A Stated Preference Experiment of Residential Location Choice in Mandalay

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***Abstract*—Mandalay, as a major commercial and industrial hub of Myanmar, is now facing great challenges due to a substantial increase in automobile, traffic volume, air pollution, and urban sprawl. The rapid urban growth can be seen by the high-density housing development in many parts of the city. However, the current development of high-density housing that is going on in the city center may not best match with people's preference, on the contrary it will even make the problem more severe resulting in traffic congestion and accelerating the urban sprawl. This paper presents a Stated-Preference (SP) experiment of housing location choice in Mandalay. A multinomial logit model is developed based on the SP survey data. Although the discrete choice model has a long history of application in the economic, transportation, marketing and geography fields, it is not well developed in location analysis. The results reveal that people are considering factors not only house size, house price, but also locational convenience in terms of commuting time, and neighborhood quality. It is also found that different socio-economic groups, i.e., ethnicity, exhibit different location preferences.**

Keywords—Residential Location Choice, Stated Preference Experiment, Logit Model, Mandalay.

I. INTRODUCTION

A considerable number of urbanizing cities around the world, including Mandalay which is the second largest city of the Union of Myanmar and is located in the middle part of Myanmar, besides being a religious and cultural center, a major commercial and industrial hub, are facing great challenges because of their growth has been marked by a substantial increase in auto-dependency, traffic congestion, air pollution, and urban sprawl. One strategy often suggested to reduce these negative effects is the integration of land-use and public transportation through intense residential development. The work of urban planners, urban designers, architects, and policy makers centers on improving the built environment and increasing the quality of people's lives. However, their work entails making decisions that are not always in tandem with people's preferences (e.g., increasing housing density, proposing a mix of land uses in residential neighborhoods, introducing public transportation close to where people live and work) [2]. Moreover, the city has been unabatedly urbanizing over the past few years. This urban growth, however, has been characterized by a low-density sprawling pattern and also has tried many approaches to face this problem. On the other hand, high-density housing should not be developed without insight into how people will respond to such developments and, more importantly is which are the factors influencing on that development.

II. LITERATURE REVIEW

A. Urban Development in Mandalay

Mandalay has long history of urbanization process. It was established by King Mindon in 1857. After the independence from British or after 1948, Mandalay continued to be the cultural capital of Upper Myanmar. During this period the population increased rapidly but the urban area of Mandalay was not remarkable changed. From 1962-1988, urban expansion started the Mandalay-Yangon highway, Mandalay-Amarapura road. Urban facilities were launched with hospitals, banks, schools and other enterprises. During this period, the Mandalay urban area developed with houses in vacant places and the population became 417,938 according to 1973 census. The population reached to 532,948 in 1983. After 1988, the government started to launch the market-oriented economy as put into practice trade opportunity which attention to encourage international trade investment. It was followed the new economic policies which pulled many people reside to urban areas [11]. According to this economic policy, Mandalay City Development Committee was constituted to set up systematic urban management and development and urban areas were expanded and absorbed the surrounding suburban areas. Under the control of Mandalay City Development Committee, the six townships are separated into three areas: Central Business District (CBD), Old-town and New-town. The current situation of that three areas are shown in Fig. 1.

B. Population

The population of Mandalay was approximately 636,000, growing to its estimated 1.2 million (86%) in twenty-one years. Based on 2013 population by the Department of Immigration, there are an estimated 240,000 households in Mandalay City with an average household size of 5.25 persons per household. Mandalay District with a population of 1.7 million occupies 28% of Mandalay Region in terms of population size [10]. About 76.4% of the district population are urban residents as shown in TABLE I. In addition, as being a religious cultural center, a major commercial and

industrial hub, people are living-together in Mandalay such as original Burmese people, seven majority ethnic groups and Chinese people who migrated to the city.

TABLE I. POPULATION OF MANDALAY DISTRICT

Region/ District/ Township	Population (thousand)			Urban Population
	Total	Urban	Rural	
Mandalay Region	6,166	2,143	4,022	34.80%
Mandalay District	1,727	1,319	407	76.40%
Aungmyaytharzan	266	266		100%
Chanayetharzan	197	197		100%
Maharaungmye	241	241		100%
Chanmyatharzi	284	284		100%
Pyigyidagun	238	238		100%
Amarapura	238	81	157	34%
Patheingyi	264	13	251	4.90%

Source: JICA Study Team: Nippon Koei Co. (2016).

(a) CBD area

(b) CBD area

(c) Old-town

(d) Old-town

(e) New-town

(f) New-town

Fig. 1. Six Districts in Mandalay.

C. Transportation

Transport in Mandalay is dominated by motorcycles. It is estimated that two-wheelers account for 92% of trips, excluding walking as shown in TABLE II. Urban bus services play a minor role. The Mandalay region has 30% of the country's motorcycle registrations with 688,652 registered motorcycles in 2014 in the city alone (1,182,691 across the region). This equates to 2.12 motorcycles per household (0.16 for cars and 0.92 for bicycles), and a motorcycle ownership rate of about 400 per 1,000 population. The motorcycle ownership rate might appear high, but international comparisons indicate that it could still grow by 50% before saturation point is reached. [9] stated that considering the city population is likely to double by 2030, the number of motorcycles may triple. Moreover, the road pattern is essentially a grid structure with wide single lane roads (about 10 meters) with occasional sidewalks and the road network is also largely uncongested during peak hours at major intersections [4].

TABLE II. VEHICLE FLEET AND MODE SHARE

Vehicle	Number	Transport Modal Share (%)
Motor-cycle	688,000	70.2
Bicycle	300,000	21.6
Car	54,000	5.6
Bus	450[a]	2.6

[a] refers to daily operations.

Source: Asian Development Bank (2016).

III. RESIDENTIAL LOCATION CHOICE MODEL

A. Factors Influencing on Residential Location Choice

The generalization of preference research results across multiple segments of the population whether based on ethnicity, income, or other socio-demographic variables is a common practice. It helps researchers aggregate research results in a meaningful way to understand a phenomenon and communicate these results with policymakers. People have different preferences, and these preferences are shaped by many factors, including one's stage in life, aspirations, and lifestyle. From this standpoint, a stream of residential preference research has focused on several clustering methodologies, often referred to as psychographics [5], to describe lifestyle as a determinant of housing-type and locational choices.

In Canada, the city of Edmonton has conducted a stated preference survey to consider trade-offs involving a wide range of elements of urban form and transportation, including mobility, air quality, traffic noise, treatment of neighborhood streets, development densities and funding sources such as taxes [8]. Besides socio-demographics, recent studies [16] have shown that 'subjective' (or soft) factors, such as attitudes and environmental awareness, greatly influence on residential location decisions [17]. Although price or affordability is one of the most important factors in determining residential locations, this factor is mostly absent in the previous studies using stated-preference questionnaires [12]. However, understanding the preference of resident in choosing the house location and what really make people to locate in a certain location is needed. [19] found that out of the attributes of household and transportation factors considered, price and brand have greatest impacts on residential attractiveness for the typical household. Therefore, to indicate the influences of different attributes for

specific groups households were established by estimating standard logit modes for those households using the observations obtained in the survey. The resulting parameters estimates for the logit model indicate the influences of the attributes.

B. Logit Model

The discrete choice modelling paradigm, and in particular the logit model, have been topics of intense and active research for many years, mainly for applications in the field of transportation choice analysis. Mathematical model, the logit model represents that the behavior of individuals trading off among the attributes of alternatives when selecting one alternative out of a set of available discrete alternatives [14]. The form for the choice situation has considered as below,

$$P_{i*} = \frac{exp(U_{i*})}{\sum_i exp(U_i)} \quad (1)$$

where

i	index representing new home location alternatives
i^*	a particular new home location
P_{i*}	probability that new home location alternatives $i*$ is selected
U_i	utility value associated with new home location alternative i, expressed in (implied) hypothetical units called "utils"

The utility function that describes utility values to the new location alternatives, linear form is as below,

$$U_i = \varphi_1 X_{1i} + \varphi_2 X_{2i} + \ldots\ldots\ldots\ldots + \varphi_n X_{ni} + \ldots\ldots\ldots, \quad (2)$$

where,

N	index representing attributes,
X_{ni}	value of attribute n for alternative i, utility function parameter
φ_n	associated with attribute n.

C. Parameters Estimation

The mathematical form of the logit model is relatively simple and convenient to work with when using empirical data to estimate the values for the parameters, φ_n, in the utility function. Consequently, this formulation is a very attractive one for modelling choice behavior and it continues to enjoy widespread use [14]. When values for the utility function parameters have been estimated, the relative influences of factors can be determined using ratios among the resulting coefficient values [18].

The significant of differences among estimates can be considered using standard t-statistics and t-ratios, with the t-ratio being the t-statistic for the estimate's difference from 0. When t-statistic or t-ratio has a value greater than 1.96 in absolute magnitude, this indicates that there is a less than 5% chance that the associated difference is due to random effects only [3], and the difference is said to be significant. The overall model goodness-of-fit can be considered using goodness-of-fit index as follows [6],

$$\rho^2(0) = 1 - \frac{L(*) - k}{L(0)} \quad (3)$$

where,

K	number of coefficients in estimated model,
$L(0)$	log-likelihood for model with zeros for all coefficients
$L(*)$	log-likelihood for model with estimated coefficients

This ρ^2 (0) index is analogous to the R^2 statistic for linear regression in that it ranges from 0 to 1, with larger values indicating a better fit. It also takes into account the number of parameters used in the model, favoring more parsimonious model specifications [6].

The NLOGIT software package (NLOGIT, 2007) [15] was used to estimate the parameters in this paper. NLOGIT is an extension of another very large, integrated econometrics package, LIMDEP, that is used world-wide by analysts of models for regression, discrete choice, sample selection, count data, models for panel data, etc. NLOGIT includes all of the capabilities of LIMDEP plus package of estimators for models of multinomial logit (MNL), multinomial probit (MNP), nested logit, mixed logit and several others. By using NLOGIT software, the model goodness of fit can consider with the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). AIC and BIC are both penalized-likelihood criteria. AIC is an estimator of out-of-sample prediction error and thereby relative quality of statistical models for a given set of data. Given a collection of models for the data, AIC estimates the quality of each model, relative to each of the other models. Thus, AIC provides a means for model selection and the preferred model is the one with the minimum AIC value [1]. Then the AIC value of the model is used as $AIC = 2k - 2\ln(\hat{L})$ where, k the number of estimated parameters in the model and $\hat{L}$ the maximum value of the likelihood function for the model. Moreover, BIC is also a criterion for model selection among a finite set of models; the model with the lowest BIC is preferred. It is based, in part, on the likelihood function and it is closely related to the Akaike information criterion (AIC). The BIC is formally defined as $BIC = \ln(n)k - 2\ln(\hat{L})$ where, $\hat{L}$ the maximized value of the likelihood function of the model, n the number of observations and k the number of parameters estimated by the model.

IV. STATED PREFERENCE EXPERIMENT

A. Questionnaire Survey Design

The questionnaire was divided into three parts: (I) Socio-economic characteristics, (II) attitudes and behaviors of considering house location and (III) SP survey for a choice

set of housing alternatives. The flow and process of questionnaire survey and SP experiment is as shown in Fig. 2. In Part I, the respondents were asked to provide the following socioeconomic information such as nature of household tenure (own or rent), current house price or rental fees per month, age, gender, employment status, education level, household income, personal income, household location, workplace/school location, commuting time (to work or study), usual mode of transport, number of household member, children younger than 11 years of age, length (years) having lived in the current house, total number of vehicles occupied by household, present dwelling type and size, plan to move or relocate within 1 year.

In Part II, the attitudes of house location choice considered by respondents were described in terms of the following, the township location of the house, the price of the house, the size of the house, having good prospect future value of the location, living in green environment, having local shops within walking distance, living near to the relatives and friends, low crime rate within neighborhood, less traffic congestion on nearby street, living closer to the main road, closer to work place/school and having parking space.

The main data-set used in this paper for the analysis is Part III and based on the Stated Preferences experiment. SP surveys are a widely used method for identifying preferences in cases where revealed preferences (RP) data are unavailable or inadequate to identify preferences [13]. In order to reveal preferences for the characteristics of the residential location choice, the SP experiment presented respondents with choice scenarios and a hypothetical situation where they were asked to choose one among three alternative residential situations. The first option was the respondent's actual area of residence and the attribute values corresponded to real observed values. The second and the third house situation were represented by two hypothetical alternatives with attribute levels pivoted around the values of the current residence situation. This setting permitted respondents to recognize a familiar choice situation, thus making the choice experiment more realistic and reliable. The three residential choice situations were described by a number of different characteristics. The experiment included variables indicating that the township location, size, price, travel time to work/school and neighborhood environment. TABLE III presents the summary details of the experiment. In each option, attribute contained the current residential location of respondents and two additional levels expressed as positive and negative percentage deviations. Besides, the example of considering better neighborhood and bigger or smaller house size are presented in Fig. 3. Based on the fractional factorial orthogonal design, the experiment contained 6 choice tasks by randomly made. The values of attributes describing the alternatives neighborhoods varied across every choice task. The SP choice experiment was conducted by using Computer-assisted personal interviewing (CAPI), is an interviewing technique in which the respondent or interviewer uses an electronic device such as tablet during the field survey.

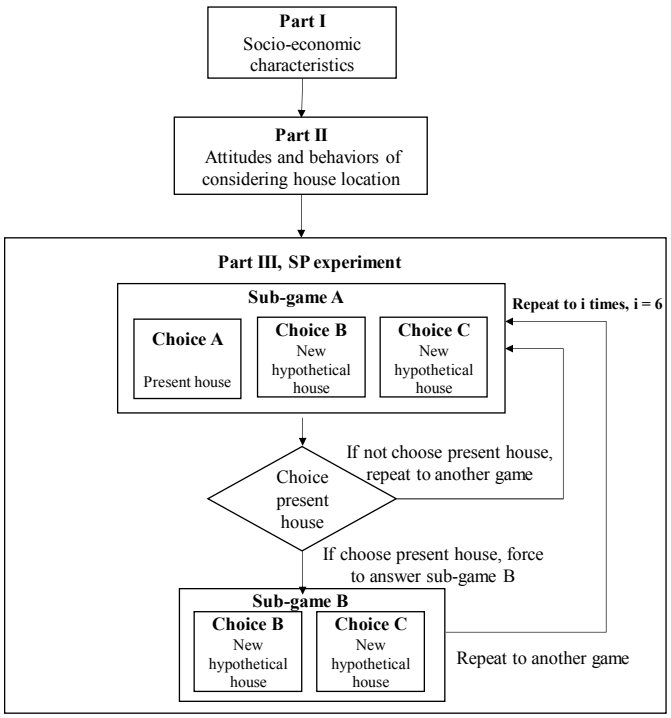

Fig. 2. Steps of the Stated-Preference Choice Experiment.

TABLE III. SUMMARY OF THE EXPERIMENT

Attributes	Levels
Location	New location, Current residence location, New location
Size	-50%, Current house size, +50%
Price	-20%, Current house price, +20%
Neighborhood environment	-10%, Current environment, +10%
Travel time to work/school	-50%, Current travel time, +50%
Experimental design approach	Fractional factorial orthogonal design
Alternatives	Current residence (A) and two hypothetical alternatives (B, C)

Fig. 3. Example of neighborhood and house size.

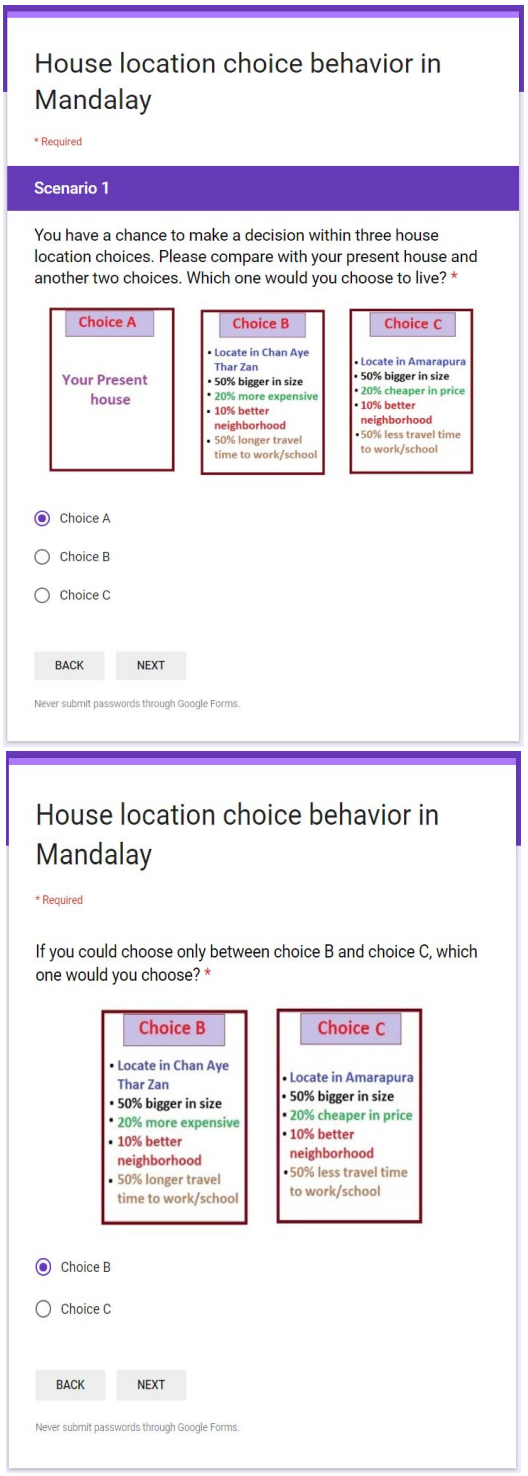

Fig. 4. Example of Google Form.

We employed Google Forms that is free. Each respondent was assigned to choose among 3 alternatives. If the respondents selected the choice of present house, they would be asked to evaluate the rest two unchosen alternatives again and make a choice as shown in Fig. 4.

B. Data Collection

The questionnaire survey was carried out by computer-assisted face-to-face interview, the respondents were randomly chosen at Government offices, Schools, Universities and Private companies/offices by self-administered questionnaire survey. These places were located in three areas (CBD area, old town, new town) of Mandalay city as mentioned above. Survey was carried out during 24th August 2019 to 28th August 2019 and shown in Fig. 4. 122 respondents were interviewed since some respondents did not want to interview survey.

Fig. 5. Computer-assisted face-to-face interview survey.

C. Characteristics of the Respondents

The general information of the respondents is described using descriptive statistics in TABLE IV. The sample was mixed in terms of gender 48 male (39.3 percent), 70 female (57.4 percent) and 4 others (3,3 percent). More than 80 percent of respondents hold bachelor degree, while 6.6 percent is master degree or more. In addition, 17.2 percent have diploma/college level education and 5.7 percent report high school.

In terms of ethnicity, 72.1 percent represent the original Burmese and 14.8 percent of Chinese people. For house type and house status, 83.6 percent live in Single house type and 69.7 percent own houses which is indicated that they have highly preferred in their own house and do not have any plan to move a new location.

D. Respondents residence and work/school location

The 34 persons (27.9 percent) live in new-town area and 31 persons (25.4 percent), 27 persons (22.1 percent) live in CBD. The 49 persons (40.2 percent) do their daily activities in CBD area. The percentage of their current house location and work/school location is as shown in Fig. 6. According to Fig. 7, 33 percent of the respondents own more than 3 private vehicles and mostly use Motorcycle (61 percent). That means people prefer to use private vehicle and they did not care about the public transportation and travel time because of less traffic congestion.

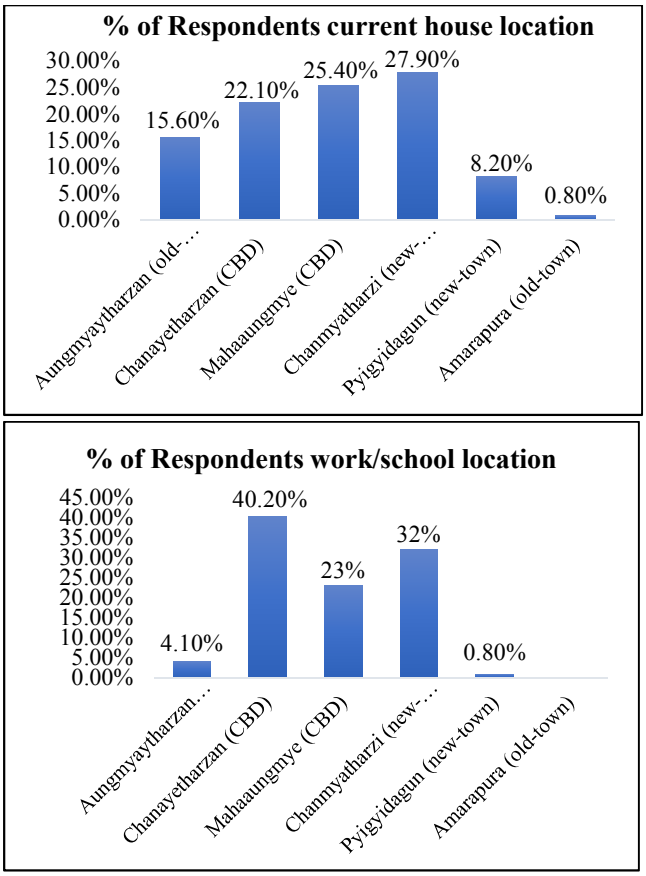

Fig. 6. House and work/school location of respondent.

E. Vehicle ownership and daily usage of respondents

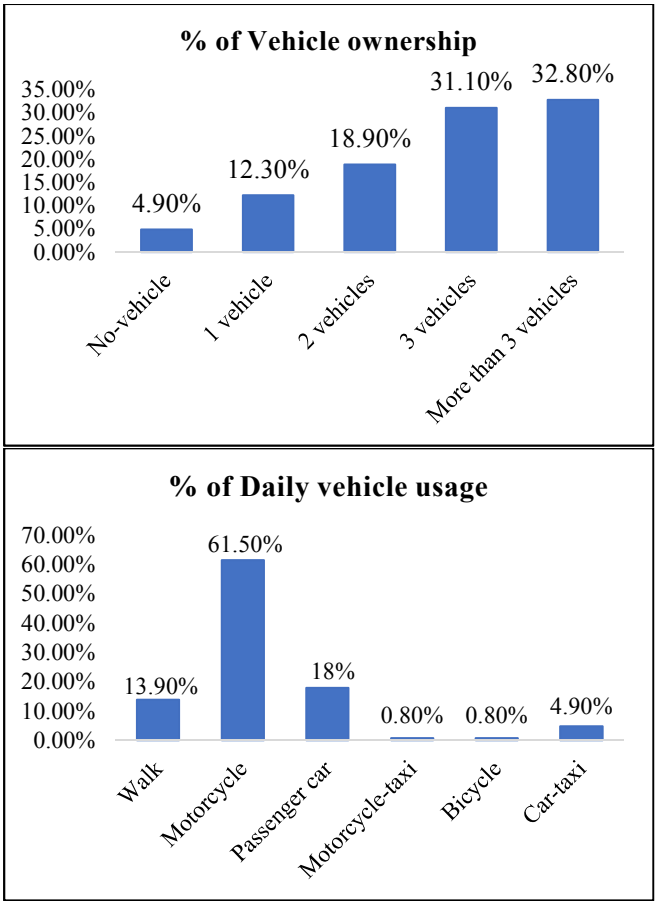

Fig. 7. Vehicle ownership and daily usage.

TABLE IV. DESCRIPTIVE STATISTICS OF THE RESPONDENTS

	Frequency	Percentage
Gender		
Male	48	39.30%
Female	70	57.40%
Others	4	3.30%
Education		
High school	7	5.70%
Diploma/College	21	17.20%
Bachelor	86	70.50%
Higher than Bachelor	8	6.60%
Ethnicity		
Burmese	88	72.10%
Kachin	3	2.50%
Kayin	3	2.50%
Mon	1	0.80%
Rakhine	1	0.80%
Shan	8	6.60%
Chinese	18	14.80%
House-type		
Single-house	102	83.60%
Condominium/Apartment	16	13.10%
Shop-house	4	3.30%
House-status		
Rent	16	13.10%
Own	85	69.70%
Government residence	21	17.20%

V. EVALUATIONS OF RESIDENTIAL LOCATION CHOICE

A. Housing Choice Status

The models were estimated for the entire sample and for various different subsample from the survey. The results for some of the estimations are shown in TABLE V, in which the results of the house status own data in three alternatives and the data part of forced to choose among only two hypothetical new location choices.

1) House location choice sub-game A

In the model estimation from the TABLE V, it is found that some of the attributes are statistically significant, i.e., the township location (CBD area), price, travel time and neighborhood environment. In the sub-sample of making choice decision between current house location and two new hypothetical situations, it is found that the respondents were likely not to live in CBD areas means that people also considered other factors and they do not care about the travel time. That is because they had their own vehicles like as motorcycle to access to every desired destination easily. In addition, the size of the house was not significant in residential location decision making.

2) House location choice sub-game B

The sub-sample of making force to choose the respondents only between two new home situations, they were likely to live in CBD areas and did not consider the size and the price. This is probably because of the travel time that they would not want to travel longer indicated by negative sign of Travel Time variable. Not only they likely to stay in CBD areas and also better-neighborhood environment is statistically significant.

TABLE V. ESTIMATION RESULT BY TWO SUB- GAMES

	Sub-game A		Sub-game B	
	b	t-value	b	t-value
Dummy of CBD area	-0.424	-2.229*	1.755	4.822*
Size	0.000	-1.091	0.000	-0.857
Price	0.001	2.306*	-0.558	-0.028
Travel Time	0.056	4.315*	-0.049	-2.808*
Dummy of better-neighborhood	-1.480	-11.891*	1.919	2.373*
Number of observations	510		238	
Goodness of fit	AIC	1.623	1.250	
	BIC	1.681	1.323	
	ρ^2	0.017	0.035	

* refers to 0.05 errors (95% statistically significant).

B. Ethnic Group

To examine how the ethnic groups of the people influences on residential location decisions, the results of estimations are shown in TABLE VI. The results of Burmese people group are compared with the Chinese or other ethnic groups.

TABLE VI. ESTIMATION RESULTS BY ETHNIC GROUP

	Burmese		Chinese or others	
	b	t-value	b	t-value
Dummy of CBD area	-1.379	-3.709*	2.074	3.371*
Size	-0.001	-1.501	0.469	0.057
Price	-0.001	-2.111*	0.000	0.759
Travel Time	0.001	0.097	-0.045	-1.459
Dummy of better-neighborhood	-0.114	-0.134	3.061	1.946*
Number of observations	158		82	
Goodness of fit	AIC	1.309	1.195	
	BIC	1.405	1.341	
	ρ^2	0.051	0.114	

*refers to 0.05 errors (95% statistically significant).

According to TABLE VI, the Burmese ethnic group does not consider the size of the house and travel time when making choice decision. And they do not likely to live in CBD areas that is they concern about the price of the house. Also, the better-neighborhood environment is not significant for this group of determining the house location decision. The estimation results for sub-sample of Chinese and other ethnic groups, location variable is statistically significant in making choice decision. The better the environment in the area, the more likely these ethnic groups to live. In addition, the price of the house is not a decision-making factor for these Chinese ethnic group.

VI. CONCLUSION

This study has examined the factors that have influence on residential preference, i.e., attractiveness of attributes with respect to various groups of people in Mandalay. The results support the existence of factors which differ in their housing choice preference. For those people who prefer their present house than the two new hypothetical houses, they apparently do not desire to live in the CBD and spend more time for travelling to work or school. This finding clearly reveals that the district location and travel time are not the main factors for people in Mandalay when choosing house. This phenomenon is due to the less congested traffic situation in Mandalay even in the peak hour. Therefore, travelling from outskirt to the CBD to work or school is not a big deal but can compromise with better neighborhood in the outer area of the city. This was examined by asking people to choose only the two new hypothetical houses. The results reconfirm that better neighborhood is preferable. The latter part of the paper has examined the preference of specific groups of the sample based on the socio-economic characteristics, i.e., ethnicity. It is found that the Burmese-race respondents mainly consider location although CBD is not preferred, neither pay attention to travel time. In contrast, Chinese-race respondents exhibit strong preference to locate in the CBD where the commercial opportunity are there while preferring a larger house locating in better neighborhood but still trade-off with travel time. The effect of other socio-economic characteristic is left for the future study.

ACKNOWLEDGMENT

This study is financially supported by Kasetsart University Scholarships for ASEAN for Commemoration of the 60th Birthday Anniversary of Professor Dr. Her Royal Highness Princess Chulabhorn Mahidol.

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