DEMAND ESTIMATION FOR CAR SHARING IN BANGKOK

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ABSTRACT

Car-sharing offers Bangkok a potential solution to its long-term traffic problems. Because this urban transportation service has only recently emerged in Bangkok, it is crucial to know what customers think about car sharing. This information will ensure service providers and government authorities are able to support investment and other policy decisions to best serve stakeholders such as travelers, commuters and investors. This research aimed to estimate demand for car sharing and investigate factors influencing the use of car sharing. A survey questionnaire was distributed to 400 respondents. The data were analyzed using multinomial logistic regression. In particular, socio-demographic and travel behaviors were tested to interpret interest in car sharing. The results revealed factors influencing the willingness to use car sharing service were gender, income, and number of owned private cars, trip duration, and average daily cost of traveling.

Keywords: Demand Estimation, Intention to use, Car Sharing, Multinomial Logistic Regression.

INTRODUCTION

Traffic problems in Bangkok have been one of the most critical issues for urban residents. In 2019, more than ten million vehicles were in Bangkok (Department of Land Transport, 2020). A large number of vehicles caused the traffic jams, insufficient parking space, air pollution, and so on. The government has tried to solve the problems with many projects, such as building more roads, developing an urban-train network and improving public transport systems. However, it seems to be inefficient. Most people still travel by a private car because the current public transport systems appear to be unsafe, inconvenience and expensive, particularly underground and sky train (Transport and Traffic Planning and Policy Office, 2018).

Currently, there is a new concept, namely sharing economy, which people can share their goods or services with other people via online platform. A car-sharing service initially appeared in the late 1980s (Wang & Yan, 2016). The concept of the service is similar to a car rental, but a rental period is shorter (one hour or less), and users need to be a member of car sharing organization before using the shared car. The member can book the car through internet and an online application (Bianchessi et al., 2013; Li et al., 2018). The customers are allowed to take a car at a station close to a starting point and return it at a station near a destination. Service charges include registration, hourly and kilometric fees (Efthymiou & Antoniou, 2016).

From the previous studies, car sharing contributes to a more efficient transport solution by reducing the number of vehicles, lowering demand for parking space, eliminating fixed costs of car ownership (Firnkorn & Müller, 2011; Nijland & Meerkerk, 2017). Furthermore, a car

sharing system leads to reductions of physical and economic resource consumption, and energy and environmental impacts (Martin & Shaheen, 2011; Baptista et al., 2014; Jung & Koo, 2018).

Among existing studies, only few studies focused on South East Asia, where transport conditions are significantly different from other parts of the world because of its public transport structure and commuters' travel behavior. Also, car sharing in Bangkok has just been operated, so it is important to understand the customers' perception of the service. Thus, the present study aimed to estimate the demand for car sharing and investigate factors, in terms of socio-economics and travel characteristics, influencing the use of car sharing. The results of this study can imply to both related business and government sector for planning and investing in the system and infrastructure, as well as issuing relevant regulations for further economic and social sustainability.

LITERATURE REVIEW

Many researchers have attempted to examine the propensity of car sharing usage, together with investigate the factors influencing individuals' decision toward car sharing. Transport modeling has been widely used for solving these issues. Regarding to the transport modeling approach, there are many different models have been proposed to predict the likelihood to use car sharing. Several studies performed logistic regression through random utility models including binary logit model (De Luca & Di Pace, 2014; Cartenì et al., 2016), multinomial logit model (Catalano et al., 2008; Chevalier & Lantz, 2015; Wang & Yan, 2016; Becker et al., 2017; Beria et al., 2017) and other logit models such as nested logit model (Dissanayake & Morikawa, 2010), or ordered logit model (Efthymiou et al., 2013). Besides, some studies employed probit model to examine the probability of using car sharing (Dias et al., 2017; Nazari et al., 2018; Vinayak et al., 2018)

Factors Influencing the Intention to Use Car Sharing

The main factors impact to the decision to use car sharing include socio-demographic and travel behaviors. There are some related studies described below.

Personal factors

Several studies found that gender was a significant attribute of car-sharing usage decision. Some studies indicated that men had more potential to join car-sharing than women (Cartenì Cascetta & de Luca, 2016; Wang & Yan, 2016). However, some studies found the opposite results (De Luca et al., 2015, Vinayak et al., 2018).

Age was found to be affected the intention to use car-sharing. Most studies found that the uses of car-sharing service tend to be younger adults (Le Vine et al., 2014; De Luca & Di Pace, 2015; Cartenì et al., 2016). Otherwise, De Luca & Di Pace (2014) did not find the relationship between age and the decision toward car-sharing usage.

There were inconsistent findings on the impact of income and the intention to use car sharing. Some studies indicated that car-sharing target group tends to be middle to high income (Le Vine et al., 2014; El Zarwi, Vij & Walker, 2017; Vinayak et al., 2018). On the other hand, Efthymiou & Antoniou (2016); Cartenì, Cascetta & de Luca (2016) found that the higher household's income, the lower probability to use car-sharing. However, De Luca & Di Pace (2014) found no statistically significant in income attribute.

Occupation and employment status were found to be statistically significant. Dias et al. (2017) found that the people who are employed full-time or self-employed have high propensity to use car-sharing service because they may be using the service for work-related activities. Kim, Ko & Park (2015) found that people who interested in car-sharing tend to be non-office workers or university students.

The empirical studies found the number of cars available in household influence the willingness to use car sharing. The lower number of available cars, the higher probability of using shared car (De Luca et al., 2015; Cartenì et al., 2016; Becker et al., 2017).

There are some individual factors affect the willingness to use car sharing. Wang & Yan (2016) found that married people are more willing to use car-sharing than unmarred people. Le Vine et al. (2014); Dias et al. (2017) found that people who live in higher residential density area are likely to use car-sharing. Fukuda et al. (2005) found that people who live in their own house preferred to choose car-sharing than other groups.

Travel behavior

Many studies found the effect of trip characteristics on the willingness to use car sharing. The most significant factors influencing the decision toward car sharing was travel distance (De Luca & Di Pace, 2014). The likelihood of using car sharing decrease when people travel for longer distance (Chevalier & Lantz, 2015; Wang & Yan, 2016). Also, the intention of using car sharing is also related to travel frequency. The more frequency of the weekly trip, the less likelihood of using car sharing (De Luca & Di Pace, 2014; Cartenì et al., 2016). People tend to use car sharing for their trip to social activity (Efthymiou et al., 2013). Cartenì et al. (2016) found that users travelling for working purpose are less willing to switch to car sharing. The current mode of transport also affects to the propensity of using car sharing. The commuters of public transport such as bus, trolley or tram have high probability to use car sharing (Efthymiou et al., 2013; De Luca & Di Pace, 2014, Wang & Yan, 2016). Furthermore et al. (2017) found that time pressure has a negative and bigger effect on the propensity of choosing car-sharing.

RESEARCH METHODOLOGY

This study employed the survey research to describe the existence of relationship between socio-demography, travel behavior and customers' intention to use car sharing. The present work used a quantitative method in data collection and analysis. A questionnaire was used as a research tool for data collection. Then, the data were analyzed using multinomial logistic regression.

Questionnaire Design

The research instrument used in the present study was a questionnaire comprising of three parts. The first part was about socio-demographic of a respondent, including gender, age, employment status, personal monthly income, area of living, type of residence, number of owned private cars. The second part was travel characteristics including main trip mode, weekly travel frequency, travel time, average one-way trip duration, average one-way trip distance, average daily travel expense, and number of fellows. The last part was the choice of willing to use car sharing with three options: will use, not sure, and will not use.

Sample and Data Collection

Before using the questionnaire, the pilot test of 30 samples was conducted for testing the questionnaire. A main questionnaire survey was distributed using random sampling method from January to February 2020 in Bangkok in the area of shopping malls, offices, and university. In total, 400 respondents participated in this survey.

Data Analysis

The independent variables used in this study comprised of socio-demographic and travel behavior. The dependent variable was the willingness to use car sharing with "will use", "not sure", and "will not use", and coded these variables as one, two, and three, respectively.

Multinomial Logistic Regression

Multinomial logit model was utilized to calculate the probability of choosing the set of the available traveling alternatives in the choice set Khan (2007); Carey (2018) or simply explain that it addresses more than two alternatives (Ji & Moeckel, 2017). If the dependent variable is coded 0, 1 or 2 and using $Y = 0$ as the baseline, the probabilities of each dependent variable category Hosmer et al. (2013) are as follows;

$$P(Y = 0) = \frac{1}{1 + e^{g1\,(x)\,+g2\,(x)}}$$

$$P(Y = 1) = \frac{e^{g1(X)}}{1 + e^{g1\,(x)\,+g2\,(x)}}$$

$$P(Y = 2) = \frac{e^{g1(X)}}{1 + e^{g1\,(x)\,+g2\,(x)}}$$

Where,

$$g1\,(x) = logit\frac{P(Y = 1)}{P(Y = 0)} = \beta_{10} + \beta_{11}x_1 + \ \dots \ + \beta_{1p}x_p$$

$$g2\,(x) = logit\frac{P(Y = 2)}{P(Y = 0)} = \beta_{20} + \beta_{21}x_1 + \ \dots \ + \beta_{2p}x_p$$

Where $\beta_{10}, \beta_{11}, \beta_{1p}, \dots, \beta_{2p}$, are coefficient for the logistic regression model, which can be analyzed with SPSS software

RESULTS

Descriptive statistics

The descriptive statistics of the participants are shown in Table 1. More than half of them (62.6%) were female. The age was mainly between 21-30 years old (48.0%), which expected to

be the majority group using car sharing. The main employment group was full time (38.8%) with monthly income below 15,000 Baht or 500 USD (47.0%). The largest group of the respondents (67%) was lived outside central business district (CBD). The main type of residence was a house (59.7%). Most respondents (44.8%) did not possess any car, and 40.8% had a private car.

For travel characteristics, the majority of respondents commuted by a private car for their daily trip (42.8%), followed by public transport (32.8%), and the rest used both a private car and a public transport (24.4%). The largest group of respondents (51%) indicated that they traveled 5-7 days a week. The travel time was mainly in rush hours (71.5%). The average one-way trip duration was concentrated in 31-60 minutes (39.0%), with the travel range of 11-20 kilometers (40.5%). This length of trip duration and distance was proper to use car sharing service. About 44.3% of the participants spend approximately 1-100 Baht for their daily trip. Most of them travel with one accompanying travelers (58.0%).

Table 1 PERSONAL INFORMATION OF THE RESPONDENTS			
Variable	Description	Frequency	Percentage
Socio-demographic			
Gender	Male*	150	37.50%
	Female	250	62.50%
Age	18-21 years old*	57	14.30%
	21-30 years old	192	48.00%
	31-40 years old	74	18.50%
	Above 40 years old	77	19.20%
Employment status	Full time*	155	38.80%
	Freelance or part time	106	26.50%
	Student, unemployed, or retired	139	34.70%
Personal monthly income	Under 15,000 Baht (Under 500 USD)*	188	47.00%
	15,000-30,000 Baht (500 – 1,000 USD)	145	36.30%
	30,001-45,000 Baht (1,001 – 1,500 USD)	56	14.00%
	Above 45,000 Baht (Above 1,500 USD)	11	2.80%
Area of living	In central business district (CBD)	132	33.00%
	Outside CBD	268	67.00%
Types of residence	Condominium or apartment with parking area under 50% of total units*	107	26.80%
	Condominium or apartment with parking area above 50% of total units	54	13.50%
	House	239	59.70%
Number of owned private cars**	None	179	44.80%
	1	163	40.80%
	2	43	10.80%
	More than 2	11	3.60%
Travel behaviors			

Main trip mode in daily use	Private car*	171	42.80%
	Public transport	131	32.80%
	Both private car and public transport	98	24.40%
Weekly travel frequency	1-2 days*	89	22.30%
	3-4 days	107	26.80%
	5-7 days	204	51.00%
Travel time	Rush hour (6 am. - 10 am./ 4 pm. –9 pm.) *	286	71.50%
	Off peak (10 am. – 3 pm./ 9 pm. - 5am.)	114	28.50%
Average one-way trip duration	1-30 mins*	144	36.00%
	31-60 mins	156	39.00%
	61-90 mins	68	17.00%
	more than 90 mins	32	8.00%
Average one-way trip distance	1-10 km*	152	38.00%
	11-20 km.	162	40.50%
	21-30 km.	72	18.00%
	More than 30 km.	14	3.50%
Average daily travel expense	1-100 Baht*	177	44.30%
	101-200 Baht	124	31.00%
	201-300 Baht	47	11.80%
	Above 300 Baht	52	13.00%
Number of accompanying travelers**	None	39	9.80%
	1	232	58.00%
	2	73	18.30%
	More than 2	44	13.90%
* is the reference category used in the multinomial logistic regression model ** is the scale type data			

Intention to Use Car Sharing

The respondents were asked about the willingness to use car sharing. As shown in Figure 1, the majority of the respondents tended to use car sharing (52%), about 36% were not sure whether they would use the car sharing service, and the rest would not use (12%). The results indicated that most people opened their mind to car sharing service Figure 1.
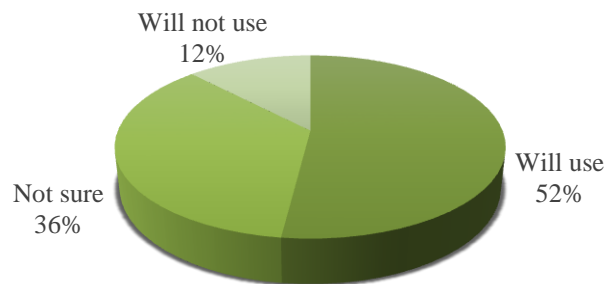

FIGURE 1
THE WILLINGNESS TO USE CAR SHARING

Multinomial Logistic Regression

Model fitting test

The data were analyzed with SPSS. The Table 2 illustrates the likelihood ratio test for the intercept-only model and final model.

Table 2 **MODEL FITTING TEST**						
Model	**Model Fitting Criteria**	**Likelihood Ratio Tests**		**Pseudo R^2**		
	-2log likelihood	Chi-square	Sig.	Cox and Snell	Nagelkerke	McFadden
Intercept-only	732.379	-	-	-	-	-
Final	605.589	126.79	0	0.272	0.318	0.164

The Parameter Estimation Results

The parameter estimation results of different groups are shown in the Table 3 and 4. The reference category for dependent variable was "Will not use", and the variables with the star in the Table 1 were point as the reference category for independent variables.

Estimate model results of "Will use" group

The results from Table 3 demonstrated that gender, income, number of own private cars, average one-way trip duration, and average daily travel expense were statistically significant at 95% confidence interval. With regards to the reference category is "Will not use", the interpretation of each was as follows;

1. Male had more intention to use car sharing than female. The probability ratio (odds ratio) of females being 0.635 (1-0.365) times lower than male.
2. Monthly income had significant on the willingness to use car sharing with negative coefficient. It means that the people who have income between 15,000 – 30,000 Baht have lower intention to use car sharing than people who earn less than 15,000 Baht per month, which was the reference group.
3. The number of owned private cars was statistically significant with a negative coefficient, indicating that the increasing of number of own private cars, the decreasing in the willingness to use car sharing.
4. Trip duration influenced customer willingness to use car sharing with positive coefficient. The result shows that people who travel from 31-60 minutes were more willing to use car sharing than people who travel from 1-30 minutes, which was the reference group.
5. The average daily travel expense had significant influence on customers' willingness to use car sharing. The absolute value of the regression coefficient was greater when the average daily cost of travel was increase. It means that the higher daily transportation expenditure, the lower willingness to use car sharing.

Variable	B	Wald	Sig.	Exp(B)
Table 3 **PARAMETER ESTIMATION RESULTS OF "WILL USE"**				
Intercept	9.82	6.86	0.009	

Gender: Female	-1.008	5.447	0.02	0.365
Monthly income: 15,000-30,000 Baht (500 – 1,000 USD)	-1.08	3.949	0.047	0.339
Number of owned private cars	-0.682	7.059	0.008	0.506
Trip duration: 31-60 Mins.	1.415	8.22	0.004	4.118
Average daily travel expense: 101-200 Baht	-1.172	6.247	0.012	0.31
Average daily travel expense: 201-300 Baht	-2.453	8.077	0.004	0.086

Estimate Model Results of "Not sure" Group

Table 4 shows the statistically significant factors, including numbers of owned private cars and trip duration, on people who were not sure whether to use car sharing. The details of analysis were as follows;

1. Similar to the 'will use group', the number of owned private cars has significant with negative coefficient. It can be concluded that the more car people have, the less intention to use car sharing service.
2. The people who travel between 31-60 minutes had uncertain opinion about the use of car sharing service rather than people who travel 1-30 minutes, which was the reference group.

Table 4				
PARAMETER ESTIMATION RESULTS OF "NOT SURE"				
Variable	**B**	**Wald**	**Sig.**	**Exp(B)**
Intercept	6.531	2.837	0.092	
Numbers of owned private cars	-1.262	18.715	0	0.283
Trip duration: 31-60 Mins.	1.057	4.305	0.038	2.876
The reference category is "Will not use"				

The Probability of Using Car Sharing in Bangkok

It can be seen in Table 1 that the majority of the respondents were female, age 21-30 years old, full time employment with personal monthly income of under 15,000 Baht. The probability of using car sharing in Bangkok can be calculated according to the logistic regression equation (1)-(5) with the parameter result from Table 3 and Table 4.

$$g1 = 9.820 + (-1.008) + 0.678 = 9.490$$

$$g2 = 6.531 + (-0.477) + 1.216 = 7.270$$

$$P\left(Y = Will\ use\right) = \frac{e^{g1}}{1 + e^{g1} + e^{g2}} = 0.901$$

$$P\left(Y = Not\ sure\right) = \frac{e^{g1}}{1 + e^{g1} + e^{g2}} = 0.099$$

$$P\left(Y = Will\ not\ sure\right) = \frac{1}{1 + e^{g1} + e^{g2}} = 6.82E - 05$$

It can be concluded that the probability of using car sharing service for people who are female with age 21-30 years old is 90.1%.

DISCUSSION AND CONCLUSION

This paper investigated the probability and the influencing factors of intention to use car-sharing services in Bangkok. Through multiple logistic regression, the significant factors toward the intention to use car sharing included gender, personal monthly income, number of owned private cars, trip duration, and average daily travel expense. In greater detail, male had more probability of using car sharing than female. This result was consistent with the studies of (Cartenì et al., 2016). The reason may be because men are braver to dispose to try new things, and they can take risk better than female.

The results showed that the people with monthly income between 15,000 – 30,000 Baht had lower intention to use in car sharing than people who earn fewer than 15,000 Baht a month. It could be implied that with the higher income, people tend to decrease the willingness to use car sharing. This result confirmed the previous study of Cartenì et al. (2016), which found car sharing attracts low-middle income class the most.

Similar to the studies of De Luca et al. (2015); Carteni et al. (2016); Becker et al. (2017), the present study indicated that the number of owned private cars had a significant effect to the intention to use car sharing. The more cars people own, the less interested in car sharing service. As expected, once people purchase a car, they will use it at the maximum utility.

Trip duration also influenced the willingness to use car sharing, which complied with the results from De Luca & Di Pace (2015). This research found that car sharing tended to attract people who travel between 31-60 minutes. The reason may be that car sharing service is designed for short to middle range of travel. Comparing to a short trip, people might use a convenient mode of transport, such as bus or motorcycle taxi, which is cheaper than car-sharing service. On the other hand, long travel distance of car sharing will cause the high price of travel as car sharing service charges both hourly and distance charges. Thus, the middle range of travel is suit to use car-sharing services the most.

Surprisingly, the results indicated that the increase in daily travel expense, the less intention to use car sharing. This was not in accordance with the previous expectations and the study of Wang & Yan (2016) which found the increase in cost of travel will raise the willingness to use car sharing. The reason of the present findings may be because the people who spend high travel cost may be a car owner. They might be reluctant to swift to car-sharing service as driving their car is more convenience and lower risk.

SUGGESTIONS

The target group of car sharing is male with low income and travel duration from low to middle range. In order to satisfy this target group, the shared car should be small, compact, or eco cars. Moreover, the locations of drop pints should cover all area and not far from each other.

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