A Study on Travelers' Behavior Towards Carsharing System: Case Study of Dalian, China

Vanduy TRAN [a], Shengchuan ZHAO [b], El Bachir DIOP [c]

[a,b,c] *Dalian University of Techonlogy, No.2 Lingong Road, Ganjingzi District, Dalian, 116024, P.R. China.*
[a] *E-mail: tranvduy@gmail.com*
[b] *E-mail: szhao@dlut.edu.cn*
[c] *E-mail: elbass88@yahoo.fr*

Abstract: Carsharing has appeared as a novel alternative to private car in urban areas and larger cities. The application and popularization of the concept has resulted in the effective control of the growth of car ownership; reducing traffic congestion, and alleviating environmental pollution. This paper seeks to find the factors effecting travelers' acceptance towards carsharing and the potential market segments to be targeted for a successful implementation of the carsharing concept in China. A Stated Preference survey was carried out in Dalian, China and Binary Logit Model was built to model travelers' acceptance towards different carsharing schemes. The results showed several socio-demographic factors affect travelers' decision making process. Gender, age, education level, income status, housing status and carsharing's knowledge had great impact on travelers' propensity to adopt carsharing system. Findings from this study can be useful to transport planners and policy makers for the implementation of carsharing systems in urban areas.

Keywords: Carsharing, Travel Behavior, Stated Preference Survey, Binary Logit Model, Policy Analysis, Dalian.

1. INTRODUCTION

Over the past decade, the rapid motorization and urbanization has brought China many challenges. China has become one of the largest automobile manufacturers in the world since 2010, with 18 million cars produced (Feng *et al.*, 2013). Demand for vehicles has grown quickly in recent years; approximately 22 million cars were brought to the market in 2013. At the same time, there were 137 million private cars on the roads of China (Li *et al.*, 2016). The increase of private vehicles has led to much negative consequences for the urban development and environmental issues in China such as traffic congestion, air pollution, and overload of parking lots. This compelled the policy makers to find a proper solution to the rapid growth of car ownership; thus "Carsharing" was identified as an innovation to deal with these problems.

The term "Carsharing" has been defined as an alternative to car ownership and it has first appeared in Europe since the 1940s before spreading to Australia, the Americas, and Asia (Shaheen *et al.*, 2009). In principle, carsharing is basically the car rental service but people usually rent a vehicle for a short period of time, usually by the hour or minute. To access and drive a vehicle, users are required to become members of a carsharing organization, and reserve the vehicle beforehand via smart phone App or Internet. For example, in North

America, a member of carsharing system was required to pay between $300 and $500 for monthly fee or deposit; usage fees were calculated based on time and miles with between $1 and $2 per hour, plus between $0.25 and $0.4 per mile. These fares charged included fuel, insurance, and several related operating costs (Litman, 2000). Carsharing program typically attracts people who usually take public transport to travel but need a car sometimes; people who owned a car before but need a second car for a while; and people who want to save money from the fixed cost of car ownership (Wang *et al.*, 2012).

In most situations, carsharing aimed at reducing car ownership and personal usage frequency. Huwer (2004) conducted a model which co-operated carsharing services and public transport system in some cities of Germany. He demonstrated the benefits of the model in reducing private vehicle demand and maintaining the use of public transport services. Many studies have stated that carsharing users would be give up their own car when they used the sharing vehicles, they have also suggested that each carsharing vehicle could remove between 9 and 13 private cars from the road (Cervero & Tsai, 2004; Martin & Shaheen, 2010; Stasko *et al.*, 2013). In another aspect, they have also considered the impacts of carsharing to personal mobility in vehicle-mile-traveled (VMT). Cervero (2003), Cervero & Tsai (2004), and Katzev (2003) determined a remarkable change in VMT of carsharing members. Shaheen *et al.* (2009) has estimated an average 44% decrease in VMT for each individual who used carsharing services.

Earlier studies have identified five main market segments as potential carsharing users: neighborhood residential, business areas, college campus, people with low-income, and commuters (Shaheen *et al.* 2005; Shaheen & Coheen, 2007; Celsor & Millard-Ball, 2007; Zhou, 2011, Efthymiou *et al.*, 2013). The characteristics of potential customers for carsharing system have also been indicated such as high education level, young-middle age, people with high income, environmental perception, and do not own private vehicle (Prettenthaler & Steininger 1999; Shaheen & Martin 2006; Nobis, 2006; Zheng *et al.*, 2009; Wang *et al.*, 2012). Besides, costs efficiency, convenience and awareness about environmental issues have also identified as the main reasons for joining carsharing (Steininger *et al.* 1996; Seik, 2000; Katzev, 2003; Lane, 2005; Zhou *et al.*, 2011; Duncan, 2011; Wang *et al.*, 2012; Rabbitt & Ghosh, 2013).

In terms of customers' behavior towards carsharing system, the literature stated that individuals and their related situation are the main factors affecting the willingness to use the services (Abraham, 2000; Zheng, 2009; Efthymiou, 2013; De Luca & Pace, 2014; Levin, 2015). In contrast, other studies indicated that the costs gap and feature of services play an importance role in choosing carsharing (Zhou, 2014; Katzev, 2003). These conclusions contributed greatly in the development and operation of carsharing system in past practice. However, these differences should be taken into consideration in order to successfully develop the concept in new markets such as China.

Since its emergence, carsharing has been successful in most large cities in China which have complete motorization, such as Beijing, Shanghai, Hangzhou, Shenzhen, and Dandong. As of 2013, carsharing in Chinese market offered approximately 800 share-use vehicles based on two types of services, "Rent by Hour" which was transformed from traditional car rental service; and " Car-pooling" which consists of more than one person in a vehicle (Wang, 2014; An, 2015). However, China is still in the process of motorization, or already completed but still relatively new. Cultural characteristics may also strongly influence the decision on whether customers would choose carsharing instead of purchasing private car for travel. Most Chinese people tend to use car ownership rather than other transport services such as carsharing because of its convenience.

There have been several studies which stated that China is a potential market to develop and apply carsharing system. They have also suggested several potential market segments for the system, which were characterized by education level, income, age, travel habits, and attitudes (Shaheen *et al.* 2006; Wang *et al.* 2012). However, there is still a lack of empirical evidence as to what factors affect the most costumers' behavior and which market segments are potential targets for developing carsharing in China. This study aims at filling this gap by collecting Stated Preference (SP) data on travelers' socio-demographic characteristics and attitudes towards different carsharing schemes. A Binary Logit Model was developed to determine the main factors influencing travelers' adoption of carsharing.

Next section describes the methodology including survey design and the theory behind the model developed. Section 3 summarizes data collection process and a description of the collected data sample. The results of the model are presented and discussed in section 4. Finally, section 5 provides some concluding comments and the directions for future research.

2. METHODOLOGY

2.1 Survey design

Given that carsharing system is not available in Dalian, China, we chose Stated Preference (SP) survey, which is more suitable for collecting data on unavailable alternatives. For example, Wang et al. (2012) performed a SP survey of 271 respondents in Shanghai about travelers' behavior toward carsharing. The research identified the common factors that affect the interest in carsharing system such as education level, age category, and income. Abraham (2000), Zhou & Kockelman (2011), Efthymiou et al. (2013), and Ohata et al. (2015) used SP survey to investigate the customer's behavior towards carsharing system. They have also specified several factors related the customers' characteristic affecting the willingness to join the system such as gender, family status, car ownership, and satisfaction; as well as the various factors related the service attributes of carsharing system such as the several costs, the access distance, the type of vehicle, and the applied technology.

The research is strategy on that the transportation planners can use to implementing the carsharing system, which can help them to select several appropriate related policies such as marketing, operations and prices. Referring to the literature review we used the generated ideas to carry out a handwriting survey. The questionnaires then were designed to gather the travelers' information which consists of three parts. The first part provides the respondents' demographic characteristics and trip preference such as current mode choice, car rental, car ownership, owning parking lot, new technology application. The second part provides a brief introduction to the concept of carsharing system to the participants (see figure 1). The third part asks about the familiarity with carsharing concept and describes the stated preference exercise. In this section, the participants would be presented three choice sets, each choice set describing several attributes of carsharing. In order to estimates the main factors affect the choice decision making, and reflect the ability taking part of carsharing servicers of travelers, the respondents were provided two alternative (binary choice) for each choice situation indicating whether they would join the carsharing or not (be willing to join: "Yes"; not be willing to join: "No"). The attributes include (1) "Fee," monthly deposit fare that each user was charged for using carsharing system; (2) "Rate/h," the fare charged calculated for user based on usage time; (3) "Rate/km," Additional cost calculated per kilometer; (4) "Distance," the distance to access a carsharing station. The attribute levels were designed based on

previous studies (Shaheen & Martin, 2006; Wang *et al.*, 2012), and from discussion with some carsharing companies located in China, such as EduoAuto, China Car Clubs, and Car2share. The attribute of carsharing and their levels are described in table 1.

Tab. 1 Value of variables and their level

Variables	Attribute level
Fee (RMB)	50, 75, 100
Rate/h (RMB)	15, 20, 25
Rate/km (RMB)	0.5, 0.75, 1
Distance (Km)	0.5, 1, 1.5

2.2 Binary Logit Model

As a common type of statistical model for the discrete choice situation, the binary logit model is a robust statistical tool to represent choice behavior. It predicts the systematic taste variation that is related to several observed characteristics of the decision maker. Many studies related to customers' behavior towards carsharing services have utilized the binary logit model. For example, Luca and Pace (2014) used binary logit model to investigate the aspect of users' behavior towards a carsharing system. Cervero (2003); Zheng et al. (2009) adopted the binary model to predict the likelihood of using carsharing system of potential members. Shaheen (1999) used logistic regression model to better understand the relationship among the characteristics, attitudes, and carsharing usage of the pilot carsharing's members. Travelers' acceptance towards carsharing system in this paper was considered as binary choice process. To reach the objectives as discussed earlier, we employed the Binary Choice model concept that was discussed in Ben-Akiva and Lerman (1985), which aims to investigate the main factors affecting travelers' adoption of carsharing system. The respondents were asked to make their decision in a binary choice where the alternatives were "Yes" if the respondent is willing to take part in the carsharing services and "No" if the respondent is not interested in the services. The modeling framework used for estimating the probability of person *n* choosing alternative *i* can be expressed as:

$$P_n(i) = 1/(1+e^{-V_{in}}), \qquad \forall V_{in} = \beta X_{in} \tag{1}$$

Where,

V_{in} : the systematic components of the utility of alternatives *i*,

β : the vectors of coefficients,

X_{in} : the vector of explanatory variables including socioeconomic characteristic and carsharing attributes.

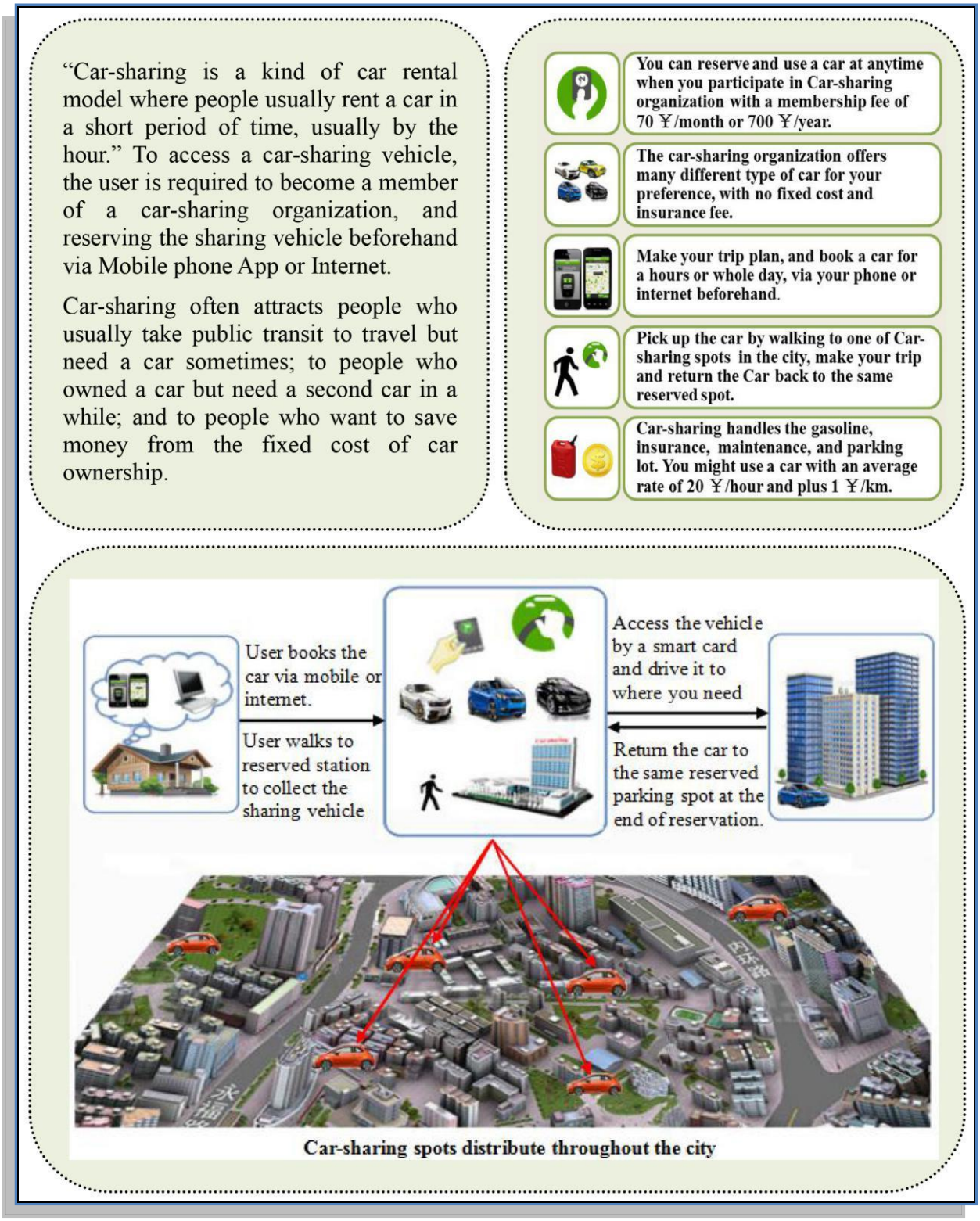

Figure 1. Carsharing brochure

3. DATA

The research data were collected in Dalian, a financial center and motorized city in the Northeast part of China, with 6,990,400 people living in 13,237 km^2. As of 2014, the density is 428/km^2, and the GDP per capital is 77,097 RMB (11,389 USD). SP survey was used in this study; four pages of questionnaire were given directly to respondents by a survey team. Respondents had to complete and return the questionnaires after two or three days. The survey was completed in March, 2016. In total, 300 questionnaires containing each three scenarios were distributed; one hundred were sent to the staff of Dalian University of Technology and the other two hundred were sent to two companies located in the city. After eliminating the incomplete and invalid responses we obtained a total of 96 samples, accounting for approximately a 32% response rate. Each respondent was faced with three different scenarios; this provided a database of 288 observations for our research.

Table 2 presents the socio-demographic characteristics of our survey population. Of the sample, the percentage of men was higher with and women representing 54% and 46%, respectively; all of participants are over 18 years old and eligible for driving license in China. 72.91% of the population in survey was relatively old and corresponded to the age group between 31 and 65 years. Undergraduate students represented the largest share in the distribution of education level (39.58%). In term of marital status, most of the participants were married. Housing situation showed that the majority of respondents have their own house and live with their family. The sample also showed that half of population has household income at a middle level, between 5000 and 10,000 RMB monthly (1 RMB ≈ 0.158 USD). The majority of the respondents (70.83%) owned more than one car, and approximately 66% of the population had a driving license. One half of the population usually uses individual car for traveling, whereas the other half uses public transport system or other modes such as biking or walking. The statistics showed that demand for new vehicle in this population is not too high, with only a handful of the population said they have plan to buy a car in the near future (12.5%). When asked about the carsharing familiarity, more than 60% of population said that they had no idea about the system, while a quarter of population indicated that they had somewhat information about the concept, and a few of them said they were familiar or very familiar with the concept.

Table 2. Socio-demographic characteristic of the sample

Attributes		Percentage of Population
Gender	Male	54%
	Female	46%
Age	18 - 30 years	25%
	31 -50 years	33.33%
	51 - 65 years	39.58%
	> 65	2.09%
Education level	Under High school	2.08%
	Vocational school	31.25%
	Undergraduate	39.58%
	Graduate	27.08%

Table 2. Socio-demographic characteristic of the sample (Continues)

Attributes		Percentage of Population
Income	< 5000 RMB	15.28%
	5000 - 10,000 RMB	50%
	10,000 - 20,000 RMB	29.17%
	20,000 - 30,000 RMB	4.14%
	> 30,000 RMB	2.08%
Car ownership	None	29.17%
	≥ 1	70.83%
Housing status	Rent/Dormitory	14.58%
	Owner	85.42%
Driving license	Yes	66.67%
	No/Under processing	33.33%
Mobile App Using	Never	43.75%
	Often	18.75%
	Sometime	25%
	Always	2.08%
Familiarity with Carsharing	Not at all	62.5%
	Somewhat	25%
	Familiar	10.42%
	Very familiar	2.08%

4. RESULTS

The model was estimated by using the maximum likelihood function method. Table 3 presents the descriptive variables that were used and the results of statistic test. Binary logit model was developed to investigate the choice behavior through various variables including demographic characteristics, carsharing attributes, and other trip characteristics such as transport mode use, use of mobile application in transportation, carsharing familiarity, and car ownership situation. The goodness-of-fit McFadden's pseudo r-square (ρ^2) and adjusted McFadden ($\rho^2_{adjuted}$) are used for fitting the overall model. An increasing ρ^2 and $\rho^2_{adjuted}$ may indicate a better fit of the model, Mc Fadden (1977) stated that ρ^2 of value between 0.2 and 0.4 should be taken to represent a well fit of the model. It can be seen that the model fits the data well with the coefficient of McFadden being 0.3658 and the adjusted McFadden being 0.2759.

As can be found from table 3, demographic characteristics had significant impact to carsharing acceptance as expected. Of these, the gender difference was positive significant, indicating that the men are more interested in carsharing than women. This result is contrary to several early studies in North America and Europe which found that women are slightly more likely to join carsharing (Nobis, 2006; de Luca and Di Pace, 2015). In their study investigating the effects of age on travelers' acceptance of carsharing in China, Wang *et al.*

(2012) suggested that young people are more likely to join carsharing. However our result shows that the age parameter is positive significant which means that as age increases the propensity to join carsharing increases. This result seems to be consistent with travel behavior in the Chinese society where most of younger people tend to own their own car rather than use a sharing vehicle service. While travel demand by private car in family and costs saving might be the main reasons for the older ones to be more interested in carsharing system. The variable associated with education level also had the expected sign as positive significant, which means that people with high education level are more inclined to use carsharing. This can be explained by the fact that a highly educated person is more likely to grasp new concept such as carsharing, thus, policy makers would be advised to implement carsharing system in areas with a highly educated populace such as business areas and university campuses (Shaheen & Martin, 2006; Zhou & Kockelman, 2011; Wang *et al.*, 2012).

Table 3. Binary logit model results

Variables		Coefficient Estimated	Std. Error	t-value
Gender	Gender, 1: Male; 0: Female	2.0472***	0.5994	3.415
Age	Age distribution, 1: if age ≥ 31, 0: otherwise.	2.5329***	0.7393	3.426
Edu	Education level, 1: college level at least; 0: otherwise.	2.6100***	0.6330	4.123
Housing	Housing status, 1: owning homes, 0: otherwise.	-3.5753***	0.8014	-4.461
Income	Monthly income (RMB), 1: income > 5000; 0: otherwise.	-2.1121***	0.5993	-3.524
CarO	Car ownership, 1: owning more than one car; 0: otherwise.	-	-	-
License	Driving license, 1: yes; 0: otherwise.	2.3662***	0.6619	3.574
Parking	Owning a parking space, 1: yes; 0: otherwise.	1.5434**	0.5091	-3.032
Mode	Using private car for daily travel, 1: yes; 0: otherwise.	-1.2389*	0.5675	-2.183
Rcar	Car rental frequency, 1: if respondent rents car sometime per week; 0: otherwise.	1.0455*	0.4441	2.354
Mobile	Mobile App using frequency, 1: often use the App to call taxi; 0: otherwise.	1.8334**	0.5891	3.112
CsF	Familiarity with carsharing concept, 1: had somewhat at least; 0: otherwise.	0.9369*	0.4577	2.047
Fee	Monthly deposit fee charged, RMB.	-0.0365***	0.0096	-3.791
Rate/h	Fare charged per hour, RMB.	-0.2250***	0.0564	-3.986
Rate/km	Fare charged per hour, RMB.	-	-	-
Distance	Accessing distance, Km.	-	-	-
Model statistics				
Observation		288		
Log-Likelihood		-91.735		
McFadden ρ^2		0.3658		
McFadden adjusted ρ^2(adjusted)		0.2759		

- Not relevant; '***" significant at the 0.001 level; "**" significant at the 0.01 level; '*' significant at 0.05 level; '.' significant at 0.1 level.

As expected, the variables representing housing status and income of respondents were negative significant. This indicates that people who own a house or have a high monthly income are generally less interested in the other transport services such as public transport, car rental, and carsharing is no exception. The variable associated car ownership (CarO) was also tested but it did not turn out statically significant. However, we suggest that these results are more realistic in China, where people tend to use their own car rather than abandon it to use carsharing services even if it might have more financial and environmental benefits.

Considering the fact that carsharing could diminish the growth of car ownership, people who usually travel by private car would have to abandon their own car and use the sharing service (Katzev, 2003; Huwer, 2004; Cervero & Tsai, 2004; Shaheen *et al.*, 2009; Stasko *et al.*, 2013). In contrary, our results showed that the variable associated with transport mode use of individuals was negative significant, which means people who use private car are less interested in carsharing than those who used the active modes such as bus, metro, bike or walking. Besides, we assumed that the limited parking space in urban areas would impact the respondents' willingness to join the sharing service. The model yielded a reasonable result as people who are satisfied with owning a parking lot would not be interested in a sharing service. On the other hand, people who occasionally rent a car for traveling would be more likely to consider joining a carsharing system. These results imply that the objective to decrease car ownership by carsharing seems to be difficult to achieve in the Chinese market. However carsharing can help increase the mobility in urban areas as well as giving to those who cannot afford a vehicle the opportunity to satisfy their travel needs.

When asked about their familiarity with carsharing service, most of the respondents (62.5%) indicated that they had no idea about the concept. Of these, however, 15.5% respondents indicated they are willing to join the system if available. However, the willingness has increased in the remaining 37.5% of the population who have somewhat information about the concept with 27.7% of them willing to join the service. As expected we have also assumed that people would be more likely to join carsharing if they were more familiar with the concept (Fukuda *et al.*, 2002; Shaheen & Martin, 2006; Zheng *et al.*, 2009). The statistic test revealed that everything being constant, the likelihood of participating in carsharing increases as respondents' familiarity with the concept increases. Technological improvements on carsharing system have been introduced in several early studies (Ohta *et al.*, 2013; Wappelhorst *et al.*, 2014), we also hypothesized that a person who is familiar with new technologies applied in transport system such as smart phone App or electric vehicle would be more likely to be interested in carsharing systems. The variable associated with the frequency of using smart phone App in transport was positive significant as expected. Therefore we suggest that integrating some new technologies into the service may attract potential customers for the carsharing system.

Certain variables associated with cost were considered important in the choice process, as it was found that the deposit fee charged per month and fare charged per hour had significant impact on respondents' choice. They both had negative signs implying that the probability of acceptance decreases as the fare increases. It should be noted that the variables associated with rate calculated per kilometer and distance (Fee and Rate/hour) were tested, but they did not turn out statically significant which seems to have no impact on carsharing choice. In this case, two hypotheses can be formulated to explain the situation. First, the limited information about carsharing could make individuals confused when calculating the fare that they would have to pay when using the system. This may have generated a bias in the way respondents compared the alternatives by only considering the first two attributes of carsharing options, Fee and Rate/hour, when they made their decision. Second, it could be that

people who are willing to join the system usually travel by public transportation rather than private car, therefore the distance to get access the vehicle might not be a problem.

5. CONCLUSION

The study sets out to explore the concept of carsharing with specific case in Dalian, China. It identified the reasons and incentives for developing carsharing system, and the role of individual behavior in choosing the concepts. Certain factors significantly affect the decision-making process with respect to different types of service. The study also sought to know whether carsharing was able to control the growth of private car which has become a huge challenge in China in recent years.

The binary logit model revealed the significant factors which effect to travelers' behavior towards carsharing system. Several demographics are identified as the main factors affecting the acceptance of the concept. We found that gender, age, education level, and housing status have significant effect on travelers' participation in carsharing. We also found that the propensity to join carsharing decreases for those who already own a car, people with high income, and own a house.

Our study revealed that carsharing results in an increase in personal mobility rather than decrease of car ownership. People who own a vehicle or usually travel by private car will be less likely to make a choice of joining carsharing, while other people who are accustomed to public transport will be attracted by the services. Besides, respondents' driving experience was considered as significant factor to increase the propensity to join carsharing. These findings reduce the likelihood that carsharing is capable of limiting the growth of car ownership in the future as discussed previously.

The attributes of carsharing did not greatly affect the choice of individuals. In this study, the monthly fee and fare calculated per hour had more significant impact on individuals' preference, while the distance to get access to the sharing vehicle was deemed not to be a problem for users, because most of the respondents who are willing to take part in carsharing are those who often travel by public transport which is very convenient for connecting other modes of transport. This leads to the consideration that integrating carsharing with public transport system as an efficient policy to attract more customers to take a part to the services. Furthermore, individuals' knowledge about the concept was determined as one of the important factors for predicting participation. Therefore, we suggest that introducing and promoting carsharing to the users are essential elements which will make the carsharing successfully in practice.

Our survey provides evidence to suggest that carsharing has a potential to be developed in Dalian and other major cities as well. Approximately 20% of the respondents of the survey population indicated that they would join carsharing system if it was available. Besides, the results of the logit model identify multiple potential segments of customer for carsharing system in China. These segments consist of male, highly educated people, individuals with lower and middle income, middle-aged and older travelers (31 - 65 years old), experienced travelers, and people who have a good knowledge of carsharing concept.

In conclusion, this research makes significant contributions in term of transport planning. Through this study planners and policy makers will pay more attention to carsharing in future. The understanding of travelers' behavior towards carsharing system is helpful for implementing suitable policies to apply and develop the concept, as well as identify the potential target markets. For further research we suggest that it is necessary to consider

several policies which can widely promote the image of carsharing in China. It would also be interesting to incorporate other types of carsharing services such as one-way service or peer to peer service to find out which one could be more successfully implemented in China. Considering the use of Likert Scale in travelers' preference would have made the result more thorough and detailed, as well as it would be helpful to predict to which extent the traveler would be willing to join a carsharing service.

ACKNOWLEDGEMENT

This work is supported by the National Natural Science Foundation of China (Grant No. 51478085). We would like to thank the reviewers for their positive comments and valuable suggestions on our work.

REFERENCES

Abraham, J.E. (2000) Carsharing: A survey of preferences in carsharing. *The Journal of World Transport Policy & Practice*.

An, H. and Gu, L. (2015) Main Success Factors for Developing Car-sharing in China.

Celsor, C. and Millard-Ball, A. (2007) Where does carsharing work?: Using geographic information systems to assess market potential. Transportation Research Record: *Journal of the Transportation Research Board*, (1992), pp.61-69.

Ben-Akiva, M. E., & Lerman, S. R. (1985) *Discrete choice analysis*: theory and application to travel demand (Vol. 9). MIT press.

Cervero, R. (2003) City CarShare: First-year travel demand impacts. Transportation Research Record: *Journal of the Transportation Research Board*, (1839), pp.159-166.

Cervero, R. and Tsai, Y. (2004) City CarShare in San Francisco, California: second-year travel demand and car ownership impacts. Transportation Research Record: *Journal of the Transportation Research Board*, (1887), pp.117-127.

De Luca, S. and Di Pace, R. (2014) Modelling the propensity in adhering to a carsharing system: a behavioral approach. *Transportation Research Procedia*, 3, pp.866-875.

De Luca, S. and Di Pace, R. (2015) Modelling users' behaviour in inter-urban carsharing program: A stated preference approach. *Transportation research part A*: policy and practice, 71, pp.59-76.

Duncan, M. (2011) The cost saving potential of carsharing in a US context. *Transportation*, 38(2), pp.363-382.

Efthymiou, D., Antoniou, C. and Waddell, P. (2013) Factors affecting the adoption of vehicle sharing systems by young drivers. *Transport policy*, 29, pp.64-73.

Feng, S. and Li, Q. (2013) Car ownership control in Chinese mega cities: Shanghai, Beijing and Guangzhou. *Journeys*,(September), pp.40-49.

Fukuda, T., Kashima, S. and Barth, M.J. (2002) Evaluating second car system, an electric vehicle sharing experiment in Tama New Town District, Inagi city, Tokyo. *Transportation Research Record*.

Huwer, U. (2004) Public transport and csar-sharing—benefits and effects of combined services. Transport Policy, 11(1), pp.77-87.

Katzev, R. (2003) Car sharing: A new approach to urban transportation problems. *Analyses of Social Issues and Public Policy*, 3(1), pp.65-86.

Lane, C. (2005) PhillyCarShare: First-year social and mobility impacts of carsharing in Philadelphia, Pennsylvania. Transportation Research Record: *Journal of the Transportation Research Board*, (1927), pp.158-166.

Le Vine, Scott, *et al.* (2015) "A new approach to predict the market and impacts of round-trip and point-to-point carsharing systems: case study of London." *Transportation Research Part D*: Transport and Environment 32, pp. 218-229.

Li, Wenchao, *et al.* (2016) Life cycle assessment of end-of-life vehicle Recycling processes in China—Take Corolla Taxis for Example. Journal of Cleaner Production.

Litman, T. (2000) Evaluating carsharing benefits. Transportation Research Record: *Journal of the Transportation Research Board*, (1702), pp.31-35.

McFadden, D. (1978) Quantitative Methods for Analysing Travel Behaviour of Individuals: Some Recent Developments',(in) Hensher. *DA and Stopher, PR (eds) Behavioural Travel Modelling, Croom Helm, London*.

Martin, E., Shaheen, S. and Lidicker, J. (2010) Impact of carsharing on household vehicle holdings: Results from North American shared-use vehicle survey. Transportation Research Record: *Journal of the Transportation Research Board*, (2143), pp.150-158.

Nobis, C. (2006) Carsharing as key contribution to multimodal and sustainable mobility behavior: Carsharing in Germany. Transportation Research Record: *Journal of the Transportation Research Board*, (1986), pp.89-97.

Ohta, H., Fujii, S., Nishimura, Y., & Kozuka, M. (2013) Analysis of the acceptance of carsharing and eco-cars in Japan. *International Journal of Sustainable Transportation*, 7(6), 449-467.

Prettenthaler, F.E. and Steininger, K.W. (1999) From ownership to service use lifestyle: the potential of car sharing. Ecological Economics, 28(3), pp.443-453.

Rabbitt, N. and Ghosh, B. (2013) A study of feasibility and potential benefits of organised car sharing in Ireland. *Transportation Research Part D*: Transport and Environment, 25, pp.49-58.

Seik, F.T. (2000) Vehicle ownership restraints and car sharing in Singapore. *Habitat International*, 24(1), pp.75-90.

Shaheen, S.A., Cohen, A.P. and Roberts, J.D. (2005) Carsharing in North America. University of California, Berkeley.

Shaheen, S., Cohen, A. and Roberts, J. (2006) Carsharing in North America: Market growth, current developments, and future potential. Transportation Research Record: *Journal of the Transportation Research Board*, (1986), pp.116-124.

Shaheen, S. and Cohen, A. (2007) Growth in worldwide carsharing: An international comparison. Transportation Research Record: *Journal of the Transportation Research Board*, (1992), pp.81-89.

Shaheen, S., Cohen, A. and Chung, M. (2009) North American carsharing: 10-year retrospective. Transportation Research Record: *Journal of the Transportation Research Board*, (2110), pp.35-44.

Stasko, T.H., Buck, A.B. and Gao, H.O. (2013) Carsharing in a university setting: Impacts on vehicle ownership, parking demand, and mobility in Ithaca, NY. *Transport Policy*, 30, pp.262-268.

Steininger, K., Vogl, C. and Zettl, R. (1996) Car-sharing organizations: The size of the market segment and revealed change in mobility behavior. *Transport Policy*, 3(4), pp.177-185.

Wang Hao, Alexander. (2014) “Carsharing - A contribution to sustainable Urban

transport in China."
Wang, M., Martin, E. and Shaheen, S. (2012) Carsharing in Shanghai, China: analysis of behavioral response to local survey and potential competition. Transportation Research Record: *Journal of the Transportation Research Board*, (2319), pp.86-95.
Wappelhorst, S., Sauer, M., Hinkeldein, D., Bocherding, A. and Glaß, T. (2014) Potential of electric carsharing in urban and rural areas. *Transportation Research Procedia*, 4, pp.374-386.
Zheng, J., Scott, M., Rodriguez, M., Sierzchula, W., Platz, D., Guo, J. and Adams, T., (2009) Carsharing in a university community: Assessing potential demand and distinct market characteristics. Transportation Research Record: *Journal of the Transportation Research Board*, (2110), pp.18-26.
Zhou, B. and Kockelman, K.M. (2011) Opportunities for and impacts of carsharing: A survey of the Austin, Texas market. *International Journal of Sustainable Transportation*, 5(3), pp.135-152.
Zhou, Jiangping. (2014) Carsharing on university campus: Subsidies, commuter benefits, and their impacts on carsharing. Transportation Research Part D: *Transport and Environment*, 32: 316-319.