Product Service System Design Research of B2C Carsharing Based on Beijing

YING Zhao\textsuperscript{a} and GUANZHONG Liu\textsuperscript{b}

\textsuperscript{a} Guangdong University of Technology, China
\textsuperscript{b} Tsinghua University, China
* Corresponding author: wuyue8656@163.com

B2C carsharing is a kind of green and sustainable way to travel in worldwide. It has developed very rapid these years in Beijing, China. However, there is a lack of research on B2C carsharing from product service system (PSS) perspective in Beijing, which is a rapid developing, densely populated Asian city with a large number of vehicles. Therefore, this paper first analyses the current situation of the development of B2C carsharing in Beijing, and summarizes the characteristics of user groups, the product service system model, and the feature of car and service environment. Then taking a typical brand as a case to elaborate the system in more detail. Based on the refinement and generalization of the existing problems, we proposes the future design recommendations for the development of B2C carsharing from a PSS view in metropolitans like Beijing.

\textit{keywords: B2C carsharing; product service system; Beijing; user experience}

Introduction

Carsharing is a type of short-term vehicle access upon which a multitude of business models are based (Shaheen et al., 2015). It originated in Europe, from the late 80s of last century, a large number of sharing cars developed in Switzerland and Germany, while it appeared at Asian region in the year of 90s(Shaheen & Cohen, 2008). Carsharing provides user fewer ownership responsibilities, and less cost. Societal benefits include less demand for parking space and the indirect benefits resulting from costs being more directly tied to actual usage and vehicles being matched to trip purpose (Shaheen, Sperling & Wagner, 1998). The driver of the carsharing organization can reduce about 51% of personal traffic energy use and greenhouse gas emissions (Chen & Kockelman, 2016). A Sharing car can
replace 4-10 and 6-23 private cars in Europe and North America (Shaheen & Elliot, 2006). Different with the traditional car rental business, sharing car not only can be rented by year, month, week and day, but also provide hour rental business.

B2C is Business to Customer. The key point of B2C business models is that a company distributes the service by supplying acquired vehicles throughout a city, and the service is mainly for maximizing profits as well as supporting sustainable mobility (Cohen & Kietzmann, 2014). Product service system (PSS) concept is an emerging field of inquiry based on functional thinking (Mont, 2004). PPS system as a system of product, service, networks of actors and supporting infrastructure that is developed to be competitive, satisfy customers and be more environmentally sound than traditional business models (Mont, 2001). Carsharing is a kind of use oriented PSS. It is a system in which a service is shared amongst users to replace a product (Centenera & Hasan, 2014). We think that PSS of B2C carsharing means a carsharing integrated system, which is operated in B2C mode, mainly includes car, special parking space, user, the leasing platform and so on. Some scholars have done research on PSS of B2C carsharing and its development. Oksana Mont elaborated B2C carsharing from product service system perspectives, and analysed in-depth about institutionalisation, PSS framework, PSS feasibility of B2C carsharing (2004). Nicola Morelli put forward methodologies and operational tools that can be applied to the research of vehicle sharing product service system (Morelli, 2006). Robin Chase suggested that Zipcar (B2C carsharing service system) is more popular with young people who are willing to accept new things (Chase, 2016).

Beijing is the capital of China, where the population density is high. According to Beijing Municipal Bureau of Statistics and NBS Survey Office in Beijing (2016), by the end of 2016, Beijing resident population is 2172.9 million. At present, like other cities with rapid development in the world, traffic resources and road resources are one of the bottlenecks in the development of Beijing transportation. Statistics of Chinese Traffic Management Bureau of the Public Security Ministry show that as of the end of 2016, car ownership of Beijing is 560 million, ranking first in the country. However, there are currently about 320 million parking spaces in Beijing, lack of 260 million (Zeng, 2016). And the cost of parking is high in the city. To control the rapid growth of the vehicle, Beijing has implemented car restriction via a lottery system. At the same time, due to the smog is more frequent in recent years, the community and governments at all levels are also increasingly concerned about the green process of transportation. The rise of traffic demand is much faster than the speed of traffic supply.

It is not efficient only by increasing the number of roads. It is very important to improve the level of the utilization of the traffic resources through the reasonable urban planning (Downs, 1962). In this context, the green way to travel – carsharing mode in support of the government is growing up fast in recent years in Beijing. Actually, there’re some scholar who have done some research on carsharing in Beijing. In 2006, Susan made a survey of the feasibility study of car sharing service in Beijing, to infer the potential market of car sharing service there, and to provide a basis for the development of car sharing. Through the investigation and analysis, there are more than 25% of the respondents who are willing to accept the sharing of cars. Among them, the higher income and education level of respondents are more willing to accept the carsharing (Shaheen & Martin, 2006). Xia Kaixuan with the method of empirical research, taking Beijing city informal car sharing
service as the object, makes an empirical analysis on the level of service, and focusing on the factors influencing the quality of service evaluation (Xia & He, 2006). B2C carsharing emerged in China in 2010 (Li, 2015). From about 2015, the development of B2C car sharing organizations (CSOs) in Beijing have becoming very rapid, more and more people choose to share the car for daily trip. It appears many new situations and characteristics which are different from Europe and America. As a typical super city of the developing countries, the travel problem of Beijing is very reprehensive, in great need of exploration and mining. The product service system of B2C carsharing in Beijing is worthy researching in-depth. Therefore, we analyses through a lot of field research in Beijing area of existing B2C CSOs, and put forward the corresponding development suggestions, in order to have some inspiration and help for the research in the future.

**Methodology**

Carsharing is a kind of service. In service design, compared with quantitative research, we emphasize the qualitative research methods, which means qualitative research is more than quantitative research (Polaine, LØvile & Reason 2015). Therefore, besides large of literature review, we also do the observation, depth interviews and service safari to survey. The survey was implemented in Beijing, between October 1, 2016 and March 15, 2017. We chose three typical special parking place to do the observation and depth interviews in the northwest, northeast and south of Beijing. Respondents for depth interviews includes 20 users of five B2C CSOs, 3 maintenance personnel of different CSOs and 4 staff of the parking place. Otherwise, the author also use the method of service safari to experience the whole process of B2C carsharing service system in 4 CSOs for 8 times in Beijing.

Meanwhile, on account of lack of in-depth cooperation with B2C CSOs, it’s hard for us to communicate with large number of users to fill in questionnaire to obtain high reliability data. Quantitative research will be further improved in the future.

**Analysis on the present situation of PSS of B2C carsharing in Beijing**

**Rapid growth phase**

The PSS of B2C carsharing is developing rapidly at present. In recent years, under the encouragement and support of the local government, a large number of brands of B2C carsharing have established and developed rapidly with the help of mobile Internet in Beijing. As of the end of 2016, all of Beijing’s current B2C sharing car network has developed to a few hundred, there are more than 2000 sharing cars in Beijing (Liu, 2016), and about 6000 sharing cars for civil servant (Liu, 2016).

**High level of intelligence**

At present, intelligent trip is as a brand feature for lots of CSOs in Beijing. Its intelligence embodied in different aspects, mainly as follows:

- Carsharing services are basically based on the mobile internet. As of December 2015, Beijing has more than 80% mobile Internet users (Wang, 2015). Therefore, at present, most carsharing users in Beijing can complete whole process of renting
car through App of CSOs or WeChat (Chinese largest cross platform communication tool) using smart phone.

• Vehicle networking technology is widely applied. In China, there’re three major themes in automobile Industry 4.0, they are smart factory, smart logistics and internet of vehicles. In carsharing industry, internet of vehicles is very significant. It helps to realize constant communication among driver, backstage management, as well as vehicle. Backstage managers can achieve to remotely control the vehicle, engine monitoring, etc. In addition, the state of the users and vehicles can be real-time known by background managers. So as to achieve real-time location of the vehicle, no stores, unattended, no need to manually transfer the key.

• Almost no face-to-face service. There is almost no staff to do face-to-face service for users, in addition to a few other certification processes, users are prompted to complete the whole rental process through self-service operation in most PSS of carsharing in Beijing. Compared with other countries and other Chinese cities, there is rarely face-to-face service between the user and staff. The intelligent level of the system is relatively high.

*Provide relative software and hardware services*
Some CSOs with strong technical background have develop relatively mature intelligent system. So they not only provide car rental services for tenants, but also the business of hardware and software services for other carsharing companies, including the development of APP, operation support system, risk control and credit system of intelligent vehicle and periphery equipment and so on.

**Analysis of the typical PSS model of B2C carsharing in Beijing**

*The main PSS model*
At present, the common PSS mode of the B2C carsharing in Beijing area is usually carried out around three stakeholders, namely, user, car leasing platform and car group. The user need to upload personal information, and pay rental fees and deposit to the platform by smart phone. They can also constantly know the information and condition of car which they want to rent on the phone, and fetch or return the car directly in special parking place. The platform will be able to know the information of all the cars and control them remotely. The car group consists of several special parking place and 1-3 staff members. Usually, staff will be responsible for surrounding parking place, while generally will not appear in the parking place. Checking, scheduling and cleaning up the car after using is their mainly job. See the following system map Figure 1.
The type of fetching and returning the car

Fetching and returning the car is the key link of PSS of B2C carsharing. For the users, the convenience of fetching and returning the car directly affects the usability and user experience of the whole product service system. There are mainly three types of fetching and returning the car in Beijing, as described next, see figure 2.

1. Fetching and returning the car both at A point (A-A). That means user must fetch and return the car in the same special parking place (Pandavc, 2016).
2. Fetching the car at A point while returning it at B point (A-B). B point is another special parking place, which may be near user’s destination.
3. Fetching the car at n point and returning it at n point (n-n). It means that user fetches the car parked by last user at any legal parking space (including special
parking space), and return it at any legal parking space (including special parking space) as he/she want. The user need to pay extra fee for parking according to the distance to the nearest special parking space.

![Figure 2](image)

Figure 2  Graphic expression of three main types of fetching & returning. source: the author

5. Under normal circumstances, type n-n is the most convenient way in three for user, and type A-A is easier to manage and spends less on vehicle scheduling. Almost all CSOs using battery-powered all-electric car like to apply type A-A & A-B, for there is always charge pile in the special parking place. While most CSOs using fuel car always choose n-n type.

Research on the characteristics of product and service environment

As a complete product service system, in the B2C sharing platform, the car should be the most important product. In addition, special parking place as the service environment, is also the thing that matters. Based on the field investigation, the author analyses the current characteristics of B2C sharing car and leasing environment as follows:

The sharing car

- Battery-powered all-electric car. In addition to a few brands, most of the current sharing cars are all driven by the battery, which have achieved zero emissions in the driving process, and is beneficial to the ecological environment protection. At the same time, due to the support of the new energy vehicle policy in Beijing, they will not be restricted by the limit line policy, and can be driven every day on the road.

- Existing models. The development of carsharing in recent years is extremely rapid, and it will spend tremendous amounts of human capital and physical capital to develop a new car. So currently, most CSOs choose existing electric cars made in Beijing, which is helpful for the development of local automobile enterprises, and has led to coordinated development of regional economy, in line with the concept of sustainable development. The appearance of the vehicle is mainly white body with colour pattern decoration. Currently, most of the leasing platform uses a white vehicle, the brand logo, slogan and two-dimensional code and other information as the colour decoration on the body of the car, which looks clean and vital.
• Special interior design. Most of sharing cars have special interior design to increase the necessary items for leasing. Generally, that will include system hardware, driving tips, service products and other small items for driving.

Special parking place
Special parking place may include special place to park, charging pile, Instructions and billboard. Currently, most of the special parking places without staff on duty, but in order to format parking place, provide convenient service for user to find the car easily and promote their own brands, some CSOs draw special pattern in the rental site.

The main user groups in Beijing
User is one of the most important stakeholders in PSS of B2C carsharing. Through the author's survey, it is found that, in addition to the characteristics of higher income and higher education, due to the new policy and cultural characteristics of the Beijing, the main user groups in Beijing also have following characteristics:

Group affected by limit line policy
In order to ease traffic conjunction, Beijing Traffic Management Bureau established limit line policy to restrict the number of cars on the road. Most of the private car owners who are limited by the policy have rigid demand to drive the car, so lots of them attempt to choose carsharing.

Diverse needs groups
Compared to other small and medium-sized city, Beijing has more diverse group of customers. From daily commute to short-term tourism, from ferrying kids to business trip. There’re many situation to use car and subdivision of user group. Typically, such as civil servant group, some government departments currently have replaced original cars to electric sharing cars.

Characteristics of rigid demand group
In the diverse needs groups, we have found a part just needs group who use sharing car relatively frequently. We should pay more attention on them. Most of them are young and middle-aged men and college degree or above through the survey. Long-term (more than 7 days) and 1-3 hours is the majority pattern of leasing.

There’re two kinds of rigid demand group through our survey. The first one is people who want to drive but without a car currently. The survey shows that many users tried to drive sharing car to practice driving. For there have been more than 2 million drivers who were waiting for buying a car from the statics of Beijing lottery system for car (Beijing, 2016). So there’re large number of people who have demand of driving in Beijing. The other group is people who own a car but cannot drive it temporarily. Usually, owing to car registration, weather cause (smog) or family need to drive.

Typical case analysis: UCAR
UCAR carsharing platform was founded in Beijing in 2015. All of the sharing cars in UCAR are battery powered. At the beginning, most of special parking places are mainly distributed around universities, research institutes in Beijing. Nowadays, UCAR has located both in Beijing and Guangzhou city in China. There’re more than 60 special
parking places in Beijing now. At present, UCAR use two types to fetching & returning the car, A-A and A-B.

Analysis of the main process of PSS in UCAR
As can be seen from the following diagram (Figure 3), besides “Auditing on line” and “cleaning up” (blue square), all necessary touchpoints (green square) and possible touchpoints (yellow square) are all above “Line of visibility”, which can be seen by users, and also, users can complete most of processes on smart phone and illustration in car. Hence, if there is no special need, user do not have to talk with the staff face-to-face. For most experienced users, self-service way is very convenient and efficient. While it is a little difficult for some fresh driver.

![Diagram of PSS in UCAR](source: the author)

Figure 3  main flowchart of PSS in UCAR. source: the author

Problems finding
Since the B2C carsharing is a new thing in China now, many operators are groping forward. We found that there is great room for improvement.

The problem of redistribution and use of existing resources in PSS of B2C
The contradiction between existing limited parking spaces and new special parking spaces, and the related problems bear the brunt. Special parking space is the necessary infrastructure for the development of B2C sharing platform, but also a scarce resource in Beijing. The parking spaces in the centre of megalopolis are always quite under strain. However, the new sharing cars are bound to some of the parking spaces, and dense special parking places is one of the most important evaluation criteria of well leasing experience for user.

Vehicle is one of the most important resources of CSOs. After investigation and analysis, it is found that most of the CSOs have encountered some common problems in the operation about vehicle. Firstly, the contradiction between the large number of existing vehicles and the new sharing cars. Vehicle registrations restrain the rapid growth of
automobile, while B2C carsharing mode requires new cars. So it is very important to coordinate the growth of the number of private cars and sharing cars. In addition, the current models cannot fully meet the needs of B2C. Currently, most of CSOs use existing all electric vehicles for operation, yet they are not design for sharing. Although the installation of some hardware and software, many of the existing vehicles still cannot fully meet users’ needs. For example, most existing model is too large, Low brand recognition, and the hardware of car networking is easy to be stolen. Moreover, most platforms offer a limited range of models. Different from the traditional car rental industry or Peer-to-Peer mode, user can choose the type of vehicle is relatively limited on most B2C leasing platform, which cannot fully meet the needs of existing users.

**Issues about user experience in the PSS of B2C carsharing**

User experience counts for a great deal in the PSS of B2C carsharing. ISO 9241-210 (Ergonomics of human-system interaction) defines user experience as “a person’s perceptions and responses that result from the use or anticipated use of a product, system or service”. As for User experience of B2C carsharing, there is not an authoritative definition of it. The author suggests that it could be users’ (mainly driver’s) feeling, feedback of the whole process of renting, which including register, car choosing, picking up, starting up, driving, charging, parking and returning, etc.

Driving is the most important part of the whole experience. Is self-service operation without any artificial services the only shape of things to come? Contradiction between a high degree of intelligence and driving safety is noteworthy. The intelligent service system make people travel more convenient and faster, however, is complete intelligent process a great user experience for everyone? It is a problem worth meditative. The safety of the vehicle driving is always the first priority. At present, most CSOs can provide complete intelligent PSS of B2C carsharing. Yet the vehicles are not familiar with most new driver, which may easily cause fault even danger.

Secondly, the current internet of vehicle system is not perfect, which need to be improved in the future. Especially from the process of fetching the car to returning it. For example, navigation for finding car is very necessary for users who are unfamiliar to road, which is worth to perfect. Otherwise, operation guidance system is essential for fresh drivers. Relevant signage system design is important. Moreover, due to few immoral users’ destructive behaviour to the car, monitor system should be pay more attention. Besides, public service platform and vehicle evaluation system is still not completed. So it is lack of channels to understand the specific condition of the car and operation details for users.

**Recommendations and Prospects**

**Integration or cooperation**

Density of special parking place greatly affects the user experience for the use of the whole system. Usually, small CSOs are difficult to bear a large number of vehicles, parking and other costs. Powerful CSOs always means more cars, special parking place and better technical support than small one for user. Therefore, we think that the integration or cooperation with others will play an important role.
There are two parts of notable powers, enterprises and government. Proper enterprise partners will provide technology, capital and human resource. And the strong support and in-depth cooperation of government departments can bring more policy support.

**Further perfection of the service system**

As the majority of B2C carsharing companies in the early stages of the establishment, with the further development of the industry and related technologies, many details of service system need to be improved and upgraded. For example, the relationship between intelligent control and face to face services in the platform system. We proposed to retain the important characteristics of the intelligent, at the same time, pay more attention to consider joining the necessary manual service from a security point of view. Appropriate face-to-face and voice communication is better than pictures and text for dissemination of information. In most cases, proper voice prompt and face-to-face service is very useful for fresh users. Simple training, detailed voice security tips, etc. for initial users may be helpful. In addition, it is noteworthy to establishment evaluation system, which will help users to understand the vehicle and the platform operation easily, and the platform can get timely feedback.

**Innovative car design for sharing**

Although the high cost of vehicle development, this paper suggests that overall design of the vehicle might be done for sharing from a new point of view, which may be considered from the following aspects: subdivision, appearance, Interior and brand. Based on the diversity of the group, user subdivision before design is very significant. Just like traditional vehicles, finding sub-groups according to research on different users’ purpose, income and habit to design different types of carsharing is necessary. It is able to meet the diverse needs of different groups. The appearance should be designed small and compact, so that it can be easy to drive and park in the crowded city. Furthermore, it would be better to be more characteristic on shape, colour and other aspects, which will help to distinguish carsharing on the road from other vehicles. Sharing car is kind of unique temporary private mobile enclosed space to the public. There are always different users to drive the car in it at different times. So we should fully take into account the behaviour and experience of different users in the car before designing interior. For example, more effective security tips, hardware concealment and other issues. Finally, Unified and distinctive brand design is also a great part of the product service system, ought to be put more effort, including App, the body of the car, special parking place and so on. So that vehicles will be more distinctive and recognizable. Currently, the overall design of the vehicle for the sharing is still relatively rare for China, a market with great potential, which might be paid close attention to.

**Conclusion**

Under the background of advocating harmonious development of economy, environment, society and science, carsharing mode is one of the most important sustainable development directions in auto industry in the future in China. Sharing car can’t replace traditional car, but is an important complement to existing travel modes. In addition, at present, the traditional models of automobile enterprises have been facing serious overcapacity in many countries. Transformation and upgrading is imperative, and sharing
Car may be another export. Some forward-looking companies have begun to get involved in the field of carsharing, such as Mercedes Benz, Volkswagen, Honda, Nissan, etc.

In today's world, car is not only the symbol of status any more, but also it can bring a driver valuable personal space and convenient travel experience. So it allows people to continue to pay attention and exploration since invented. Drivers in Beijing area also have a huge demand for cars, yet at the same time, as a super big city, Conciliating and relieving the traffic contradiction is imminent in Beijing. And such a violent conflict has become inexhaustible power to push pioneer in this industry and users in Beijing region to jointly promote the development of B2C carsharing service system. Under the circumstances, there are more and more Beijingers have chosen sustainable carsharing.

Although the B2C carsharing service system in Beijing is still in the primary stage, but we believe that, along with further development of technology and constantly improvement of people's awareness of environmental protection, the service platform will have a more mature model and perfect system. At the same time, there are some other countries and regions all over the world are facing similar problems like Beijing. The relevant develop ideas, models and experiences of Beijing may be worth thinking about.

References


About the Authors

**Ying Zhao** Doctoral candidate at Guangdong University of Technology

**Liu Guanzhong** is a professor at Academy of Art & Design Tsinghua University