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ANALYSIS OF CAR SHARING APPLICATION ON CONSUMER ORIENTATION AND THEIR MODAL SELECTION IN BANGKOK

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ABSTRACT: This paper analyzes the possibility of car sharing application in Bangkok by focusing on the potential target users regardless of socio-economic characteristics and modal choice behavior with respect to their perception and responsiveness on the assumed car sharing's service attributes, particularly what factors affect their decision on making choice probability. Demand forecasting on the use of car sharing system is performed. Introducing car sharing, as being well-known system in Europe and North America as an innovative mobility for substituting vehicle ownership, seems to be an appropriate remedial countermeasure to tackle the rampant increase of private vehicles because car sharing allows different users to share use a fleet of diversified vehicles several times a day with convenient and privately environment. The findings revealed that factors affecting a user's decision making on choice probability are socio-economic like income, occupation, and education as well as service attributes like travel time and costs.

Keywords: Car sharing, Possibility, Users' socio-economic, Attitudes and Modal selection.

1. INTRODUCTION

Car ownership has been increased at annual growth rate of about 10 to 22 percent over the past decades. The number of vehicles registered in Bangkok soared from 600,000 in 1980 to 2.7 million in 1993 and from 4 million in 1998 to 4.2 million in 1999 and increased to 4.4 million in 2000 (OCMLT, 2001a; OCMLT, 2001b; Fukuda *et a1*, 2001; Chairatananon, 2002 and Fukuda *et al*, 2003). Of those vehicles registered in 2000, 1,315,016 were passenger cars. It is expected that this trend will continue to increase. Evidence shows that the number of households with access to vehicles gradually increased between 2000 and 2021, particularly for multiple vehicle households. The rapid vehicle growth has had adverse effects on traffic congestion and air quality as well as noise pollution. The decline of mobility is damaging Bangkok's economy significantly. Bangkok loses 35 percent of its gross city product in

congestion (Gakenheimer, 1999). Hence, the promotion of rational use of private automobile is significantly essential. Figure 1 shows percentage of modal share in Bangkok.

Introducing car sharing system may be an alternative mode of transportation to complement the use of private vehicles. Car sharing founded in Europe as a result of environmental concern and becomes widely used in North America, is a short term automobile rental service with a fleet of various type of vehicles provided to members for periodical use. Insurance, gasoline and maintenance costs are included in the membership rate. However, it is controversial in that even car sharing can help to rationalize the rampant motorization, it is certain that new trips will be generating during the non-peak period for the occasional trip purpose and hence relatively creating environmental impact.

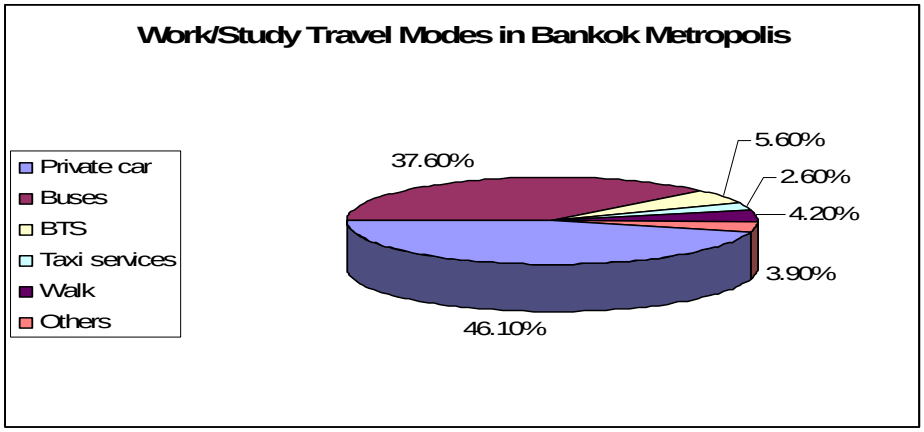

Figure 1 Modal share of Public and Private transports in Bangkok
Source: Chairatananon, 2002.

However, before discussing the possible introduction of car sharing (CS) in Bangkok, the following points should be reviewed.

- Who would utilize a car sharing system because their working style and travel behavior are quite different from Europe and North America.

- Modal choice behavior should be studied because there is a big diversity relative to income distribution.

Buses form the core of the hierarchical transport system in Bangkok (i.e., people have to take paratransit such as pick-up truck ridesharing so called Song-taew or motorcycled taxi from their house located in a dead-end alley in order to access the main street having bus service). Most public transportation users have to take several transport modes to commute to their workplaces while most of car users just drive their car straight to their office. Thus, there are two possibilities to introduce car sharing system:

1. use car sharing for a full commute; or
2. use car sharing to access to main public transport such as bus and rail mass transit (which is similar to station car systems in Europe and North America)

Utilizing car sharing (CS) as a main mode may seem easier to implement since an existing car driver can shift to use car sharing without modifying their travel pattern. However, for a system to operate efficiently and economically in this manner there must be sufficient user demand for vehicle use independent of the commute trip. On the other hand, using car sharing

as a feeder transport mode seems applicable but has a limited application area and target users would be public transport users. The opportunity to be a car sharing user of this group might be relatively low considering their income capacity. Therefore, this study discusses the possibility of introducing car sharing as a main mode and as a feeder transport mode.

2. OBJECTIVE

Since car sharing is a relatively new concept and has never been introduced to the Bangkok Metropolitan previously, it is important to know the public's perception towards car sharing. Identification of the influencing factors, which can contribute to the strategic planning of car sharing systems in Bangkok is a primary objective of this research. Socio-economic characteristics such as income play a significant role in affecting modal choice probability. Therefore, this study aims at analyzing the consumer orientation through identifying the potential market of car sharing (CS) in Bangkok in terms of socio-economic characteristics with respect to modal choice behavior. The perception and responsiveness as well as demand forecasting on the assumed car sharing's service attributes and its usage are also elaborated. These explanatory variables will be utilized to develop a binary logit model for a feeder type system and multinomial logit model for a main mode type system.

3. RESEARCH METHODOLOGY

3.1 Questionnaire Design

Abraham (1999) utilized SP survey for his car sharing (CS) study in Canada which revealed very useful results on variables influencing the attractiveness of car sharing such as: distance of a car sharing station, cost of usage and type of reservation. Paul McMillan *et al* (1997) suggested that the use of SP for a carpooling survey is helpful to predict how the population will behave in future situations. The future situation needs to be described mathematically, and the attributes of the population can be combined with the model to predict the aggregate behavior of the commuter.

This paper employs the stated preference (SP) survey technique. It should be noted despite SP data describes hypothetical contexts (flexibility) and seems to be reliable when respondents understand and are committed to and can respond to the tasks, it cannot easily be represented changes in market and personal constraints effectively.

In this study, a stated preference survey was designed to elicit their preferences based upon the hypothetical situations given. Two types of method were utilized.

1. The rating scale method was employed to elicit perceptional information. Respondents were asked to give each attitudinal question scores according to their attractiveness.

2. The discrete choice method was used to elicit their preference on modal selection. Respondents were presented with nine different hypothetical situation questions regarding feeder mode choice (i.e., between paratransit and car sharing) and main mode choice (i.e., between their current mode such as automobile, bus and car sharing) with respect to its attributes. Respondents were asked to choose one among modes given.

For the assumed attitudinal questions, a definition of terms and conditions on car sharing operation as well as service attributes was illustrated on the 3 A4-sized pages. An illustration providing pictures of assumed car sharing vehicles and its parking stations combined with a brief explanation of the car sharing concept and its service attributes were presented. Usage costs, port system, diversified vehicle types and technological devices, as well as its advantages and disadvantages were demonstrated to allow respondents to visualize and envision a big picture of car sharing. The respondent was then asked their perception towards car sharing service attributes and how car sharing could benefit them as an individual as well as how car sharing can help alleviate societal problems. The respondents were allowed to rate scores freely: 1 to 2 is disagreeable, 3 is fair, and 4 to 5 is agreeable for the 14 affirmative questions. The hypothetical situations of modal selection were presented in terms of numerical service attributes and used experimental design to vary the numbers. Those attributes were access time, travel time, waiting time, and travel cost.

This study attempts to develop a binary logit model for a feeder transport mode between paratransit and car sharing and multinomial logit model between automobile, bus and car sharing. Note that car rental and taxi were not included in the model because the use of car rental is not very common in Thai society unless there is a special occasion or emergency (In terms of a car rental cost, a minimum booking of one day is approximately 1800 Baht or equivalent to Yen 5,000 per day. Taxi is sometimes convenient but lacks privacy and safety). The contents of questionnaire included:

- socio-economic characteristics of the traveler - gender, age, educational level, and monthly income;
- travel purpose – commuting, shopping, and travel patterns of current mode (on the day that conducted the interview);
- transportation mode choice - attitudinal questions towards car sharing and assumed situational questions between automobile, bus, and car sharing with respect to service attributes, such as travel time and costs (respondents had to select between automobile, bus, and car sharing for the situations provided); and
- the future perspectives of car sharing usage.

3.2 Data Collection

Due to the Thai peoples' lack of car sharing (CS) knowledge, the only way to collect data was to use a face-to-face interview approach. This method is quite expensive but can gain lot of accurate information from respondents.

There were 600 samples conducted with those who are vehicle owners and non-vehicle owners. The respondents had employers and / or residences are located nearby mass transit stations (i.e., BTS and MRTA stations) or within a 10 km radius. Additionally, there was a preference for both target groups to earn a higher income (e.g., 10,000 Baht and upper or equivalent to Yen 30,000) and possess a higher educational level (e.g., college graduate). Note that lower income and lower educational groups were also included as survey respondents for comparison purposes.

The site selections for this study covered an area of 6 districts: Chatuchak, Ladprao, Huay Khwang, Wattana, Paholyothin and Phayathai districts, where BTS and MRTA lines are in close proximity, see Figure 2. Table 1 represents population and household income in the study areas. The period of the survey was 3 months started from April, 2003 to June, 2003.

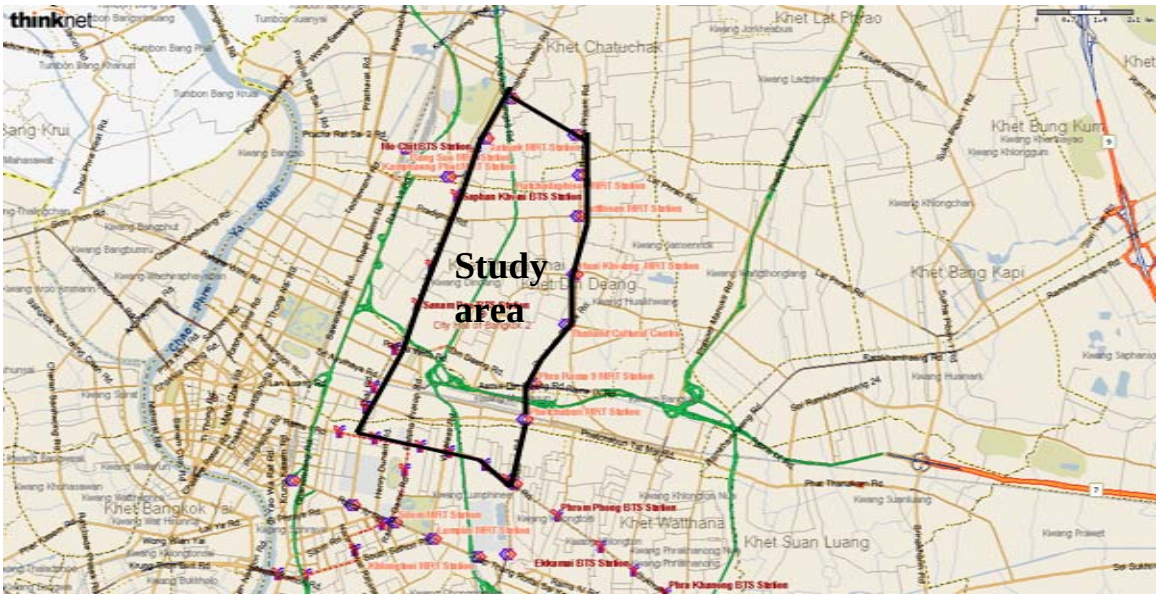

Figure 2 Study areas of car sharing: Chatuchak, Ladprao, Huay Khwang, Wattana, Paholyothin and Phayathai Districts.

Table 1 Number of populations in study areas and their household income

No. of populations in study sites in 2000 and household income in 2002					
DISTRICT	**No. of household (2000)**	**Male (2000)**	**Female (2000)**	**Total (2000)**	**Average household income 2002 (Baht)**
CHATUCHAK	71,422	82,236	87,707	169,943	20382
PHAYATHAI	26,951	46,628	44,463	91,091	30722
LADPHRAO	37,991	50,454	57,671	108,125	24064
HUAYKWANG	31,041	37,500	41,095	78,595	26021
WATTANA	40,808	38,757	42,148	80,905	19168
PAHOLYOTHIN	26,951	46,628	44,463	91,091	30722

Source: UTDM data and AMP Consultancy Co., Ltd.

4. ATTITUDINAL BEHAVIORAL ANALYSIS TOWARDS CAR SHARING SYSTEM

As mentioned in the earlier section, Bangkok has never previously experienced the introduction of a car sharing system, therefore it might be difficult for respondents to conceptualize the attributes. According to 429 validated samples out of 600, the attitudinal analysis shown that the service attributes have strong influence on their perception. The results succinctly indicated that accessibility, vehicle diversification, technology, and travel cost variables had the strongest influence. The level of preference of statistical mean for travel cost shows the lowest value of only 2.5. This significantly implies that the cost perception has a strong influence on the attractiveness of car sharing. Respondents believed the travel cost of their current mode is still cheaper compared to the cost of car sharing usage. This may be true for public transport users considering the cost of bus transport usage, i.e., 3.50 Baht per one fixed route non-air-conditioning bus and 16 Baht per one fixed route air-conditioning bus (Yen100 = 36 Baht). On the other hand, for those who use their own vehicle, the cost of

private car usage is still much higher than the cost of car sharing usage. The attitudinal results from the survey are presented in the Table 2.

Table 2 Attitudes towards the use of car sharing (CS)

Attitude towards the use of car sharing	Level of preference Disagree---Fair----Agree					Mean	Std.
	1	2	3	4	5		
CS helps traveling faster	9.1	15.9	48.5	23.8	2.8	3.0	0.9
CS reduces travel time and increase shopping time	8.4	16.8	45.9	25.2	3.7	3.0	1.0
CS saves travel cost than current mode	18.2	35.7	31.0	12.6	2.6	**2.5**	1.0
CS provides easy accessible to the system	7.7	23.5	42.2	24.0	2.6	2.9	0.9
CS provides sufficient vehicles with diversification	9.3	19.3	49.0	19.3	3.0	2.9	0.9
CS attract to shift from current mode to CS vehicles	12.1	27.0	39.4	18.6	2.8	**2.7**	1.0
CS provides better convenience that take you to any place	9.3	17.2	40.1	28.2	5.1	3.0	1.0
CS equips with technological devices that bring you more convenience and comfort to travel	2.6	17.5	40.3	30.5	9.1	**3.3**	0.9
CS creates equity in mobility	7.0	25.6	40.6	24.0	2.8	2.9	0.9
CS can be an alternative mode for emergency	1.9	7.5	24.2	45.7	20.7	**3.8**	0.9
CS alleviate traffic congestion in Bangkok	13.3	28.7	34.5	16.8	6.8	**2.8**	1.1
CS can reduce air and noise pollution in Bangkok	11.7	32.2	32.2	16.8	7.2	**2.8**	1.1
CS enhances the use of mass transit: BTS or MRTA	1.9	7.7	45.0	35.2	10.3	**3.4**	0.8

The attributes of accessibility and vehicle diversification due not appear to be attractive attributes for a car sharing system. The inexperience of respondents towards car sharing usage may be a factor generating an unpleasant attitudinal behavior for some of the attributes. Most respondents still imagined car sharing as being similar to car rentals which are available at the airport or some business areas. Many respondents may not have made the distinction that car rentals can be accessed only by other modes of transport and not by cycling or walking. Many respondents likely did not realize that car sharing stations could be provided near their workplace or residence with a diversification of vehicles, this might influence the respondents to consider the use of car sharing. Among attributes only the mean of technological devices is above 3.0. Respondents perceived that a car sharing vehicle equipped with technological devices would bring them more convenience and comfort to travel.

A portion of the survey (question 1-13) addressed the perceptions of the respondents towards potential societal benefits. It is interesting that respondents perceived car sharing as an alternative mode for emergency and a complement to mass transit. These perceptions imply a positive sign for the strategic planning of a car sharing system. However, some of respondents did not perceive that car sharing can contribute to the reduction of traffic congestion and environmental problems. Car sharing may rationalize the efficient use of vehicles. It is still controversial whether its principal effect would be the significant increase of mobility, particularly for occasional trip purpose. It is uncertain whether or not car sharing would reduce the quantity of vehicles on road and thereby contributing to reducing environmental problems.

5. ANALYSIS OF THE FUTURE PERSPECTIVES ON CAR SHARING USAGE

It is quite difficult to estimate demand for new technologies and new attributes when user has no experience with those products and attributes, particularly, the demand for shared use of vehicle. This requires some organization of a household’s travel patterns and lifestyle. For instance, for what reasons/purposes and duration/frequency are users going to use and how far are users willing to accept to walk in return to shift using car sharing?

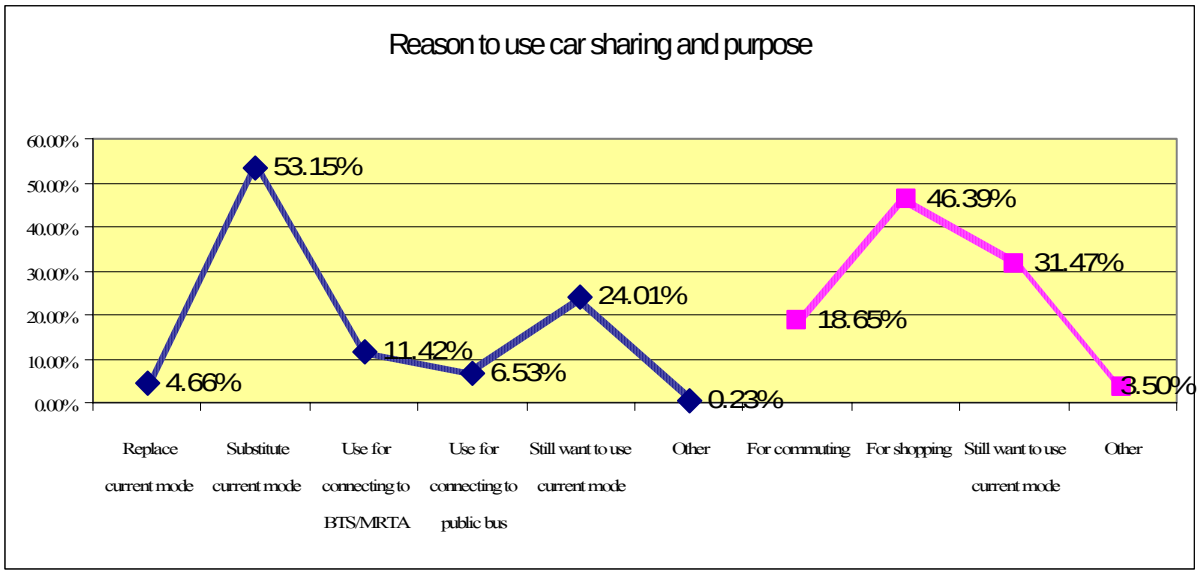

Figure 3 Percentages of reason to use car sharing and purpose

In this section, the demand forecasting for car sharing usage was simply generated. Figures 3 to 5 demonstrated the future use of car sharing in terms of purpose, frequent use, and distance from car sharing stations to living/working place and BTS/MRTA stations. According to Figure 3, more than 53 percent of respondents answered they will use car sharing to substitute for a portion of their current travel. Whereas 24 percent of respondents stated that they still want to use their existing mode for travel purposes, more than 11 percent of them wish to use car sharing for connecting to BTS and MRTA. 46 percent of respondents stated that they would use car sharing for shopping trip purpose and 18 percent of them answered they would use car sharing for commuting trip purpose. 31 percent of respondents indicated that they still want to use their existing mode for all travel purposes.

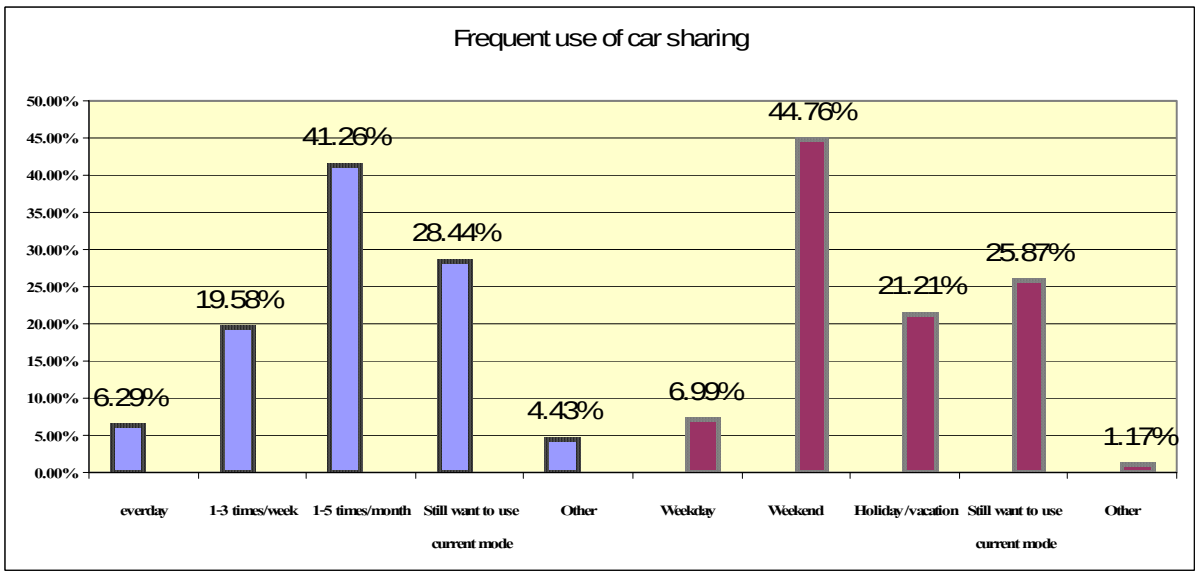

Figure 4 Frequency and duration of car sharing usage in percentage

As indicated in Figure 4, 41 percent of respondents indicated, car sharing use of 1 to 5 times a month and 19 percent stated they would use car sharing for 1 to 3 purposes a week. However, some respondents still stated that they still want to use the existing mode for all travel

purposes. Interestingly, most of respondents indicated that they would use car sharing for a weekend journey and 21 percent would use car sharing only on vacation and 6 percent for weekday. 25 percent of respondents stated that they still want to use their existing mode.

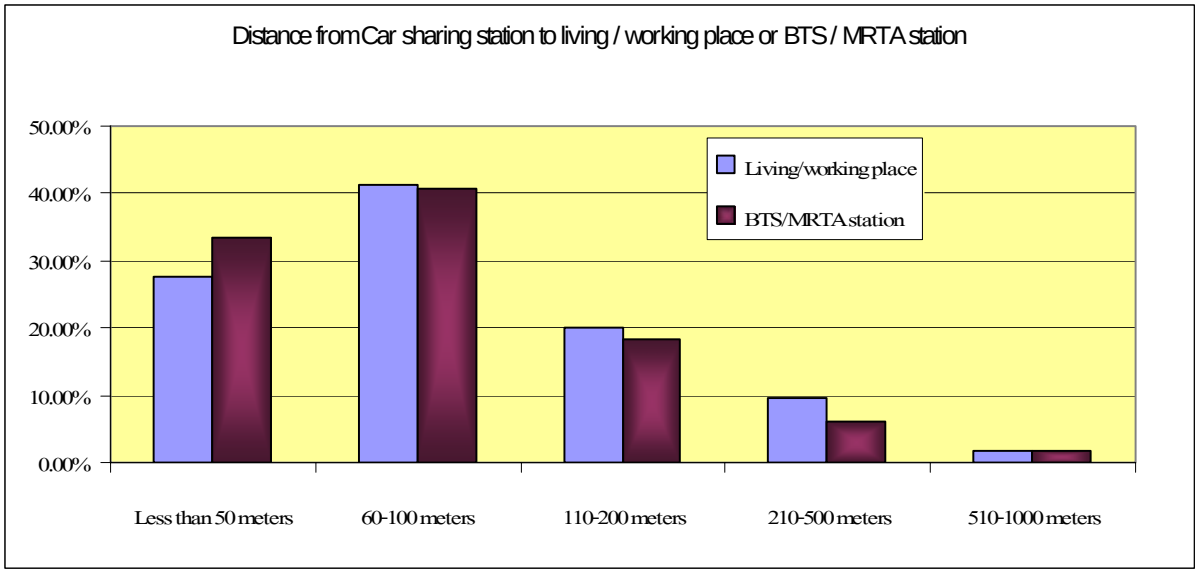

Figure 5 Distance between car sharing station and living /working place and BTS/MRTA station

Relative to walking distance, the majority of respondents answered they are willing to walk to a car sharing station from their place if the distance is within 60 to 100 meters, less than 50 meters is 27 percent, and 20 percent is for 110 to 200 meters. Assuming a car sharing station was provided close to BTS and MRTA stations so that you could park the car and transfer to BTS or MRTA. According to Figure 5, 40 percent of respondents stated that they are willing to walk to a car sharing from BTS or MRTA stations if the station is located within a 60 to 100 meter walking radius and 33 percent of them indicated their willingness to walk if the CS station is located within 50 meters.

6. DEVELOPMENT OF MODAL CHOICE MODEL TO ESTIMATE POTENTIAL DEMAND FOR CAR SHARING SYSTEM

Following McFadden (1974), Ben-Akiva and Lerman (1985), and Hensher (1994) representative utility is usually specified to be linear in parameters: $V_{nj} = \beta^{/} x_{nj}$, where x_{nj} is a vector of observed variables relating to alternative j, the logit probabilities for binaly logit model become

$$P_{ni} = \frac{e^{\beta^{/} x_{ni}}}{\sum_j e^{\beta^{/} x_{nj}}} \qquad (1)$$

Consider a binary choice situation first: a feeder mode choice between paratransit and car sharing. Suppose that the utility of the feeder mode choice from each type of system depends only on the travel time and travel cost as well as the convenience and written as a linear function of the observed factors, the utility of each feeder mode choice can be written as:

$$U_a = \beta_1 TT_a + \beta_2 TC_a + \varepsilon_a \quad \text{and} \quad U_c = \beta_1 TT_c + \beta_2 TC_c + \varepsilon_c \qquad (2)$$

where subscript a and c denote paratransit and car sharing system, TT and TC stand for travel time and travel cost, β_1 and β_2 are the scalar parameter. Here, the scalar parameter can be either positive or negative.

The unobserved component of utility for each alternative, ε_a and ε_c, varies over commuter depending on how each commuter views the convenience of each commuting mode choice. If these unobserved components are distributed IID extreme value, then the probability that the commuter will choose to take car sharing is shown as follows:

$$P_c = \frac{e^{\beta_1 TT_c + \beta_2 TC_c + \varepsilon_c}}{e^{\beta_1 TT_a + \beta_2 TC_a + \varepsilon_a} + e^{\beta_1 TT_c + \beta_2 TC_c + \varepsilon_c}} \tag{3}$$

And the probability of choosing the paratransit is the same but with the $e^{\beta_1 TT_a + \beta_2 TC_a + \varepsilon_a}$ as the numerator. The probability of choosing the car sharing will be decreased if either TT_c or TTC_c rises while those of the automobile remain the same (assuming that both β_1 and β_2 are negative, as expected).

Multinomial choice model can be defined as same manner. Assume, there is one more commuting mode choice, namely bus. The utility is specified the same as for paratransit and car sharing:

$$U_b = \beta_1 TT_b + \beta_2 TC_b + \varepsilon_b \tag{4}$$

With this extra choice available, the probability of choosing the car sharing is

$$P_c = \frac{e^{\beta_1 TT_c + \beta_2 TC_c + \varepsilon_c}}{e^{\beta_1 TT_a + \beta_2 TC_a + \varepsilon_a} + e^{\beta_1 TT_b + \beta_2 TC_b + \varepsilon_b} + e^{\beta_1 TT_c + \beta_2 TC_c + \varepsilon_c}} \tag{5}$$

6.1 Model structure

Thus, we classified car sharing as a feeder choice for mass transit and as a main mode for commuting as follows:

- Binary logit Model for feeder mode: paratransit – car sharing
- Multi-Nomial Logit Model for Main Mode: automobile – bus – car sharing

In this study, NLOGIT3 is used to perform the parameter estimation (Green, 2002 and Green, 2003). The variables in the research are categorized into two groups: level of services and socio-economic characteristics. The socio-economic variables such as age and income are classified as observation-specific constant because it will be the same respondent who decides to choose the transportation mode. However, the attribute of each mode such as access time, travel time and travel cost must be the alternative-specific variables as each alternative has individual characteristic.

All the variables were initially evaluated to place in the model but finally only those variables which were significantly different from zero were kept in the model. The statistical significance is based on one-tail t-statistic which must be greater than 1.96 (for positive

values) and be less than -1.96 (for negative values). This statistical significance implies 95% confidence interval. However, some variables that had t-statistic between -1.96 and 1.96 were kept in the model if those variables influenced the travel behavior and level of service in each alternative. Moreover, the constant was placed in the model regardless of the confidence interval because the constant captured all remaining unobservable effects.

6.2 Obstacle and limitation of Data for estimation

The main problems of the survey are:

- The respondents were distracted by environmental surroundings since the survey took place near BTS and MRTA lines. This resulted in some respondents trying to skip answering some long descriptive questions.
- Some respondents were in a hurry to board the train resulting in leaving half of the questionnaire unanswered.

The dataset used for estimating the model is believed to be a comprehensive source with a few missing data. Observations with missing data were not discarded since the missing data was not statistically significant in the final model. For example, the number of car variable is not significant in the feeder choice model so the observations missing that variable were not discarded.

7. ESTIMATION RESULTS

7.1 Estimation of binary logit of feeder choice model

The parameter estimation results for binary logit of feeder choice model are shown in Table 3. According to the estimation results, estimated parameters possess the expected sign and most of the parameters are significant at 95% confidence interval. The car sharing constant is set at a 0 value as a baseline and the constant of paratransit mode equals 1.5273. The constant of paratransit mode is significantly positive indicating the respondents' preference to paratransit. Although the car sharing concept and its service attributes were demonstrated prior to questioning the hypothetical situations, still people feel more accustomed to using paratransit. This can be interpreted that the respondents feel uncertain about the level of services a car sharing system provides.

With regards to access time and waiting time, paratransit seems to have influences on the respondent's utility. Respondents would favor paratransit if their access time and waiting time are less. In reality, the waiting time of para-transit is relatively long (approximately 5-20 minutes) while the access time is substantially moderate (approximately 5-7 minutes). This implies that the less access time and waiting time for the respondents, the higher probability to choose that alternative transportation mode.

According to the access time and waiting time coefficients in car sharing choice in Table 3, the estimated coefficient of the access time variable shows statistically positive whereas the estimated coefficient of the waiting time variable indicates statistically negative. This implies that the access time has less impact on respondents' preference. However, there is a possible interpretation for this phenomenal result in that there might be erratic sampling that occurred during the estimation / running the model.

Regarding socio-economic indicators of feeder choice, it was found that male respondents in the age bracket of 36-55 years tend to favor car sharing as the coefficient indicates significantly positive. Likewise, the coefficient of respondents who are government officials, state enterprise officials or company workers with income levels between 25,000 - 35,000 and 35,000 – 55,000 Baht shows significantly positive. This implies their preference to car sharing rather than paratransit. Also the respondents who live their own house or own apartment, and have more than one household vehicles are likely to be potential users of car sharing. This could be explained by the fact that normally Thai males in the middle age with higher or middle income levels are supposed to be able to afford a car already.

Table 3 Estimation of binary logit of feeder choice probabilities

Variable	Estimated Coefficient	Coefficients Standard Error	T-statistic
Para transit			
Constant	1.5273	0.2467	6.1910
Access time	-0.0220	0.0089	-2.4630
Wait time	-0.0728	0.0091	-7.9900
Car sharing			
Access time	0.0234	0.0090	2.5880
Wait time	-0.0414	0.0090	-4.6050
Variable cost	-0.0107	0.0022	-4.7670
Occupation indicator 1 (1 if the commuter is government/state enterprise officer, 0 otherwise)	0.3001	0.1009	2.9740
Occupation indicator 2 (1 if the commuter is company worker, 0 otherwise)	0.4576	0.0894	5.1200
Occupation indicator 3 (1 if the commuter is teacher/professor, 0 otherwise)	-1.2866	0.3739	-3.4410
Income indicator 1 (1 if the commuter's income is between 5,000 and 15,000 Bahts, 0 otherwise)	-0.3108	0.0856	-3.6300
Income indicator 2 (1 if the commuter's income is between 25,000 and 35,000 Bahts, 0 otherwise)	0.5615	0.1186	4.7330
Income indicator 3 (1 if the commuter's income is between 35,000 and 55,000 Bahts, 0 otherwise)	0.5775	0.1642	3.5170
Living status indicator 1 (1 if the commuter lives in his/her own house, 0 otherwise)	0.2327	0.0953	2.4420
Living status indicator 2 (1 if the commuter lives in his/her own apartment, 0 otherwise)	0.5791	0.1672	3.4640
Age indicator (1 if the age is between 36 and 55 years, 0 otherwise)	0.2044	0.0826	2.4740
Gender indicator (1if the driver is male, 0 otherwise)	0.1603	0.0743	2.1560
Number of car indicator (1 if number of cars in household is more than 1, 0 otherwise)	0.4254	0.0831	5.1220
Restricted log-likelihood (Constant only)		-2364.8886	
Log-likelihood at convergence		-2195.9185	
ρ^2		0.0716	
Number of observations		3771	

As mentioned earlier, occupation indicators of government/state enterprise and company workers appeared to prefer car sharing. Utilization of car sharing is considered time saving and more convenient relative to paratransit for those who have a positive response to car sharing. The coefficient for teachers/professors shows an insignificant value and the negative sign implies their non-preference to car sharing. It is simply understandable that a portion of

the people who have a higher education seem to think quite systematic and practical before choosing the choices provided in the question. Before making a decision whether to choose between paratransit and car sharing modes with respect to its service attributes, these respondents will often estimate the costs associated with the travel time (access time and waiting time) then select the most practical alternative. This group is unlikely to be potential car sharing users.

As for the income indicator, the estimated coefficients are significantly inconsistent with each other. The income level between 5000 and 15000 Baht indicates insignificant and the negative coefficient implies the respondents' refusal to use car sharing due fundamentally to its costs of usage. However, income levels between 25000 and 35000 Baht and between 35000 and 55000 Baht present the positive coefficients. Obviously, car sharing service is more expensive than Para transit. The car sharing target group must be at least a middle income group who has income from 25000 to 35000 Baht. This result also corresponds with the age indicator between 36 and 55 years old. Generally, most people who earn salary between 25000 and 55000 Baht are supposed to be from 36 to 55 years of age according to their working experience and skill level.

Not surprisingly, the coefficient for respondents who live in their own apartment indicates significantly positive meaning an increased preference to car sharing relative to those who live in their own house. As already known, Bangkok is one of the most densely populated cities in Asia, hence living in apartment seems to be more prevalent for those accessing to public transport. Most of apartments do not provide sufficient parking spaces for all tenants. Even though the apartment owner may afford a car, the limitation of parking space might affect their purchasing decision. Therefore, car sharing service may fit this group of people.

7.2 Estimation of Multinomial logit of main mode choice model for commuting trip purpose

The parameter estimation results for multinomial logit for the main mode choice model for commuting are shown in Table 4 below. According to Table 4, the estimated coefficients for automobile travel time and bus travel time shows significantly negative. This implies that the respondents/commuters will have a high probability to select these alternatives if they provide less travel time. The bus seems to be the least preferred choice for the commuters. In Bangkok, the current situation consists of bus services being operated by both state and private enterprises under subsidization. Both operate with little commercial incentive indicated by the failed attempt raise the fares. BMTA service is lacking in terms of the number of buses and the amenities inside the bus. Therefore, the commuters feel the mode is too unreliable and uncomfortable for commuting to work. Therefore, this is the least utilized commuter alternative.

The socio-economic coefficient such as number of household cars, age, and occupation indicates significantly positive meaning that the more cars they have the higher probability to select automobile use. Likewise, the respondents/commuters from age bracket of 26 to 45 years old tend to have preference for automobile ownership. Having owned a car has been integrated with their life already as it brings convenience, safety and freedom to travel regardless of location and time. It can be seen in most urban societies, that people in the middle age appear to own a car for not only individual use but also for psychological need (Maslow, 1970 and George, 1996). The student commuters tend to prefer automobile. The

preference students place on the automobile is because they choose the mode that provides them maximum utility.

In the case of car sharing, the cost of usage appears to play a significant role in affecting the choice probability. As the variable cost of car sharing increase the probability to select car sharing is less.

Table 4 Estimation of multinomial logit of main mode choice probabilities for commuting purpose

Variable	Estimated Coefficient	Coefficients Standard Error	T-statistic
Automobile			
Constant	-1.9010	1.7586	-1.0810
Travel time	-0.0169	0.0098	-1.7260
Number of cars indicators (1 if number if cars in household is more than 1, 0 otherwise)	2.6497	0.4936	5.3680
Age indicator (1 if the age is between 26 and 45 years, 0 otherwise)	1.0818	0.4227	2.5590
Occupation indicator 1 (1 if the commuter is student, 0 otherwise)	1.6066	0.8874	1.8100
Bus			
Constant	-2.6229	1.7171	-1.5280
Travel time	-0.0100	0.0067	-1.5060
Car sharing			
Variable cost	-0.0384	0.0238	-1.6170
Income indicator (1if the commuter's income is higher than or equal to 25,000 baths, 0 otherwise)	2.7415	0.6257	4.3820
Educational level indicator (1 if the commuter's educational level is certificate, 0 otherwise)	0.9002	0.4965	1.8130
Occupation indicator 2 (1 if the commuter is government/state enterprise officer, 0 otherwise)	-0.7304	0.4771	-1.5310
Restricted log-likelihood (Constant only)		-174.8720	
Log-likelihood at convergence		-141.1817	
ρ^2		0.1927	
Number of observations		234	

This is presumably because they have other alternatives available. The estimated coefficient of income variable in the car sharing mode shows statistically significant. This implies that those who tend to select car sharing are likely to have income level higher or equal to 25,000 Baht. Also, those who have a certificate educational level have a higher probability to choose car sharing. It can be implied that this group may have lower income and do not own a car due to lack of budget. Car sharing can relatively fulfill their travel demand and creates equity in terms of mobility. However, in this model, the government /state enterprise officers have no preference to choose car sharing.

8. CONCLUSION

This study analyzed attitudinal behaviors regarding the perception towards a proposed car sharing system. This paper also described the development of a discrete choice model to elicit the Bangkok peoples' car sharing preferences in response to different attributes and situations. Utilizing SP data collected from field surveys in the Bangkok Metropolis, a binary logit model

for feeder mode and a multinomial logit model of main mode for commuting trip purposes were constructed. Finally, the demand forecasting for car sharing usage was analyzed. The findings are summarized in the following manner.

By employing attitudinal questions, it was discovered that the level of services has strong influence on their perception in terms of accessibility, vehicle diversification provision, technological assistance and travel cost in particular. The cost perception plays a significant determinant role for an individual's decision making on modal choice probability. If the cost of car sharing usage can be lower than the cost of their current mode usage, it is possible that their perception on the cost of car sharing usage would change.

The estimation results of a binary logit model for feeder mode contribute significantly to the identification of the level of services and potential target market for car sharing. Considering the level of services, access time and waiting time play a significant influence role on individual's preference towards paratransit and car sharing. If car sharing could reduce access time and waiting time, it is likely that respondents would shift to use car sharing. On the other hand, socio-economic characteristics such as occupation, age, household vehicle, living status and particularly income have a significant impact on an individual's decision making towards choice probability. Also people who live in their own house, own apartment, and have household vehicle more than one are likely to be potential users of car sharing. Therefore, according to the explanatory variable results from attitudinal analysis and the model estimation results of binary logit model for feeder mode, this clarifies that the provision of car sharing as a feeder transport mode or known as "station car" in Europe and North America is feasible and applicable to introduce in the Bangkok Metropolis. The estimation results of a multinomial-logit model for main mode contribute significantly to the identification of the level of services and the potential target market for car sharing in terms of travel time, variable cost, education, and income in particular. It is apparent that bus transport mode has only a partial effect on individual choice probability against automobile and car sharing. The variable cost of car sharing tends to have negative impact on car sharing choice probability. If car sharing could provide lesser variable cost than automobiles, it is presumable that the respondents would shift to use car sharing.

In conclusion, the results in this study indicate the possibility to introduce car sharing as a feeder transport mode and as a main mode for commuting in the Bangkok Metropolis if: 1) we target the right market (according to the estimation results, potential target users that are male and who are in the age bracket of 36 – 55 years old, hold certificate level education work at government, state enterprise, or company worker with income level between 25,000 to 35,000 Baht and 35,000 to 55,000 Baht, and live in their own house or own apartment); 2) select the appropriate location for car sharing station; and 3) provide the level of services in compliance with users' demands. However, an introduction of car sharing to the entire Bangkok area may be too large an area to manage. This would require huge capital. The specific boundary should be concentrated to a specific region (e.g., Ladprao or Huaykwang Districts in Bangkok Metropolitan). To succeed in implementing a car sharing program, a small scale and manual operation system from the start-up level may be appropriate. Implementation of a car sharing project may be better off in a new housing development area or a tourist location. Moreover, the demand forecasting for the future use of car sharing indicates the need for grassroots planning and its level of service requiring more specification. Nevertheless, further studies should focus on minimizing cost, evaluating individuals and societal benefits, analyzing public and private sector involvement and most importantly the government incentive should be reinforced.

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