

# 1. Private Car and Motorcycle Dependency: Users' Characteristics through Analysis of People's Perceptions and their Travel Behaviors - A Case Study of Phnom Penh City Center, Cambodia

プノンペン市における自家用車と自動二輪車依存：認知と交通行動に着目した利用者特性分析

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This study aims at investigating people's perception on private motorized vehicles use taking into account Phnom Penh city center as the study area. Two mode choice models were developed: among car, motorcycle and walk for short distances, and between private motorized modes and expected future bus service for long distance trips. MNL estimations resulted that attitude of shyness of walking and annoying motorcycle taxi drivers, perception on obstruction of retail business on sidewalk, level of streets' cleanliness, and availability of public spaces nearby residential' locations did influence mode choice for short trips, while BL estimations suggested the shorter walking time to bus stop and increase of motorized vehicles parking cost might influence behavior to prefer bus service for long trips.

## 1. Introduction

### 1.1. Statement of the Problems

The rapid motorization occurred recently in Phnom Penh city would be a harmful effect on its livability in the future. Base on traffic accident statistics from Phnom Penh Municipality and National Road Safety Committee, such an increase might lead to increase of traffic accidents and fatalities; the majority of number of traffic accidents was found among motorcycle drivers. Referring to Phnom Penh Transport Master Plan 2001, the estimation of parking demand would exceed the supply size in the central part of city center area by year 2015. Meanwhile Japan External Trade Organization (JETRO) suggested that the congestion degree in Phnom Penh would become worse, reaching to 1.25 if there were not any transportation policies to reduce travel by motorized transport in the future from year 2020.

As being said, these would lead to traffic problems as congestion and air pollution. Transportation planners show interest toward promoting non-motorized travel options as pedestrian or bicycle and public transportation as bus or rail transit in order to discourage private motorized vehicles dependencies to some acceptable level. In Phnom Penh, there is no bus service recently, as well as few pedestrian trips which were investigated in the city center trips (JICA Study) whereas many people prefer motorized modes; therefore, this research would likely focus on what reasons influencing people widely depend on private motorized vehicles.

### 1.2 Research Objectives

The modal shifts might be defined as main goals from this research. The approaches to be taken before considering modal shifts are to identify current people perception and their travel behavior on private motorized vehicle dependency through analysis of mode choice model among car, motorcycle and walk, and between private motorized vehicles and expected public transportation system as bus in corresponding to trip distances. To clarify such issues, the specific research objectives are defined as follows:

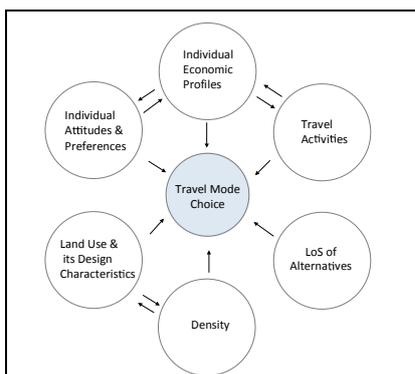
- Identify significant factors tending individuals to decide travel mode for city center trips while taking short distance trips into consideration
- Taking into account potentiality of bus development in Phnom Penh, the research needs to identify policy variables influencing individual selecting bus or private motorized vehicles through stated preference survey
- Recommend policies plan for Phnom Penh Transportation Development in order to reduce private vehicles' dependencies as well as to encourage more walk trips

## 2. Literature Review

Many literatures were discussed among built environment, pedestrian travel behavior approach, walking distance criteria, attitudes and psychology of individual, and level of services of alternatives in travel mode choice study. Susan Handy (2005) claimed that the built environment was defined as land use, transportation system and design attributes. She also stated that moving

in the built environment that offers better opportunities for walking are associated with increase of walk trips. In addition, as claimed by Kitamura et al. (1997), the attitudinal preferences were more strongly associated with travel than land use characteristics, which suggested land use policies promoting higher densities may not alter travel demand unless the attitude of people were also changed. Relating to utility theory, Mcfadden (1974) stated that individual obtains utility from different activities that require travel and thus make travel and choices to maximize their utilities. These means that not only land use, transportation system and level of service of alternatives, but attitudes or psychological factors of individuals as well, would likely influence the travel mode choice. However, there is no empirical research supporting this claim from behavioral perspective for Cambodia, as Phnom Penh City is the main area where the study would likely focus on.

Based on the review, there is a relationship between travel mode choice and individual characteristics as attitudes and perception, type of activities and economic profile. Levels of service of alternatives are also affecting travel mode option. Meanwhile, land use characteristics, design and density; surrounding environmental condition has strong effect on mode choice as being said. Therefore, **Figure 1** shows the framework before looking into the strong explanatory parameters.



**Figure 1. Conceptual Model Framework**

### 3. Research Hypothesis

Due to nature of trip distances, the models were considered into two difference ways of choice preferences: short distance mode choice and long distance mode choice.

For short distance cases, the model was considered among car, motorcycle and on foot. The hypotheses are set up on the factors affecting the travel mode choice beside the travel time

as follows:

H1: Availability of public spaces as park or shopping center located in the city center nearby their home would influence the mode choice behavior for those whose trips are shopping or recreation

H2: Difference attitudes of individual as symbol of status, convenience, shyness of walking and annoying motor taxi driver would affect the mode choice behavior for short distances trips

H3: Link (sidewalk) environment perception as perceiving retail business activities on sidewalk, and cleanliness of street possibly has effect on mode choice behavior.

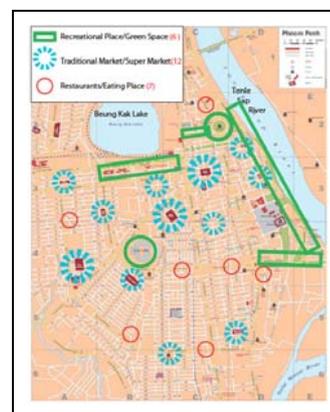
For long distance trip, the mode choice model was considered between current private mode use and expected bus service in the future. The hypotheses are as follows:

H1: Longer travel time would likely affect the future mode choice behavior

H2: While the walking time from origin to bus stop decreased and parking cost increase; the individual satisfaction of using current mode might be decreased.

### 4. Methodology

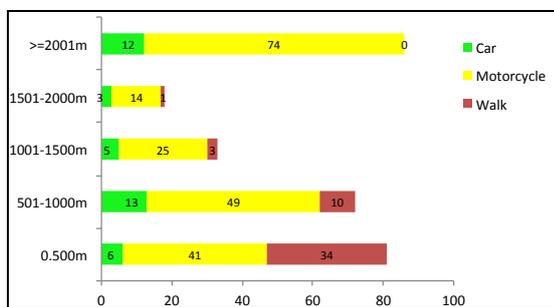
The intercept interview surveys were carried out in the city center of Phnom Penh at the location shown in **Figure 2** to capture travel behavior, attitude on car/motorcycle dependency, walking environment perception, and stated preference survey between expected bus service and current private motorized modes. 290 samplings were successfully obtained for respondents whose first trip of tours was made for the city center. Additionally, the built environment, and mode share audit were also carried out at the roadside nearby the interviewing area. Multinomial and Binary Logit Model were developed in this study.



**Figure 2. Location of Interview Survey**

## 5. Model Estimation Results

The multinomial logit model was developed among car, motorcycle and, walk for residents travelling nearby their home in city center while the binary logit model, which was considered between expected future bus service and current private motorized vehicles (combining car and motorcycle) preferences for those who travelled farther from their home. As shown in **Figure 3**, 52.7%(153 respondents) out of 290 trips for distance under 1km was utilized for modeling choice considering behavior among car, motorcycle and walk due to high frequency of observed walk trip rate, and 47.3% of trips for distance over 1km was utilized for modeling choice considering expected future bus service preferences.



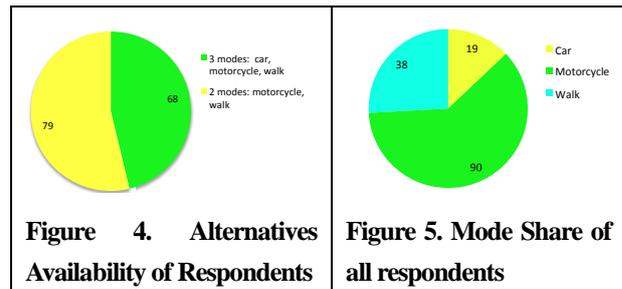
**Figure 3. Travel Mode Choice by Trip Distance**

### 5.1 Mode Choice Model Under One Kilometer

As being said, the multinomial logit model was developed.

In common sense, the alternative “driving a car or motorcycle” has been declared not available to individuals who did not possess a driving license. But In Phnom Penh, based on the collected data, there were still many respondents who did not own the driving licenses, drove car/motorcycle. In that sense, the choice set was generated based on the experiences of driving either households’ car or motorcycle. Those who have never driven households’ car or motorcycles for their going out behavior were excluded from analysis. Therefore, 147 respondents have ever driven private motorized vehicles whereas 6 respondents excluded have never driven either car or motorcycle.

As shown in **Figure 4**, 68 out of 147 respondents whose households had availabilities of 2 transport means: car, motorcycle while 79 respondents had only motorcycle in their home. Individuals, who had car in household, always had motorcycles too. On the other hand, **Figure 5** illustrates the mode share number among 147 respondents.



**Figure 4. Alternatives Availability of Respondents**

**Figure 5. Mode Share of all respondents**

Choice Set alternatives were defined as: 1: for Car, 2 for Motorcycle and 3: for walk which alternative specific constants were defined for car choice and motorcycle choice.

**Table 1** summarizes the mode choice model estimation. The overall model performance was significant but some of explanatory variables were not significant. With regard to significance, some of the estimated parameters are significantly different from zero at 95% confident level. The likelihood ratio  $(-2\{LL(0) - LL(\hat{\beta})\})$  and  $(-2\{L(c) - LL(\hat{\beta})\})$  are much larger than the tabulated of a mode  $\chi^2$  at the 5% level which implies a good fit. On the other hand, the model performs rather well; Rho squared was 0.552 suggesting a rather strong explanatory power of variables.

It is natural found that symbol of status coefficients explained positive sign for both car and motorcycle; it explained significant effect on car use behavior, but it did not explain the significant level for motorcycle use. On the other hand, people attitude on motorcycle use was explained that motorcycle is much more convenient mode for travelling in the city center shown as positively significant whereas the parameter for car choice was explained positively insignificant.

Meanwhile, the attitude of shyness of individuals from the look of other people in case of walking explained a negative significant effect on walk choice. It was similarly found on negative coefficient for walk choice for the parameter of annoy of motorcycle taxi driver asking for riding in case of walking; It concluded that some private car and motorcycle drivers felt shy or embarrassed of walking in the street, and felt annoyed with motorcycle taxi drivers who are always asking for riding in case people walk in the streets. A positive sign parameter of obstruction of retail business and other activities on sidewalk explained significant effect of choice behavior. It was interpreted that some car and motorcycle drivers felt that the on sidewalk activities hampered pedestrian traffic, or if the activities on sidewalk were free of obstruction on walking traffic, it would lead to increase walk trips shifted from car and motorcycle. In addition, it was found similarity of the perception on cleanliness of the streets and-

**Table 1. Mode Choice Estimation Results for Trip Distance Under One (1) Km**

<b>Variables</b>		<b>Parameter</b>	<b>T statistics</b>
Constant (car)	$\beta_1$	-5.147	<b>-2.122</b>
Constant (motorcycle)	$\beta_2$	-6.591	<b>-2.913</b>
Travel Time (minutes)	$\beta_3$	-0.474	<b>-2.807</b>
Car representing symbol of status (Car, 1-5 scale)	$\beta_4$	1.494	<b>2.964</b>
No. of car (car)	$\beta_5$	-0.717	-1.492
Car_ convenience in city center (car, 1-5 scale)	$\beta_6$	-0.034	-0.086
Dummy driving license (car)	$\beta_7$	1.476	1.418
Motorcycle representing symbol of status (motorcycle, 1-5 scale)	$\beta_8$	0.392	1.246
Motorcycle_ convenience in city center (motorcycle, 1-5 scale)	$\beta_9$	0.911	<b>3.048</b>
No. of Motorcycle (motorcycle)	$\beta_{10}$	0.769	<b>2.813</b>
Dummy driving license (motorcycle)	$\beta_{11}$	0.604	0.803
Attitude of Shyness/embarrassing from other people looking at in case of walking (walk, 1-5 scale)	$\beta_{12}$	-0.713	<b>-2.378</b>
Attitude of annoy of motorcycle taxi driver asking for riding in case of walking (walk, 1-5 scale)	$\beta_{13}$	-0.833	<b>-3.015</b>
Perception on level of cleanliness of streets, sidewalk (walk, 1-5 scale)	$\beta_{14}$	0.718	<b>2.164</b>
Perception on retail business and other activities on sidewalk (walk, 1-5 scale)	$\beta_{15}$	0.713	<b>2.415</b>
Interaction between trip purpose for recreation with park/plaza within 300m network distance (walk, Dummy 1, 0)	$\beta_{16}$	2.728	<b>2.864</b>
Interaction between trip purpose for traditional shopping with shopping center within 300m network distance (walk, Dummy 1,0)	$\beta_{17}$	1.765	<b>2.048</b>
<b>Statistical Output</b>			
No. of Observation			147
Availability of 3 modes			68
Availability only motorcycle and walk			79
No. of Parameter			17
LL(0)			-129.464
LL(c)			-118.975
Log L			-53.254
Rho squared (0)			0.588
Rho squared (c)			0.552
R squared adjusted (c)			0.529
Chi Squared			164.053

Bold is significant at the 0.05 level:  $t \geq 1.960$

sidewalk, which was explained, as positively significant effect on walking choice utility. So some car and motorcycle drivers felt the streets were unclean which lead them making decision on selecting their own motorized mode or if cleaned streets would attract more walking trips. Regarding the socio economic variables, the effect of driving license coefficient was positively insignificant for both car and motorcycle because

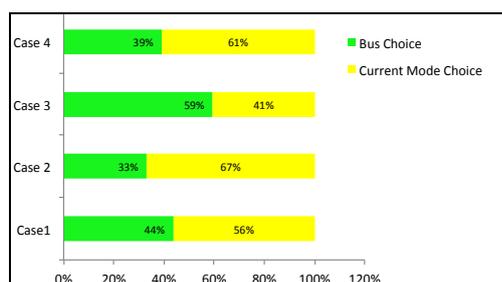
there were many car and motorcycle that did not own the driving license. At the same time, the effect of travel time coefficient was negatively significant for choice behavior. It explained that longer travel time would affect people to change their mode. However, the stronger predictors were found among the dummy parameter of interaction between trip purpose for recreation with availability of park and plaza

within 300m-network distance located in the city center and dummy parameter of interaction between trip purposes for shopping mall with availability of shopping mall within 300m-network distance located in the city center. Some drivers might use car and motorcycle for engaging recreation for farther destination in case of the absence of availability of public spaces within the said distances.

Other parameters as safety perception, attractiveness of streetscapes, attractiveness of commercial activities, sidewalk width, weather and other attitude factors as well socio economic variables introduced in the study were tested in the model but they did not explain the significant effect on choice behavior. Therefore they were taken out from the model.

### 5.2 Mode Choice Model Over One Kilometer

The model was developed on binary choice case for those who used current private motorized modes for trips over one kilometer, and their preferences on expected bus services considering trips on the day they were interviewed. Four cases were developed from experimental design considering three attributes of two levels: the parking cost (current cost and 4000riels), access time to bus stop (max.5min and 10min) and bus fare (1200riels and 2000riels. As shown in **Figure 6**, 56%(299 cases) of respondents would prefer current travel modes rather than using bus (233 cases) in the future while; for case 2 and case 3, around 69% and 61% of respondents preferred current travel modes in the future which were due to the access time from home to bus stop designed in max. 10min.



**Figure 6. Future Travel Modes Preferences and Cases**

The concept of choice set  $C_n$  was defined as respondents who used current private motorized modes excluding travelling on foot. 133 of respondents were considered.

The binary logit model is interacted between two dependent variables; the model was able to assumed the choice set alternative as - 1: for current motorized mode and 2 for bus. Utility functions are considered only for current motorized mode as its simplicity. The alternative specific constant was

defined for current motorized mode choice. It means the Utility for bus is assumed to be zero only in the model output.

**Table 2** summarizes the mode choice model output. The overall model performance was significant. With regard to significance, some of the estimated parameters are significantly different from zero at 95% confident level. The likelihood ratio  $(-2\{LL(0)-LL(\beta)\})$  and  $(-2\{L(c)-LL(\beta)\})$  are much larger than the tabulated of a mode  $\chi^2$  at the 5% level which implies a good fit, and Rho squared was 0.307 suggesting a model is well fit.

The output illustrates that parking cost parameter explained negatively significant effect on current motorized mode use in the future. It was interpreted some drivers tended to prefer bus in case that parking cost per hour increase; as 4000riels was assumed as predicted price in the future in this study. Meanwhile, the bus flat fare limiting to 2000 riels (0.5\$) proposed by JICA and JETRO study was still preferable for Phnom Penh citizens, which was explained insignificant effect to the choice behavior. Regarding the access time to bus stop, individuals tended to prefer private motorized mode if the access time from home to bus stop took longer walking time or he or she tended to use bus if the access time from home to bus took short time; as 5 min was assumed to be short, and 10min was the long time in maximum. On the other hand, the model showed that people who lived outside city center tended to prefer bus for travelling to the city rather than those who stayed in the city center area. Its coefficient showed strong predictor for choice behavior of individual. For the complex tour, it was explained as the significant effect with negative sign on current private mode use. It is interpreted that people preferred bus rather than car while they made the complex tour, which is unusual case. This might be caused by the expected increase of parking fee in the city. However, people who travelled for recreational trips to the public space tended to use their current mode rather than bus.

Regarding travel time, the parameter explained negatively significant which was that the private motorized vehicle users who travel for longer time or distance tend to change from current modes to bus in the near future for their similar trip characteristics. The suggestion of level of parking fee, bus fee and access time to bus stop might be important factor for Phnom Penh transportation planner to consider for polices to reduce private motorized vehicle dependencies from taking bus service development into account.

**Table 2. Mode Choice Estimation Results**

Variables	Parameter	T.Sta.
Constant (current motorized modes)	2.839	<b>4.155</b>
Travel Time (minutes)	-0.138	<b>-7.028</b>
Home location (Dummy: 1 outside, 0 inside the city center)	-1.349	<b>-5.299</b>
Complex tour (Dummy: 1,0)	-0.681	<b>-2.962</b>
Private Vehicle Parking cost (in \$)	-0.003	<b>-3.341</b>
Trip Purpose (Dummy: 1 Recreation, 0 otherwise)	0.529	<b>2.324</b>
Driving license (Dummy: 1,0)	0.286	1.543
Bus fare (in \$)	-0.003	-1.089
Access Time to Bus Stop (minutes)	0.185	<b>4.114</b>
<b>Statistical Output</b>		
No. of Observation		532
No. of Parameter		9
LL(0)		-368.754
LL(c)		-364.649
Log L		-252.341
Rho Squared (0)		0.315
Rho Squared (c)		0.307
Adjust Rho Squared (c)		0.301
Chi Squared		224.617

Bold is significant at the 0.05 level:

## 6. Conclusion

Based on the estimated models, following policies are introduced as:

1. Government shall consider opportunity on Public Park or plaza and shopping mall/market development within 300m-network distance as catchment area for residents in the city center to provide people enough accessibility for recreational and shopping activities respectively. Due to the simulation results, if the availability of park increasing 60% in the city center and shopping mall increasing 40%, the shift from motorized transport to walk trips for recreation and shopping trips shall be around 23% in which 21% would be from motorcycle drivers.

### 2. Bus Service Planning

- Bus fare of 1200riels suggested by JICA for bus fare, and 2000riels suggested by JETRO for Sky Rail would be recommendable for future bus development by year 2020
- Access time from origin to bus stop shall be considered in maximum 5 min as much as possible and the constraint for car parking shall be set through parking charge increase up in

minimum case of 4000riels/hours. Due to the simulation result, if the access time to bus stop decreased 50% along with the increase of 50% of parking cost, the mode shift from motorized transport would be observed around 16%. So bus service preference would share around 60%.

3. Government shall take measure on issuing a clear space of pedestrian zone to increase walking attitude for people through avoiding the obstruction of retail business and other activities on sidewalk, and issuing street cleanliness system to increase a sense of cleaned streets for individual traveling in the city center. Based on the simulation, if increasing 50% of respondents' attitudes on cleaned streets, and increasing 50% of attitude of respondents on a sense of clear pedestrian zone were made, 14% of motorized transports would shift to walk. In addition, the establishments on increasing walking attitudes from how to make citizens do not feel annoyed motorcycle taxi drivers and shy from the look of other people in case they are walking. While decreasing 50% of the said attitudes, around 22% of motorized transport users would shift to walk.

### 4. Enforcement for drivers who are non-license holders

To sum up, the research identified the constraint on how and why individual's perceptions are formed and influenced which could be the important finding before any such physical improvement or interventions are undertaken.

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