Sustainable bike sharing assessment : *Exploring the usage of the free - floating system in Chengdu, China*

Jeroen Schulte
Bachelor thesis Spatial Planning & Design

Colophon

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Author :	Jeroen Schulte, S2779676
Contact :	j.schulte.3@student.rug.nl
Education :	BSc. Spatial planning and design Faculty of spatial sciences University of Groningen Study year 2017/2018
Mentor :	dr. I. Boavida Portugal
Illustration font page :	Shuncheng st., Chengdu. (Jeroen Schulte)

university of groningen / faculty of spatial sciences

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Abstract

Public bike sharing as travel mode is globally increasing in popularity in urban areas and have the capability to transform urban transportation systems. Due to developments in ICT a new bike sharing system, FFBS, has emerged in China since recent years. This type of bike sharing is GPS based and does not rely on docking stations anymore. This research was designed to better understand the usage of this system by focusing on the usage of the FFBS and the effect of the FFBS on the urban transportation system. The research has focused on long-term users because bike sharing is part of their travel habit. The research has an exploratory and quantitative approach and is not intended to generalize for the whole population of long-term users. Questionnaires are conducted to get the results. Long-terms users use FFBS mainly because it provides flexible transportation. Results of the usage show that 50 percent of the respondents use the FFBS on daily routine. For the factors influencing usage, there is a negative significant correlation between daily usage of bike sharing and ownership of a private car. Bike sharing is mainly used for commuting purposes. However, there is no significant effect between commuting and daily usage of FFBS. For exploring the trip characteristics the results show that users use bike sharing especially for trips between the 0 and 15 minutes. Most of the time they use the shared bike in combination with the subway. In terms of modal shift, bike sharing mainly replace trips users did before with the subway and a large share of car owners have operated trips by public transport and bike sharing they did before with the private car. Several policy recommendations are proposed based on the analysis of the results, for governments keeping in mind that FFBS is a private business model with minimal government involving.

1. Introduction

1.1 Background

Due to the reliance of the bike as transportation mode, China was known as the kingdom of bicycles in the 1970s. However, the role of the bike as transportation mode has significant decreased due too motorization and economic growth (Zhang et al., 2015).

These two developments cause traffic congestion, traffic safety problems and air pollution in Chinese cities. Air pollution is troubling for both individuals and cities. During the day, many Chinese cities are covered by a layer of smog, resulting from the emission of greenhouse gasses. Furthermore, air pollution causes 6,1 million premature deaths in the world. It is the fourth highest cause of death. More than 50 percent of these deaths are in China and India. Transport is a big contributor to air pollution in China. Only the coal burning industry is more polluting (Independent, 2018).
Another trend which aggravates the urban mobility problems is rapid urbanization. At the moment, more than half of the world's population lives in cities. According to the United Nations (2014), it is expected that this number will increase to 66 percent in 2050. The urbanization in China is very extreme, the country has more than 100 cities with 1 million inhabitants. This number is expected to grow to 221 cities with more than 1 million people in 2022 (Guardian, 2018). This rapid urbanization rate will increase the demand for urban mobility.

Because of the urban mobility problems and the increase in urban mobility demand, cities are seeking for sustainable transportation modes. Therefore the use of the bike for short distances is encouraged by means of implementing bike sharing programs. Bike sharing, the shared use of a bicycle fleet, increases bicycle use in the urban area (Zhang et al., 2015). The shared bikes can be used for a single journey without returning the bike to the pick-up location.

At the moment China has the largest bike sharing fleet in the world (Fishman, 2016). Not only in China, but also in many other countries around the world, bike sharing as a transportation mode in urban areas is rapidly increasing. Bike sharing programs raised from just a few programs in the 90's to at least 800 programs in 2016 globally (Fishman, 2016).

Bike sharing has a lot of advantages for cities and individuals. Shared bikes occupy less space than motorized vehicles and do not produce emissions. Furthermore, bike sharing has different advantages for citizens. They can connect citizens with public transport stops and increase the psychical activity of citizens. In general, bike sharing can increase the use of bicycles which will normalize and promote cycling (Ricci, 2015). Pucher et al. (2011) argued that the usage of bike sharing can result in a renaissance of cycling where cycling can become a dominating way of traveling.

1.2 Aim of the research

As a result of recent increase in popularity in bike sharing programs (=BSS), there is lack of research on the role of BSS in cities. Fishman (2016) emphasis that China has the largest bike sharing fleet of the world, but the amount of research in China towards bike sharing does not reflect this.
Besides, results of investigating cities in China have important insight for the country itself but also for bike sharing in general (Fishman, 2016).
The research will focus on the travel behaviour of long- term users of bike sharing. Long-term users, at least using shared bikes for half a year, are preferable because bike sharing is part of their travel habit.
Bike sharing can play an important role in urban transportation systems (Shaheen et al., 2010). The objective of this research is to explore the trip characteristics and factors influencing these trip characteristics. Through understanding the usage of bike sharing, the role of bike sharing in the urban area can be examined

In order to achieve the research aim it is important to research why users make use of BSS, how users operate their bike sharing trips and what the effect is of their use of BSS on other transportation modes. For measuring these indicators the research has a quantitative character.

This resulted in the following research question:
What is the role of a bike sharing system in the urban accessibility of Chengdu?

For answering the research question the following sub questions are formulated

- *What is bike sharing and how has bike sharing developed?*
- *What is the role of bike sharing in the urban accessibility?*
- *Why do people make use of a bike sharing system?*
- *What are the trip characteristics of a bike sharing system?*
- *What is the effect of a bike sharing system on the usage of other transportation modes in the city?*

Because the research is focusing on the impact of bike sharing on other transportation modes, focusing on respondents of one city is the best way to get a representative dataset. Every city has a transportation system, which differs from other cities. Furthermore cities differ in geographical characteristics like slope or weather, focusing on more than one city can result in bias.

Midgley (2011) argued that BSS work best in dense areas. In the report of Optimizing Bike Sharing in European Cities (2011) a population power limit of 100.000 inhabitants is recommended. Chengdu is chosen for this research because of to its high urbanization rates, rapid traffic development and her status as economically emerging region (Imfo, 2017).

1.3 Structure of the research

The second chapter of the study will provide a literature review about the definition and history of bike sharing. Furthermore the role of bike sharing within the urban context is discussed. Chapter 3 will explain the way primary data has been collected and in which way it contributes to the secondary data of the previous chapter. Subsequently, chapter 4 will provide an explanation of the context where the research takes place. In chapter 5 the results of the primary data of chapter 43will be discussed. These results will be reflected on the theoretical framework of chapter 2. Finally, chapter 6 provides the main conclusions of the research, limitations, recommendations and a reflection.

2. Theoretical framework

This chapter consist of two parts. The first part will provide insight in how bike sharing has emerged and developed over time and will define the concept, because it is necessary to understand which type of bike sharing is covered in this research. The second part will explain the development of urban accessibility and the role of bike sharing in the urban transportation systems in cities.

2.1 Bike sharing

Bike sharing exist for more than 50 years. Following the literature in most cases four generations of bike sharing are being identified.
In 1965 the first bike sharing program, called the '' Witte fietsen '', emerged in Amsterdam. This program is seen as the first generation bike sharing. Free-shared bikes were implemented as a solution for the air pollution and increase of motorized vehicles. This program failed almost immediately after its launch. Bikes were often stolen or damaged because the bikes did not have a lock (Shaheen et al., 2010).

The first big scale bike sharing program was launched in 1995 in Copenhagen. This second generation bike sharing is mostly characterized by two developments.
The first development was the use of a coin deposit system. With a coin deposit system users have to put a coin in the bike for unlocking. The second development was the use of docking stations. These are stations where you can pick up and drop off the shared bikes. In imitation of Copenhagen, different European cities implemented a BSS (Shaheen et al., 2010). Like the first generation shared bikes, second generations shared bikes got often damaged and stolen due to the animosity of the user.

The third generation bike sharing is characterizing by the removal of the animosity of the user (Fishman, 2016). Users have to register before using a shared bike. This resulted in a decline of the problems, bike theft and damage, of the first and second generations. Another important development is the incorporating of technology in shared bikes. The use of technology allows the tracking of bicycles. The first big scale third generation BSS emerged in 2005 in Lyon (Shaheen et al.,2010).

The developments in shared bikes kept improving which resulted in a fourth generation of bike sharing. In contrast to the previous generations there is no agree in the literature about the conceptualizing of the fourth generations bike sharing. Shaheen et al. (2010) named the role of bike sharing as part of multi modal travel. Midgley (2011) stated that the use of electric bikes in the fourth generations BSS will increase.
Due to improvements in the information and communication technologies of shared bikes the most important characteristic of the fourth generation is the use of dock-less BSS. The starting point of this type of BSS occurred in 2015 in China. Ofo, a Chinese company started with implementing shared bikes in the public area. These bikes consist of a smart lock. By use of a smartphone people are able to lock and unlock bikes by scanning a QR code (Spinney & Lin., 2018). Furthermore the use of Global Positioning System on smartphone allows users to track the location of nearby bikes.
The amount of companies operating free-floating bike sharing systems has rapidly increased the last year. Ofo and Mobike are the most popular free-floating bike sharing (=FFBS) companies with a market dominance of 90 percent. After the success in China, both companies are now trying to spread their shared bikes float to other countries (Technode, 2018).

Free-floating bike sharing systems are operated by companies. Therefore, bike sharing has shifted from a public oriented bike sharing to a private oriented bike sharing. Private bike sharing is

characterized by profitable bike sharing services with minimal government involvement (Shaheen et al., 2010). Fishman (2016) expect a further growth of this type of bike sharing in the future.
The developments of bike sharing show that the conceptualizing of bike sharing is regularly subject to change.

Definition

As a result of the developments and expansion of bike sharing there are different definitions of bike sharing. To execute this research properly the different types of shared bikes will be differentiated and the distinction between rental- and shared bikes will be explained.
According to Shaheen et al. bike sharing provide ''Individuals to use bicycles on an as-needed basis without the costs and responsibilities of bike ownership'' (2010, p.1). An important feature of bike sharing is the open character of the system, through registration all citizens can make use of a bike (De Maio, 2009).

In general there are two types of bike sharing. The first type is a back to many system. This type of bike sharing consists of docking stations. People can pick up a bike and deliver it somewhere else.
The second type of bike sharing are FFBS or dock-less BSS. Researchers from international papers use both definitions, but the meaning of both concepts is the same. For a good distinction between this type and the type of bike sharing that uses docking stations, this research will use free-floating as concept. FFBS gives users the ability to pick up bikes and drop off bikes everywhere in the city. FFBS bikes have a GPS tracker. As a consequence these bikes are operable by users through apps on smartphones. These apps provide users to lock and unlock bikes digitally, and for tracking bikes in the surroundings.

Bike sharing distincts itself from bike rental because of the possibility to make a single trip (DeMaio, 2009). The famous OV-Bike in the Netherlands is an example of bike rental (Gossling, 2018). The OV-bike is focused on the after transport of train travellers and can be rented for 24 hours (Nederlandse Spoorwegen, 2018). This type of rental of bikes is called back to one. You have to deliver the bike to the original location.
As a consequence of the different types of bike sharing there is not an umbrella definition for the concept. This part of the theoretical framework has tried to explain the most important characteristics of bike sharing.

2.2 Role bike sharing in urban accessibility

2.2.1 Accessibility

The concept 'accessibility' is an important concept when talking about transport systems. According to Litman (2017) transport planning should be based on accessibility.
Many scientific researchers have defined the notion of accessibility over the years. According to Litman, "accessibility refers to the ease of reaching goods, services, activities and destinations, which together are called opportunities'' (2017, p.6).

The rise of the car caused pressure on the accessibility of cities. A research in English cities of Buchanan (1964) stated that the main problem caused by motorized vehicles is traffic congestion. Other less measurable problems of the increasing use of motorized vehicles were noise pollution, increase of emissions and smell pollution. Buchanan (1964) argued that the problems are getting worse when the use of motorized vehicles is increasing.
In the geography of transport systems (Rodrigue, 2006) the above mentioned problems are confirmed. Due to the increase in demand of mobility and supply of infrastructure there is more mobility. These developments increases the pressure on the accessibility.
In addition, transport planning focused on solutions in favour of motorized vehicles for decades (Litman, 2017). As a result of the motorization, urbanization and the concerns about climate change transportation planning is facing a paradigm shift with a focus on accessibility in planning (Litman, 2017). Accessibility is provided by the transport system.

One approach in improving accessibility is the use of shared mobility services like bike- and car sharing in which assets are shared between users and often are privatized. A high quality public transport and building on these shared modes and developments in ICT is one of the novel mobilities that could assist in achieving seamless door-to-door mobility: *mobility on-demand* (Kamargianni et al., 2016). In addition, Jäppinen et al. (2013) stated that integration of sustainable transport increases the competitiveness against the private car.
Furthermore, improvements in ICT foster sustainable development. Where shared mobility becomes the standard, the amount of vehicles declines what result in easing congestion (Gossling, 2018).

Gossling (2018) also stated that in the future, apps integrate public and private transport choices over the full range of transport modes. This results in achieving the growing expectations for personalized, more integrated and sustainable transport solutions. These developments will increase the possibilities for multi modal travel and therefore improving the accessibility of the transport system.

2.2.2 Role bike sharing in the urban area

FFBS is an ICT based shared mobility. FFBS has just emerged rapidly since 2016, therefore relevant research is limited and focuses more on BSS. As a consequence, this part of the theoretical framework will mainly focus on a critical review on the existing body of literature about BBS, which are similar to FFBS.

Usage of bike sharing

In terms of *user characteristics* there are different important factors that influence bike sharing usage. Exploring these factors is necessary to understand their travel demand. In his literature review about bike sharing Fishman (2016) found out that , most of the time, convenience is the most important reason to use bike sharing.
In terms of the demographics of users, several studies found out that gender and age play an important role in the usage of a BSS. In average, bike sharing users are more often men than women. Especially in countries where there is a low average level of cycling results shows that men use bike sharing much more often than women (Goodman & Cheshire., 2014; Fishman, 2016). A reason accountable for this difference is that men in general like to cycle more than women (Vogel et al., 2014). Vogel et al. (2014) also found out that bike sharing users, in average, are aged young. In their study about the BSS in Lyon they showed that 81 percent of the users is between 18 and 49 years old. Also, Murphy & Usher (2015) found out in their study about bike sharing in Dublin, that most users are male and are relatively young.

In the literature there is a role for ownership of vehicles in relating to bike sharing use. A study of capital bike sharing in Washington found out that only 29 percent of bike sharing users owned a private bicycle (Buck et al., 2013; Fishman, 2016). A study in Montreal showed that bike owners use shared bikes less often than people without a bike (Bachand-Marleau et al., 2012; Fishman, 2016). The results of both studies imply that citizens who own a bike make less use of a BSS.
Besides bike ownership, car ownership also influences usage of bike sharing. Results of Montreal showed that people with a car have a 1.5 times greater odd of using bike sharing (Bachand-Marleau et al., 2012; Fishman, 2016). Following from the literature, bike ownership has a negative influence on bike sharing usage and car ownership has a positive influence on bike sharing usage.

In terms of *trip characteristics* bike sharing can fill a gap in the urban mobility of cities. The final goal of bike sharing is to expand and integrate cycling into transportation systems, so that it can become a daily transportation mode (Shaheen et al., 2010). BSS are of most importance in dense urban systems. Figure 1 shows the role of the bike sharing within the urban transportation system for inhabitants of the city. Tourists base their trips most of the time on considerations that differ from inhabitants. As shown in figure 1, bike sharing is a relative cheap transportation mode and is purposed for short inner city trips (Midgley, 2011). This corresponds to a study of Fishman et al. (2014) about bike sharing trip duration, using data from Minnesota, Washington, D.C., London, Brisbane and Melbourne they found out that most trips are between 16 and 22 minutes. In terms of distance people are willing to cycling 1 to 5 kilometers (Rahul & Verma, 2014). The majority of travelers will choose other public transport options if their travel distance is more than 3.5 km (Keijer & Rietveld, 2000).

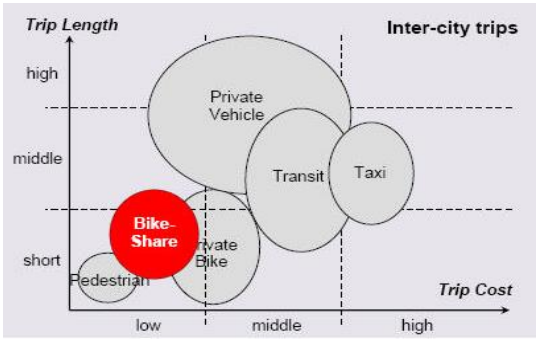

Figure 1 - Role bike sharing in urban mobility (Midgley,2011)

Bike sharing is a mode for short trips as showed in figure 1 and therefore often part of a trip chain, thus in conjunction with other transportation modes. Just a few trips of bike sharing are single trips

(Fishman,2016). Bike sharing can play a significant role for improving the connection between modes and reduce travel time for travelers (Murphy & Usher, 2015). People who undertake trips with shared bikes are doing trips they did before with another transportation mode. This results in a modal shift among transportation modes.
Bike sharing can contribute to the goal of transport planning which is to improve connections among resource efficient modes and reduce the reliance and use of motorized vehicles (Litman, 2017). Therefore the two most important transport modes relating to bike sharing will be discussed: public transportation and motorized vehicles

Public transport integration

Fishman (2016) described two possible relationships between bike sharing and public transport. These are substitution and integration. Bike sharing can replace a trip otherwise made by public transport, or bike sharing can stimulate integration by being part of the trip by travelling by public transport. An important role for bike sharing is the ''last mile'', bike sharing can be used for the last part of the journey (Ricci,2015).
Pucher & Buehler underline the importance of bike sharing in conjunction with public transport above other transportation modes : '' bicycling supports public transport by extending the catchment area of transit stops far beyond walking range and at much lower cost than neighborhood feeder buses and park-and-ride facilities for cars "(2009, p.79).
In addition, Jäppinen et al. (2013) argued that a BSS must be seen as a part of a public transport rather than a separate transportation system. A recent research of Shen et al. (2018) about FFBS found out that access to public transport is associated with higher usage of dock-less bikes.
The different studies show that it is essential to have a high quality public transport for an efficient usage of a BSS.
At the same time, bike sharing can relieve crowded public transport. Fishman (2016) stated that many public transport trips where substituted for trips by shared bikes.

Motorized vehicles shift

Another important role BSS can play is substituting trips previous made by motorized vehicles. A decline in the use of motorized vehicles leads to emission reductions and reduced congestion and fuel use (Shaheen et al., 2010). These positive environmental implications are however context limited. Fishman et al., (2014) concluded that only a small share of bike sharing journeys are replacing car trips, varying from 2 percent in London to 21 percent in Brisbane.
Murphy & Usher (2015) found out that 20 percent of bike sharing trips are replacing car trips in Dublin. Murphy & Usher (2015) claimed that a BSS may provide a useful transportation mode for people to allow people to switch from cars to bicycle, particularly for short trips in the future. Due to the flexibility of FFBS it is possible that this system can cause for a larger shift from motorized vehicles to bike sharing.

3. Methodology

3.1 Method

This section will describe which method is used for each sub-question
Sub-questions 1 and 2 are answered by international scientific literature. For relevant literature, Google scholar and smart cat are consulted. Most used search terms include : ‘’bike sharing’’, ‘’Free-floating bike sharing’’, ‘’bike sharing usage’’, ‘’urban accessibility’’, ‘’shared mobility’’, ‘’bike sharing China’’. Also, the researcher has searched in the literature list of relevant articles. This is the snowball method.

In order to get familiar with the context of the study area an document and newspaper analysis will be executed focusing on the urban transportation system of Chengdu.
Primary data will be used for answering sub-questions 3,4 and 5.
The investigated bike sharing type for the primary data research is FFBS due to his rapid development and increasing popularity. Also, because of a lack of scientific literature about FFBS and so enhance the relevance of the study.
Subsequently, the research focuses on the understanding of the use of bike sharing and on the characteristics of bike sharing trips. According to McLafferty (2010) questionnaires are useful for gathering information about people's characteristics, their perceptions and their behavior. Since the research has a quantitative and exploratory character, questionnaires are the most favorable primary research method. By use of a questionnaire insight in a large group got obtained. The questionnaire is conducted according to the principle of simple random and provided in the Chinese language. The questionnaire was designed to be relatively short and convenient so that: (1) users of the shared bikes could complete it within a short timeframe (c.2-3 minutes); and (2) the response rate would be high.

3.2 Primary data

In figure (2) the most important concepts and relations are displayed.
The gray box displays the context of the research, the free-floating bike sharing system.
The blue box is the concept for answering the main question, the urban accessibility. The urban accessibility is influenced by the trip characteristics of the FFBS and by modal shift.
The trip characteristics influences the urban accessibility directly. Results of the trip characteristics of bike sharing are obtained by the sub-questions. Modal shift is caused by the usage of bike sharing.

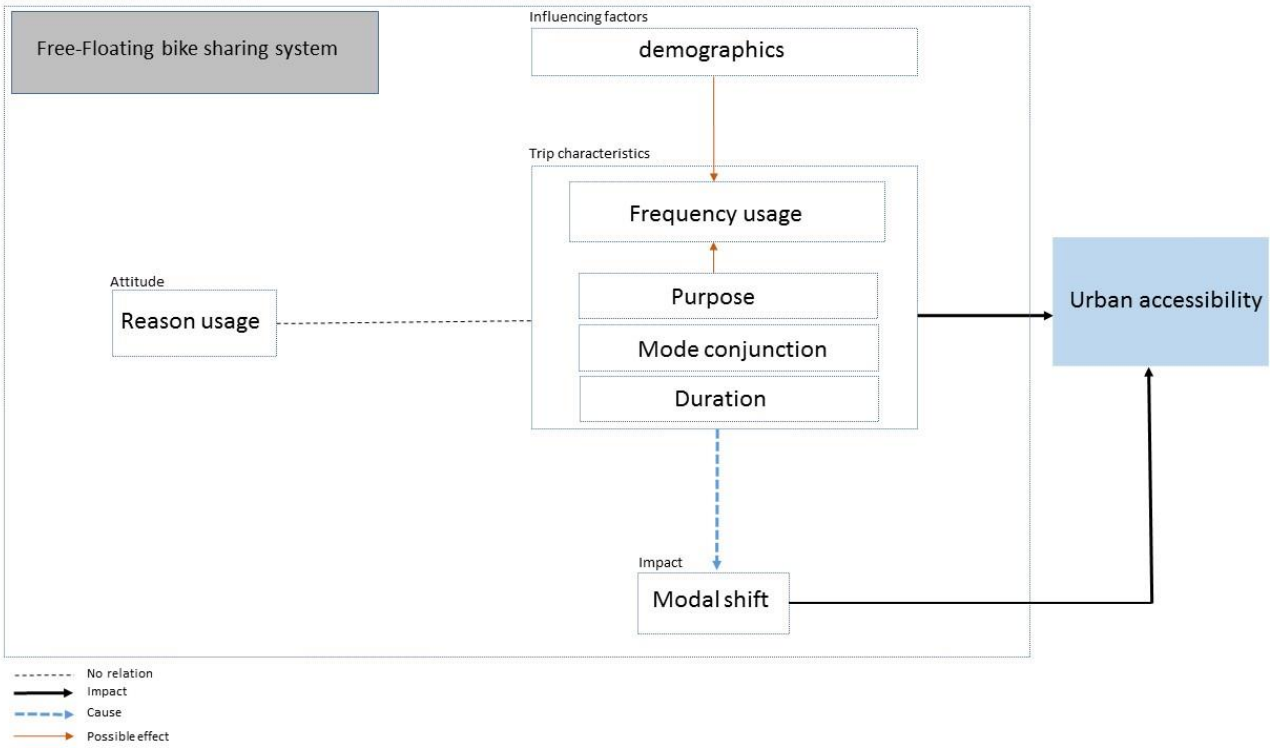

Figure 2 - Conceptual model (Own source)

3.3 Analysis of the questionnaire

For each sub-question particular questions of the questionnaire (Appendix) are of importance for answering these sub-questions. The following section provide an overview per sub-question.

- Sub-question 3 : *Why do people make use of a bike sharing system?*

For answering sub-question 3, there needs to be looked to question 7 of the questionnaire. The answers of question 7 are of importance for understanding the usage of FFBS in general. The target group of the research are bike sharing users. An understanding of the psychological motives to choose for bike sharing are of importance for the interpretation of the results. For this sub-question there will be made use of descriptive statistics. Therefore, no hypothesis are formulated.

- Sub-question 4 : *What are the trip characteristics of a bike sharing system?*

For answering sub-question 3, there needs to be looked to question 1,2,3,5,6 &10 of the questionnaire.
Question 5 provide insight in the frequency of bike sharing usage of users. Subsequently, questions 1 ,2 & 3 are important. These questions are about the demographic characteristics of users. These questions provide insight in gender, age and ownership of vehicles of users. There will investigated which factors influence usage of bike sharing.

Therefore, following from the theoretical framework the next hypothesis for the demographic characteristics of users are formulated :

H1 : *There is no significant effect between gender and the frequency of usage of bike sharing*.

H2 : *There is no significant effect between age and the frequency of usage of bike sharing*.

H3 : *There is no significant effect between bike ownership and the frequency of usage of bike sharing.*

H4 : *There is no significant effect between car ownership and the frequency of usage of bike sharing*.

Question 7 is about the main purpose of bike sharing trips. The following hypothesis is formulated :

H5 : *There is no significant effect between bike sharing purpose and the frequency of usage of bike sharing.*

Afterwards, insight in question 5 and question 10 will be provided. These questions are about the characteristics of the trip in terms of duration and mode conjunction. These questions will be investigated by the use of descriptive statistics.

- Sub-question 5 : *What is the effect of a bike sharing system on the usage of other transportation modes in the city ?*

For answering sub-question 5, there needs to be looked to question 4,9 and 11 of the questionnaire. These questions are about the impact of bike sharing on other transportation modes. Question 4 provide insight in the cycling levels of the respondents, question 9 provide insight in modal shift of a particular transportation mode to bike sharing. Question 11 provide insight in multimodal travel behaviour of car owners. For this sub-question there will be made use of descriptive statistics. Therefore, no hypothesis are formulated.

3.4 Statistical analysis of the questionnaire

The questionnaire consist of answers with nominal variables. A chi square test is suitable for testing the independence of two or more nominal or ordinal variables. Therefore the hypothesis' of the previous section will be tested by means of a chi square test. The significance level is 5 percent. The significance level is the probability of rejecting the null hypothesis when it is true. A significance level of 0.05 indicates a 5 percent risk of concluding that a difference exists when there is no actual difference. This level of significant is used for all statistical analysis in this research.
The statistical tests will be executed by the software program IBM SPSS statistics 25.

3.5 Primary data collection

The questionnaire is conducted in the first week of May 2018. It was decided to use an online questionnaire because of the high internet usage and ownership of smartphones in China (Mei & Brown, 2016). Western survey platforms are not available in China due to the great firewall. Therefore the Chinese survey platform Wenjuan was selected. The free version of Wenjuan has no response limits and the data can be exported in excel (Mei & Brown, 2016).
Moreover, Wenjuan has the possibility to share the questionnaire with WeChat. WeChat is a Chinese social media platform with almost 1 billion users. By use of WeChat, the link was shared by acquaintances of the researcher. These acquaintances are living in the city of Chengdu. After 4 days, 37 respondents had filled in the questionnaire. Moore and McCabe (2006) state that a sample size of 50 respondents is sufficient to represent a population.
Hence, 18 face to face questionnaires are conducted in the city centre, near Tianfu square. This resulted in 55 respondents in total. The researcher showed, through the use of offline google translate, a short introduction to the questionnaire in Chinese. If the questioned people were willing to fill in the questionnaire, the researcher showed a QR code. By scanning the QR code the respondent was able

to fill in the questionnaire immediately on his own smartphone. Especially people waiting in a line were willing to fill in the questionnaire.

3.6 Quality of data

The questionnaire is focused on long-term users living in Chengdu. In the introduction of the questionnaire it is stated that questionnaire is focused on this target group. However, the questionnaire is primary conducted online and accessible for everyone. Therefore it is possible that non-Chengdu citizens have filled in the questionnaire. Furthermore there is no distinguish between the duration of living in Chengdu. It is possible that people who just moved to Chengdu or live in Chengdu temporality filled in the questionnaire. These outcomes could affect the quality of data in a negative way.
There is a possibility that some groups are underrepresented as a result of the online questionnaire. Young people are more often online then older people and they are more likely to own a smartphone. Furthermore, the questionnaire was shared by citizens who are between the age of 22 and 36. Therefore it is obvious that most reached respondents are also part of this age group, which also affects the distribution of the age groups in the research.

3.7 Ethical questions

For this research there is an important ethical consideration. The researcher only speaks English, whereas Chinese people in general do not speak any English. The questionnaire is therefore provided in the Chinese language. As a consequence of the language gap, the researcher was not able to further explain the questions to the respondents by the face- to face questionnaires.

4. Background of study area

For a good understanding of the context of the research and for interpreting the results afterwards a short introduction about Chengdu is provided.

Profile of the study area

Chengdu is the capital city of the province Sichuan in the middle of China. Located in the middle of the country it functions as a gate for travellers to Tibet in the West, Xi'an in the North and Kunming in the South (Figure 3). In 2014, the city of Chengdu has 7.2 million citizens, but the whole metropolitan area has more than 13 million inhabitants. The city centre has a high density population, whereas the suburban area is less densely populated (Imfo, 2017). Chengdu is, like many Chinese cities, characterized by high rise flats.
The city has a subtropical monsoon climate characterized by an early spring, hot summer, cool autumn and warm winter. The average annual temperature for the year is 16 degree Celsius.

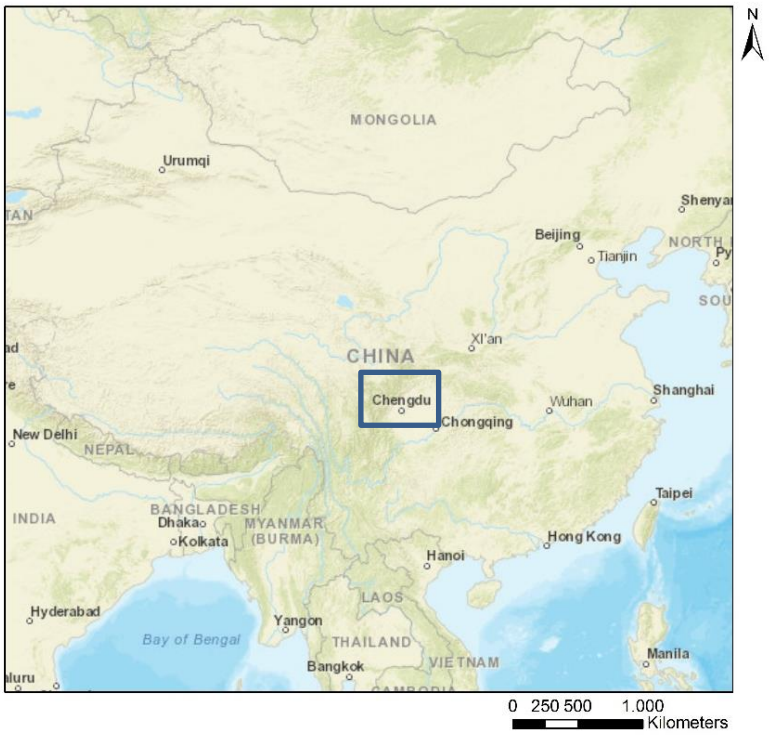

Figure 3 - Location Chengdu within China (World street map, Arc Map)

Urban transportation system

Chengdu is the largest transportation junction in Sichuan and also the largest in southwest China.
The ownership of private cars has increased the last years. At the moment Chengdu has more than 3 million registered cars (Imfo, 2017). Due to this the congestion on the roads has increased, which is causing 47 percent of the roads in general to be congested (Telegraph, 2016). As a consequence transport gas and emissions have become the main source of air pollution in Chengdu (Wang, 2016).

The public transport system of Chengdu is characterized by high tech solutions. At the moment the transportation system of Chengdu includes national railway, rapid railway, metro, bus and taxi services (Wang, 2016). However, there is lack of a well-integrated system between these single components. Also the supply of public transport is limited which contributes to the high ownership of cars (Imfo, 2017). The vision of the city is therefore to create a more integrated mobility system and expanding the public transport network. In 2020 the city is aiming on a public transport transportation share of 65% (Imfo, 2017).
What can hamper usage of public transport in China, is the fact that young people often prefer a high quality of life. A car is part of a high quality lifestyle (Wang, 2016). Owning a car is often seen as a status symbol (Gossling, 2018).

Free-floating bike sharing in Chengdu

The city of Chengdu has different top priorities with respect to improving the urban mobility. Bike sharing can play a significant role in most of the priorities. It can help in reducing congestion, reduce space usage, increase the usage of active mobility and improve the access to locations. The city is characterized as a bicycle friendly city: Chengdu has flats roads and relative slow speeds (Chengdu

expat, 2016). This could contribute to normalizing cycling as transport mode by means of bike sharing (Ricci, 2015). Also, a well-integrated public transport will enable an increase in cycling (Imfo, 2017).

The two dominating bike sharing companies, Ofo and Mobile, are present in the city. They started with implementing shared bikes in Chengdu in the spring of 2016. After Mobike and Ofo different other free-floating companies started with implementing bikes in Chengdu. The most actual numbers of the amount of shared bikes in Chengdu date from spring 2017. A research of Tencent showed that there were 200 thousand shared bikes in Chengdu. This number was expected to grow to 360 thousand in the end of 2017 (China Channel, 2017). However, due to the rapid development of bike sharing such data is quickly outdated and no recent public data is available.
Average prices for most bike sharing companies in Chengdu are around 1 Yuan (≈ 0,13 euro) for an hour. Some bike sharing companies provide free half hour ride promotions.

Figure 4 - Shared bikes in the shopping area in the city centre, Chengdu (Schulte, 2018)

5. Results

This chapter will discuss the results of the primary data collection of Chapter 3. First the attitude of bike sharing users will be discussed, subsequently the factors affecting usage of bike sharing and afterwards the impact of bike sharing on other transportation modes.

5.1 Understanding usage

Looking at figure (5) it is noticeable that there is one factor predominantly chosen by the respondents. For 67 percent of the respondents a main reason to use bike sharing is that it provides flexible transportation. A possible explanation that flexible transportation is an important reason is the availability of the bikes throughout the whole city. Furthermore, the bikes do not rely on fixed locations. The second most important reason is convenience. This factor is for 42 percent of the respondents a main reason to use bike sharing. Fishman (2016) stated that convenience is the most important reason to choose bike sharing. The difference with the results of this research can be explained by the fact that previous research focused on BSS with docking stations and therefore are not flexible. The third most important reason, with 36 percent is to save on transportation costs.

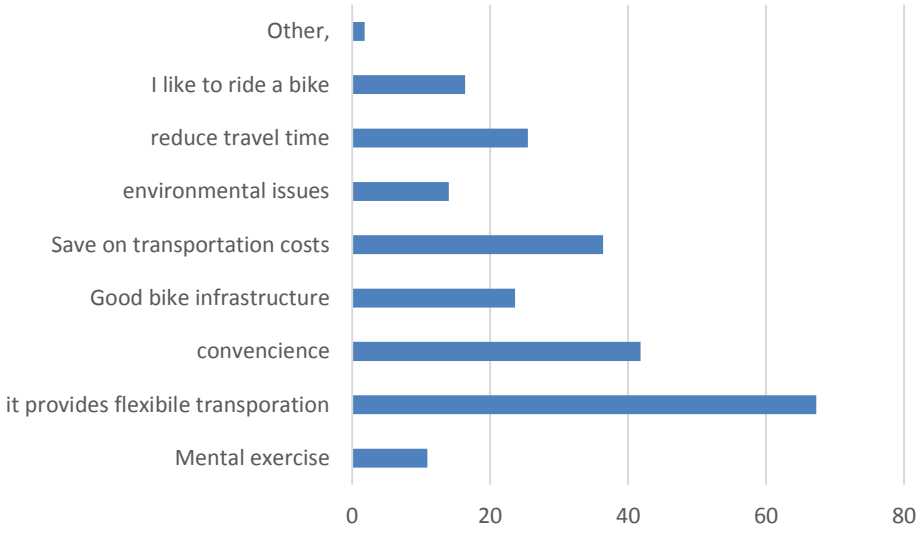

Figure 5 – Reasons to use bike sharing (in percentage)

5.2 Usage of bike sharing and factors determining usage

The ultimate goal of bike sharing is that in the end it will become a daily transportation mode (Shaheen et al., 2010). The results show that bike sharing is not for everyone a daily transportation mode The results of long-term users shows that 44 percent of the respondents use the bike one to three times a day. Only 6 percent use the shared bikes more than three times a day. An overview is provided in figure (6).

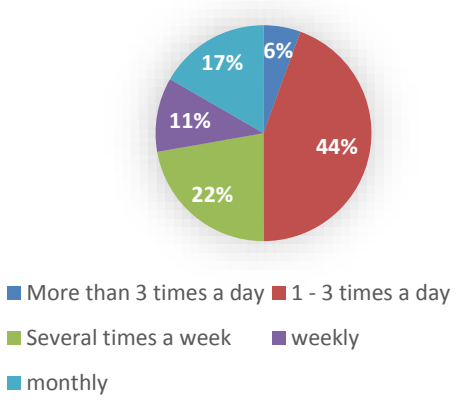

Figure 6 - Usage of bike sharing (in percentage)

Demographics

Questions 2,3 and 6 are about the demographics characteristics of the respondents. These contain the variables gender, age and ownership of transport modes.
The age group is not normally distributed. The age group 18-29 has by far the largest share with 73 percent of the total respondents. Therefore, the age group is not included in the factors affecting usage of bike sharing.
For the other factors a chi square test was conducted to test whether there is significant relation between the factor and daily usage. For meeting the requirements of the chi square test, the researcher has merged the groups together : two variables, 1 to 3 times a day and more than 3 times a day, are merged into one group. The weekly and monthly users are merged into one group as well. As a consequence the frequency of usage is transformed in a dummy variable with 1=daily users and 0= non-daily user

The first demographic factor that has been tested is gender. Results of the chi square test in table (2) show that the level of significance is lower than 0,05 : p = 0,883.
Therefore hypothesis 1 is correct. Based on this test it is assumed that there is no relation between daily usage of bike sharing and gender.

		Daily usage shared bike		
		Yes	No	Total
Gender	Men	15	15	30
	Female	12	13	25
Total		27	28	55

	Value
Pearson Chi-Square	,022
Degrees of freedom	1
Level of significane (2-sided)	,883

Table 1 & 2 – Descriptive statistics & Outcome chi square test : daily usage bike sharing and gender

In terms of bike ownership 16 respondents own a private bike, which is 29 percent of the total (table 3). This correspond with Buck et., (2013) who found that 29 percent of users of a BSS own a private bike.
Results of the chi square test in table (4) show that the level of significance is more than 0,05 : p = 0,931. Therefore hypothesis 2 is correct. Based on this test it is assumed that there is no relation between daily usage of bike sharing and bike ownership. This is in contrast with the findings of Bachand-Marleau et al.(2012) who found out that bike owners make less use of bike sharing

		Daily usage shared bike		
		Yes	No	Total
Own a bike	No	19	20	39
	Yes	8	8	16
Total		27	28	55

	Value
Pearson Chi-Square	,007
Degrees of freedom	1
Level of significane (2-sided)	,931

Table 3 & 4 – Descriptive statistics & Outcome chi square test : daily usage bike sharing and bike ownership

In terms of car ownership 36 percent of the respondents own a private car. This relative high percentage is in line with the ownership of cars in Chengdu among inhabitants. Chengdu has more than 3 million private vehicles in the city where the city population is around the 7,2 million.

Results of the chi square test in table (6) show that the level of significance is lower than 0,05 : p = 0,000. Therefore hypothesis 3 is incorrect. Based on this test it is assumed that there is a relation between daily usage of bike sharing and car ownership.

		Daily usage shared bike		
		Yes	No	Total
Own a car	No	24	11	35
	Yes	3	17	20
Total		27	28	55

	Value
Pearson Chi-Square	14,615
Degrees of freedom	1
Level of Significance (2-sided)	,000

Table 5 & 6 – Descriptive statistics & Outcome chi square test : daily usage bike sharing and car ownership

However, a statistical effect does not include the strength of the association between the variables. For interpreting the statistical effect a Cramer V test was conducted to test the correlation between the variables car ownership and daily usage. Cramer v is a measure of association between two nominal variables, giving a value between 0 and 1.
A value close to zero suggest that there is no correlation between the variables, while a value close to 1 suggest that there is a very strong correlation between the variables.

Nominal by nominal	Value
Cramer V	0,515

Table 7 – Outcome Cramer V test : daily usage bike sharing and car ownership

The results in table (7) show that the correlation between the variables is 0,52. This suggests that there is a moderate strong correlation between car ownership and daily usage of bike sharing. Based on the descriptive results this suggest that on average car owners make less use of shared bikes than people without a car. This is in contrast with the findings of Bachand-Marleau et al. (2012) who found out that car owners make more use of bike sharing.

Purpose

The FFBSs bikes are located in the whole city. Therefore they can be used for all kind of activities. Respondents were asked for which purpose they mainly use bike sharing.
The results show that 56 percent of the respondents use the shared bikes mainly for commuting trips. This are trips from or towards school or work. Commuting trips are most of the time operated on daily routine.
To test whether there is a relation between purpose and daily use of bike sharing a chi square test was executed. However, due to the requirements of the Chi square test the variable purpose is transformed in a dummy variable because more than 20 percent of the cells was expected to below five.

Results of the Chi square in table (9) show that the level of significance is more than 0,05 : p = 0,13. Therefore hypothesis 5 is correct. Based on this test it is assumed that there is no relation between daily usage of bike sharing and trip purpose.

		Daily usage shared bike		
		Yes	No	Total
Main purpose commuting	Yes	18	13	31
	No	9	15	24
Total		27	28	55

	Value
Pearson Chi-Square	2.289
Degrees of freedom	1
Level of Significance (2-sided)	,130

Table 8 & 9 – Descriptive statistics & outcome chi square test : daily usage bike sharing and car ownership

No relation between commuting and daily usage can mean two things. The first is that people with main purpose commuting use the bike not every day for commuting. The other reason is that users ,who use bike sharing for non-commuting trips ,also do trips on daily routine.

5.3 Trip characteristics

Travel time

An important indicator for usage of bike sharing is the travel time, because this provide insight in the reachable destination's provided by the FFBS. On average people use the bike to cycle 1 to 5 kilometers (Rahul et al.,2014).In Chengdu, users of the FFBS use the bike especially for short distances. Results show that 56 percent of the questioned people use the shared bikes on average between 0 and 15 minutes (Figure 7). This corresponds with Midgley (2011) who defines shared bikes as a transportation mode for short distances.

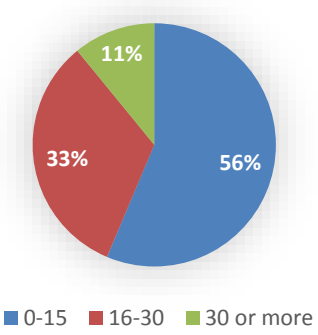

Figure 7 - Average trip duration (in minutes)

Mode conjunction

The vast majority of the bike trips are executed in conjunction with other transportation modes as show in figure (8). Connectivity among transport modes is one of the main goals of transport planning (Litman, 2017).

For 40 percent of the respondents the main transport mode used in conjunction with bike sharing is the subway. Chengdu has a large scale subway system in the city, bike sharing have based on the results a significant role in the first or the last mile for the subway (Ricci,2015). Chengdu has also a large scale bus rapid system. However, the bus do not play a significant role in mode conjunction with bike sharing.

18 percent of the users did not operate their bike trips in conjunction with other transportation modes. This corresponds to previous research of Fishman(2016) about the BSS which states that in most cases bike sharing is part of a trip chain.

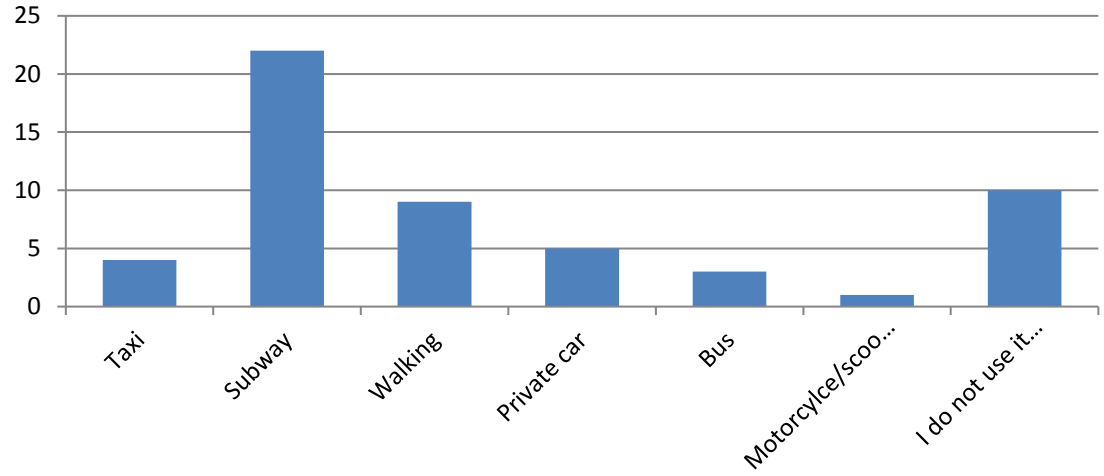

Figure 8 – Using bike sharing in conjunction with the following transportation mode (In percentages)

Conclusion

People use shared bikes in most cases for short distances and for commuting purposes. People fill full their trips most of time in conjunction with other transport modes. In many cases the subway. This can be explained by the fact that the reachable destinations are beyond cycling distances.

5.4 Mode impact

Bike sharing can have an impact on the transportation systems in cities. First of all, bike sharing can play an important role in the normalizing of cycling and increasing cycling levels (Ricci, 2015). The results of this research affirm this statement. 78 percent of the respondents have increase their cycling levels as a result of their bike sharing use. 16 percent respondents have started to cycle as a result of bike sharing. For only 6 percent of the respondents the FFBS has no impact on their cycling levels. These results show that bike sharing can play an important role in normalizing cycling and increasing cycling levels in Chengdu and increasing the psychical exercise of citizens (Ricci, 2015).

Modal shift

Bike sharing can substitute trips that users did before by using another transportation mode. Following figure (9), the main substitute mode is the subway. This transportation mode is substituted for bike sharing for 35 percent of the respondents. The second most substitute mode is walking. FFBS is therefore mainly replacing sustainable transport modes. This is in line with the research on bike sharing in Dublin where Murphy & Usher (2015) found out that most trips by bike sharing replace sustainable transport modes.
Likewise mode conjunction, the role of the bus in terms of modal shift is marginal.

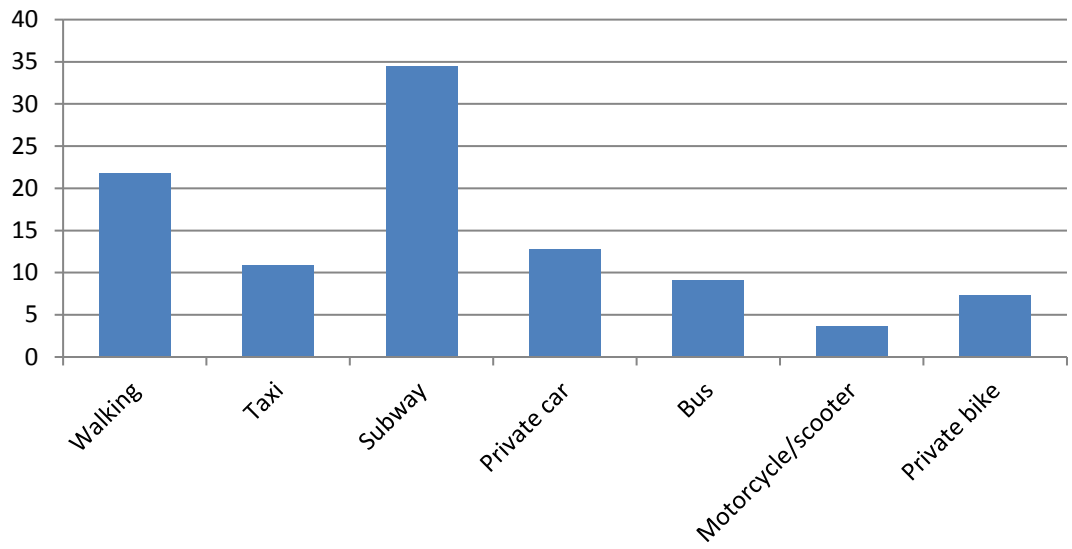

Figure 9 – Using bike sharing instead of the following transportation mode (in percentages)

Car impact

One of the main targets of transport planning is to reduce the reliance on the car (Litman,2017). Reducing of car use has many environmental advantages for cities (Shaheen et al.,2010).

20 long-term users own a car, however only 35 percent of them use bike sharing to replace trips by private car. More positive for saving energy resources and improving multimodal travel are the results of the combination public transport and bike sharing. 55 percent of the car owners have make trips with the combination bike sharing and public transport. Which is 22 percent of the total respondents (Figure 5). These trips they previously made by private car. Despite the fact that car ownership has a negative effect on usage this result shows that the combination and public transport has the potential to resource efficient modes and reduce the reliance and use of motorized vehicles (Litman, 2017). This correspond with the statement of Murphy & Usher (2015) who argued that BSS may result in an decrease of car trips especially for short inner trips.

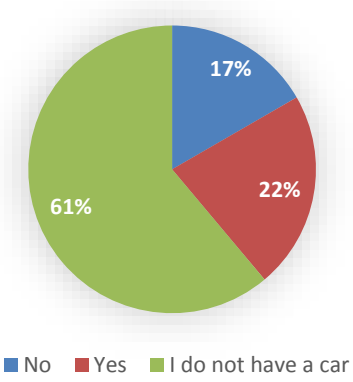

Figure 10 : Multi modal travel public transport and bike sharing (Car owners)

6. Conclusion

This chapter will discuss the results of the previous chapter and conclude it in a deeper way. Conclusions will be related to the sub-questions and the research question. The context of Chengdu takes a central role herein.
Subsequently the limitations of the research will be discussed and recommendations for further research. In the end a reflection on the research process will be provided.

6.1 Answering sub- and main question

Bike sharing has developed over time, which resulted in different definitions. The main characteristic of bike sharing is the possibility to make a single trip (DeMaio, 2009).
The development of bike sharing has gone through four stages: 1) de Witte fietsen in Amsterdam 2) the coin deposit system 3) incorporating ICT in bike sharing. At the moment the fourth generation is developing. The fourth generation consist of internet based bikes. These bikes can be picked up and dropped off everywhere within a geographical area (Spinney & Lin., 2018). This type of shared bikes is called free-floating bikes.

Bike sharing can play an important role in the urban accessibility of cities.
Bike sharing is implemented for encourage taking the bike for short distances in the urban area (Zhang et al., 2015). The most important role of bike sharing is public transport integration and modal shift from motorized vehicles.
The research was mainly designed to explore the characteristics and influential factors relating to the usage of FBBS. Results of the research is based on a quantitative questionnaire among citizens.
People make use of a FBBS because it provides flexible transportation. Other important reasons are convenience and saving on transportation costs.
In terms of trip characteristics of FBBS, the results show that 50 percent of the respondents use the shared bikes daily and 50 percent use the shared bikes on non-daily routine. In terms of factors influencing usage, the results show that car ownership has a significant negative effect on the daily usage of bike sharing. Most respondents use the shared bikes for commuting trips. However, there is no significant effect between the purpose of the trip and daily usage of bike sharing
In terms of duration most users use the bike for trips between the 0 and 15 minutes. This corresponds with Midgley (2011) who argued that BSS is mainly purposed for short distances. In terms of mode conjunction most trips are operated in conjunction with the subway.

With regards to the impact of bike sharing on other transportation modes, remarkable the subway is also the mode that is most substituted for trips by shared bikes. One of the goals of bike sharing is to reduce the use of motorized vehicles (Shaheen et al., 2010). In the research just a small amount of bike sharing trips replace car trips. One reason can be the low amount of respondents who own a car. However, 22 Percent of the car users have operate trips by bike sharing in conjunction with public transport. These trips they did before with the private car.
With regards to cycling in general the implementation of bike sharing has resulted in an increase in cycling levels. For a small amount of respondents the use of shared bikes has had no impact on their cycling levels. For the other respondents, bike sharing has resulted in starting with cycling or in an increase of cycling. Bike sharing can therefore play an important role in normalizing the image of cycling (Ricci, 2015).

On the basis of the analysis the research tried to answer the following research question*: What is the role of a bike sharing system in the urban accessibility of Chengdu?*

Bike sharing can influence the accessibility of Chengdu in different ways. The results show that the implementation of bike sharing results in increase of cycling as transport mode in Chengdu. This increase results in improving physical exercise for citizens. A critical note is that bike sharing also replaces walking as transport mode and therefore reduces the impact of physical exercise of citizens. Despite this, FFBS have the potential to form part of a broader policy to encourage active transport solutions.
The results also show that the shared bikes in Chengdu are mainly used for short trips and in combination with other modes. Therefore, FFBS has to be seen as part of multi modal travel, which is one of the cornerstones of transport planning (Litman, 2017). Chengdu has an high urbanization rate with a lot of development under construction. To improve multimodal connectivity it is important to build new land use development, in particular commercial, and public transport stops on cycling distances. Therefore within a range of 15 minutes cycling. This can result in an increase of the combination public transport and bike sharing. In particular the role of the subway is important because this mode is often used in conjunction with shared bikes. Besides, shared bikes can also relieve the crowdedness in the subway of Chengdu. The subway is the most substituted transportation mode for bike sharing.
The city of Chengdu has more than 3 million cars (Imfo, 2017). The results of this research show that this characteristic is problematic. There is a negative relation between car ownership and daily usage of bike sharing. Important therefore is the role of the government in discouraging car use. However, the results also show that FFBS has the potential in reducing car trips. 55 percent of the car users take a shared bike in combination with public transport. This results in a decrease of emission, noise pollution, congestion and smell pollution (Shaheen et al., 2010). The usage of bike sharing and public transport by car owners strengthen the importance of new development of the city within cycling distance of public transport stops.

To conclude, the usage of bike sharing can improve the accessibility of Chengdu. As mentioned in the rapport of Chengdu, the city has high tech solutions with regards to public transport but there is a lack of integration between the components (Imfo,2017). The flexible transportation mode FFBS has the ability to improve connections and facilitate the way of traveling for city inhabitants and contribute in the public transport goals of the city.
Whether bike sharing has a real impact on improving the urban accessibility lies in the daily usage of users. The ultimate goal of bike sharing is that in the end it becomes a daily transportation mode (Shaheen et al., 2010).

6.2 Limitations and recommendations for further research

There are some limitations to this research.
The most important consideration is the sample size. There is a probability that the sample size of 55 inhabitants is not sufficient to represent the large population of Chengdu. In fact, this research has an exploratory character to provide a meaningful insight in the usage of a FFBS in a city. Due to time constrains it was not possible to get a larger sample size. A suggestion for further research is therefore to enlarge the sample size to be able to get a better reflection of the population of Chengdu.

The second consideration is the influence of the weather. The questionnaire is executed in spring. The weather in Chengdu is in this period most dry and warm. Therefore respondents could be more optimistic about the FFBS than they would have been in periods with worse weather. For example in December and January when the temperature is quite cold or in the July and August when there is a

lot of rain in combination with high temperatures (Shen et al., 2018). A suggestion for next research is to investigate the FBBS in the city in different periods of the year.

The third consideration is the quality of the questionnaire questions. People were only be able to give one answer for most questions. However, it was possible that more than one answer was applicable for the respondents. For example, people use bike sharing for different purposes but they were only allowed to give one answer. This might have caused bias in the answer of the questions.

Many respondents use bike sharing for commuting trips. Commuting is a daily routine travel between one's place of residence and place of work, or study. Such trips have a large impact on the urban accessibility. Therefore, a suggestion for further research is to focus the study on commuting trips and to make a distinguish between weekend and week days

6.3 Reflection

Many choices have been made during the research process. The most important decisions will be briefly explained.

The first goal was to do a qualitative research in Chengdu. However, due to the language gap between the researcher and the respondents this was not realistic. The researcher did not keep in mind the English language skills of Chinese people.
Therefore, the study was changed to a quantitative approach with questionnaires. As a consequence, the questionnaire is set up in a relative short time frame due to time constrains. This affected the quality of the questionnaire. Firstly, the questionnaire was partly based on the theoretical framework. The researcher has therefore to change the theoretical framework at some points because the questionnaire was already conducted.
Besides, the order of the questions was not very logic. It was perhaps better to order the questions based on the sub-questions. Also, the question about mode conjunction might have been more explicit. It could be that users use multiple transportation modes for their trip. Besides, many respondents have chosen walking as main conjunction mode in combination with bike sharing. However, it is not clear how this combination between bike sharing and walking is defined keeping in mind that all bike sharing users have to walk to their bike.
To conclude, the next it is better to spend more time on making the questionnaire and base the questionnaire on the theoretical framework.

The research was focused on long-term users living in Chengdu. Due to the access to internet everyone was be able to fill in the questionnaire. For the next time, the researcher could add questions in the questionnaire to eliminate the non-target group of respondents from the questionnaire.
Furthermore, many people were face-to face willing to fill in the questionnaire. If the researcher would have conduct from the beginning face-to face questionnaires, it might be that the research would have a higher sample size.

In terms of the content of the research, it was perhaps better to focus the study on one aspect of bike sharing keeping in mind the word limit of the research. This could have resulted in a more detailed analysis. For example, a study focus on the attitude of FFBS users or a study on focus on the factors regarding bike sharing use. If the study was focused on factors influencing usage, the researcher could have use more factors which influence usage. Also if the study was focused on trip characteristics the research could have add questions about peak hours, distinction between weekday and weekend etc.

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Appendix

Questionnaire about bike sharing in Chengdu (Chinese)

1.性别

☐ 男
☐ 女

2.年龄

☐ 0-18
☐ 18-30
☐ 30-50
☐ 50 或更多

3.我现有以下交通方式

☐ 汽车
☐ 自行车
☐ 摩托车
☐ 以上都不是

4. 您是因为接触了共享单车而学会的骑行吗？

☐ 是
☐ 没有
☐ 没有 但增加骑自行车

5.您通常在骑行上花费多少时间呢？

☐ 0-15
☐ 15-30
☐ 30 或者更多

6.在城里，您使用共享单车的频率大概是怎样呢？

☐ 每天超过 3 次
☐ 每天 1 - 3 次
☐ 一周几次

☐ 每周
☐ 每月一次

7.您使用共享单车的主要目的

☐ 上学或工作
☐ 购物
☐ 社会/娱乐
☐ 个人预约
☐ 运动/休闲
☐ 餐厅或餐点

8.使用自行车共享的最重要原因（选择 3）

☐ 精神锻炼
☐ 它提供了灵活的交通选择
☐ 它的方便
☐ 良好的单车基础设
☐ 节省运输成本
☐ 环境问题
☐ 减少旅行时间
☐ 我喜欢骑自行车
☐ 其他,

9.想想你最常使用共享自行车的行程 – 在使用自行车共享之前，你是如何完成这次旅行的。

☐ 步行
☐ 出租车
☐ 地铁
☐ 汽车
☐ 总线
☐ 摩托车

10.**你最常使用哪种交通方式与共享**单车结合？

☐ **步行**
☐ **出租**车
☐ **地**铁
☐ **汽**车
☐ 总线
☐ **摩托**车
☐ **我不使用其他模式与自行**车共**享**

11.**自从使用共享**单车以来，我已经将共享单车与公共交通工具结合在了一起，替代了我之前通常使用私家车出行。

☐ **没有**
☐ **是**
☐ **我没有**车

Questionnaire about bike sharing in Chengdu (English)

1.What is your gender ?

☐ Male
☐ Female

2.What is your age ?

☐ 0-17
☐ 18-29
☐ 30-49
☐ 50 or more

3.Which transportation modes do you own ? multiple choice

☐ Car
☐ bicycle
☐ motorcycle
☐ none of the above

4.Did you start cycling as a result of shared biking?

☐ Yes
☐ No
☐ No, but I increased my cycling levels

5.How much time do you usually spend on riding shared bikes?

☐ 0-15
☐ 16-30
☐ 30 or more

6.How often do you use shared bikes in town?

☐ More than 3 times a day
☐ 1 - 3 times a day
☐ Several times a week
☐ weekly
☐ Once a month

7.What is the main purpose of using your shared bike ?

☐ Go to school or work
☐ shopping
☐ Social/Entertainment
☐ Personal appointment
☐ Sports and leisure
☐ Restaurant or meal

8.The most important reason to use bicycle sharing (multiple choice to 3)

☐ Mental exercise
☐ It provides flexible transportation options
☐ Its convenience
☐ Good bike infrastructure
☐ Save on transportation costs
☐ Environmental issues
☐ Reduce travel time
☐ I like to ride a bike
☐ other, …

9.Which transportation method do you use most often in combination with a shared bicycle?

☐ walk
☐ taxi
☐ subway
☐ car
☐ bus
☐ motorcycle
☐ I don't usually use it with other vehicles

10.Think about the trips you use most often to ride a shared bike - how did you complete the trip before sharing it with your bike?

☐ walk
☐ taxi
☐ subway
☐ car
☐ private bike
☐ bus
☐ motorcycle

11.Since using shared bikes, I have combined shared bikes with public transport instead of the usual way I used to travel with private cars.

☐ No
☐ Yes
☐ I do not have a car