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RESIDENTIAL LOCATION CHOICE ANALYSIS ALONG THE URBAN RAILWAY CORRIDOR IN BANGKOK, THAILAND

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ABSTRACT

It has long been recognized that transport accessibility has a large impact on residential location choice decision; however, these effects have rarely been quantified, particularly in developing country. This paper evaluates how households consider transport characteristics in their residential location decisions with regard to new urban railway system opened in December 1999 in Bangkok, Thailand. Specifically, our goal is to make an extensive analysis for assessing the extent to which transport and other factors impact on the location decision-making. The data for this paper is obtained from household activity survey. The discrete choice model in the context of multinomial logit model is then applied to explore what factors are more significantly effective on their decision of house location. For the case of Bangkok, there are various factors especially household characteristic attributes and transport related attributes influencing households on making decision. Among these typical factors, rather than transport factors, the socio-demographic status particularly income and workplace location is found to play a significant role in explaining the location decision of people.

Keywords: Residential location choice, Mode choice, Urban railway, Multinomial logit model, Bangkok

INTRODUCTION

The importance of transportation accessibility in explaining the residential choice is well known. Changes in accessibility are likely to influence the relative attractiveness of a location. Given that residential land use occupies about two thirds of all urban land, and that home-based trips account for a large proportion of all travel, residential location is one of the most important household long-term choice decisions (Harris, 1996; Guo and Baht, 2002). Therefore, a renewed emphasis on location decisions is critical to examining the importance of accessibility for transportation and land development (Cho et al., 2008).

Much of the previous research has assumed that commuting time and cost are endogenous to people's decisions about where to live and work (Abraham and Hunt 1997; Levine 1998; Clark et al., 2003). Formal economic was based on the intuitive concept that the residential location choices of individuals are based on a trade-off between the increasing costs of commuting to work and the decreasing unit prices of housing and land that are associated with living further out from a central area of employment (Alonso, 1964; Mills, 1972; Muth, 1969 and Lerman et al., 1980). It could be assumed that, according to this theory, the poorest houses will be on the very outskirts of the city, as that is the only place that they can afford to occupy. However, in modern times this is rarely the case, as many people prefer to trade off the accessibility of being close to the CBD, and move to the edges of the settlement, where it is possible to buy more land for the same amount of money (as Bid Rent states). Likewise, lower income housing trades off greater living space for greater accessibility to employment. For this reason low income housing in many North American cities, for example, is often found in the inner city, and high income housing is at the edges of the settlement (Lerman et al., 1980).

Similarly, the bid-rent theories offer explanations of the apparent paradox that in Bangkok city, Thailand. Empirically, it seems like low-income households tend to locate on high-priced urban land to save their travel cost and time, while higher-income households choose suburban locations where land is cheaper. The explanation lies in the relative preference of high-income households for large residential lots and their greater willingness to pay for transportation over long distances to and from work (Lerman et al., 1980). However, these trends have been continually changing; the middle and high income have been moving back to inner area since the 47 km of rail transit system namely BTS and MRT began operation in 1999 and 2004 respectively. The introduction of the two rail networks is believed to have significantly changed in the both urban land development as well as the resident behaviours since the decade of its operation. The urban railway system has been the alternatives for residents those living near these mass transit routes to daily commute to workplaces and avoid heavy congestion (Sirikolkarn, 2008). Consequently, proximity to the railway systems is now one of the major concerns when resident choose the location to live as people value their time and cost saving from commuting to their workplaces.

As the mechanism of household location decision-making plays an important part in the urban and transportation planning, it is worthwhile to study what makes people select their house location. Substantive work is questioning the level of significance that transport context plays in residential location and supporting individual characteristics as the main factor in explaining their selection. For the case of Bangkok city, although no direct study was made with respect to home location choice preferences, it seems like the accessibility by the

urban railway have been becoming one factor for Bangkok resident to select their house location. However, the extent to which transportation accessibility can be a main determinant of residential location choice decision is still not well understood. Therefore, this study originally aims to examine factors influencing on housing choices decision. In particular, we will try to investigate how much the transportation factors play a significant role in determining where people choose to live compared with socioeconomic and demographic factors in disaggregate manner.

THE PROSPECT OF TRANSPORTATION AND RESIDENTAIL DEVELOPMENT IN BANGKOK

Bangkok Metropolitan Region (BMR) area comprises of Bangkok Metropolitan Area (BMA) and its five adjacent provinces. BMR covers 7,758 sq km. The total population of BMR in 2011 was 12 million, or 15.5% of the total population of Thailand. In 2011 metropolitan Bangkok had well over 11 million inhabitants resulting in a density of 6,377 persons/sq km and persistence of severe transportation problems. Recently, two rail transit systems known as BTS and MRT was first operated with route covering the central business district and inner city area in 1999 and 2004 respectively. The former is elevated rail system comprising two main lines with the total of 23.5 kilometers, 24 stations and the latter is the subway line on the 20 kilometer-service length with 20 stations. Moreover, network extension plans are in the process of being implemented.

The BTS was built in the middle of some of the city's most congested and highest rent arterial roads. These include Silom Road, the backbone of one of Bangkok's Central Business Districts, and Sukhumvit Road, lined with hotels, shopping centers, and high-priced condominiums. In 2009, the total downtown condominium supply reached 58,006 units, increasing 1,737 units or 3% from the previous year. It is expected that the greater the land development along the BTS route, the greater the number of potential users of the BTS. Traffic condition along this transit line is being improved as people are changing mode to travel by the transit instead of driving private car in the congested traffic under the BTS structure (Vichiensan et al.2007).

The previous study revealed that the area along the 5.5-km eastern section of BTS, from Asoke station to On-nut station has undergone rapid development as can be seen by the increased number of office building, high-rise condominium, large retail store and shopping complex. Additionally, the BTS impact study showed that the station surrounding areas have very large potential for development whereas the farther area gains benefit by improved accessibility. As seen from figure 1, the residential high-rise buildings have been mushrooming along the two urban railway corridors.

The attractiveness of the location along the transit corridors encourages the development of residential land use as shown in Figure 2. According to the Bangkok Metropolitan Administration, more than 500,000 single trips are made daily (Sirikolkarn, 2008). Both BTS and MRT have been the alternatives for residents those living near these mass transit routes to daily commute to workplaces and avoid heavy congestion. Consequently, proximity to the BTS and MRT systems is now one of the major concerns when buying residential properties as people value their time and cost saving from commuting to their workplaces.

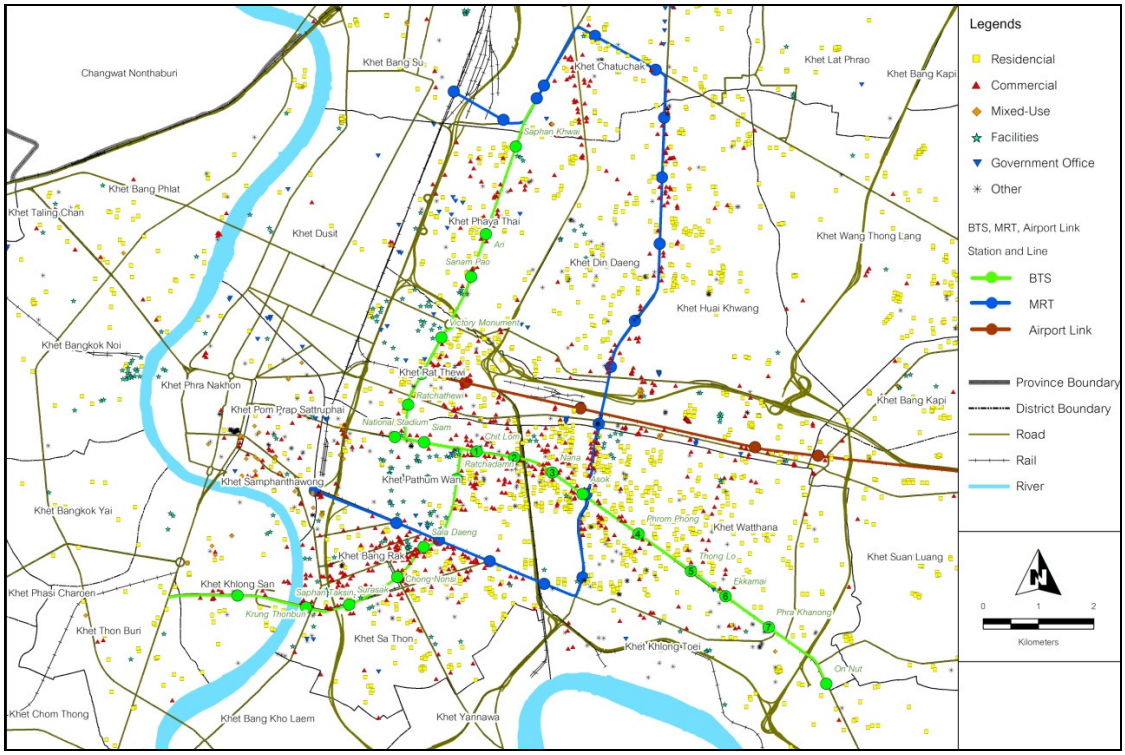
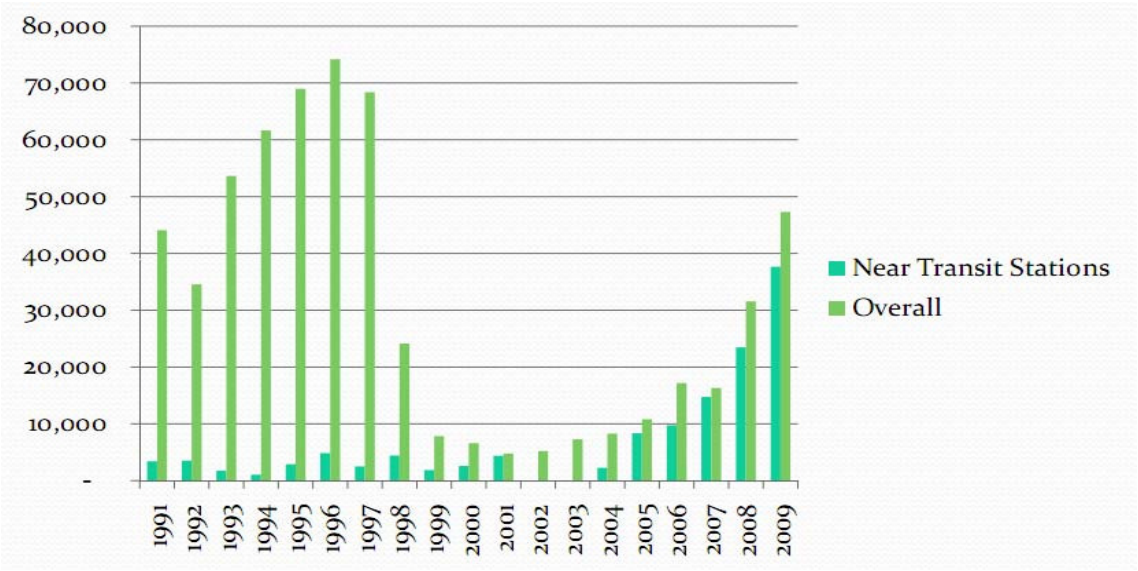


Figure 1 – The Distribution of High-rise Building along the Rail Transit Lines



Source: Chalermpong (2011)

Figure 2 – New Condominium Units within 1000m of Transit Stations comparing to overall area in Bangkok

THE REVIEW OF RESIDENTIAL LOCATION CHOICE ANALYSIS

The choice of residence of households generally involves trade-offs among several factors which give the household the highest possible utility. Fundamentally, consumers make personal choices regarding residential density and location based on a series of housing, neighbourhood, job, and transportation tradeoffs. Over the past decade, it has become increasingly clear that transportation is only one element of what has been termed the total

activity system in which each household is involved. The previous research hypothesized that aside from house characteristics, the relative travel times and ease of access provided by roads and public transport systems present in a particular area contributes to the location's degree of attractiveness. The main determinants were included monthly house rent, travel time to work and proximity to rail. The study concluded that there exist two types of households when choosing a residential location: first, are those households that use public transport and believe that public transport influences the quality of the residential location while the second type are households who do not intend to use public transport and consider the degree of attractiveness of public transport insignificant to the location (Hunt et al., 1994; Rivera, 2005).

Besides transportation accessibility, however, there is a variety of other residential location attributes that may affect the housing and location choices of households. These may include the socio-demographic characteristics of householder such as age, household size and income or the characteristics of housing such as racial composition of neighbourhoods, residential density and the size, quality, condition, and price of the housing stock (Lerman et al., 1980). Many previous studies have examined the impact of socio-economic factors and the level of public services on the actual location decisions of households. These studies provide evidence for several conclusions(Mayo,1973; Friedman, 1975; Lerman, 1975 and Pollakowski, 1975); (1) The levels of community expenditures on police, fire, education, and recreation services are less important factors in location choice for most households than is transportation accessibility to work, (2) The effect of transportation access on location choice decisions is overshadowed by household income and size considerations, and (3) Household auto ownership level decisions are related to residential location decisions (Rivera, 2005).

THEORETICAL BASIS OF THE MODEL

Data Collection

In this paper, we analyse the household travel survey data to assess the factors affecting the selection of residential location. Data was obtained from the household travel survey of Bangkok conducted in December 2008 by Team Logistic and Transportation Consultant Company, providing information on the purpose, mode, origins and destinations, and other features of the journey. The respondents of 10,340 randomly selected households in a whole Bangkok city Area is used for the Bangkok Transport Development Project.

We focused solely on journeys to work since classic location theory holds workers trade-off commuting and housing costs when choosing a residential location (Alonso, 1964). The survey questionnaire addressed socioeconomic variables and individual travel patterns. Data available for each household includes the location of home and workplace, car ownership, the household's size and income, and the mode of travel to work, travel cost as well as travel time. The total of 600 household samples was extracted according to model requirements of:

1) single-worker households
2) households that moved after the BTS operation in 1999.

From table 1, it summarizes the characteristics of household chosen as the samplings of this study. There are two location choices divided by the proximity to the railway; near and far

from the BTS line, namely BTS resident and non-resident. Following the TOD framework, the former means the house locating within 1 kilometer along the railway corridor; the latter is those locating in distance between 1-2 kilometers of the transit line. Most of the BTS residents those living near the railway within 1 kilometre are high income, car owner, single-person household and the householders those working near BTS corridor. Likewise, we define the each worker's job location as same as the house location.

Table 1 – Summary of samplings' socio-economic characteristics

		Near BTS (%)	**Far BTS (%)**
Income group	Low income	6.43	10.52
	Middle income	23.29	23.09
	High income	70.28	66.40
Car ownership	No	23.69	14.36
	Yes	94.38	85.64
Single family	No	94.38	87.75
	Yes	5.62	12.25
Workplace near BTS	No	39.36	86.12
	Yes	60.64	17.51
BTS passenger	No	69.88	95.49
	Yes	30.12	4.51

This study then creates to model utilizing random-utility theory in order to characterize the choice of home and travel mode of resident. Hence, multinomial choice model is adopted to assess to what extent the residential location choice behaviour can be explained by the socioeconomic characteristics and transportation variables.

The Identification of Variables

In deciding which variables that are known and likely to influence the choices being modelled, it is necessary to take account of the behavioural and mathematical structure of the model, the intended use of model, and the data that are available for applying the model. Probabilistic models generally and logit models in particular make it possible to develop useful choice models that do not include all variables that influence the choice being modelled. This does not imply, however, there are certain types of variables that must be included to obtain a useful model (Handson, 1995). Since the first aim of this survey was conducted to examine the existing travel behaviour of Bangkok's residents for urban model development, for this paper, there is a data set compatible with discrete choice models in the context of multinomial choice. Under limitation of data set, there are two set of variables using in this paper; transportation and household characteristics variables. The former indicates the cost and time in travelling from home to work as many research has also assumed that travel time and cost are endogenous to people's decisions on house location. The latter measures attributes of household affecting residential decision i.e. income, single-person family and car ownership. From the previous study on travel behavior in this city, the income groups are categorized into three groups that are (1) low income – those who earn less than THB 10,000 a month, (2) middle income- those whose income are THB 10,000-

20,000 and (3) high income-those who obtained revenue more than THB 20,000 (Tangphaisankun, 2010).

The Proposed Model

The analysis of residential location choice at the household level was largely enabled by the development of discrete choice modelling methods. The early applications by Lerman (1976) and McFadden (1978) on this subject paved the way for a generation of research on identifying different contributing factors and making connections with travel-related behaviours. Much of this work is centered on the utility maximization concept where housing choice is represented as a bundle of other associated choices. An advantage of the discrete choice approach is that it is based on microeconomic random utility theory, which states that households trade-off different location attributes when choosing their location that maximizes their utility (Sermons and Koppelman, 2001; Rivera, 2005).

Suppose the BTS railway affects on the residents to select their house location, there are two location choices divided by the proximity to the railway; near and far the BTS line. As mentioned above, the house locating within 1 kilometer and between 1-2 kilometers along the railway corridor are defined as living near and far the BTS respectively. Also only two alternative modes; BTS and other modes are used. Therefore, the alternative that integrates the choice of residential location and travel mode is divided into 4 broad categories i.e. 1) near the transit line and use the BTS, 2) near the transit line and do not use the BTS, 3) far from the transit line and use the BTS and 4) far from the transit line and do not use the BTS.

The multinomial logit (MNL) formulation is only one of a family of discrete choice models but it has been, and still is, widely used in practice and research. In the analysis, each household is assumed to select the alternative location which maximizes its utility. This utility is expressed as a function of attributes of the alternative and the attributes of the household itself. The coefficients of this function are statistically inferred from the actual decisions made by households (Lerman, 1980). They are estimated by fitting the data to the model. The Maximum Likelihood Estimation method is the fitting technique commonly used in practice.

The probability of a household *h* choose the i^{th} of the available alternatives is given by

$$P(ih) = \frac{\exp^{V_{(Zih)}}}{\sum_{j=1}^{J} \exp^{V_{(Zih)}}}$$

The function V is specified as

$$V = \beta_0 + \beta_1 X_{\text{travel time}} + \beta_2 X_{\text{travel cost}} + \beta_3 X_{\text{income}} + \beta_4 X_{\text{car ownership}} + \beta_5 X_{\text{single person family}} + \beta_6 X_{\text{workplace location}}$$

Where β_0 = constant
β_i = coefficient of X_i

RESIDENTIAL LOCATION CHOICE MECHANISM ANALYSIS

The empirical results of past studies on residential location choice have varied from place to place. However, the residential location study in Bangkok is still rare. Based on the limitation of available data, we try to initially understand Bangkok residents' decision-making mechanism on their house location, in particularly, since the urban railway system was introduced as the new urban transportation mode for urban resident. Among the typical variables on location choice analysis, the accessibility by new transit mode, the BTS, could be considered as one factor influencing on their decision where to live.

The Framework of Residential Location Choice Analysis in Bangkok

The choices of residential location are enormous complex to realize. The definition of the term "residential location" could sensibly refer to the exact house or apartment that a household chooses. This study attempts to further concentrate on linking residential location with different modes and other travel choice behaviours. Much of research made significant on the interplay between residence location and mode choice selection (Eliasson and Mattsson 2000; Krizek 2006; Pinjari et al., 2008a). Likewise, in the context of Bangkok city where the car dependent rate is very high, it seems like the households simultaneously select mode choice to go to work as they choose where they will live. This means the choice of house location influences the choice of travel mode to work. For instance, people who live far away from the BTS; the BTS non-resident, are unlikely to choose to go work by the BTS. On the other hand, some people may intentionally choose to live near the transit line because they want to go to work by the transit. In this case, the choice of mode to travel to work affects the choice of residential location. Therefore, the choice of residence location and work trip modes will be jointly determined in this study. The travel modes exclusively on home-based work trip that are presented in the model are categorized into two modes; BTS and other modes. These two categories will minimize the complexity of the model and picture the real impact of transit on household's decision.

In addition, many research suggested that workplace location can be a dominant determinant in explaining house location choice. These studies have examined commuting factors and the relations between the locations of residence and workplace (Clark and Withers 1999; Waddell et al., 2008; Cho et al., 2008; Rivera, 2005). In reality, most residential choice location decisions are based on present location of workplace. Nevertheless, it should be made clear at the outset that the goal of this study is limited to better understanding the households' location and related choices, and not the complete interplay between job and residence location. Thus, workplace is assumed to be exogenous to residential location decision-making in this study. Furthermore, workplace located near the BTS within 1 kilometre is assumed to be the potential workplace as it may be one reason for resident to live near the BTS line and go to work by the BTS.

Considering these various impact factors on the residential location choice behaviour, this paper focuses on not only the transport related attributes mainly comprising the travel cost and travel time but also non-transport related attributes concerning socio-demographic attributes, while controlling for house and built-environment characteristics. It is noted that

our goal here is to understand the household's location and other related choices of travel mode but not the whole interaction between employment and residence location. We aim to make an extensive analysis for assessing the extent to which these factors affect people's choice decision. Then the main hypothesis is set. Among these typical factors, rather than transport accessibility, the socio-demographic status particularly income and auto ownership level will play a significant role in explaining the residence location of single-worker households in this city.

The Residential Decision Mechanism of Bangkok's Residents

Table 2 shows the estimated values of the coefficients of the model. The coefficients were estimated by the maximum likelihood method using the data described above. The coefficients for the explanatory variables including commuting cost and time as well as middle income are clearly significant, while the other factors are not significant at $P < 0.05$. The signs of several of the estimated coefficients are worthy of attention. The negative signs of the coefficients of travel time, travel cost and car ownership indicate that other things being equal, the alternatives with high travel time, travel cost, and that involve having car tend to be less preferred than alternatives that have low travel times and do not involve these variables. On the other hand, the positive coefficient of low income and middle income implies that these groups are more likely to live near the transit route and go to work by the transit, other things being equal.

Table 2 – Estimated value of the model's coefficients

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Intercept	-.843	.559	2.274	1	.000**	
Total two-way travel time	-.064	.022	8.661	1	.003**	.938
Total two-way travel cost	-.035	.009	15.244	1	.001**	.953
Low income	.234	.467	.252	1	.616	1.264
Middle income	.351	.359	.965	1	.011*	1.421
Single-person family	.392	.427	.843	1	.359	1.575
Car ownership	-2.521	.495	25.961	1	.998	0.080
Work location near BTS line	3.570	.389	84.172	1	.000**	16.564.
Null log-likelihood	2016.834					
Final log-likelihood	1294.145					
Pseudo R-Square	.559					

**p value of less than 1%

*p value of less than 5%

Among the significant predictors, due to magnitude of the coefficient, workplace location near the rail transit is the best predictor of residents' decision to live near the transit line. The BTS residents those working near the BTS will choose the BTS for their mode choice. The odds ratio value associated with work location is quite high. When location is raised by 1 unit, the householders are 16 more times likely to belong to the BTS resident and BTS user. Comparison to other income groups, only middle income seems to be the main group those living near the BTS and travelling by the BTS. Meanwhile, single-person family as well as car ownership cannot be the influential factors of householder who decides to live near the BTS and use the BTS as alternative.

The main condition of householders to be the BTS residents and use the BTS as alternative depends on where they work. The distance between workplace and the railway affects their decision on house location and travel mode. This can be implied that the Bangkok residents rely less on a combination of alternative modes, ignoring any changing of modes. The convenience of one linked trip from home to work by the BTS is preferable. It seems like there is a poor connectivity between the rail transit and other existing transportations in this city as the former study on mass transit in this city concluded that both rail transit systems have not yet achieved the main goals to reduce traffic congestion and attract more ridership. The two main reasons are the lack of connections to main transportations, and the difficulty in accessibility (Charoentrakulpeeti et al., 2006). These shortcomings dissatisfied commuters and led to low system performance and level of patronage. Besides expanding the mass transit network coverage, the future urban transportation plans should mainly consider on improving connectivity, both passenger accessibility and connection to the station as mentioned in the previous study (Tangphaisankun, 2010).

However, as discussed above, it can be noted that the condition is true particularly to the choice decision of middle income group since this income group is significantly meaningful to predict transit resident and passenger. The Bangkok, in similar fashion to other Asian cities, has a relatively young middle-income population. The housing provision towards housing affordability targets these middle-income earners as main buyers. This group will relatively create significant demand for smaller unit sizes in exchange for high quality condominium and housing units in quiet locations but with access to mass transit lines. Not only middle income but also high income group are the exclusive target group of residential property market along the transit corridors. Notwithstanding, by comparison with the high class, the middle class is more likely to be transit passenger as shown below in figure 3. The study on the travel behaviour of condominium resident along the BTS on Sukhumvit Road showed that most of the residents are the high income group and automobile dependent, while the BTS shares about 33% of all trips made by condominiums residents (Sakpongsatorn, 2010). Unlike the two income groups described above, living near the BTS tend to be less preferred than other alternatives for the low income people since the average price of condominium in this zone seems to be unaffordable price for low income residents. As a result, being the BTS residents is beyond the means of most low income Bangkokians.

Even though the low income group chooses to live far from the transit corridors, they are the main group of the BTS passengers as seen below in figure 4. This can be supported by the previous finding that the low income group tends to be more captive riders than the middle and high income group. They rely on the public transportation such as rail transit, bus and paratransit for their work trip. In contrast, the two other groups seem to be choice transit riders who have a vehicle but choose the transit for some trips. Also, the previous study stated that one main reason of the failure to attract transit ridership in this city is the incomplete and small networks that generally follow middle- and high-income residential areas (Charoentrakulpeeti et al., 2006). Therefore, providing more target groups like the low income to be the BTS residents will be better to extend the number of transit passengers. The policies to encourage the more low income group to live near the railway corridors should be promoted. The development of housing near transit that is affordable to a broader range of incomes should be carefully investigated.

In addition, the transportation variables; the travel cost and time, are found to be less potential predictors. It can be implied that the householders are less likely to move to live near the BTS line if the travelling cost and time can be reduced. This finding concurs with previous findings which found that transportation factors are less important determinants in location and travel choice. Surprisingly, the car ownership has no significant impact on the household's decision on their house location and mode choice. Hence, the hypothesis of the good predictor of car ownership could be rejected. It can be summarized that the Bangkok residents basically select to live near the BTS line and use the BTS for their trips regardless of the ability to use the private vehicles. This reveals the true choice rider characteristic. This characteristic will be the great chance to promote the number of public transit in this city.

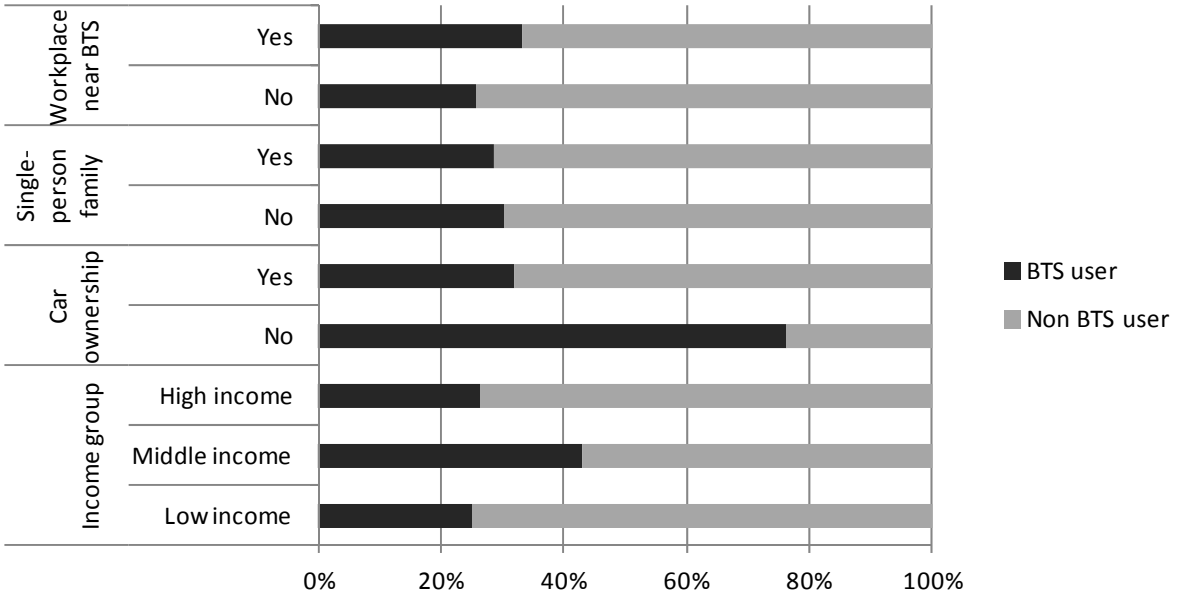


Figure 3 – The characteristics of BTS residents

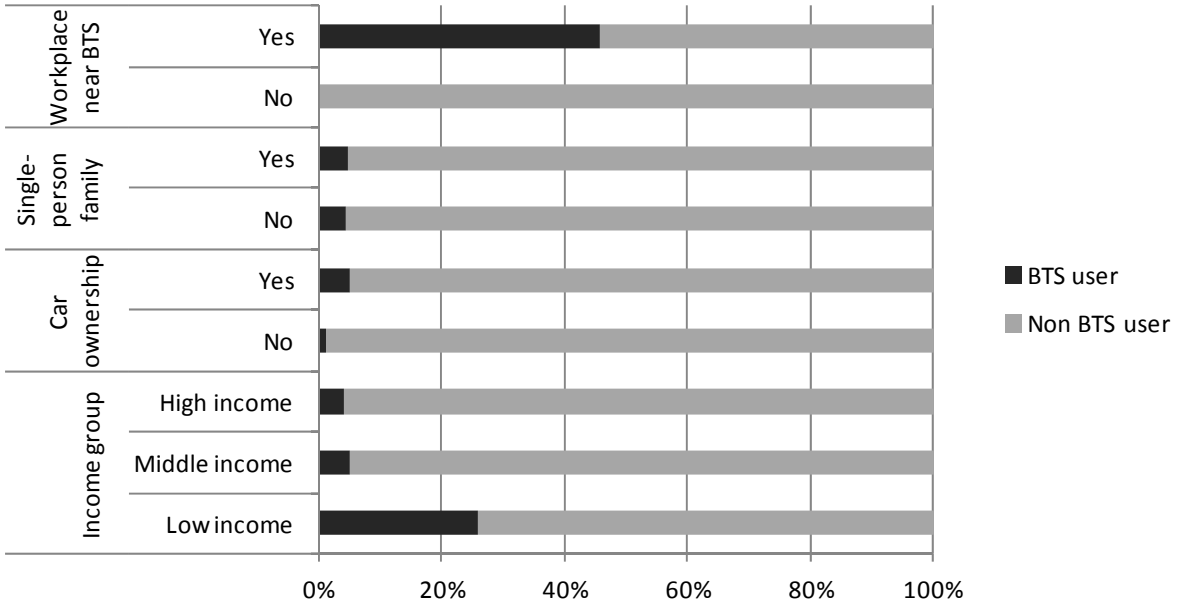


Figure 4 – The characteristics of BTS non-residents

CONCLUSION

In this paper, we employ Bangkok city where the first urban rail transit system was introduced over past decade as a case study in order to investigate the role of urban railway in determining residential location decisions. Initial findings provide the better understanding on the nature of Bangkok residents' decision-making on house location.

From the hypothesis mentioned above, the study explores several potential factors for understanding the decision-making on residential location. The empirical results from the multinomial choice model indicate that the hypothesis is identified since the certain factors more important to predict who will live near the transit line and travel by the BTS are finally found. The study exhibits statistically significant factors such as work location, middle income group, the travel cost as well as travel time affecting the probability of the transit residents and passengers. Rather than transportation characteristics, households' explanatory characteristics can potentially explain their decision on allocation to the BTS residents or non residents as well as the BTS users and non-users. Particularly, the workplace location proximity to transit can be the strongest predictor for householders' residential location and travel choice selection. Meanwhile the car ownership is not significant factor affecting the households' decision.

In conclusion, the outcomes of the research can assist the policy makers in solving the strategic issues of the future development of the urban railway corridors. A better understanding of the linkage between households' characteristics and residential decision mechanism will facilitate improved and integrated urban and transportation planning. This research expects in contributing greater extra details on spatial choice behaviour to better understand the likely measures that would have to be taken to encourage greater residential land use development and mass transit use. In addition, the challenges for further study are to find out the interplay between job and house location as the workplace location is the best predictor in this study. For long-term predictions of household locational patterns it is important to examine both workplace location choice and home location choice (Abraham et al., 1997).Therefore, the choice of residence location, job location and work trip mode will be jointly determined in the future study. Special attention shall be given to two-worker households to give us an insight on how workers in the household assess each worker's disutility when relocating. Hopefully, the validity of our research findings will be enriched by the further studies in order to expedite the advancement of urban and transportation development in the city.

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