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Characteristics of Mode Choice within Mass Transit Catchments Area

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Abstract: Findings from commuter travel survey data that taken from mass transit systems in Bangkok and Manila Mass Transit Systems revealed that those who live and having destination as well in mass transit catchment area are not the regular mass transit users. It is meant that the transit system of the study areas are suffering with limited number of ridership. This paper is trying to exhibit the characteristics of mode choice for traveling that both of origin and destination point are within mass transit area. In doing so, multinomial logit model were developed to explain the regular mode choice of those residing in transit catchment areas. The results reveal that access distance and car availability have crucial influence on the tendency of regular mass transit use. Taken together, the results implied that within acceptable walking distance, increasing the quality of walking environment proves an important strategy that can make walking to station more attractive, thereby inducing modal shift to transit. For longer distance, improving feeder bus service is still indispensable, especially in the case where other access modes are very limited.

Key Words: *mass transit ridership, access distance, mode attributes, multinomial logit model*

1. INTRODUCTION

1.1 Research Background

A major problem faced by mass transit authorities in countries like Thailand and Philippines is that the ridership has failed to meet the forecasted level. The main reasons of the failure include limited rail transit network coverage comparing to road network, competition rather than complementarily with other mode of public transportation (e.g. bus service) in same corridor, and the lack of accessibility for trips from origin to transit station. In order to make mass transit work effectively, transit system should be attractive enough to magnetize a large number of passengers. To solve the problem by rail network expansion is very expensive and takes a long time to implement. Moreover, bus route operational reforms usually receive little attention from policymakers and sometimes need more synchronization among transportation institutions. Therefore, one potential to attract directly as many people as possible by the improvement transit accessibility should be explored more toughly in order to provide a cost-effective and efficient solution.

Studies from advanced countries revealed that factors affecting mass transit ridership can be categorized into four groups: transit level of service, accessibility, land use, and users' characteristics (Zhao *et al.*, 2002). The first group and certain elements of the second group are in the transit operator's domain where the operators have full authorities to enhance the system in order to gain more ridership. Pedestrian accessibility to transit has been long recognized as an important factor in determining ridership. Transit use decreases as walking distance to reach station increases. It was showed that transit ridership declines exponentially with walking distance to the transit stop.

This research gives attention on convenience and comfort issues related to making access trips reach mass transit station. It concentrates on accessibility to mass transit system in order to attract more passengers, especially to attract those who live within mass transit's catchments areas. Focusing on those people might have a great potential to increase overall transit ridership, as had been stated by Oram and Stark (1996). The objective of this research is to propose effective policies station accessibility improvements in order to increase mass transit ridership for selected mass transit systems in developing countries with case of Manila and Bangkok Mass Transit System. The main problem that the research aims to answer is how do accessibility parameters influence the mode shifting to mass transit within the mass transit corridor areas.

The main assumption in this research is that the characteristics of mass transit service such as fare, train headway, train speed and train capacity are the given condition. This assumption leads to the research limitation that although fare discount and service improvement might have role in transit use, their influence is not the main issue that will be addressed by this research. Another important assumption is that, within station coverage area, each individual has free choice to use at least two access modes, with walking as one of them, to reach his or her desired station. Thus, the locations in remote areas where there is a high dependency of car user, for example, are not considered. Also, the elderly and people with disability are not a major concern in this research. Note that, since Metro Manila or Manila Metropolitan covers thirteen cities including the City of Manila, in this research, the name of Manila is associated with Metro Manila.

Station coverage area could be defined as a circular area while radius of 1,000 to 2,000 meters from mass transit station was often used. The maximum walking distance might be used to define the coverage area; however, it varies in many studies. Stringham (1982) used the distance of 1,200 meters while Halden (2000) used 2,000 meters. In GIS application, it is common to use the distance of 800 meters to access mass transit (Hilman, 1997). In the case of Singapore, it was found that to access mass transit stations, about 90% of users were willing to walk the distance shorter than 1,000 (Wibowo, 2005).

1.2 Factors Influencing Transit Ridership

The factors related to transit ridership might be organized into internal and external factors. The internal factors are factors that transit authorities can control and manage such as aspects related to fare system, transit capacity and headway, station amenities, and so on. The external factors, on the other hand, are those that beyond the transit authorities' control such as number of population and employment in station area, land use system, and so on. Socioeconomic characteristics are part of the external factors since the authorities are unable to change or to modify the individual characteristics of the transit users.

In the reality, these two groups of factors could not stand separately. They influence each other. For instance, an increase in the number of population (external factor) in station area may change transit demand, which in turn may change the transit level of service (internal factor). Comparing among internal factors, many studies found that transit riders are more attracted by service improvements rather than fare decreases (Syed and Khan, 2000; Cervero, 2001). Comparing internal and external factors, several researchers found that external factors have stronger impact on ridership than internal factors (Chung, 1997) or incorporated with demographic parameters, such as age, level of education, income, and car ownership (Abdel-Aty, 2001). One key point to make mass transit system work is the system should be attractive enough to attract as many passengers as possible. Lacking of this the transit will suffer losses regardless how good internal or external factors applied.

Other studies indicated that transit ridership increase could be achieved by transportation policies designed to encourage shifting from car to transit, such as parking strategies and expansion of transit network (see Chung, 1997 for example). However, Fouracre *et al.* (2003) found that in the developing cities the majority of beneficiaries of mass transit are likely to be existing public transport users while switching from private car to mass transit is less likely to occur. Most private vehicle users come mainly from high income groups who value very high comfort and convenience of personal transport. Actually, number of ridership can be gained more by persuading people to use transit more often. Oram and Stark (1996) suggested that the infrequent riders are a critical transit market and perhaps the key to build higher transit ridership. This research elaborated the concept of infrequent ridership for mass transit system. Case of mass transit systems of some developing countries was used.

1.3 Accessibility Issues Related to Transit Ridership

Many transit accessibility studies associated to how people with disability access and use transit services. Indeed, the disabilities related to transit accessibility might be in many forms such as financial disability (e.g. cannot afford the transit fare), social disability (e.g. feel unsafe to use transit at night), virtual disability (e.g. unable to access information of the transit service due to language barrier or insufficient information provided), and so on. Since the disability of an individual might differ to others, transit accessibility could come as result of the interaction between transit element and people when they attempt to use it. Apart from disability and elderly issue, transit accessibility can be distinguished into regional and local accessibility. The main concept of the regional transit accessibility is considering the number of opportunities that can be reached within reasonable time (or cost) using transit. This concept can be applied to compare mass transit and other public transportation or between transit and private car for the same pair origin and destination. The deterrence function can be used to express the connection quality that can be derived as the function of travel time or travel cost.

The local transit accessibility is a mode-specific component of regional accessibility, i.e. access to transit. How easy a transit stop to be reached by walking becomes main issue in many studies related to transit accessibility. In the same manner, the number of destinations that can be reached by ten minutes walking from transit stop could be the main issue in egress trip. Walking is the basic and original mode of transportation and it constitutes important component in the transportation system, especially in public transportation. The concept of transit accessibility is therefore associated with a certain threshold of walking distance or walking time. Poor transit accessibility often implies that the distance or the time to walk to reach transit terminal are more than these thresholds. However, various available access modes, as competing mode of walking to access, might have a role as well (see Chalermpong and Wibowo (2007) and Olszewski and Wibowo (2005) for examples). Related to ridership, the transit use might decrease as the distance to reach station increases. Zhao *et al.* (2002) revealed that the transit ridership declined exponentially with walking distance to transit stop.

2. DATA COLLECTION AND PRELIMINARY ANALYSIS

2.1 Data Collection

The main data was collected through the interview survey into two mass transit systems, i.e. Manila and Bangkok Mass Transit System. The purpose of the survey is to collect detailed information about commuter trips related to mass transit use. The survey was focused on residential areas surrounding mass transit stations. Various methods of data collection were carried out depending on the local situation. Mainly, the questionnaire was distributed on not only by door to door home interview survey, but also distributed to travelers in public areas such as mall and CBD areas. To obtain higher response rate, surveyors introduced general description about the survey and the purpose of research and asked respondents to fill out the questionnaires.

The questionnaires in the interview survey were divided into several parts. In the main part, respondents were asked to describe their trips from home to their destination in detail (itinerary trip data). Every mode, including non-motorized mode was asked to be written down. Origin point, destination point, time elapsed and cost for the particular mode was asked to be reported. There were two trip data asked, one is the trip details if using mass transit system and the other is the detail if using other mode for the same pair of origin-destination, i.e. home to office or school (see Table 1 for example).

Table 1 Typical Completed Form for Itinerary Data (Bangkok Data)

Location/Segment		Transport mode/ Others	Total Time Consumed (minutes)	Fare or Out of Pocket (Baht)	Route of Public Transport (Sign Board)
From (Origin)	To (Destination)				
Home	Mo Chit BTS sta	Walking	7	0	
Mo Chit BTS Sta	Siam BTS sta	BTS	11	35	
Siam sta	Rama I road	Walking	4	0	
		Wait for bus	6	0	
Rama I road		Bus	7	12	Bus No. 162
Phayathai road		Walking	3	0	
Total			38 min.	47 Baht	

In Manila, thirteen-nine station areas are surveyed which number of raw observation of 1396. There were twenty-one of them cannot be used because of incomplete or missing data or the destination beyond the study area. In Bangkok, only fourteen station areas were surveyed with raw observation of 344, while 22 of them were rejected.

2.2 Characteristics of Mass Transit Use

Table 2 shows the general characteristics of mass transit use in the study areas. The main mode reported in the table is the mode that respondents usually used to their daily travel. Since the survey was carried out within mass transit coverage areas, it is not surprising that the proportion of mass transit use is the highest. However, as can be seen from the table, the proportion of fixed route transit is higher as well. This finding might indicate the rivalry of mass transit and fixed route transit within the mass transit corridors.

Table 2 Summary of Mass Transit Trip Characteristics

General Trip Characteristic	Proportion of Respondents	
	Bangkok (n = 322)	**Manila (n = 1375)**
Main mode: mass transit	45.3%	44.7%
car (drive or car share)	17.4%	9.0%
fixed route transit (e.g. bus)	34.8%	44.5%
for-hired transit (e.g. taxi)	2.5%	1.8%
Trip purpose: work	83.5%	56.1%
education	16.5%	36.5%
others	n.a.	7.4%
Frequency of mass transit use:		
never use (within a week)	28.4%	24.0%
occasional (only once a week)	12.9%	20.4%
frequent (2 -3 times a week)	22.4%	16.2%
regular (more than 3 times)	36.3%	39.4%
Mass transit line	BTS: 58.7% MRT: 41.3%	LRT1: 43.6% LRT2: 28.9% MRT3: 27.5%

Besides that, it is shown in the table that the frequency of mass transit use varies from very rare (only once a week) to almost every workday. More than 40% of respondents were those who rare or occasionally use mass transit. Therefore, it seems that mass transit systems in the study areas are less effective and suffer high proportion of infrequent transit users. These results reveal as well that the effective strategies to gain more transit ridership should be aimed at infrequent users group who live within transit coverage areas.

2.3 Characteristics of Access Trip and Access Distance

There is various access modes recorded in the data survey of the study areas as shown in Figure 1. Note that for Bangkok, the data of Netipunya (2006) were used. Access mode of car comprises park and ride as well as drop off. In Bangkok, the access mode of *tuk-tuk* is a tricycle taxi while *songtaew* is covered pick-up truck and operates as paratransit. Motorcycle is classified as taxi because it is for-hired motorcycle.

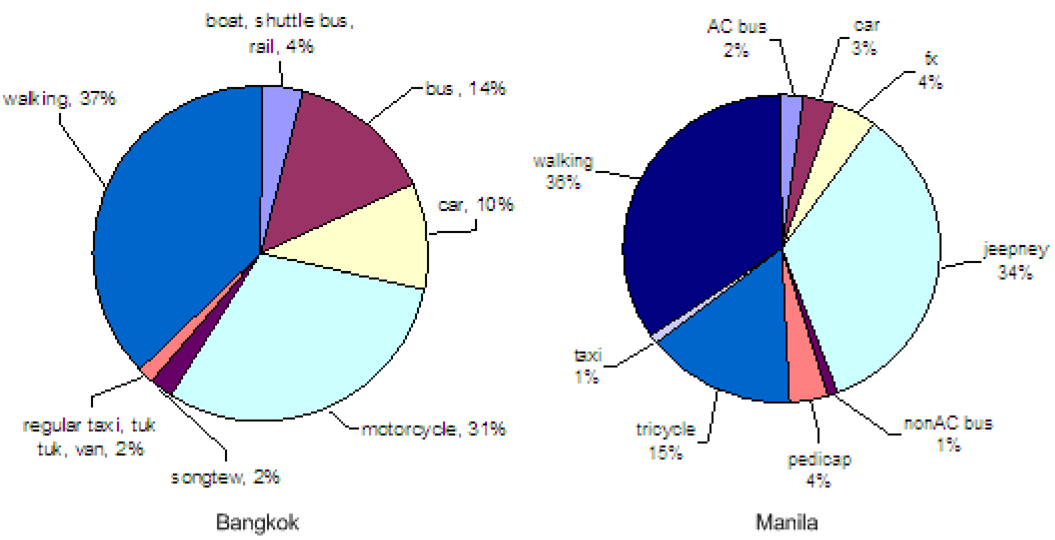

Figure 1 Access Mode Share in the Study Areas

In both of study areas, walking is a dominant mode to access station. In Bangkok, the second dominant access mode is motorcycle taxi. Despite the safety issues, this mode has highest maneuver ability in congested areas. It can take shorter route through narrow streets or even running on sidewalk to avoid traffic congestion. In Manila, since *jeepney* dominates public transportation system, it was not surprising that mode was the major access mode.

Revealing from data analysis, the proportion of walking to access station will decrease as the distance to station increases and, on the other hand, the proportion of non-walking access modes increase (see Figure 2). In Bangkok, motorcycle taxi is preferable among others. The proportion of using car is relatively high in Manila although there are limited car parks provided in station areas. This finding might indicate high proportion of car sharing or drop off by car. It was revealed as well that less than 10% of respondents walk longer than 1000 meters and none over than 2000 meters to reach station. Since the research focuses on mode selection in mass transit corridors, only observations with access distance equal or less than 2000 meters were used. Consequently, there were 1071 and 238 observations was used for case of Manila and Bangkok, respectively.

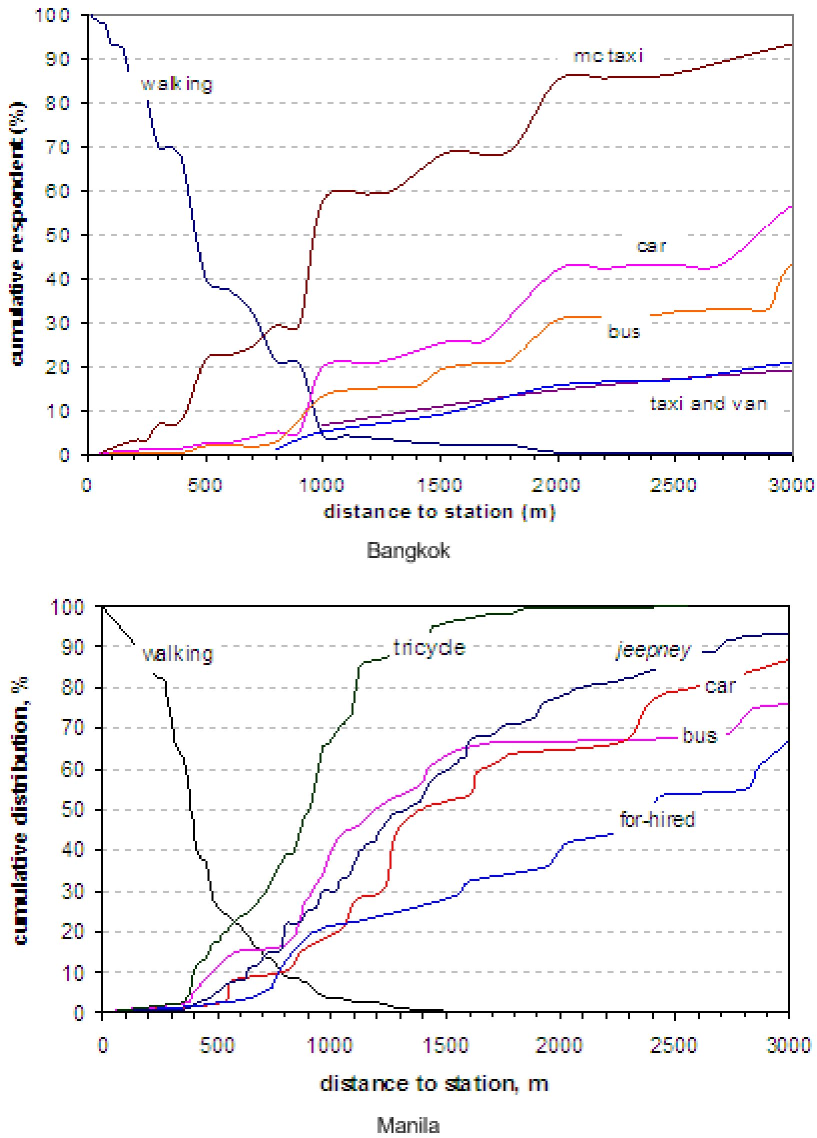

Figure 2 Relationship between Access Mode and Distance to Station

3. MODEL DEVELOPMENT AND DISCUSSION

3.1 Alternative Modes

Within mass transit corridor under study, besides mass transit and private car, there are many alternative modes can be used to travel from home to destination (i.e. workplace or school). According to the survey results, there are many alternative modes reported. However, based on station area surveyed, it was found that some stations have small numbers of observation for particular alternatives and others do not have. Therefore, to have fair proportion, the alternative modes then were classified into four groups, namely, mass transit (group name of rail); private vehicle (car); fixed route transit (fix); and for-hired transit (hire). The description of alternative modes in the model can be seen in the table below.

Note that the alternative of private car is available only for those who own car or living in car owning households or those with option of car-sharing is available. In model development, the alternative of private car was applied to only those who have car availability. Among all observations, only 24.2% of all respondents had car available for use in Manila and about 46.7% in Bangkok.

Table 3 Summary of Alternative Modes in Study Areas

Group of Mode (variable name)	Manila	Bangkok
Mass Transit (rail)	LRT1; LRT2; MRT3	BTS; MRT
Private Vehicle (car)	Mostly are private car.	Mostly are private car.
Fixed Route Transit (fix)	• *Public bus*. Air-conditioned and non-air-conditioned. Most of the buses are operated by private companies. • *Jeepney*. Dominant public transportation in Manila. It has capacity of 12 to 14 passengers and it is provided by private operators. • *Fx*. The Asian Utility Vehicle (AUV) or Megataxi is air-conditioned van with capacity of 10 passengers.	• *Public bus*. Air-conditioned and non-air-conditioned. Some articulated buses are provided by the Bangkok Mass Transit Authority (BMTA). • Songtaew. This is a modified pickup truck with capacity of 10 to 12 passengers. It has operates like paratransit. • *Boat*. A bus-water that operates in waterway network in Bangkok area. The capacity varies depend on its size and route.
For-Hired Transit (hire)	• *Regular taxi*. Most taxis are air-conditioned and metered.	• *Van*. Air-conditioned van with capacity of 12 to 14 passengers. Mostly connected suburban area to CBD areas. • *Regular taxi*. Most taxis are air-conditioned and metered. • *Tuk-tuk*. A tricycle-motor taxi with capacity normal of 2 to 4 passengers.

3.2 Mode Attributes for Non-Chosen Modes

One problem that might appear in mode choice model is how to determine the mode attributes for non-chosen modes. The detailed itinerary trip data were expected to consist of detailed information of respondents' trip using mass transit and trip using non-mass transit mode for the same pair origin and destination. From the survey results, only approximately half of respondents gave complete information for both modes. Besides that, the mode choice model was planned to consider three to four available modes. Thus, the additional information of other alternatives that were not reported by respondents is needed.

In such case, the best approach to have information of each alternative is to gather the information directly from the respondents. However, this is not always possible. By assumption that information on the attribute level of all alternatives within the choice set are available at the aggregate level, Hensher *et al*. (2005) suggested four possible solutions. In this research, one of their proposed solutions was used, i.e. synthesizing data by combining other information and average value of alternative's attribute. The procedure of data generation that used in this research can be explained as follow.

In the interview survey, respondents were asked to notify their address and their destination area. Respondents reported as well their station or their nearest possible station where the distance between home and station (namely as access distance) and also between station and their main destination (namely as egress distance) can be calculated. While respondents who walked to reach mass transit station reported their access time, the average walking speed can be determined. This speed was then used to determine access time for those who has the non-chosen mode is mass transit whereas it was assumed that walking is access and egress mode. Table 4 shows how to generate data for non-chosen alternative. According to the table, for instance, the total travel time for traveling using mass transit would be summation of access time, haul time, and egress time.

Table 4 Generation of Time and Cost Variable for Non-Chosen Alternative

Trip	**Assumption Mode**	**Generating Data For Time**	**Generating Data For Cost**
Access	Walking	acc_dist / walking_speed	0
Egress	Walking	egr_dist / walking_speed	0
Rail	Mass Transit	sta_dist / rail_speed	rail_fare (calculated)
Private car	Car	OD_dist / car_speed	OD_dist*average_cost (per_km)
Fixed route transit	Jeepney (Manila) Bus (Bangkok)	OD_dist / jeepney_speed	Fare structure of jeepney (or bus)
For-hired transit	Taxi	OD_dist / taxi_speed	Fare structure of taxi

Note:
acc_dist: distance between home to station, measured.
egr_dist: distance between station to destination, measured.
sta_dist: distance between origin station and destination station, measured.
OD_dist: distance between home to destination within mass transit corridor

To validate the generated value, the set of origin and destination pairs were randomly selected from the data set. Since the study areas were within the mass transit corridor, pairing was based on origin and destination stations. Therefore, for Manila data set, 180 observations from the nine pairs of station origin and station were selected. A student test or *t-test* was carried out to reject the null hypothesis that average value of actual time and cost was equal to the average from the generated data for the same pair origin and destination. For example, Table 4 shows the *t-test* results of average travel time of the mode group of fixed-route transit (*Jeepneys* for the case of Manila). The variable of *fixtime* refers to the average total travel time of fixed-route transit from actual data (reported by respondents) and the variable of *tfix* is associated to the average total travel time from generated data. It can be seen in the table that the null hypothesis of *fixtime* is equal to *tfix* cannot be rejected at the significance level of 5%. Therefore, it could be said that the generated value can be accepted statistically to complete the information of the non-chosen alternative.

Table 5 The Student's t-test to Evaluate Time of Fixed-Route Transit

Two-sample t test with unequal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
fixtime	95	52.15789	3.041789	29.64769	46.11835	58.19744
tfix	180	57.966	2.308298	30.96907	53.41103	62.52098
combined	275	55.95957	1.844658	30.59019	52.32806	59.59107
diff		-5.808109	3.870442		-13.42782	1.811599

Degree of freedom: 273

Ho: mean(fixtime) – mean(tfix) = diff = 0

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
t = -1.5006	t = -1.5006	t = -1.5006
P < t = 0.0673	P > |t| = 0.1346	P > t = 0.9327

3.3 Model Development

3.3.1 Data Format

The statistical software of NLOGIT 3.0 was used to develop the mode choice model. The data setup for this software is somewhat unique with some similarity with the panel data format. Unlike other statistical package that presents each row of data as an independent observation, NLOGIT needs to assign several rows to represent a single observation. In other words, in NLOGIT, each row of data is strictly not independent from each other. To illustrate, Table 6 shows the data format that is ready to be imported to NLOGIT data input.

Table 6 Data Format for Model Development

id	altij	cset	choice	ttime	tcost	acdist
1	1	3	1	69.18893	14	1280
1	3	3	0	125.413	22.87	1280
1	4	3	0	77.25158	178.94	1280
2	1	3	0	19.79479	12	720
2	3	3	1	25.39932	30	720
2	4	3	0	15.64541	56.84	720
5	1	4	0	36.41084	24	960
5	2	4	1	40	15	960
5	3	4	0	40	15	960
5	4	4	0	32.03924	89.33	960
6	1	4	0	23.46906	13	560
6	2	4	1	20	50	560
6	3	4	0	35.56314	9.71	560
6	4	4	0	21.9061	69.25	560

The table presents a data set of four individuals and it is shaded to represent a choice set of everyone. Each row within a block corresponds to an alternative within the available choice set. There were not all individuals have the same choice set. As can be seen in the table, the first two individuals have only three alternatives while the last two have four alternatives.

The *id* variable is the label for an individual, as id = 1 indicates first individual, id = 2 for the second, and so on. The variable of *altij* is an index that informs NLOGIT which line of data corresponds to which alternative mode. The four alternatives are labeled as number 1 to 4 while the altij = 1 stand for alternative of mass transit, altij = 2 for car, and so forth. The variable of *cset* is number to inform NLOGIT of the number of alternative within a particular choice set. For those who have car availability the number of choice (cset) is equal to four while for those who do not have, it is equal to three.

The *choice* variable indicates which alternative within the choice set was chosen. The number 1 denotes that an alternative was selected while the number 0 denotes that it was not. Thus, the sum of the choice variable should be equal to 1 for each individual. The variables of *ttime* and *tcost* are specific to each alternative and the value varies among alternatives. The variable of access distance (acdist) is specific to individual and the value is constant for each block.

3.3.2 Mode Choice Model

The multinomial logit (MNL) model was developed with four alternative modes in the choice set while some respondents having partial choice set. The alternative of private car was only for those with car availability. The models were estimated using data with mode-attributes specific in addition to individual-specific characteristics to explain the mode selection. Note that this MNL model is also known as *conditional logit model* or *categorical logit model*. Table 7 shows the estimation results of the mode choice model. Model 1 and Model 2 is represented mode choice model of Manila and Bangkok, respectively.

The alternative mode of for-hired transit is the base alternative, whose coefficient is therefore not estimated. Negative sign of the estimated coefficient implies that the probability of the alternative being chosen would be decreased as the value of related variable increase. For instance, all coefficients estimate of time and cost have negative sign that indicates the mode alternative become less attractive to be chosen as the total travel time or total travel cost increase, *ceteris paribus*.

In the case of Manila, by examining the constant term, after controlling for all other factors, it is revealed that the probability of private car to be chosen has the highest level while the probability of for-hired transit (i.e. taxi) has the lowest. This finding implies to the order of preference of modes in the study areas, i.e. car, mass transit, fixed-route transit (bus, jeepney and fx), and taxi (for-hired transit). In addition, since alternative of car has the highest coefficient value and the alternative was available to only those who has access to use a car, the results confirm that mass transit mode is less attractive to car users and mode shifting to mass transit might be less even they lived within station coverage area. Fillone (2005) found as well those who has car availability considered that mode of private car was the most preferable mode to travel within Manila while taxi is the least level. The author claimed that lowest level of using taxi was caused by its cost that was relatively high among other public transport modes.

One of the important finding in the model results is that the coefficient estimated of access distance has negative sign for mass transit mode and positive for the others. It means that probability of mass transit being chosen decreases as the distance increases. On the other hand, the probability of using non-mass transit mode increases as the distance increases. Most of car users might value highly the convenience aspect in using mass transit comparing to using car.

Longer distance to access is related to inconvenience where more effort is needed to reach mass transit station. As a result, those who has car availability would keep use a car rather than shifting to mass transit as the distance to station increase significantly. This type of respondents valued alternative of car as the highest among other modes and they are less likely to use mass transit. This finding agrees with the result of survey that the main reason of not using mass transit is because having a car that is available for the trip. Model result shows as well that non-car availability respondents would give similar response as the access to station increase. However, the response might not as much as the group of car availability did.

Table 7 MNL Models with Attributes Specific

Parameters	Model 1: Manila	Model 2: Bangkok
	Coefficient (t-value)	
Mass transit		
Total travel time (minutes)	-0.0618 (-7.22)**	-0.1237 (-1.72)*
Total travel cost (PHP or THB)	-0.0295 (-2.97)**	-0.0801 (-1.29)
Private car		
Total travel time (minutes)	-0.062 (-4.02)**	-0.1163 (-1.15)
Total travel cost (PHP or THB)	-0.0265 (-4.8)**	-0.3099 (-1.81)*
Fixed route transit		
Total travel time (minutes)	-0.0743 (-14.15)**	-0.1116 (-0.21)
Total travel cost (PHP or THB)	-0.0431 (-3.53)**	-0.0473 (-1.75)*
For-hired transit		
Total travel time (minutes)	-0.0675 (-5.46)**	
Total travel cost (PHP or THB)	-0.045 (-7.04)**	
Access distance (meters)		
Mass transit	-0.0017 (-3.74)**	-0.0048 (-1.82)*
Private car	0.0018 (1.73)*	0.0012 (1.36)
Fixed route transit	0.0013 (1.71)*	
Constant		
Mass transit	1.5762 (2.92)**	1.1712 (1.74)*
Private car	2.4415 (3.89)**	0.7401 (1.6)
Fixed route transit	1.303 (1.65)*	
Parameters of Statistics		
Log-likelihood at zero	-1484.7213	-261.4697
Log-likelihood at constants	-921.6390	-169.7189
Log-likelihood at convergence	-679.1669	-117.3223
Rho squared w.r.t. zero	0.5426	0.5513
Rho squared w.r.t. constants	0.2631	0.3087
%-correct prediction	61.8%	73.5%
No. of observation	1071	238

notes:

** significance at the level of 5%; * significance at the level of 10%

PHP: Philippine Peso (Manila); THB: Thailand Baht (Bangkok)

As can be seen in the table, mode choice model of Bangkok seems not as good as Manila data. Due to limited number of observation for some station areas surveyed and limited number of alternative mode, the model for Bangkok data was used only three alternatives since variable of for-hired transit was discarded and used fixed-route transit as the base alternative. Similar to Manila, the mode of private car was available only to those who have access to use a car (drive alone or drop off).

Despite to the statistical significance and less number of alternative mode, model result of Bangkok data come out in the same way to those from Manila data. Coefficient estimated of time and cost has negative sign for all alternatives. Access distance has negative sign for mass transit mode and positive sign for non-mass transit mode, i.e. private car and fixed-route transit. The magnitude of coefficient estimated of access distance from the Bangkok data is relatively bigger that from Manila data. It might be said that car owners in Bangkok are more sensitive than their companion in Manila.

3.4 Discussion

The objective of the development of mode choice model is to understand how to persuade potential users to use mass transit more often, particularly to those who lived within station coverage area. The role of access distance in shifting of their modes to mass transit is the concern. Wibowo (2008) found that parameters of socioeconomic were somehow influencing the mode selection. However, in this paper, the model was developed with focusing on mode attributes specific and transit accessibility only.

Due to the data characteristics, the mode choice model of Manila and Bangkok data are slightly different. In the case of Bangkok, the mode alternatives include mass transit, car, and bus while in the Manila case the alternatives include mass transit, car, fixed-route transit (bus, jeepney, and fx), and for-hired transit (i.e. taxi). In both of the study areas, the alternative of car is available only to those with car availability. Despite the model form, both models reveals similar results related to factors affecting mode choice behavior and mode preferences. From the model of both of the study areas, it is revealed that time, cost, and distance to station have roles to attract people shifting their travel mode to mass transit. The time in the model was associated with the total travel time while the cost is referred to the total of out-of-pocket cost.

The interpretations of the constant terms in the model imply that those who have car available are most likely to use their car as compare to mass transit. However, as found in the case of Bangkok, the mass transit mode is slightly preferred to car even when a car is available. It is probably due to mass transit's advantage in the term of time saving for the pair of origin-destination within mass transit corridors.

As seen in Table 7, it is revealed that the magnitude of the absolute value of the total travel time for mass transit is higher than the total travel cost for both of study areas. It might be shown that mass transit demand is inelastic with respect to time rather than cost. This finding indicates that reduction of travel time will give greater effect rather than to travel cost in order to increase mass transit ridership.

In both of the study areas, the distance between home and transit station has negative effect on the probability of choosing mass transit. Since the data used for model estimation were defined within the distance of 2000 meters where many access modes, foremost walking, are available this result highlights the impact of walking access on transit ridership. Most of other variables reflecting transit accessibility revealed insignificant effect on choice probabilities. It was conjectured that the insignificant results of the effect accessibility variables may be due to the lack of variability in the observed value of variables.

4. CONCLUSION

Although the final mode choice models estimated for Bangkok and Manila are slightly different, both models revealed similar pattern related to factors affecting to mode shifting and mode preferences. The results suggest that time, cost, and distance to the station have significant influence in persuading people to shift their mode to mass transit. Like in many transit studies, models results revealed that car availability has negative effect to the tendency of transit use. Also, the demand elasticity of mass transit from the models of study areas appeared similar. Transit demand is inelastic with respect to both time and cost, with the latter relatively more inelastic. Thus, the improvement related to travel time will give greater effect than improvement related to cost. Improvement on distance to access station could be seen as improvement on travel time using mass transit. The distance to access station can be seen virtually as the effort to reach mass transit. Hence, increasing the convenience aspects on the way to station (such as providing shelter or better footpath) should improve the transit accessibility although the actual distance is remain. By doing so, mass transit would be more attractive to gain more ridership.

Since the model was developed for area where the walking to access is possible, the walking accessibility model can be developed in order to evaluate factors affecting on the propensity to walk to reach station. Among other variables, it is revealed that access distance has a key role in all models that were developed in this research. Access distance and car availability have roles to induce people to use mass transit. Within acceptance walking distance, increasing the quality of walking environment could be an important strategy to make walking to reach station become an attractive way and to have more mass transit users. For longer access distance, improvement strategy can be carried out by adding more feeder mode to access station. Evidence from some literatures and as well found in this research, revealed that mass transit system is less attractive for those who have car available. Providing parking garage in station area could increase mass transit attractiveness for car users group. It could be combined with providing exclusive shuttle bus to connect between high-income residential area and station.

The study was carried out on limited number of station areas at two mass transit systems from two cities in developing countries. The research finding could not mirror all real condition of mass transit systems in developing countries. However, the findings are able to present some observable facts that might be useful in giving more understanding how to make mass transit work. It might be a typical in developing countries that mass transit improvements have beneficiary for the existing public transportation users rather than to private car users. Thus, the improvement strategies to persuade transit captive users shifting to mass transit or using mass transit more often should give significant effect on ridership rather than spending too much resource to convince private car users shift to mass transit. Taking into account this fact, further studies can be carried out such as using market segmentation approach to increase mass transit ridership, and so on.

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