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INVESTIGATING TRAVEL BEHAVIOR ASSOCIATED WITH THE INTRODUCTION OF CAR-SHARING SYSTEM IN BANGKOK

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Abstract: A study of the potential use of a new transportation mode often challenges transport planners in forecasting future demands. Various factors influence travelers on making decision, especially attitudes, demography, and travel characteristics leading to, if not properly examined, unreliable demand forecasting. A Car-sharing system is an innovative transportation mode for Bangkok people to shift from an existing mode. This paper focuses on a study of the travelers' opinion on the new mode and the potential use of the Car-sharing system in Bangkok regarding pre- and post- attitudes toward the system. A two-phase analysis of a preliminary study and an attitude-related research are conducted to elicit travel behavior information associated with an introduction of the Car-sharing system. Descriptive and conductive statistics are presented for describing the relationship between the level of interests and the travelers' explanatory characteristics. The study develops a methodology to treat the attitude variables by group classification and then incorporate attitudes in modeling process (Binary Logit Model). In addition, two classification methods (Statistical and Judgmental) are considered and compared. The study brings about the understanding on the effect of attitudes toward the Car-sharing system resulting in more accurate estimation of the use of the system.

Key Words: Car sharing, Pre- and post- attitude, Mode choice, Statistical method, Judgmental method

1. INTRODUCTION

The traffic congestion in Bangkok has been in existence for a long time. Bangkok people have realized that the traffic congestion certainly causes not only environmental problems but also damages to the country's economy. It was reported that Bangkok's traffic congestion alone had cost the economic damage of 116 billions baht from passengers' excessive travel time and 27 billions baht in extra vehicle operating expenses (Fukuda et al., 2001). The major contributing factor of these problems is undoubtedly the disproportionate number of private vehicles in the street. Private cars are popular and the growth of vehicle ownership is increasing continuously. At the present, the vehicle ownership of Bangkok residents is

approximately 254 cars per 1,000 persons (Office of Transport Policy and Planning, OTP, 2002). Moreover, new vehicles are registered at an astonishing rate of 762 vehicles per day. Although Thai government has tried to reduce the private car usage by promoting the use of public transportation and the mode shifting, the overall result of these congestion alleviations are not remarkable. Nowadays, Bangkok has still relied on traditional public transport. The reasons might be that the implemented measures do not make traditional public transportation systems comparable with the private cars. The private cars still mean superior and provide invincible benefits, for example, privacy, social status, and convenience. The Car-sharing system plays a significant role in filling the gap.

A Car-sharing system, a short-term automobile rental service providing a fleet of cars available to members who periodically need to drive errands, is probably an interesting approach that may fulfill Bangkok people's needs and help reducing the crave on owning a private vehicle. Travelers will make great use of Car-sharing system transport. Since Thai government has adopted a policy in constructing rail transit network, Car-sharing system help reduce travelers' traveling time. Besides privacy and comfort, Car-sharing system will encourage to use effective public transport. Car-sharing station will be located in area akin to railway station to get simply access to public transit. This contributes to sustainable transport. For this reason, Car-sharing has a useful effect on transportation, in terms of reduced traveling time and public transport usage. Car-sharing system also leads to economic advantages, which relate to transport perspective. Travelers travel by electric car or hybrid car so as to avoid consuming fuel. The use of Car-sharing helps diminish economic loss originating from vehicle operating cost. In addition, a decrease in traveling time is attributed to multi-modal trip (Car-sharing system and effective public transit). Therefore, economy eventually gains the benefits from Car-sharing system.

However, the acceptability of the system depends on traveler's behaviors and attitudes, and how they justify benefits from the system. It can also be offered in a variety of arrangements. Thus, to introduce the system successfully, one wishes to find a proper collection of a set-up that could best fulfill the prospect customers' needs and maximize the acceptance.

2. OBJECTIVES

The Car-sharing system has never been implemented in Thailand, especially Bangkok, thus it is unfamiliar for travelers. A study by Fukuda et al., (2003) on the potential use of the Car-sharing system in Bangkok indicates that the respondents are expectedly interested in the system. However the study does not specify details on the Car-sharing system configuration in comparison with the existing modes. Therefore, this paper aims to investigate the travel behaviors associated with the introduction of the Car-sharing system in Bangkok. This research attempts to gain understanding on traveler's choice selection between the Car-sharing system and the existing modes regarding traveler's intention and attitudes toward the Car-sharing system.

3. METHODOLOGY

To realize the trustworthiness of conclusion provided with the hypothetical car-sharing mode scenario, the methodology including a questionnaire was designed to capture travelers' behaviors and attitudes with minimal biases, yet simple to conduct. The research was divided into two phases. The first phase emphasized on the relation of travelers' behavior, travel characteristics, and level of services. The survey utilized a face-to-face interview with a stated preference survey. The questions were simply deliberated so that respondents could quickly understand the Car-sharing system and present their travel patterns and socio-economic information. Moreover, they could contemplate about the stated Car-sharing service attributes at the level of their interest. The second phase focused on travelers' interest in the Car-sharing system in association with their attitudes toward the system. To ascertain the understanding of travelers toward the questions, an information chart concerning the definition of the Car-sharing system and the hypothetical operating services were given to the respondents so that they would have identical knowledge on the system. This definition was given in the middle of the survey as well as situations containing attributes of the Car-sharing system and other existing modes. The details of the Car-sharing service characteristics proposed to respondents were

- Price structure: admission fee, monthly fee and service fee
- Port (station) system: round-port system and multi-port system
- Technology level: high, medium and low

During the second survey, two sets of the important travel behavioral variables, *attitudes*, toward the Car-sharing system were collected to classify respondents' intention into the positive or negative group, and to see the changing attitudes after receiving more precise information on the system. The two sets of attitudes were (1) pre-attitudes, the attitudes rising before respondents knew the price structure and service characteristics of the Car-sharing system as illustrated in the information chart, and (2) post-attitudes, the stated attitudes after selecting preferred mode choice (using the Car-sharing or the existing modes) on situation-by-situation basis. The traveler's attitudes were rated in five-point rating scales (1=very unendurable, 2=unendurable, 3=fair, 4= beneficial and 5=very beneficial). Each respondent was questioned with the 9 different Car-sharing scenarios and asked to choose whether they would shift mode when the Car-sharing system was proposed along with their existing means of transport. In the second survey, 429 respondents were successfully interviewed and 3,861 observations (429 times 9) for the stated choice analysis were collected. The summary of data gathered from both phases was listed in Table 1.

Table 1. Collected Survey Data in this Study

Details	First Phase	Second Phase
Survey period	October-November 2002	April-May 2003
Number of Samples	592	429
Respondent's condition	Residing within 10-kilometer radius from BTS and MRT route	Residing within 10-kilometer radius from BTS and MRT route
Essential collected data	socio-economic information, traveling patterns, Car-sharing service attributes, and levels of interest	Attitudes and choice selection in comparison with the existing modes

Note : BTS is Bangkok Transit System or Skytrain and MRT is Metropolitan Rapid Transit or Subway.

The study areas were chosen along mass rapid transit routes of Bangkok Transit System (BTS) and Mass Rapid Transit System (MRT), which was under construction during the survey period, in Bangkok Metropolitan area covering an area of 6 zones: Chatuchak-Ladprao, Paholyothin-Phayathai, and Ploenchit-Sukhumvit. These locations have potentials for the Car-sharing system to be used as a connection to the permanent and reliable public transportation system. The survey selected only people living within 10-kilometer radius from BTS and MRTS routes in order to ascertain that they would have an easy access to the skytrain and the new subway.

4. ANALYSIS ON TRAVELER'S INTEREST IN THE CAR-SHARING SYSTEM

4.1 Intention to use the Car-sharing system

The intention to use the Car-sharing system of travelers was explored by using the first phase data (socio-economic information, traveling patterns, Car-sharing system service attributes, and level of interests) to underlie the correlation between individual's level of interests and other personal and traveling characteristics.

First, the data on travelers' interests was purposely converted into qualitative and quantitative variables for a better (simpler) representation of their interests and for further analyses. The levels of interests were merged from five levels to three levels in order to indicate travelers' preference in the Car-sharing system. The levels of interests became "interested", "not sure", and "not interested". The first two levels were used to qualitatively specify potential users of the Car-sharing system. The other level indicated less or negative preference. The results of the first survey indicated that the amount of travelers who were interested, not sure, and not interested in the Car-sharing system were 47, 29, and 24 percent respectively.

4.2 Correlation of travelers' interests and socio-economic characteristics

After re-grouping the levels of intentions (interests), the Chi-square and the two-way Analysis of Variance (ANOVA) were performed on the first phase data to disclose the correlation between travelers' interests and characteristics. The results of the correlation with the socio-economic data were shown in Figure 1.

As illustrated in Figure 1, five travelers' socio-economic variables could explain the interests. These were age, education level, income, residential type, and car-parking availability. However, the explanation of the interests had to be done with care, since many socio-economic variables were interrelated with each other. Education was the only variable with no correlation with others. It was clear that the preference on using the Car-sharing system could plausibly be characterized by travelers' socio-economic data (demographic data). However, it was remarked that the travelers' interests should also be considered with other factors, such as traveling characteristics and levels of understanding on the system.

4.3 Correlation of traveler's interest and travel characteristics

The One-way Analysis of Variance was applied to demonstrate the correlation between travelers' interests and traveling characteristics. The results of the analysis were presented in Table 2.

Socio-Economic Data	Main Effect	Interactive Effect
Sex (S)	×	✓
Age (A)	✓	✓
Marriage status(ST)	×	✓
Education level (ED)	✓	×
Occupation (OC)	×	×
Income (IN)	✓	✓
Residential type (RE)	✓	✓
Household member (HM)	×	×
Vehicle (VH)	×	×
Car usage (US)	×	×
Car parking (PK)	✓	✓

Figure 1. Correlation between Travelers' Interests and Socio-Economic Characteristics

	S	A	ST	IN	RE	H	V	US	PK
S					✓		✓	✓	
A			✓	✓					✓
ST		✓							✓
IN		✓							
RE	✓								
H							✓	✓	✓
V	✓					✓			
US	✓					✓			
PK		✓	✓			✓			

	S	A	ST	IN	RE	HM	VH	US	PK
S					✓		✓	✓	
A			✓	✓					✓
ST		✓							✓
IN		✓							
RE	✓								
HM							✓	✓	✓
VH	✓					✓			
US	✓					✓			
PK		✓	✓			✓			

Note : S=Sex, A=Age, ST=Marital status, IN=Income, RE=Residential type, HM= Household member, VH=Vehicle ownership, US=Car usage, and PK=Car parking availability

Figure 1. (Cont.) Correlation between Travelers' Interests and Socio-Economic Characteristics

According to Table 2, almost all traveling characteristic parameters of the vacillating group (i.e., "not sure" group) represented the greatest value comparing to those of the "interested" and "not interested" groups, with only an exception on the average total traveling time by a main mode variable of the interested group. The results were also consistent in both working and shopping trip purposes. The figures for the "interested" group came in the second and the least value belonged to "not interested" group. It was remarked that the differences among travelers' interest groups were not significant at a high confidence level (except the access time on foot and traveling time on a subordinate mode). Nonetheless, the findings reasonably conformed to the respondents' travel behavior that travelers who spent less traveling time were not probably interested in the Car-sharing system.

Table 2. Mean and Standard Deviation Values of Traveling Characteristics (for working and shopping trip purposes) (minutes)

Traveling Characteristics	**Travelers' Stated Levels of Interests**			
	"interested"	**"not sure"**	**"not interested"**	**Total**
NU	1.30/1.02 (0.79/0. 47)	1.45/1.15 (0.68/0.54)	1.28/1.04 (0.83/0.55)	1.34/1.06 (0.77/0.51)
TIM	48.68/31.45 (28.81/21.02)	48.79/33.06 (23.77/18.82)	43.71/28.53 (31.61/24.04)	47.54/31.22 (28.19/21.21)
WAIT	6.83/4.10 (9.79/6.89)	7.26/5.68 (9.33/8.62)	5.34/3.13 (8.92/5.34)	6.60/4.33 (9.47/7.18)
ACTIM	5.31/4.15 (6.84/5.30)	6.26/5.06 (6.37/5.66)	4.22/3.08 (5.29/3.78)	5.33/4.16 (6.40/5.14)
MTIM	37.85/24.67 (23.63/18.47)	34.16/24.70 (19.23/15.54)	33.13/23.81 (25.93/21.9)	35.66/24.48 (23.08/18.54)
SUBTIM	10.83/6.78 (14.53/9.41)	14.63/8.35 (14.31/9.15)	10.58/4.81 (14.17/6.64)	11.88/6.78 (14.47/8.84)

Table 2. (Cont.) Mean and Standard Deviation Values of Traveling Characteristics (for working and shopping trip purposes) (minutes)

Traveling Characteristics	**Travelers' Stated Levels of Interests**			
	"interested"	**"not sure"**	**"not interested"**	**Total**
MTIM	37.85/24.67 (23.63/18.47)	34.16/24.70 (19.23/15.54)	33.13/23.81 (25.93/21.9)	35.66/24.48 (23.08/18.54)
SUBTIM	10.83/6.78 (14.53/9.41)	14.63/8.35 (14.31/9.15)	10.58/4.81 (14.17/6.64)	11.88/6.78 (14.47/8.84)

Note : xx/xx are the average traveling characteristics for working and shopping trip respectively
(xx/xx) are standard deviations in accordance with the xx/xx above
NU = the number of mode transfers
TIM = total traveling time
ACTIM = access time to the Car-sharing system on foot
WATIM = total waiting time
MTIM = total traveling time by a main mode
SUBTIM = total traveling time by a subordinate (secondary) mode

The results in Table 2 also inferred that the respondents who indicated "not sure" implied ambiguous intentions whether they were either interested or not interested in the Car-sharing system. However, the greatest average values of traveling characteristics of this group implied that, if the Car-sharing system was open for full functional services, this "not sure" group became prospective users, since they presumably have the greatest potentials to decide to choose traveling by the Car-sharing system.

5. ANALYSIS ON THE RELATIONSHIP BETWEEN TRAVELERS' ATTITUDES AND THE USE OF THE CAR-SHARING SYSTEM

This section attempts to reveal the relationship between travelers' attitudes and intentions to

use the Car-sharing system. The analysis required the treatment of attitude variables into simpler, yet meaningful, forms. The analyses on both pre-attitudes and post-attitudes were determined to demonstrate the difference in the inferences. The data in this analysis came from the second survey.

From the basis that the use of the Car-sharing system was decided based upon trade-offs among attributes perceived by travelers, the analysis was implied to disclose the significance of each attribute (attitudes in several dimensions) and the trade-off process. However, a large number of attributes made it difficult to observe the effects of the trade-offs. Consequently, it was essential to reduce a number of attributes by eliminating some unimportant or unrelated attributes or grouping them into few explanatory variables. Two methods were proposed: statistical and judgmental methods. With the statistical method, the representative factors could contain the grouped attributes' details in statistical and behavioral meanings. In the judgmental method, all raw attributes were manually classified into three categories (aspects) based on their similarity (of their behavioral effects). No matter which method was used, the representative factors in each category were significantly related to corresponding behavioral meaning of the variables.

Using the statistical method, the component analysis (Factor analysis) was applied to group all pre-attitude attributes into three representative factors named arbitrarily as travel factor (F1), convenience factor (F2), and society factor (F3). Table 3 showed that the groups of the attitudes on the Car-sharing system were explained by each representative factor and loading factor scores. These factors represented the total of fourteen pre-attitude attributes. Later on individuals' attitudes will be characterized by these three factors. Applying Factor analysis, the pre-attitude attributes represented by the same factor (travel factor, convenience factor and society factor) had relatively higher loading factor scores than other factors' values. The loading factor scores from the pre-attitude attributes were also presented in Table 3.

Table 3. Grouping and Loading Factor Scores of Pre-Attitudes (Factor Analysis)

Pre-Attitude Test	**F1**	**F2**	**F3**
1. The Car-sharing system helps you travel faster	0.440	0.723	0
2. The Car-sharing system will save your shopping time	0.455	0.728	0
3. The Car-sharing system helps you reduce your traveling cost than your existing mode	0.716	0	0
4. The Car-sharing system provides easy accessibility to the system	0.567	0	0.302
5. The Car-sharing system provides sufficient vehicle that matches your need	0.698	0	0.238
6. The Car-sharing system can attract you to use its services instead of using your existing mode	0.723	0.282	0.231
7. The Car-sharing system provides better convenience that take you to any places	0.611	0.492	0
8. The Car-sharing system is equipped with technological devices that bring you more convenient and comfortable to travel	0.499	0.509	0.308
9. Technologies equipped with the Car-sharing system can attract you to use Car-sharing for traveling instead of your existing mode	0.637	0.330	0.276
10. The Car-sharing system creates equity in the public's traveling	0.262	0	0.539
11. The Car-sharing system can be an alternative mode for emergency	0	0.742	0
12. The Car-sharing system can alleviate the traffic congestion in Bangkok	0.206	0	0.810
13. The Car-sharing system can reduce air and noise pollutions in Bangkok	0.321	0	0.711
14. The Car-sharing system increases the use of public transits: BTS or MRTS	0	0.519	0.561

Note : F1 = Convenience factor
F2 = Travel factor
F3 = Society factor

In the judgmental method, the pre-attitude attributes were grouped into each category (aspect) by human judgment, since the behavioral reasoning could be utilized to judge the grouping of the attitudinal factors. The results of both methods were shown and compared in Table 4. It was found that two methods of attitude grouping produced different outcomes. The travel factor shared common traveling time attributes but the judgmental method included traveling cost and accessibility in this factor. This small difference could make deviation in later analyses and thus the outcomes from both grouping methods were considered separately throughout the research.

Table 4. Comparison of Classification of Pre-Attitudes into Groups by Statistical Method and Judgmental Method

Representative Variables (Aspects)	**Grouping Method**	
	Statistical	**Judgmental**
Travel Factor	faster traveling time for work purpose	faster traveling time for work purpose
	faster traveling time for shopping purpose	faster traveling time for shopping purpose
	convenient Car-sharing technology	reduced traveling cost by Car-sharing
		easy accessibility
Convenience Factor	attractive Car-sharing	attractive Car-sharing
	convenient Car-sharing	convenient Car-sharing
	convenient Car-sharing technology	convenient Car-sharing technology
	technology	technology
	sufficient vehicles	sufficient vehicles
	reduced traveling cost by Car-sharing	
	easy accessibility	
Society Factor	equity	equity
	traffic congestion	traffic congestion
	pollution	pollution
	public transportation system	public transportation system

After the pre-attitude attributes were grouped into three representative variables, travelers' attitudes (now characterized by three factors) were used to classify the travelers' intention of Car-sharing usage into 2 segments (negative and positive) based on each factor (aspect) using Clustering Analysis. Each classification allowed us to clearly understand how respondents expressed their attitudes towards each aspect of the Car-sharing system relating to other modes. Total observations were then separated into 2 segments with respect to pre-attitudes by Cluster Analysis and post-attitudes by classifying rating scale values. Selecting preferred choice for each of 9 situations, the respondents had to express their post-attitudes describing how many times they considered that the Car-sharing system was better or worse than the existing modes in that situation. A measurement of post-attitudes was eleven-point rating scale meaning as 1-5 equal to worse, 6 equal to equivalent, and 7-11 equal to better.

Table 5 presents the differential number of travelers in various attitudinal segments. With statistical and judgmental methods, all attitudes were categorized into 6 segments, positive/better, positive/equivalent, positive/worse, negative/positive, negative/equivalent and negative/worse. Each group contains its own observations, and their attitudes certainly indicate the inclinations of attitudes (pre-/post-). Rational respondents who have positive dimensions in both the attitudes were shown in shaded blocks.

Table 5. Number of Observations Classified by Pre- and Post-Attitude Classification

Post-Attitude	Grouping Method	Pre-Attitude Travel Aspect		Pre-Attitude Convenience Aspect		Pre-Attitude Society Aspect		Total
		Positive	Negative	Positive	Negative	Positive	Negative	
Better	Statistical	1,151	984	1,626	509	938	1,197	2,135
	Judgmental	1,380	713	1,218	875	1,116	977	2,093
Equivalent	Statistical	364	428	534	258	369	423	792
	Judgmental	500	292	423	369	427	365	792
Worse	Statistical	456	478	549	385	403	531	934
	Judgmental	545	431	448	528	423	553	976
Total	Statistical	1,971	1,890	2,709	1,152	1,710	2,151	3,861
	Judgmental	2,425	1436	2,089	1,772	1,966	1,895	

With the statistical method and judgmental method, the percentages of total observations having corresponding attitudes were 42/47 percent in the travel aspect, 52/45 percent in the convenience aspect and 38/43 percent in the society aspect respectively. Only in the convenience aspect by the statistical method, more than 50 percent of total observations expressed corresponding attitudes. It implies a group of travelers is prone to use the Car-sharing system. In case of non-rational group expressing contrast attitudes (positive/worse and negative/better). In the travel aspect, 37 (33) percent of total observations expressed non-corresponding attitude by the statistical method (judgmental method). In the convenience and society aspects, the statistical and judgmental method caused the number of observations having non-corresponding attitudes of 27(34) and 41 (36) percent of total observations respectively. It is noted that the number of respondents expressing corresponding attitudes were more than the number of non-rational travelers. Moreover, the percentages of observations have an increase in the number of observations based on the positive directions of pre- and post- attitudes, and the two attitude-grouping methods result in the same tendency of final outcomes

In the later analysis, the rating of “better” and “worse” post-attitudes was used in the choice model formulation and analysis. The observations from respondents answering 6, which implied indifference, were eliminated from the dataset. Therefore, there were 3,069 observations (approximately 75 percent of all) left in order to study the effects of pre-and post-attitudes toward the use (probability) of the Car-sharing system.

6. ANALYSIS OF THE PROBABILITY OF THE USE OF THE CAR-SHARING SYSTEM

The probability of the use of the Car-sharing system was conducted by binary logit mode choice analysis between the existing mode and the Car-sharing system by using the results of the previous analysis after both statistical and judgmental attitude-classification method. The difference in the mode choice analysis after the statistical and judgmental methods was in attitudinal factors, especially pre-attitudes being grouped into 3 aspects. With the statistical

method, all of the pre-attitude attributes was grouped into 3 factors: travel, convenience, and society. These factors were applied as dummy variables in the choice modeling process and each factor (variable) had two values that were positive and negative. According to the other means of the statistical methods, the research treated the three factors as specific generic variables by applying factored scored in modeling utility function composed of attitudinal variables. The calibration used 80 percent of all observations to model 3 pre-attitude variables and to formulate a set of model structures (utility functions). The model structures were randomly created by combining explanatory variables with pre-attitudinal variables in various forms in order to gain the best models that were statistically valid and could explain travelers' behaviors. The total probabilities derived from the valid models were classified and analyzed with respect to post-and pre-attitudinal variables as indicated in earlier section. It was noted that the society aspect was dropped in the final model calibration.

Table 6. Results of Modeling Process

Variable	**Statistical**		**Judgmental**					
	Factored Score	**Dummy**	**TP**	**TN**	**CP**	**CN**	**SP**	**SN**
CONSTANT	1.57 (9.20)	2.535 (12.40)	1.330 (6.99)	1.356 (5.36)	1.178 (5.77)	1.335 (7.48)	1.657 (7.33)	1.277 (4.97)
WAITEX				-0.0471 (2.88)			-0.0218 (2.35)	
TIMCS				-0.0144 (2.20)			-0.0107 (2.13)	
TIMEX				-0.0144 (2.20)			-0.0107 (2.13)	
TOTIMCS	-0.0132 (3.77)	-0.0129 (3.71)	-0.0167 (4.27)		-0.0081 (1.98)	-0.0210 (3.57)		-0.0184 (3.58)
TOTIMEX	-0.0132 (3.77)	-0.0129 (3.71)	-0.0167 (4.27)		-0.0081 (1.98)	-0.0210 (3.57)		-0.0184 (3.58)
COSTCS	-0.0051 (6.69)	-0.0048 (6.43)	-0.0054 (6.40)	-0.0060 (2.95)	-0.0068 (7.40)	-0.0038 (2.80)	-0.0054 (4.78)	-0.0064 (5.17)
COSTEX	-0.0051 (6.69)	-0.0048 (6.43)	-0.0054 (6.40)	-0.0060 (2.95)	-0.0068 (7.40)	-0.0038 (2.80)	-0.0054 (4.78)	-0.0064 (5.17)
TECHCS	0.2890 (5.01)	0.2870 (5.01)	0.3268 (4.98)		0.3802 (5.44)		0.3559 (4.73)	0.2313 (2.69)
PORTCS	0.2649 (2.647	0.2558 (2.57)	0.4273 (3.77)		0.3817 (3.20)		0.3867 (3.07)	0.3462 (2.38)
TRL	0.3753 (7.57)	1.0190 (8.36)						
CON	0.4957 (9.36)	0.5080 (5.36)						
Equation set	1	2	3	4	5	6	7	8
L	-1416.87	-1435.74	-1064.61	-405.87	-939.21	-522.10	-837.41	-657.57
ρ^2	0.35	0.35	0.27	0.48	0.26	0.45	0.30	0.34
% Correct		77%	75%	86%	86%	74%	76%	82%

Note :TP = Positive pre-attitude in the Travel aspect ; TN = Negative pre-attitude in the Travel aspect
CP = Positive pre-attitude in the Convenience aspect ; CN = Negative pre-attitude in the Convenience aspect
SP = Positive pre-attitude in the Society aspect ; SN = Negative pre-attitude in the Society aspect
V_{CS} = utility function of the Car-sharing system ; V_{EX} = utility function of the existing mode
TOTIMCS (EX) = total traveling time by the Car-sharing system (existing mode)
TIMCS (EX) = traveling time by the Car-sharing system (existing mode)
COSTCS (EX) = Cost by the Car-sharing system (existing mode)
WAITEX = total waiting time by the existing mode
TECHCS = technology level of the Car-sharing system
PORTCS = port system of the Car-sharing system
CON = dummy variable of convenience pre-attitude
TRL = dummy variable of travel pre-attitude

Formulating the choice model after the judgmental method, the modeling process was independently performed with observations with respect to the directions of pre-attitudinal variables in each aspect. This avoided the use of values representing the overall attitudes as done in the Cluster analysis. Therefore, the choice modeling was separately performed for each segment (positive and negative) of any aspects without introducing any dummy variables. The total number of sets of models was six. In any aspects, the probabilities were automatically classified according to pre-attitudes. Later, the probabilities were also classified by identifying rating scale values to specify for better than or worse than group.

By applying statistical and judgmental method to develop the choice modeling of the probability on the use of the Car-sharing system, these resulted in the list of utility functions as shown in Table 6.

From the equations above, equation sets (1) and (2) were used in determination of the Car-sharing probability by the statistical method. With both means of the statistical method indicated that the pre-attitude coefficients of dummy method were different from factored score method. Nevertheless, both of them resulted in slightly different statistics values and predictable outcomes. These implied that travel and convenience factors had impacts on decision towards the use of the Car-sharing system. Equation sets (3)-(7) were used to estimate the probability by the judgmental method. It was noted that the equations had no pre-attitudinal variables and were composed of time and cost attributes. Equations sets (3), (5) and (7) for positive pre-attitudes indicated that port system and applied technology levels influenced the preference of the Car-sharing system of travelers who had positive pre-attitudes in any aspects.

7. ANALYSIS ON THE EFFECTS OF PRE- AND POST-ATTITUDES TOWARD THE CAR-SHARING PREFERENCE

The study was to compare the effect of pre-attitudes and post-attitudes toward the declared preference on the Car-sharing use. The group classification was applied to group pre-attitude factors (convenience, travel, and society) and separated observations into positive and negative segments based on these three factors. The post-attitudes were classified as better and worse. The probabilities on the Car-sharing usage were classified with respect to pre-attitude factors resulted from the statistical and judgmental analysis method. Then the grouped probabilities were separated with respect to post-attitude factors by identifying rating scale values. It was noted that the calculation of probabilities for each specific pre- and post-attitude group utilized corresponding utility equations described in the previous section. Finally, four groups of probabilities were determined for each attitude aspect. The results of the analysis were shown in Table 7.

Table 7 displayed that the “rational” travelers, who had positive attitude towards the system, yielded the highest prone to use the Car-sharing system, which could be considered on the attitudes in all attitudinal aspects (travel, convenience, and society). This was consistent for the “rational” travelers, who had negative attitude towards the system. This traveler group was not likely to use the Car-sharing system. However, Table 7 also suggested that the choice modeling could produce a probability for the travelers who had contradict understanding about the system in the pre-attitude and post-attitude questioning, and the results were somewhat in between the two rational groups mentioned above. The analysis suggested that the procedures for obtaining travelers’ attitudes should be aware of the understanding on the system by the respondents, otherwise the final probability could be misleading.

Table 7. Average Probability and the Number of Observations by Attitude Aspects

Attitudinal Aspect	**Segmentation (pre-/post-)**	**Average Probability, percent (Number of Observations)**	
		Statistical	**Judgmental**
Travel	positive/better	25.49(1,151)	25.77(1,380)
	positive/worse	21.76(456)	22.21(545)
	negative/better	11.21(984)	13.62 (712)
	negative/worse	9.76(478)	12.09(431)
Convenience	positive/better	26.14(1,626)	26.96 (1,217)
	positive/worse	19.92(549)	23.67(448)
	negative/better	17.34(509)	14.50(875)
	negative/worse	13.85(385)	12.44(528)
Society	positive/better	22.54(938)	22.77(1,115)
	positive/worse	17.05(403)	20.19(423)
	negative/better	21.72(1,197)	20.14(977)
	negative/worse	16.63(531)	16.89(553)

The consideration on the effect of two grouping techniques in Table 7 reported that both methods could lead to similar results, in terms of the level of probabilities and trends. The differences in probability level were in an acceptable range for a practical use.

8. CONCLUSION

This study developed a methodology to analyze the attitudes of travelers toward the use of the Car-sharing system in Bangkok. Since the system has been introduced, the study employed, revealed and stated preference survey techniques with scaled attitude questions to capture travelers' interests and preferences on the system. Moreover, pre- and post-attitudes were collected to realize the effect of information and understanding on levels of preference in various attitudinal aspects and on the potentials of the Car-sharing usage.

The direct questioning to travelers resulted in 47 percent showing interests in using the Car-sharing system. Further analysis on correlation between the stated intentions and traveling characteristics reveals that people who stated "not sure" hold the greatest potentials in the usage. For working trip purpose, access time (on foot) and total traveling time on secondary modes significantly influenced the interest in the system.

The study illustrated the group of travelers who had intentions to use the system. However, the traveling characteristics had a stronger correlation with the intention. People who had less utility (longer traveling time) stated a higher degree of intentions to use the system. A major finding on the travelers' intentions was that the people who stated an ambiguous decision, i.e. "not sure", turned to have the highest potentials to be the users of the Car-sharing system.

Dimensions of attitudes could be grouped into fewer explanatory variables, and these variables could be used for the demand estimation and modeling.

The research presented the technique to deal with travelers' attitudes by grouping several factors into usable quantitative variables. The paper revealed difficulties in grouping them as illustrated by comparing results from the statistical (factor analysis) and judgmental method. The two methods of the group classification--statistical (factor analysis) and judgmental method--produced similar results in this study. The analysis of attitudinal aspects indicated that the convenience and travel attitudes heavily affected an individual decision on the use of the Car-sharing system.

Bearing in the possibility of arbitrary answering, the pre- and post-attitudes revealed the "rationale" of users. The classification was needed to categorize travelers based on their pre- and post-attitudes. The directions of attitudes were used in modeling purpose. The results showed that the grouping was important and leaded to more reliable estimation of the preference and probability of the Car-sharing use. It was suggested that attitude variables should be incorporated in the mode choice modeling.

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