressing the last-mile problem

When people commute or travel in daily lives, there is often a distance between the final destination and the nearest public transportation stop to be reached. This distance may be too short to use traditional transportation or the road might be too narrow for a car to fit in. Riding a shared bike directly from the station to the final destination can help users save time and complete a brief trip. Compared with cabs, this way is more economical, users only need to pay a short rental fee to use the bike at any time, which is more suitable for short-distance travel like the last kilometer. Most conveniently, the current bike-sharing system has a wide coverage area and the main parking spots are near subway stations and bus stops. Citizens can easily find shared bikes around them when they get off the bus and quickly complete the last distance without spending time walking. At the same time, the use of dockless bikes gives citizens the flexibility to park bikes around their destinations without being limited to fixed routes and stops. By studying the impact of North Dakota State University's bike share program on other public transportation, researchers found that bike share is a better alternative to public transportation in small and medium-sized communities [4]. The reason of it might be that people in places with high population densities choose bike sharing for its convenience and affordability, while in places with low population densities bike sharing can supplement the transportation network and provide a better alternative for travel.

2.1.2. Bike sharing to ease traffic congestion

Traveling with shared bicycles instead of cars could reduce the number of motor vehicles on the road, ease traffic congestion, improve the urban environment and increase the utilization rate of roads. During the morning and evening peak periods of commuter travel, workplaces and residential areas are always stuck with a large number of vehicles. On many streets in Beijing, China, commuters can be stuck in traffic jams for hours before reaching their destinations. For places that can be reached in less than half an hour by bicycle, it takes even longer to drive a private car and get stuck in the middle of the road. The emergence of bike sharing optimizes the allocation and use of urban road resources, improving road utilization and efficiency. Bicycle travel occupies far less road space than cars, and their small size allows them to travel freely among the traffic, which could lead them to save a lot of public resources. At the same time, the speed of bicycles is relatively stable, and frequent violent acceleration or deceleration, can improve the efficiency of the road. Many cities have already placed non-motorized vehicle paths such as shared bicycles on both sides of the road, separating from motorized vehicles way and sidewalks, to increase the safety of driving.

2.1.3. Bicycle Sharing for Energy Conservation and Emission Reduction

With the global getting warmer, climate issues have become a major focus for researchers. Low-carbon mobility, which has been advocated, refers to the reduction of fossil energy use and carbon dioxide emissions on the premise of rational use of transportation resources. Low-carbon travel has been promoted around the globe because excessive carbon dioxide and other greenhouse gases absorb and re-radiate heat from the surface of the earth, causing a rise in temperature, triggering climate

change, and destroying the environment where people live. Through the regression results of AQI at different breakpoints, it is reported that researchers could conclude that although the overall effect of bike-sharing travel on environmental management is not significant due to the interference of temperature and other factors, its combination with subway travel can better manage the environment [5].

2.2. Negative impacts

2.2.1. Urban landscape

Although the emergence of dockless shared bicycles has brought a convenient way of traveling for the public, the phenomenon of indiscriminate parking has seriously affected the aesthetics of the city and the use of public space. Some users ignored the designated parking area and parked their bikes in spaces like blind alleys, sidewalks, bushes, etc. for their convenience. After remediation, shared bicycles must be parked in the designated induction area next to the road before they can be locked. However, in many places nearby large commercial districts or office buildings, a large number of shared bicycles would be parked in the morning and evening peaks. The parking area is not large enough or sometimes it is occupied by other private non-motorized vehicles. Therefore, shared bicycles can only be piled up to make it difficult for users to take out the car.

2.2.2. Improper recycling and waste of resources

As a public resource, shared bicycles have been maliciously damaged by some lawless elements [6]. Maintenance workers claim that some bicycles are lacking parts to use. Some bicycles are also damaged by the wind and sun. They cannot be ridden even after users scan the code. These abandoned shared bicycles are often not recycled promptly, resulting in a waste of resources due to the low recycling price and imperfect recycling channels for the electronic components included in the body itself, such as smart electronic locks, batteries, and circuit boards. In China, at least 10 million bikes were scrapped within a few years when shared bikes were first introduced. These not only take up public space resources, but also generate a large amount of solid waste that is difficult to dispose of. Even if there are companies that recycle discarded bicycles, the meager profit largely hinders the incentive to do so.

3. The current situation of shared bicycle parking and existing strategies

3.1. Status

3.1.1. Lease-payment imbalances

At present, the imbalance between vehicle rental and return has become a big problem in the management of shared bicycles. Related studies say that the use of shared bikes increases in places close to city attractions and other public transportation stops [7]. Analyzing the relationship between local shared-bike ridership and socio-demographic and related variables for Toronto's bike-sharing system, El-Assi et al. found that population and employment density, as well as land-use attributes, are positively correlated with high-frequency use of public bikes. As a result, there are currently larger numbers of shared bikes near subway and bus stops, and parking locations are more concentrated. A certain amount of parking spot sizes has also been constructed in areas with high concentrations of residential, office, and commercial shopping based on foot traffic data. Dockless bikes can be parked and locked at any time around destinations until 2020, which results in a large number of bikes often concentrated around heavily used roads, occupying public space. Mingjia He et al. used shared bicycle travel data from Nanjing, China to identify factors associated with bicycle rental and return imbalance, and found that the problem was most pronounced on weekday mornings [8]. As a result, a large number of cluttered shared bicycles gather in front of major office buildings and shopping centers, which are often piled up on major pedestrian traffic routes or occupied by private bicycles and electric vehicles with no place to park. This is especially true around intersections, which can

prevent pedestrians from accessing the site and cause traffic jams for turning vehicles. Yet in many other parking spots where there should be unused bikes, there is not a single working bike.

3.1.2. Poor distribution of parking spots

In recent years, shared bicycles have been required to park in defined induction zones, and the current planning for shared bicycle parking areas is insufficient and the distribution of positioning points is imprecise. Parking spots are mainly located around public transportation stations and commercial offices, while there are fewer parking spots elsewhere along the route, without taking into account older neighborhoods with underdeveloped infrastructures. Users may need to ride a long distance after arriving at their destination before they can stop and lock their bikes, which makes the original convenience plummet. For example, when cycling on certain streets in Beijing, the parking area shown in the positioning is on the opposite side of the road, but there is no crosswalk nearby, so the user needs to make a big detour to pinpoint the right parking area.

3.2. Bicycle-Sharing Strategies

3.2.1. Shared Bicycle Parking Strategy

In order to solve the problem of haphazard parking of shared bicycles, some relevant measures have been introduced. As the previous bicycle positioning system only reads the final parking coordinates at the end of the trip, without restricting the user's parking position, resulting in the phenomenon of haphazard parking breeding. Now the user must ride the bike to the designated parking area, according to the positioning to determine whether to meet the parking demand, only sensed the legal parking area, can be locked. Beijing Bicycle Association has also issued the Beijing Regional Internet Leasing Bicycle Industry to regulate user parking behavior joint restrictive covenant to urge users to civilized riding, according to the requirements of orderly parking. Users who illegally park their bicycles outside the electronic fence would be forced to find a regular parking spot again through APP pop-ups and SMS reminders, and violators will be fined a fee ranging from 5-20 yuan.

3.2.2. Bicycle Sharing Placement Strategies

The current placement of shared bicycles is mainly based on the size of the city, road traffic, and surrounding facilities to determine the placement of points and scale, but there are still many unreasonable places. Every night, workers regularly replenish enough bikes in major public places, while during the day, they rely on the flow of people to maintain the number of shared bikes in each spot. Most companies will calculate the target audience, make an assessment of the budget and markup, and then determine the number of bikes to be deployed under the maximum profitability scenario before officially launching them. A large number of shared bicycles in economically developed first-tier city areas with large populations are left unorganized, while there are few shared bicycles in less crowded suburbs or in second- and third-tier cities where there is still some demand for shared bicycles.

3.2.3. Bicycle-Sharing Recycling Strategies

For malfunctioning or abandoned shared bicycles, most regions recycle them at specialized recycling centers. Shared bicycles being recycled are mainly divided into several types. (1) When users find an unusable bicycle, they report the location of the vehicle in the app, and the back office collects and sends it for repair based on the location. (2) Bicycles that have reached the end of their service life and may have potential safety hazards should be recycled periodically. When recycling, firstly, the enterprise sends workers to the bicycle according to the location of the bicycle that needs to be recycled, and then sends them to the maintenance center uniformly after going to all the marked points. However, this strategy has many drawbacks: (1) Since the submission of damage reports is not mandatory, many damaged bicycles cannot be found in time. (2) Uneven bicycle parking locations and large changes in recovery routes increase the labor and resource costs of recovery. (3) The

capacity of single recycling is limited, which may not be able to complete the recycling of all vehicles in time.

4. Discussion

4.1. New recycling processes

To address the current defects of damaged shared bicycle recycling, we propose to increase the number of recycling stations in the city. The researchers use K-means analysis to re-optimize the site selection of recycling centers, calculate the site selection with the orientation of saving transportation costs, and propose to subdivide the recycling area of shared bicycles, and set up corresponding recycling stations in the corresponding location of each area [9]. The corresponding person in charge of the daily manual re-inspection of the degree of vehicle damage along the route of the regional drop-off point at a fixed time and enter the information, and the trucks will then be recycled according to the route after the re-inspection, which will be able to accurately screen the broken bicycles and improve the operational efficiency.

4.2. Distribution of bicycle drop-off and parking points

Because the usage and return volume of shared bicycles are highly related to the layout of public facilities in the urban built environment [10], this paper suggests considering the layout of facilities in the city to arrange the placement points and parking points. For example, using transportation zoning as a spatial unit division method, the POI data of transportation facilities, scenic spots, enterprises, education, residences, culture and sports in different urban areas are partitioned to calculate the ratio of usage and return volume, and the placement points are scheduled according to the calculated ratio. In locations with particularly high foot traffic, at least multiple parking spots need to be set up within every 50 meters. In addition to the first-tier cities, the same calculation should be done for second and third-tier cities, and the number and location of parking spots should be reasonably planned. Adequate transportation facilities should be provided for people traveling to neighboring cities. At the same time, vehicle restrictions should be imposed on the planned placement locations to avoid the accumulation of vehicles.

4.3. Parking options

The positioning error of the electronic fence can now be solved with AI accurate positioning, the platforms should update the GPS positioning system in time to reduce the inconvenience caused by the positioning error cannot be parked. In order to reduce users as before forced into the already full area, but also allow users in a hurry to park quickly, companies can give a certain discount to regulate the parking of users, and the unregulated area of the lock will be a reminder of the message will pop up once, and after that to confirm the lock will be based on the distance from the parking spot to deduct the corresponding cost. This can encourage more people to look for standardized parking spaces, while avoiding the embarrassing phenomenon of not being able to find a space to park a car, app developers can also introduce a new feature to correct the location of the parked vehicles, when users find illegal parking phenomenon, the software to choose and ride the car to the corresponding standardized parking spot can get a discount for the next ride. If big data can be reasonably utilized to locate each vehicle, managing shared bikes would become easier.

5. Conclusion

This paper mainly discusses the impact of bike sharing on cities on a global scale, analyzes the problems and strategies of the current situation of bike parking, and proposes a new management approach to recycling and placing shared bikes, and hopes that this research will provide ideas for solving the parking problem in the future.

The emergence of shared bicycles has brought great convenience to people traveling. However, as the number of bicycles gradually exceeds the demand, irregular parking and vandalism have a serious impact on the appearance of the city. In addition, shared bicycles are often vandalized, resulting in a waste of resources as they cannot be recycled on time.

At present, there is an imbalance in the rental and return of shared bicycles, that is, in different areas, the utilization rate of shared bicycles varies greatly. At this time, there would be some users cannot rent a car. In addition, there is also the problem of irrational distribution of parking spots for shared bicycles, with a large number of parking spots clustered around public transportation stations and fewer parking spots elsewhere along the way, resulting in some users not being able to park their bicycles promptly. In response to these problems, administrators have used a variety of different countermeasures, increasing the amount and scope of placement, enhancing supervision and restricting user behavior on the app. However, most of the existing bicycle launching and parking points are concentrated around commercial and public transportation stations, and even if platforms adopt measures such as conventions and fines to restrict users, they still cannot solve the problems of massive accumulation of bicycles and indiscriminate parking.

This paper suggests the use of traffic zoning-oriented distribution of facilities within the spatial unit to calculate the parking point distribution model, in each line of the city according to the need to arrange parking spaces. For the recovery of abandoned vehicles, we also carry out corresponding zoning to increase the number of recovery points and manually enter the information to increase the efficiency of recovery. In addition, in order to regulate parking, we suggest that companies can promote standardized behavior by issuing discounts and, under reasonable circumstances, imposing fines or deducting credit for users who violate the norms. In the future, bike-sharing technology should combine big data with advanced algorithms to maximize usage efficiency. At the same time, enterprises, users and the government should cooperate to strengthen supervision, management and law enforcement, and establish an efficient and reasonable operation mechanism, to give full play to the value of bike-sharing as a mode of transportation in the city.

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