

Location and Mode Choice Decision Mechanism Analysis of Multi-Worker Household in Bangkok, Thailand

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Abstract: The first introduction of urban railway in Bangkok, Thailand, is believed to have a significant influence on residents' spatial and travel behavior decisions. Whether or not it has become a major determinant of people to choose to live near the railway corridor as well as to commute to work by this mode should be examined. This paper aims to investigate the factors involved in household choices decisions of multi-worker households who are more constrained in selecting residential location, workplace location and travel choice than one-worker households, with particular emphasis on the role of transport factors. The discrete choice modeling is used to explore to what extent the transport factors in terms of each worker's commuter cost and time affect their choices decisions as compared to other factors. Model estimation reveals that, rather than transport factors, socio-demographic status is found to play a significant role in explaining their decision mechanism.

Keywords: Multi-worker household, Location choice, Mode choice, Multinomial logit, Bangkok

1. INTRODUCTION

Residential location and travel choice behavior potentially shape cities in important ways. More than half of land resources in an urban area are generally dedicated to residential activity and home-based trips account for a large proportion of all travel (Digambar et al., 2010; Harris, 1996; Guo and Baht, 2006). Round-trips between home and work represent most of city residents' daily commuting patterns that are part of the residential location decision. Basically, the decision making to select where to live and work will continue to influence the long term transportation pattern of families and individuals (Montgomery and Curtis, 2006). Therefore, any future urban and transportation planning initiative cannot afford to overlook the dynamics of residential location choices. From land use and transport interaction approach, city's residents settle in areas that are amenable to access by modes of transportation available at that time. As clusters of settlements become growing, the better transportation facilities are needed. As new modes of transportation are provided, cities will develop respectively (Srinivasan, 2000). There are three sets of effects of land use changes due to transportation changes. First round effects include change of route and mode, second round effects include change of residential location, employment location, shopping location, and trip distribution, third round effects are the location of new dwellings, jobs and shops (Mackett, 1994 cited in Srinivasan, 2000).

Among all transport modes, mass transport systems are the most change influencing. This is due to the benefits they generate such as shorter travel/dwell times as well as a faster and more reliable service. That the urban railway has a great impact on residents' spatial and travel behavior decision is clearly understood; however, to what extent it has influence on people's decision-making on choosing residential and job location and mode choice is still questionable, especially in a city being young in urban railway experience such as Bangkok, Thailand. Over the past 10 years, two rail transit networks known as BTS and MRT were firstly introduced in this city with routes covering central business district and inner city area. Likewise, the railway system is believed to be a major determinant of Bangkok residents to select their house or workplace location in proximity to this railway corridor as well as to select this transit as their mode choice.

Considering the residential location choice in Bangkok, the settlement pattern in this city has been continually changing. The middle and high income have been moving back to inner area due to the extensive development on real estate and housing market along the railway corridor. Previously, 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-distance traveling to and from work (Lerman et al., 1980). Since the decade of its operation, the urban railway 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 line is now one of the major concerns when residents choose the location to live as people value their time and cost saving from commuting to their workplaces by using this mode. If policies towards public transport development in the city need to be effective to encourage residents to drive their cars less and ride mass transit more, it is necessary to understand the determination of residential and job location and travel pattern of residents those living near the urban railway.

The study of location and travel choice behavior has captured the interest of scholars in a diverse range of disciplines. Studying these decisions can reveal a great deal about expectation of the city's residents on land use and transportation development. As the mechanism of households' decision-making plays an important part in the urban and transportation planning, it is worthwhile to study what makes people select their house and job location and travel mode, particularly in the household with more than one worker has profound effects on their decisions. Therefore, the objective of this paper is to examine factors influencing on multi-worker households' choices decisions including the location and commuting pattern, with particular emphasis on the role of transport factors. For the case of Bangkok city, even though no direct study was made with respect to the interplay between location and travel choice preferences, we make general assumptions that the accessibility by the urban railway have been becoming one factor for Bangkok residents to choose to reside near to the railway and they are regular railway users. Specially, how workers in the multi-worker household assess each worker's disutility when relocating should be considered. For this reason, we try to investigate how much the transportation factors in terms of each worker's travel cost and time play a significant role in determining the decision mechanism of these households those living near the railway corridor compared with socioeconomic and demographic factors in disaggregate manner.

Finally, it should be made clear at the outset that our goal is jointly considering households' location and related choices including the interplay between residence and job location as well as mode choice decision. We assume that residential location (and indeed workplace location) and travel choice are endogenous because it is possible that individuals

make their housing and work location decisions on the basis of (preferred) travel arrangements.

2. URBAN GROWTH AND COMMUTING PATTERNS OF BANGKOK'S RESIDENTS

Bangkok Metropolitan Region (BMR), as one of Asian's mega cities, has been undergoing rapid urbanization and motorization. The BMR area comprises of Bangkok Metropolitan Area (BMA) and its five adjacent provinces covering 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. From the urban development-related plans and projects in Bangkok and surrounding areas, the future urban development direction will place emphasis on the decentralization of activities in the central business districts (CBD) to surrounding areas with a major aim to alleviate the high-density land use in the existing commercial centers. Due to the congestion problem, the downtowns are expanded to cover the surrounding areas. Rail and road systems have been developed to provide the convenient transport network within the 7 commercial sub-center areas and linkage with CBDs, thus promoting the job and housing balance concept.

The aforesaid urban development concept complies with the changes in travel behavior. Some people move to live in suburbs, increasing the number of commuters between suburban areas and CBDs, especially the northeastern and western Bangkok. At the same time, some people move to CBDs to live near their offices, raising the number of trips in the same area. About a decade ago, Bangkok launched its first two rail transit systems known as BTS and MRT to service 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 called the Mass Rapid Transit Master Plan (M-MAP) are in the process of being implemented containing a 20-year development plan for urban railway during 2010 to 2029. There will be totally 12 routes with a total distance of 509 km which extends the plan of 2008 to cover fast-growing suburban areas (Office of Transport and Traffic policy and Planning, 2010).

The first railway line, 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. Many planners have predicted that Bangkok's real estate and housing developments would follow patterns previously established in Asian mega-cities such as Hong Kong and Tokyo. In these two major cities, the mass transit lines and especially the areas near or adjacent to mass-transit stations have become key new-development areas, both for office buildings and housing. Presently, many station areas of the BTS and MRT have become some of the most desirable areas to live and work for Bangkok resident. The mushrooming of high-rise residential and commercial buildings along the rail corridor can be seen in figure 1. In the past three or four years, both high-end and the middle-income condominium developers have launched successful projects in the area. The Real Estate Information Center's (REIC) statistics show that in 2007, the average home size in Bangkok had fallen. More people were choosing to purchase smaller-sized condominiums, many of which were located near or adjacent to mass-transit lines rather than purchasing more-costly single family homes. This new trend for city condominium living is also creating

a new type of owner, executives that wish to live in condominiums during weekdays and in their homes outside the city on weekends(GH bank Housing Journal).

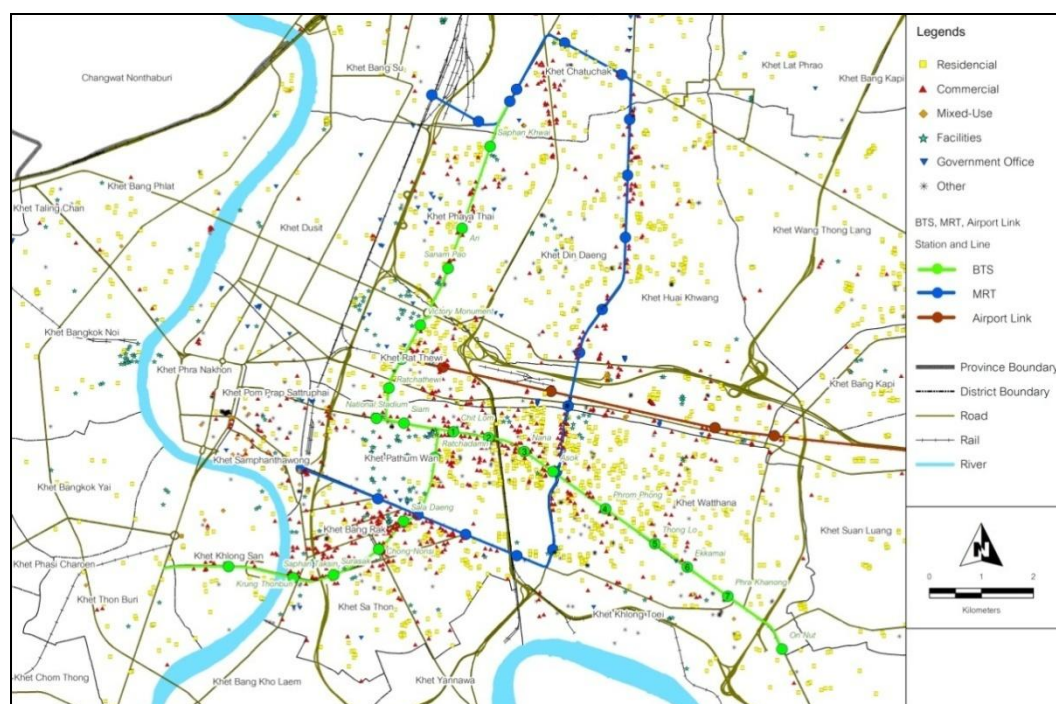


Figure 1. The distribution of high-rise residential and commercial building along the rail transit lines

Bangkok suffers from some of the most severe road-based traffic congestion in the world. Current travel demand in this city is 18 million trips per day. 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. There has been an upward trend of demand for rail mass transit in BMR especially for the BTS. Despite the recent growth in railway passengers, the modal share is still small or only 5%. Compared to the small share of urban railway, the mode share is overwhelmed by private car 29%. Car ownership has grown according to a rise in income level and road-oriented development. Also, the public transport systems in the BMR are still not well-established to be sufficiently convenient for users. Since the railway systems started operating, rail mass transit usage of the BTS and the MRT in Bangkok has seen a gradual rise but slower than expected and in 2009 accounted for 0.62 million trips (or 5.2% of the total trips per day). Several reasons explain the lower-than-expected ridership; personal car usage of high income earners and the limited coverage area of existing railway routes. This relatively slow growth in market share can be also largely attributed to the delayed formation of a comprehensive transport plan as well as implementation delays. Whilst mode choices in this city depend on a number of factors such as affordability (relative price), convenience (proximity as well as punctuality), total journey time and safety, it is expected that the change in market share of Bangkok's mass transit market will be primarily driven by congestion of road-based transit and new supply of rail-based transit (BTS annual report 2010/2011).

The Bangkok city is seeking to reduce the growth of car-based travel by developing public transport networks. Of course, Transit-Oriented Development or TOD approach can be expected to increase the level of the mass transit users in this city. As this approach is today widely considered to be one of most sustainable forms of urban development, it is being

practiced in many parts of the world as a means of reducing the dominance of private automobile travel and promoting settlement patterns that are conducive to transit riding (Calthrope, 1993; Cervero et al, 2004, Dunphy et al., 2004). From the theoretical aspect, based on population density and metropolitan size, this city thus seems very well-suited to TOD implementation. The city has many prerequisites for TOD. It has revealed the characteristics of mixed land use and densely populated high rise in the downtown areas served by this transit line. Rationally, this seems to be the great opportunity for TOD fostering in this city. While there are signs of growing demand for TOD, the city has many problems with land-use transport systems to implement this approach (Wasuntarasook, 2012). Moreover, the previous study found that recent efforts to foster TOD have seemingly not yet reached the TOD goals for sustainable development to reduce over-reliance on private automobile since most of the railway residents are car user rather than transit user (Sanit et al., 2012).

3. REVIEW OF MULTI-WORKER HOUSEHOLD'S LOCATION AND TRAVEL DECISIONS

During the past decades, accessibility has long been identified as the central influence in urban theory of residential location, with Alonso (1964) and others formalizing the trade-off between housing and commuting costs and time with the assumptions of single-worker households and exogenous workplace location. Many new researchers pointed out that such assumptions should be reconsidered (Watterson, 1994; Simpson, 1987; Waddell, 1993; and Rivera, 2005). They discovered that a model comprised of workplace and residential location explains urban commuting distances better than models of residence or workplaces alone. Now, more than ever before, household choices regarding employment and place of residence are often jointly made decisions (Montgomery and Curtis, 2006). Some studies have tried to improve model by including transport mode choice as part of household' location choice decision process. They have also attempted to make the modeling procedure complex in order to capture the influence of each household member to household's overall utility by considering all working members of the household in the model (Abraham et.al, 1997 cited in Rivera, 2005). As the residential decision is made by individuals and households, the outcome may be conditioned by the workplace decision or vice versa. If it is each household decision, it may be conditioned by one member's workplace choice, and condition a second member's workplace choice (Ben-Akiva and Bowman, 1998). An increasing prevalence of multi-worker households means that the interaction between household location and commuting decisions is more complex than it once was (Montgomery and Curtis, 2006).

Residential and workplace locations in multi-worker household have typically been studied by analyzing the length of both spouses' journeys to work. Particularly, a dramatic rise in female labor force participation has made dual-earner households more prevalent than single-worker households. The influence of female work location on residential location choice in these household has been already researched. Gender differences in dual-earner households, in terms of commute distances and the relative influence of commutes of the male and female workers on the residential location were examined in the previous studies. These studies concluded that women work closer to home and have shorter commuting times than men (Hanson and Johnston, 1985; Madden, 1981; Gordon et al., 1989; Waddell, 1996). Some studies claimed that they have more limitation on their job search and employment opportunities resulting in the need to minimize travel time in order to devote more time to family responsibilities (Madden and White, 1980 cited in Waddell, 1996). These findings of shorter work trips for women suggest that women will be more likely to have to change jobs

when the family changes residence, and may choose to constrain the job search to locations closer to the residence. It can be concluded that the female work commute has less influence on the residential location choice than the male commute.

The presence of a second worker was hypothesized to add constraints on household choice. Evidence from five cities in USA showed that women's earnings opportunities and commuting burdens influence not only the wife's choice of workplace but the husband's job site and the household residence as well (Freeman and Kern, 1997). However, in the case of Manila, the study concluded that the hypothesis that the utility of the primary worker is given more priority in the location choice decision does not hold true. The result implied that the degree of disutility is shared both by the two workers and no priority is given to either one (Rivera, 2005). Likewise, Plaut (2006) found that commute decisions in dual-income households operate as 'complements' rather than 'substitutes', that is in residential selection commute trips are jointly chosen to be either longer or shorter for both spouses. This study only included households where both spouses commuted to work by car so it is difficult to tell whether the finding can be applied to two worker households who travel by other modes (Montgomery and Curtis, 2006).

Another important factor is the presence of children in the household (Madden, 1981; Mok, 2007; White, 1986). At least, school becomes an additional location factor for the household (Green, 1997; Sultana, 2006). It may also increase commuting times for parents (White, 1986). Lastly, Most of the studies on decisions among location options were examined with a discrete choice model, yielding more easily interpreted estimates of their determinants (Quigly, 1976; McFadden, 1978; Weisbrod et al, 1980; Friedman, 1981; Pollakowski, 1982; Nechyba and Strauss, 1988; Waddell, 1996; and Nurlaela, 2012). Although the current model was estimated with single-worker households, it can be extended in a direct way to deal with multiple-worker households where a choice dimension is added for each additional worker's workplace (Waddell et al., 2006). Therefore, the model of location and mode choice in multi-worker household has been developed under the framework of these studies by using this modeling approach (Freeman and Kern, 1997; Waddell, 1996; Rivera, 2005).

4. HYPOTHESIS ON MULTI-WORKER HOUSEHOLD'S LOCATION AND COMMUTING CHOICE DECISION VARIABLES

As we believe that the two rail networks in Bangkok have significantly changed in the resident behaviors and the TOD has been fostering in this city, this study has been started with the question why multi-worker households choose to reside near to the railway and whether or not they are regular railway users. Specifically, sub research question is that how the determination of residential and job location choice (as proximity to the rail line) and travel behavior (i.e. mode choice) are controlled in terms of transport accessibility and socio-demographic factors. This means that we wonder how transport accessibility is important in location and mode choice decisions.

Based on the literature review mentioned above, the hypothesis must have some connections with these empirical studies background. In multi-income households, we hypothesize that the presence of second worker's work location has the influence on household's residential location choice and travel choice decisions. The main reason is that the decision mechanism of household choice selection basically involves trade-off among several factors which give the household the highest possible utility. Among workers in this type of households, there will be one worker's workplace that is the most important to

consider than the other ones when relocating. One worker who will be defined as primary is typically the head of the household, if he or she is employed full time or has the highest income. Other workers are termed secondary. Accordingly, the utility of the primary worker is given more priority in the choices decision making. All workers' accessibility to work are jointly treated as a dependent variable with their house and workplace location in the study

In this research, we examine the influence of transport and household characteristic factors on the residential location and mode choice decisions. But we control for the effects of house and built-environment characteristic variables on these decisions. Firstly, as mentioned in Kim (1995) and Charron (2007) cited in Surprenant-Legault (2010), the transport factors in terms of the travel cost and travel time between house and workplace of each worker play a significant role in determining the decision mechanism of these households because they illustrate to which extent the commute distance associated with the household's choices and constraints is split between the all partners. This type of household minimizes commuting distances more than one-worker household. Notwithstanding constraints and the variety of factors or motivations affecting home to work distances, minimization of distances remains desirable for all households and is a tendency effectively reflected in commuting behavior. Lastly, we decide which socio-demographic factors connect the location and travel behavior of workers living in the multi-worker household. These factors concern the characteristics of this household type such as housing tenure, the presence of child, car ownership and household income. Rather than transport factor, we expect these factors particularly income and the presence of child to have more influence on their choice decisions.

5. MODELING LOCATION AND MODE CHOICE

5.1 Data Collection

In this paper, we analyze the household survey data to assess the factors affecting the selection of residential and job location and mode choice. Data was obtained from the household survey of Bangkok conducted in December 2008 by Team Logistic and Transportation Consultant Company. The survey questionnaire addressed socio-demographic 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. A total household samples are extracted according to model requirements of: 1) multi-worker households and 2) households that moved after the first railway operation in 1999.

5.2 The Proposed Model

From the recommendation of previous studies, it has been proved that most residential choice location decisions are based on present location of workplace. However, for long-term predictions of household locational patterns it is important to examine both workplace location choice and home location choice. Hence, the residential location, workplace location and mode choice are jointly determined in this study.

Suppose the 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 from the BTS and MRT line, namely railway 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. Similarly, we define each

worker’s job location. Also only two alternative modes; the rail transit and car are used. To minimize the complexity of analysis, we assume two workers living in multi-worker household jointly choose residential location, worker 1's workplace and worker 2's workplace to maximize utility. Therefore, the alternative that integrates the choice of residential location, job location and travel mode is divided into 32 broad categories as seen in Figure 2.

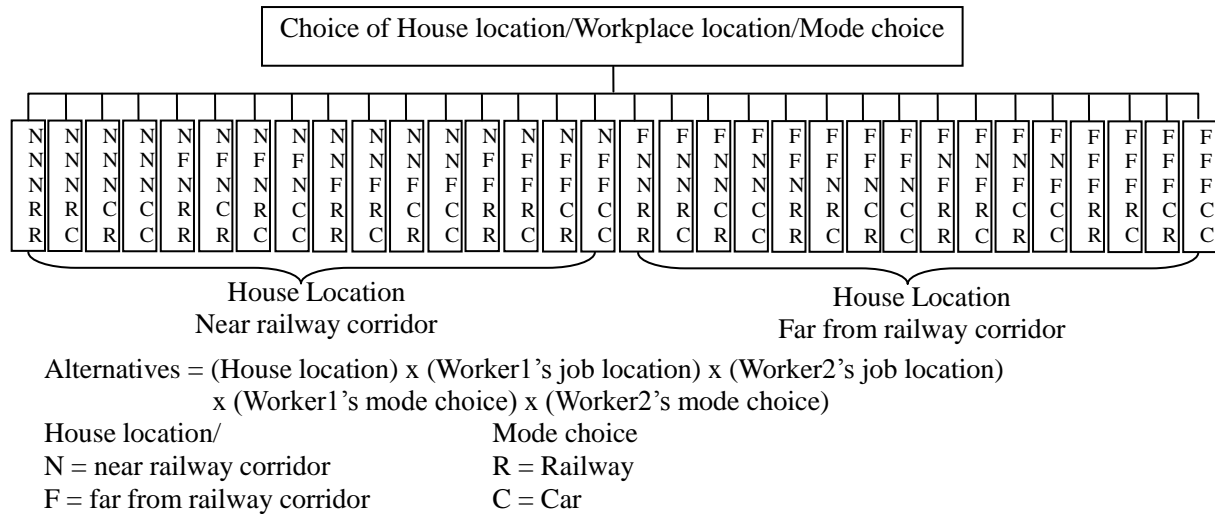


Figure 2. Location and Mode Choice of Multi-Worker Household

From previous studies, the basic model of multi-worker households’ location choice and mode choice is a disaggregate discrete choice model in the context of multinomial logit model. The distance linking the household’s house to one of its workplace constitutes the main variable of this study. This choice determines the commuting cost and time of both workers. We define utility (V) 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

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

The function V is specified as

$$V = H + \sum_{w=1}^2 M_w \tag{2}$$

Where,

- H = Household characteristics
- M= Transport mode characteristics

6. THE CHARACTERISTICS OF BANGKOK'S MULTI-WORKER HOUSEHOLDS

Table 1. Summary of samplings' characteristics

	Variables	House location near railway				House location far from railway			
		W1Z1 W2Z1	W1Z1 W2Z2	W1Z2 W2Z1	W1Z2 W2Z2	W1Z1 W2Z1	W1Z1 W2Z2	W1Z2 W2Z1	W1Z2 W2Z2
W1 Mode choice	Railway	33.3	51.6	14.5	23.1	90.3	47.8	23.1	0.0
	Private Car	66.7	48.4	85.5	76.9	9.7	52.2	76.9	100.0
W2 Mode choice	Railway	50.0	9.7	90.0	15.4	66.7	47.8	42.3	10.3
	Private Car	50.0	90.3	10.0	84.6	33.3	52.2	57.7	89.7
HH Income	Low income	10.0	15.5	10.0	5.3	19.1	22.0	13.8	15.3
	Middle income	25.8	33.7	10.0	7.7	33.3	18.7	15.4	17.2
	High Income	64.2	50.8	80.0	87.0	47.6	59.3	70.8	67.5
Presence of Child	No child	25.0	25.8	30.0	7.7	33.3	17.4	34.6	17.2
	Have child	75.0	74.2	70.0	92.3	66.7	82.6	65.4	82.8
House tenure	Rent	8.3	12.9	20.0	15.4	16.7	4.3	23.1	6.9
	Owner	91.7	87.1	80.0	84.6	83.3	95.7	76.9	93.1
Car ownership	No car	0.0	3.2	0.0	0.0	0.0	4.3	7.7	3.4
	Have car	100.0	96.8	100.0	100.0	100.0	95.7	92.3	96.6

W1 = Worker 1's Workplace location

W2 = Worker 2's Workplace location

Z1 = Near railway,

Z2 = Far from railway

The table 1 summarizes the characteristics of household chosen as the samplings of this study. Most of the respondents, both living near and far from the railway or zone 1 and zone 2, are high income, car owner, and households with children of school age.

Focusing on multi-earner households, the residential location and mode choice decisions of workers are based on their job location as both workers will apparently commute by the transit if their workplaces are located near the railway station. Conversely, they choose to travel by car in the case that their job locations are far from the station. Also, their job locations would be less accessible by other modes than the car. In addition, the primary and secondary workers have different trip modes and accessibility to workplaces. Evidently, the primary workers seem to have priority over the secondary workers to drive the car due to the higher proportion of their car using. As men account for approximately 90% of primary worker group, the car dependency of the primary earners originates from men's preference for driving car. The length of their trip is likely to increase more when the car is used instead of the transit mode. The secondary earners seem to be more constrained than the primary ones to reach the same level of accessibility to workplace. They are less likely to drive the car, but they are more likely to be the car passenger or to take the public transit. They prefer to work in the job location that easily access by the railway than in the other job centers. Therefore, the household that has the worker 2's job location near the railway line mostly more selects the railway than the car as their travel choice to work.

For the railway resident, if people with a preference for traveling by train will, on average, live near to railway stations we would expect at least one worker in this family opts to use the rail transit. However, both earners mostly use their car rather than rail transit for

their work trip. Next section will explain why they don't commute by the railway and what kinds of households are most inclined to move to station areas and use the transit.

6. LOCATION AND MODE CHOICE DECISION MECHANISM OF BANGKOK'S MULTI-WORKER HOUSEHOLDS

Table 2. Estimated value of the model's coefficients

Variables	B	S.E.	Wald	Sig.	Exp(B)
Intercept	8.946	2.845	9.885	.002**	
Worker1's two-way travel time	-.087	.055	2.535	.018*	.917
Worker2's two-way travel time	-.046	.047	.973	.024*	.955
Worker1's two-way travel cost	-.073	.025	8.415	.004**	.930
Worker2's two-way travel cost	-.051	.022	5.681	.017*	.950
Distance between W1W2 workplace (Car user)	.200	.226	.784	.376	1.221
The presence of child	-2.932	3.271	.803	.015*	.053
Low income	.493	4.103	.014	.036*	1.637
Middle income	-.686	1.669	.169	.008**	.503
House owner	-1.053	1.193	.296	.075	.349
Number of observations	600				
Null log-likelihood	-1288.223				
Final log-likelihood	-893.541				
Pseudo R-Square	.544				

** Significant at 1% level;

* Significant at 5% level.

With an iterative procedure for model calibration, we finally obtain the best set of variables as necessary. It is also proved that there are no correlations among these variables. Table 2 shows the estimated values of the coefficients of the model. The coefficients are estimated by the maximum likelihood method using the data described above. The coefficients for the explanatory variables including workers' commuting cost and time, low income, middle income, and the presence of child are clearly significant, while the other factors are not significant at the 0.05 level. The signs of several of the estimated coefficients are worthy of attention. The negative signs of the coefficients of travel time and travel cost from home to individual's workplace, middle income, the presence of child, and house owner indicate that other things being equal, the alternatives with high travel time and travel cost of each worker's commuting to work, as well as that involve being middle income, having child and owning house tend to be less preferred than alternatives that have low travel cost and travel time and do not involve these variables. On the other hand, the positive coefficient of low income as well as long distance between workers' job location implies that they are more likely to live near the transit route and go to work by the transit, other things being equal.

Even though all variables relating to transport factors are all significant below the 95% confidence level, the parameter estimates of travel cost and travel time variables for the worker1 and worker2 show that they are slightly less impact on the households' location and mode choice compared to other variables. It indicates that the householders are less likely to move to live near the railway line and use this mode to commute if the travel cost and time can be reduced. This finding concurs with the previous findings which found that transportation factors are less important determinants in location and travel choice behavior.

Among two workers, all else being equal, they have different sensitivity to travel time and cost accessibility to individual's workplace. This implies that the households tend to locate themselves close to any one worker's work locations in order to save his/her travel time and travel cost rather than to live either longer or shorter for both workers. The utility of the primary worker is given more priority in the location choice decision because the coefficient of worker1's commuting time and cost is stronger than that of worker2's. Hence, the hypothesis that one worker's workplace will be more important to consider when relocating can hold true. Since most of the primary earners represent male, it can be said that the female work commute has less influence on the residential location choice than the male commute.

For car-owning households, the distance between the workplaces of the two workers have a positive impact on the choice preference of households being the railway residents and passengers although it was found to be not significant. This could mean a probability for two earners not to share riding for their work trip in case of long distance between two workplaces. Moreover, the negative and high coefficient value of the presence of children supports the idea that their child's school location becomes an additional location factor that has powerful effect on the household's choice decision. Logically, children's school trip traveling that is immaturity and dependency on adults will encourage car oriented mode of family mobility which directly affects to household travel patterns.

Considering income group, low and middle income group is meaningful to predict transit residents and passengers. These income groups are more likely to choose their residence closer to the closest employment centre where they can commute to work by the railway, while they are also likely to live at locations which are close to the train line at the same time. Basically, new housing provision towards housing affordability targets the 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 corridor so these two income groups account for the majority group of multi-worker households those living near the railway in this study. Notwithstanding, by comparison with the high class, the middle class is more likely to be transit passengers. The study on the travel behavior of condominium resident along the railway, 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). 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).

Although an average price of condominium along the railway route seems to be unaffordable price for low income residents, living near the BTS tends to be more preferred than other alternatives for the low income households if members' job location are located near the transit line. The model predicts that the odds of deciding to be the railway residents as well as the railway passengers are 1.637 times higher for the low income families than they are for other income groups. Along the railway lines, there are many transitional zones where the land use has been changing rapidly since the launch of the first railway system. The poor residents can live at the cheap apartment rental available in these zones and go to work by using the railway. They are willing to trade-off proximity to their workplace to the good quality of house. Although most of them choose to live far from the transit corridors, if there is at least one member working near the transit, the proportion of using the railway is explicitly high regardless of house location as mentioned above in table 1. This is the reason why they are expected to be the main group of the railway passengers. This can be supported

by the previous finding that this 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. Therefore, in order to promote the more railway passengers, we should encourage more people whom can be proved to be regular transit passengers like the poor people to have more chance to live near the railway corridor. The policies on development of housing near transit that is affordable to a broader range of incomes should be carefully investigated.

7. 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 location and mode choice decisions. Initial findings provide the better understanding on the mechanism of Bangkok resident's decision on residential location and travel behavior specially attention given to multi-worker households who are more constrains in selecting house location, workplace location and travel choice than one-worker households. The result gives us an insight on how workers in the household assess each worker's disutility when relocating. Two factors including transport factors and household characteristic factors are investigated in this research, while controlling for house and built-environment characteristics.

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 presence of second worker's work location has the influence on residential location choice and travel choice in multi-worker households. There are different impacts of travel time on workers' choices decisions. The utility of the primary worker is given more priority in the location choice decision. Also, the certain factors more important to predict which household will live near the transit line and travel by the railway are finally found. The study exhibits statistically significant factors such as both workers' commuting cost and time, low income, middle income and the presence of child affecting the probability of being the transit residents and passengers. Rather than transportation characteristics, households' explanatory characteristics can potentially explain the multi-earner household's decision on allocation to the railway residents or non-residents as well as the railway users and non-users. Particularly, the presence of children can be the strongest predictor for Bangkok residents' location and travel choice selection.

By the recommendation of Ewing and Cervero (2010) on the TOD approach, the destination accessibility reflects the proximity or ease of access to regional trip opportunities such as employment. It is the most important aspect of the built environment affecting journey to work transport mode share. The research suggested that having residences and jobs in close proximity will reduce the vehicle-trips. Although Bangkok has many prerequisites for TOD with highly mixed land use, jobs/house diversity should be considered as the critical issues to support TOD implementation. The joint determination of house location and workplace location choice are therefore required to be able to understand the underlying reasons for travel behavior and subsequently predict travel outcomes of future TOD in this city.

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 spatial and travel choice

decision mechanism will facilitate improved and integrated urban and transportation planning especially strategies for TOD implementation. This research expects in contributing greater extra details on spatial choice behavior to better understand the likely measures that would have to be taken to encourage greater residential land use development and mass transit users. In addition, the challenge for further study is to find out the impacts of school quality on household residential location choice since the presence of children is the best predictor in this study. Not only the household members' workplace location but also their child's school location will add more constraints to the household choices decision. Hopefully, the validity of our research findings will be enriched by the further studies in order to achieve the urban and transportation development in the city.

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