

Study On The Design Of Car-Sharing Parking Space In The Background Of Smart City--A Case Study Of Suzhou

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Abstract—With the rapid development of shared cars in big cities, the contradiction between shared transportation and traditional transportation space is increasingly prominent. This paper is a case study of Suzhou that analyses the current problems of car-sharing parking space and therefore puts forward some optimization suggestions of the car-sharing parking space design under the background of smart city, hoping to provide some reference for the development of shared transportation.

Keywords- Smart City; Car-sharing; Parking Space; Design

I. INTRODUCTION

The concept of sharing originated in the late 1970s. In 1988, the world's first listed car-sharing company was established in Germany. Car-sharing services have gradually sprung up in countries such as Japan, Singapore and France since 1997. As of October 2012, car sharing service has been provided in more than 600 cities around the world. China's car-sharing industry began in 2011, which started from a few sporadic businesses, offering users kind of traditional car rental service. In the second half of 2015, this service was gradually integrated with the Internet, through which car reserving, pick-up, and returning can be completed through mobile devices, thus shared cars came into being.

The concept of smart city is generated as the development of computer and network technology. On February 24, 2009, IBM (International Business Machines Corporation) proposed "Smart City Wins in China" in China, afterwards China entered the development of smart cities. Smart city is built on the basis of big data of the Internet, which is through the Internet of Things, cloud computing, artificial intelligence and other information technology to build communication and connection between people and things, things and information and information and people, thus helping to urban management and optimization. From 2009 to 2017, more than 500 cities in China have put forward policies for the construction of "smart cities".

Under the development of smart cities, shared transportation has ushered in a new opportunity for development. The smart city's network infrastructure and information processing framework provide great convenience and large-scale application possibility for shared transportation. However, the contradiction between the shared transportation space and traditional one is bound to deepen meanwhile. Since at the beginning of traditional transportation space planning, there is no shared

transportation space and its corresponding infrastructure, resulting in the situation of shared transportation largely occupying urban public space. This series of contradictions not only limits the development of shared transportation, but also brings new urban problems. Therefore, this paper attempts to take Suzhou as an example to study the connection between smart cities and shared transportation parking space, aiming to strengthen the application of smart cities and promote the healthy development of shared transportation.

II. OVERVIEW OF THE DEVELOPMENT OF SHARED CARS AND ANALYSIS OF PARKING SPACE PROBLEMS IN SUZHOU

A. Overview of car-sharing development in Suzhou

As one of the first pilot cities of national smart cities, Suzhou boasts the fastest development of shared car in Jiangsu Province. At present, there are 3 or 4 companies engaged in the business of shared automobiles in the Suzhou market. The brands of shared cars mainly include Evcad, GoFun, Linkage Cloud and Youon, among which the mainstream models are new energy electric vehicles. Taking Evcad, which provides electric car hourly leasing service, as an example, its scale of service network, registered users and vehicle amount have grown rapidly since it entered the Wuzhong District of Suzhou in 2016. There are 122 open service network sites in downtown Suzhou, with large and small ones covering all administrative districts, showing a distributive situation of more in suburbs and fewer in central urban areas. There are 18 service network sites in Gusu District, and totally 104 in Huqiu District, Wuzhong District, Xiangcheng District and Wujiang District. Among them, Wuzhong District is the area with the largest number of service network sites, up to 39. The number of service network sites in the entire Suzhou area reaches 283, with the number of shared car users in Suzhou exceeding 100,000. Such rental service network sites continue to increase at a speed you can't imagine.

B. Analysis of the status quo problems

According to the field research on the existing car-sharing parking space in Suzhou (Fig. 1), we find that the research on shared transportation parking space mainly contains the following problems:



Figure 1. Current status of shared parking space in Renmin Road parking lot and SM Plaza parking lot

1) In the overall layout design of shared car parking space, the current research does not make a comprehensive study on the differences of elements such as shared transportation space, type of urban land use and population distribution. The layout of some car-sharing service network is unreasonable, which makes shared car charging and parking difficult. Besides, the existing parking space cannot meet the parking demand, while the car ownership continues to grow, thus the problem of sharing car parking difficulties in the future will be more serious. A series of contradictions between shared transportation space and traditional traffic space not only failed to solve the existing problems of urban traffic, but also increased urban traffic congestion and urban environmental problems.

2) Because attention paid to the design of shared traffic parking space is not enough and the parking space lacks adequate functions, most of the shared parking space relies on traditional parking lots to open up specialized parking spaces. But mixed parking with traditional cars can no longer meet the space requirements of shared transportation modes. Most of the research on shared transportation stays in the operation mechanism and service flow of shared transportation while few studies are carried on the shared parking space.

3) Intelligent supporting equipment can't meet corresponding requirements. The concept of information technology has not been fully applied to the existing parking facilities. The city has low application rate of indicative signs and mechanical parking facilities. And the establishment of unified parking information platform is not perfect, resulting in low utilization rate of some parking facilities and parking lots, which do not play its due role in the tense areas of in the downtown city. What's more, most of the parking facilities are semi-automated by computers, and the operation of parking and picking up vehicles are so complicated that needs some full-time management personnel to operate on the side, which increases the management cost of the parking facilities.

III. DESIGN IDEAS FOR CAR-SHARING PARKING SPACE

In view of the above status quo, whether it is Suzhou or other first-tier and second-tier cities in China, solving the parking space problem is the key to the healthy development of shared automobiles. In the urban area where

parking spaces are scarce, how to expand the parking space of shared cars is a topic worthy of in-depth study and discussion.

First, the potential of existing parking lots should be fully explored to improve resource utilization efficiency. Learning from the "parking shift" method in Shanghai parking space, which is also known as "zip parking" abroad, the use of parking resources can be maximized. The core of "zip parking" is "sharing", that is, parking people can share various parking lots, especially the sharing of public parking lot facilities. Obviously, shared parking can tap onto the urban construction and public parking space resources, and maximize the utilization of space and time resources for parking lots. Based on this idea, regional shared planning and design can be implemented in the parking space of the relevant building resources such as commercial offices, residential areas, hospitals, catering and entertainment buildings which are suitable for sharing conditions in Suzhou city.

Secondly, moderately reconstruct the existing shared parking space. Unlike shared bicycles that can be parked anywhere and occupy small space, shared cars require certain parking space. The connection between the car sharing parking mode in the parking space and the traffic flow line and other functions can affect the utilization rate of land resources and the utilization rate of the vehicles. At present, the parking space layout of vehicles mainly includes three types: parallel parking, diagonal parking and vertical parking. Each parking mode has its different characteristics: the advantage of parallel parking is that it is convenient to access the car, the construction cost is low, but the land utilization efficiency is low; the vertical parking can achieve high land utilization rate but its construction cost is high. Due to the different parking heat in urban space, the design of parking space for shared traffic should be tailored to local conditions. On the one hand, in the bustling downtown area of the city, land resources are scarce and expensive. Thus, the design of parking space for shared vehicles should focus on the vertical space for multiple-facets development and rational utilization. On the other hand, the shared parking space should be designed to the horizontal space of the ground in the suburbs or scenic areas where space is relatively abundant, as is considered from the perspective of cost saving.

1) Design of car-sharing parking space in the core area of the city

At present, the parking space in the central city of the big city itself is very scarce and high-demanding. It is obviously difficult to achieve to separately allocate certain parking area for the shared cars. With the gradual increase in the utilization of urban central space, public facilities in the downtown area tend to be highly space-efficient. It adds more possibilities to utilize the vertical space while reducing and streamlining the original parking lots under the premise of its unchanged functions. The parking space design plan should be based on miniaturization and

spatialization. We should make good use of roadsides, Hutongs, or a cobblestone alley, and open spaces in the communities. With vertical design as the design idea, the number of parking lots will be increased to solve the parking difficulties with the ground occupancy rate unchanged.

For example, in some commercial districts, office buildings and core residential areas in downtown Suzhou, we can learn from Japan's experience in establishing an automated three-dimensional parking space to make full use of the potential parking spaces on the roadside, especially to assemble self-propelled three-dimensional parking lots and mechanical parking lots that maximize space utilization. (Fig. 2)



Figure 2. Mechanical parking lot

2) Design of car-sharing parking space in the suburbs

In areas where the traffic density in urban suburbs is relatively small, such as in many surrounding areas of colleges and universities in Suzhou, or in suburban commercial spaces, considering the construction cost, we can learn from the "slanted parking system of topography elevation difference", a research project of the Housing Management Office of Haishu district, Ningbo. This pilot project has been built in the temporary parking lot of Shangshu Street in Haishu district.

"The construction of slanted parking system of topography elevation difference" is a double-slope parking lots constructed from reinforced concrete (Fig. 3), similar to the diagonal baffle shoe cabinets in the resident's home. In the same plane, the front side is inclined to the ground 11 degrees to "borrow" 1.2 meters of vertical height space; the reverse floor is raised 1 meter, and then 11 degrees obliquely to construct a corridor-like space. In this way, the lower parking space gets a height of 2.2 meters. When parking on the upper and lower floors, the vehicle can be moved up or down from the slope. Taking advantage of the terrain gap, the driver can park one car at a time on the same plane without waiting. Considering the upper parking slope, each parking space can be equipped with protective devices

such as rubber anti-slip strips and tire stoppers, and the column is covered with anti-collision facilities. Compared with the mechanical three-dimensional parking garage, the parking in the slope parking garage is convenient and the cost is lower. The average cost per berth is about 20,000 RMB, which is about half of the cost of the mechanical three-dimensional garage, and the number of parking berths can be increased by at least half.



Figure 3. The construction of slanted parking system of topography elevation difference

3) Suggestions for design of car-sharing parking space in future cities

The design of shared transportation space environment will become a major component of urban public space design in the future. The shared traffic space design should be placed in the plan of overall environment of the city, and public transportation space should be reserved. It should be taken into consideration in the early planning, and evenly arranged in large commercial areas, office areas, parks and greening area. For the design of future shared parking space in cities, we can be bolder in learning from some advanced foreign intelligent parking lots, such as the new parking lot of Volkswagen at Wolfsburg, which has two 20-storey 42-meter-high cylindrical glass car towers, with each tower storing 400 vehicles (Fig. 4). This parking lot full of technology is mainly to exhibit the new car of Volkswagen. The robot arm in the center of the transparent building can transport the cars of the underground parking lot to the exhibition center upstairs at a speed of 2 meters per second. The construction of this parking lot is very significant for the exploration of the automatic parking technology in the new era and also opens up brand new ideas for the parking space of shared cars.



Figure 4. New parking lot of Volkswagen at Wolfsburg,

IV. INTELLIGENT EQUIPMENT FOR SHARED TRANSPORTATION PARKING SPACE IN THE CONTEXT OF SMART CITIES

1) Intelligent parking management technology

The development of intelligent parking system needs no management personnel, and the car owner can complete the car parking and pick-up just by pressing two buttons; it also has infrared scanning and monitoring functions to ensure the safety of the owner when parking and picking up the vehicles, and reduce the risk of the previous public parking facilities; At the same time, the indicative signs are also placed on the facility. During the driving process, the number of empty parking facilities and the charging situation can be directly acquired, so that the driver can choose whether to park on the device or not; the shared transportation station parking space is equipped with an automatic sensor to identify whether the vehicle's model matches the charging facility. Besides, the sensing system also automatically detects and synchronizes the vehicle conditions to the shared transportation station space system and automatically charges the vehicles. If there is a safety hazard in the parking cars, the parking space will automatically report it to the maintenance station, where there will be specialized personnel to have the car repair.

2) Intelligent App management system

With Apps designed to share parking facilities, real-time parking conditions and equipped with navigation search and other functions, users can use the software to view parking conditions and location, then quickly find parking facilities near the destination, thus achieving the concept of "cloud parking."

3) Green energy supply system.

Solar energy is the first choice for green eco-energy since in the process of generating electric energy, no harmful objects are generated and it is not affected by geographical regions and is convenient for conversion. The most common solar technologies on the market are solar cells and solar films, which are guided under the photovoltaic volts principle that directly converts solar energy into electrical energy, thereby charging the battery. In the design and application of shared parking facilities, it is conceivable to attach solar film to the top of the carport to

store solar energy, thereby providing electrical energy to the engine, moving bearings and other functions in the facility.

V. CONCLUSION

In general, car-sharing development in China is still in its infancy. On the one hand, shared cars can effectively reduce the number of urban motor vehicles, improve traffic flowing efficiency, alleviate air pollution, and will also play a positive role in energy conservation and environmental protection. On the other hand, the overall development of shared car still faces severe challenges, and a series of problems like parking difficulties have become the bottleneck for the development of shared cars. However, relying on the development of 5G network, Internet of Things technology, smart city and the development of shared car parking space in the future, the future of shared transportation is worthy of unlimited prospects and expansion.

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