Environmental Impacts of Car Sharing

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Abstract: The service efficiency of private cars gets enhanced after the appearance of car sharing. To explore the environmental impacts of car sharing, this article integrates the results from some researches related to the topic. The impacts are illustrated from four aspects. First, the improved mobility of vehicles reduces the parking demand, which means that the related parking space and traffic facilities are saved. Next, the convenience and flexibility of car sharing have negative impacts on the purchase of private cars, which will cut down the use of relevant resources. In addition, with more electric cars joining into car sharing, the automobile exhaust tends to be reduced. Apart from the positive effects, car sharing has some challenges in operating system. Additionally, in order to stabilize the positive environmental impacts, the coordination with other modes needs to be strengthened.

1 INTRODUCTION

Vehicles undertake a major part of trips in modern society. However, the inefficient use of private cars has negative impacts on the environmental protection. Recently, similar to the sharing idea in public transport, a new transport mode aiming at sharing a car with others has appeared. The original intention of car sharing is to improve the using efficiency of private cars. However, the impacts on the ecological environment made by car sharing are controversial.

From the positive perspective, the parking problem can be alleviated. Moreover, the consumption of private cars will decrease and the related materials will be saved (Baptista et al., 2014). In addition, by introducing electric vehicles into the system, the car sharing system promotes the electric automobile to be accepted by more people.

From the negative perspective, car sharing may induce extra travel demand, which may increase the traffic burden and gas emission. Moreover, as the user is required to pay for each trip according to the travel time and distance, the parking time is shorter than before.

This paper aims to illustrate the complex impacts on environment made by car sharing system. It is organized as follows. To begin, Section 2 introduces the basic features of car sharing system. Then, Section 3 explains the possible impacts from four aspects. Next, Section 4 puts up with some problems in current operating system. Finally, Section 5 presents some concluding thoughts.

2 BACKGROUND

In recent decades, the highly developed internet provides a powerful technological platform for sharing economy, making the business information between suppliers and consumers able to be shared in real time. With the sharing economy growing, car sharing gradually draws attention from the public.

2.1 Car sharing system

Car sharing pattern can be classified into peer-to-peer sharing and car sharing organization. In the peer-to-peer sharing system, users can post detailed information about leasing and hiring private cars on the platform, then the platform assists in making the available private cars shared among users in demand by matching providers and customers. Uber is the representative platform. In the other pattern, the organization sells service to users by distributing cars among streets and renting them through the...
application. Zipcar is the representative organization.

In addition, for the company offering cars for rental like Zipcar, operating types can be classified into round-trip pattern and one-way system. In the former service, users have to get the car from stations and returned it to the station after using. In the other pattern, users can get access to the car without the restriction of a fixed station.

2.2 Why share?

In order to promote the usage of car sharing, researchers have explored the reason why people choose car sharing system.

First, researches showed that the main factor encouraging the use of car sharing is about economic benefits (Matzler et al., 2015). In most cases, car sharing is cheaper than taxi service. This promotes costumers to try this new transport mode and passenger volume is gradually transferred from other transport modes to shared cars.

Moreover, the flexibility of sharing cars fills the gap caused by transfer (Sioui et al., 2013). In most cases, the distribution of existing trip production cannot be satisfied completely by the current public transport, since the trip is influenced by complicated factors and the capital invested in the public transport system is restricted. Thus the public transport system is hard to satisfy the door-to-door traffic demand of passengers. However, by joining in the car sharing, passengers can obtain the flexibility without the financial burden of owning a private car.

2.3 Driving behavior

Researches have stated that the attitude towards driving sharing cars is different from driving private cars. Compared to driving a private car, users need to give cash to the service provider after every trip instead of using car keys to start a private car. Researchers have found that people tend to reduce the frequency of car trip after taking part in the car sharing organization (Baptista et al., 2014).

On the other side, researches have suggested that users tend to make the best use of cars during the available period (Leclerc et al., 2013). For example, the car sharing trip usually tends to cover a shorter distance. When the distance is short, the expenditure is slightly higher than bicycle and public transport, which is acceptable for most users to try a more convenient travelling way. According to a survey aimed at the impacts of car sharing in North America, the travelled distance collected from consumers of car sharing is illustrated with graphs. As the following histogram (Figure 1) shown, the annual distance traveled in car sharing vehicles is mainly short distance (Martin and Shaheen, 2011).

![Annual Distance Traveled in Car Sharing Vehicles](image)

In addition, compared to regular trips, people tend to park the car for a shorter time during the reservation period.

2.4 Users and travel purpose

Researches have expounded that those people who do not have a car, get highly educated, do not go working by car, have a job and are mainly young people (Rabbit and Ghosh, 2013) are the main consumer group of car sharing. The consumer group lacks commuters, which form the main part of urban daily traffic flow. As commuting trips usually cover longer travel time and distance, using car sharing vehicles may lead to a considerably high cost, which makes it not so attractive to commuters.

Moreover, the travel purpose of shared cars is mainly for non-work (Leclerc et al., 2013). Researchers have explored that most people choose the sharing car as a transport mode for shopping and leisure activities rather than working, which is probably due to the fact that working trips are relatively longer.

3 IMPACTS ON ENVIRONMENT

From the perspective of government, the impact on environment of car sharing is more critical than the economic benefits. However, the current market and legal regulation still have some parts unsuited to the new transport mode. Whether the government will take measures to promote the growth of car sharing depends largely on the impact on the ecological environment (Jorge and Correia, 2013). Thus it is necessary to value the impact on the ecological environment from various angles.
3.1 Parking space

When speaking of the parking problem, it is the trip pattern that generates the phenomenon. For people traveling by public transport, parking demand does not exist. However, for those who travel by private cars, their cars need to stay at the parking lot. According to a survey, private car stays in parking place for nearly 90% of time (Jorge and Correia, 2013). In most cases, when a number of cars need a parking space, the road is simultaneously filled with vehicles which are running to satisfy newly added traffic demand. This disequilibrium indicates the waste of both land resources and vehicle resources.

However, if the cars which have parking problems can be replaced by car sharing vehicles, both the parking problem and traffic congestion will be solved. On one hand, drivers tend to make the best use of reservation, so the parking time is shorter than a regular trip. In addition, by staying in motion instead of occupying the parking place for most of the time, the number of cars that needed to find a parking place drops down.

3.2 Vehicle consumption

Researchers have discovered that the car sharing makes a negative impact on the vehicle purchasing (Martin et al., 2010). In urban area where the car sharing has a considerable number of clients due to its mature system, research has observed that the purchase of private cars is reduced significantly.

Providing a lower cost for short-term trips, car sharing can be considered as an alternative transport mode. Especially in places where convenience and flexibility are offered to clients, car sharing is the best choice to finish a short trip.

For carless households, car sharing offers an economical access to the vehicle traveling. For other people, joining in the car sharing organization helps them to get rid of the irreplaceability of a private vehicle to finish trips.

3.3 Electric automobile

Car sharing allows clients to use the vehicle without fixed high cost on purchasing and other subsequent expenditure, such as the maintenance, tax and insurance. When the car sharing pattern and electric vehicles are integrated, the application of electric vehicles can be promoted. These vehicles powered by clean energy are expensive in the early stage of development. Moreover, although the clean energy does benefit the environment, it has a poorer road performance compared to traditional vehicles. Thus public usually holds a negative attitude towards buying electric vehicles.

However, car sharing makes those electric vehicles available to the public at a fairly lower price. By increasing the users of electric vehicles, the electric vehicles will get more financial support from the market. As time going by, the electric vehicle manufacturers can expand their business and thus the CO₂ emissions can be reduced by using clean energy.

3.4 Greenhouse gas emission

Researches have proved that the mechanism of emission reduction is not just a simple summarization of reduction in all sections, but the balance of increase and decrease from all parts involved in the traffic process. The total calculation includes the interaction between shared cars and other transport modes, the behavior change in households and treatment of old private car.

On one hand, car sharing increases the greenhouse gas (GHG) emission.

First, car sharing allows the carless households using the vehicle service at a lower price, expanding the use of vehicles to a larger group of people on the whole. For those carless households, the vehicle is listed in the mode choice with public transport modes and bicycle after joining in the car sharing. In this way, the time of producing GHG emission is lengthened and the frequency of car trip taken by carless households increases. For those people, the GHG emission tends to increase.

Next, car sharing generates new traffic demands instead of alleviating the traffic jam mainly consisting of commutes. According to a survey, car sharing is used as a substitute for the private car and taxies in some private trips, such as visiting friends and going to hospital. Moreover, car sharing is used to replace the public transport in shopping trips mainly because of the comfort and low price in short distance (Baptista et al., 2014). However, since the car sharing service is not designed to adapt to certain traveler groups, the interaction between car sharing and those transport modes is hard to predict. Thus, the proportion of substitution is too changeable to determine.

On the other hand, the car sharing does benefit the reduction of greenhouse gas (GHG).

First, advanced control and arrangement system which aim to improve the mobility of sharing cars allow the vehicle keep serving clients. Compared to the private vehicle, the usage efficiency is improved by sharing one car with more than one passenger. As one shared car can finish several trips which are
coordinated in time schedule, the extra private cars replaced by the shared car equal to the eliminated original traffic demand. In total, researches have revealed that a car sharing vehicle can replace 6 vehicles (Baptista et al., 2014). Moreover, the gas emission gets reduced by the car sharing. Researches have shown that the car sharing leads to a significant net reduction of gas emission (Martin and Shaheen, 2011).

Figure 2 can illustrate the balance. Although most respondents increase the gas emission, the sum of reduction (from zero to the left) is greater than the increasing part. By adding the negative number and positive number, a net reduction in gas emission is generated.

Figure 2: Change in GHG emissions (t GHG/year).

4 PROBLEMS AND CHALLENGES

Although car sharing draws a beautiful future for us, several problems do exist during the operation process. In order to help the car sharing to take effect in protecting environment, the deficiency of the operating system has to be compensated.

4.1 Relocation problem

In general, car sharing serves the public in two ways. One is round-trip car sharing system, and the other is one-way car sharing system.

From the position of car sharing operator, the one-way system generates more floating vehicles, which makes it difficult to balance the relationship between satisfying traffic demand and gaining profits by relocating the vehicles. However, from the position of clients, the one-way system offers a more convenient service in travel. In order to attract more clients and expand the business, most car sharing organizations tend to choose the one-way operating system.

In addition, researchers have found the mechanism of interaction between supply and demand, while the control methods have been explored by using mathematical methods. However, those proposed methods have limitations in applying to a wider application (Jorge and Correia, 2013).

4.2 Influence on other transportation modes

As shown before, car sharing may lead to a reduction in public transport usage. If car sharing encourages clients to transform from public transport to car sharing vehicles, the impact on the environment is negative.

In order to prevent the car sharing from grabbing consumers from the public transport system, some measures need to be taken to change the competitive relationship between two modes. One way is to integrate two modes into a mutually beneficial payment system. For instance, car sharing can encourage passengers to use the public transport by providing those clients who hold travel cards of public transport with a preferential payment. By including the utilization of public transport into the price incentive mechanism of car sharing, the total impact on the environment will remove the negative interaction between car sharing and public transport (Firnkorn and Müller, 2012).

In order to stabilize the positive impacts on the environment, the interference policy is needed to ensure the activity of public transport even when the car sharing is welcomed.

5 CONCLUSIONS

This paper aims at revealing the impacts on environment of car sharing. Section 2 reviews the basic information of car sharing, including the operating system, the motivation of choosing car sharing, the changes in driving behavior and the purpose of travel. Drawn by the low cost of obtaining vehicle service, many people choose the car sharing vehicle mainly for short trips. Covering lower parking time and shorter distance, those trips are mainly for non-work purposes. Next, Section 3 presents the impacts on the environment brought by car sharing. The impacts can be classified into four types. Firstly, by improving the mobility of the vehicle, the equal traffic demand can be undertaken by fewer vehicles than before. Consequently, both the parking land space and the transport facilities used for parking get reduced. Secondly, because car sharing can allow users to use vehicles at a lower price, owning a private car becomes less necessary.
than before. Thus, the decrease in purchasing vehicles leads to the decrease in materials used to manufacture automobiles. Next, car sharing promotes the expansion of electric vehicles. Finally, the car sharing leads to a net reduction in GHG emission. Although car sharing increases the using frequency of carless households by making the car service more available among people, it also draws people who used to travel by private car to try this transport mode. From an overall perspective, car sharing makes positive impacts on reducing the GHG emission. Then Section 4 describes two problems in current car sharing system. Firstly, to relocate vehicles more efficiently, the relationship between vehicle supply and traffic demand needs to be solved. Next, the interaction between car sharing and other transport modes needs to be improved to generalize the application of car sharing. In order to strengthen the positive impacts on environment, these problems needed to be solved in the future.

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REFERENCES


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