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**DISCRETE CHOICE MODEL:  
RESIDENTIAL LOCATION CHOICE**

**Flora Pandya  
Suresh Maind**

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# DISCRETE CHOICE MODEL: RESIDENTIAL LOCATION CHOICE

Flora Pandya<sup>1</sup>  
Suresh Maind<sup>2</sup>

## Abstract

Household's decisions are much more complex as where to live and work while also choosing for the mode of transport to be used. Housing decisions are interdependent on the workplace location as people reside close to working location so as to reduce the time and cost. We have analyzed the residential location choice for the Mumbai Metropolitan Region (MMR). Discrete choice model's one of the family multinomial logit models are used for the analysis. Results indicate that the distance to the CBD, price of the house and income are most significant factors that influences the residential location choice.

**Key Words:** Residential choice, Location choice, Multinomial logit model.

**JEL Codes:** C01, C25, D11, O18, R14.

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<sup>1</sup> Research Scholar, Department of Economics, University of Mumbai, Mumbai- 400 098.  
Email id: [florapandya@gmail.com](mailto:florapandya@gmail.com).

<sup>2</sup> Associate Professor, Department of Economics, University of Mumbai, Mumbai- 400 098  
Email id: [sureshmaind123@gmail.com](mailto:sureshmaind123@gmail.com)

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## 1. INTRODUCTION:

Urban transportation is linked to the urban spatial structure. The urban structure largely depends on the land use pattern and the availability of transportation facility. The component of land use pattern depends upon the economic activities (production, consumption, *etc.*) that take place and their level of concentration or the intensity of those economic activities. Transportation is the major source of mobility among these economic activities. Transportation influences the land use patterns as well as land use patterns have significant impact on the transportation. Thus, there is a two-way interaction between the land use pattern and transportation. Changes in transport are likely to produce changes in land use, and these long-term effects of transport policy may be of considerable potential importance [Pandya, R. J., and Katti, B. K. (2012)]. Public transportation projects are often massive and mutually exclusive, with irreversible cumulative effects over long periods. [McFadden, D. (1974)].

Urban development directly influences the decisions of individuals and households who in turn affect the performance of the transportation system in terms of travel volumes, speeds, congestion and environment impact. [Ben-Akiva, M., and Bowman, J. L. (1998)]. According to location theory, the agent acts in their own self-interest motive as firms tries to maximize the profits and consumers tries to maximize the utility from consuming the commodity. Since housing is a heterogeneous commodity the preference of housing depends on various factors and other attributes that are associated with that commodity. Decisions are influenced by the accessibility, space and environmental factors. Accessibility is clearly of interest in both residence and workplace choices and is in fact largely determined by these two choices [Waddell, P., Bhat, C., Eluru, N., Wang, L., and Pendyala, R. (2007)]. Household's decisions are much more complex as where to live and work while also choosing for the mode of transport to be used. Household locations and workplaces are strongly interdependent choices because they jointly determine commuting time. [Inoa, I. A., Picard, N., and De Palma, A. (2013)]. Thus, accessibility plays a crucial role in determining the residential location and workplace location choices.

The purpose of this study is to analyze the location preference for housing in Mumbai Metropolitan Region (MMR). To understand the factors that affects the location decisions of households in MMR. To analyze the decision of households with respect to housing characteristics, locational factors, socioeconomic variables, travelling time and cost from work place. The paper is organized as follows: Section 2. Overviews on literature of classical bid rent models and household decisions to choose residential location. Section 3 discusses the data collection and its coverage. Section 4 presents a brief idea about the methodology in modeling the choices. Section 5 discusses the empirical results and last section concludes the findings of the paper.

## **2. REVIEW OF LITERATURE:**

The location theorist Von Thunen model gave a different perspective for valuing the land other than given by the Ricardo which was based on fertility of soil (indestructible power of soil). Valuing land in terms of the locational factors which are available for quick access to the market and reduces the transportation cost has higher land value than the land which has poor access. Thus, land closest to the city, will have more value (in terms of price). Further extension of the Von Thunen model was used by Alonso in a mono-centric model where all employment opportunities are placed at center of the city which is called central business district (CBD). As the distance from the CBD increases the land values decreases and vice-versa. These are commonly known as the bid-rent. A bid rent function is determined by the consumer willingness to pay for the land at particular location. Hence, different users compete with each other for the land closest to the city center where, all market opportunities are placed. Access to employment is crucial for determining the attractiveness of the location in a mono-centric model [Alonso (1964), Muth (1969) and Mills (1972)]. Employment opportunities those which are concentrated at center makes periphery less attractive as it incurs the transportation cost. However, in reality city have poly-centric framework where there are many CBD. In a polycentric framework does the bid rent model works same as in case of mono-centric model is questionable? However, in literature an argument prevails of employment being endogenously or exogenously determined. Whether employment is

exogenous and concentrated or not, from a typical resident's perspective accessibility to employment opportunities is a key determinant of location choice. [Ahlfeldt, G. (2007)].

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 each household is involved [Sanit, P. (2013)]. Other than the employment the household decisions are also influenced by the location of house and the infrastructure facilities which are available near to the house *e.g.* proximity to the railway station. 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. [Sanit, P. (2013)]. In literature, there are two diverse groups which believe that household's decisions are influenced by transportation and the other group believes that transportation does not influence any location decision of the household. [Weisbrod, G., Lerman, S. R., and Ben-Akiva, M. (1980)] study indicates that though transportation have role in determining the location but it is not as significant as the socioeconomic and demographic factors. Whereas, [Sanit, P. (2013)] studies the decisions with regard to new urban railway opened in Bangkok with various income and workplace locations. He found that transport and socio-demographic factors played a significant role in choosing location of a house. The decision between workplace and the railway affects their decision on house location and travel mode. [Sanit, P. (2013)].

Housing decisions are interdependent on the workplace location as people reside close to working location so as to reduce the time and cost. Several studies have a view point that housing and work place location are determined either 'jointly' or 'sequentially'. 'Jointly' in the sense both location choice is simultaneously chosen whereas, 'Sequentially' determined means that one choice is influenced by the other choice location. It means choosing a residential location first and then workplace location or vice-versa. These studies include [Waddell, P., Bhat, C., Eluru, N., Wang, L., and Pendyala, R. (2007), Inoa, I. A., Picard, N., and De Palma, A. (2013)., Jiao, P., Sun, T., Guo, J., and Li, Y. (2015).]. The decision of workplace choice is also associated with the job change and migration. The household relocate to other housing location because of

job change. This is form of sequential choice where job change influences the housing location. The studies related to migration and job changes are [Linneman, P., and Graves, P. E. (1983). Clark, W. A., and Davies Withers, S. (1999). Van Ommeren, J., Rietveld, P., and Nijkamp, P. (1999).]

The housing location also depends upon the commuting behavior which is based on the several activities. These activities influence the travel behavior and have motives for travel like work, school and colleges, market, *etc.* Such activity based model and travelling schedules on the peak hours are studied by [Ben-Akiva, M., and Bowman, J. L. (1998)., Kumar, M., and Rao, K. K. (2007)]. Activity and travel scheduling occur at more frequent and regular interval such as days and weeks [Ben-Akiva, M., and Bowman, J. L. (1998)]. Travelling time are more important than the distance as even though distance is less but because of traffic and congestion it takes more time to reach at the destination.

Location decisions are more thoughtful when it regards the longer term. [Inoa, I. A., Picard, N., and De Palma, A. (2013)]. The housing decisions are much more multifaceted as it does not only involve a single person decision but the family as a whole. The primary tours are related to the work are more influential than the secondary tours like school and market. Mode choice differs between primary and secondary tours. Use of transit almost disappears for secondary tours. [Ben-Akiva, M., and Bowman, J. L. (1998)]. Extension to the case of the multiple worker households is conceptually straightforward but substantially increases computational complexity and is therefore set aside for future research [Waddell, P., Bhat, C., Eluru, N., Wang, L., and Pendyala, R. (2007)].

### **3. DATA COVERAGE:**

Data was obtained from the household activity survey conducted by the researchers in Mumbai Metropolitan Region (MMR). For estimating the value of a good there are two approaches the first is stated preference approach and second is revealed preference approach. Stated preference approach is an experimental approach where the

preferences are captured on the basis of hypothetical (experimental) framework while revealed preference approach is based on the observed behavior of the individuals. Thus, deriving their preferences from their associated markets. We have analyzed the data based on revealed preference approach (survey based). The survey questionnaire addressed the socioeconomic variables of individuals, travelling pattern, location of house and workplaces, attributes of house, mode of travel, travelling time and cost. A total sample of 287 households were extracted and used for the analysis while the other samples were rejected because of incomplete information. The households were randomly selected from the Mumbai Metropolitan Region (MMR) which was cluster on the basis of the municipal corporations. The focused area of the study was Mumbai city and suburbs, Thane, Kalyan-Dombivali, Bhiwandi, Vasai-Virar, Navi-Mumbai and Panvel. The survey includes both the household who have stayed in same locality and households who have shifted to new location. This helps us to understand better the location decision choices of the households. The location decisions are influenced by characteristic of house, location of house, workplace location and constrained by income and price of house. In Mumbai, the prices are exorbitantly high as compared to the other areas. The focus of our study is to examine whether a household choose a location within the Mumbai with closer to the railway station or not as it impacts accessibility to work. The burgeoning prices in Mumbai have led to unaffordable homes for the poor and middle income groups making it difficult to buy homes and reside within Mumbai. Since, households closer to railway station have more accessibility than the households who choose to stay far from railway station. The location choices are divided into two parts the location choice within the Mumbai and outside the Mumbai with nearer to the railway station and far from the railway station. The framework chosen for near and far is based on distance as well as the time. 15 minutes' walk-able distance is considered to be nearer and more than that as far from the railway station. The distance within 1- 2 kilometer of railway station is considered to be as nearer. The other variables used for the analysis are the distance to the CBD, price of the house, income, house type, area per sq. ft., nearby school, nearby hospital, duration of water supply, toilet facilities, parking facilities, travelling time and cost.

#### 4. MODELLING CHOICES:

Discrete choice models are widely used to model the housing location with qualitative data set. The earlier contribution by McFadden, D. (1978) in the field of housing market and transportation studies pertaining to housing choice and travel behaviors. Theoretically model of urban location often posits a population of consumers with identical tastes and a housing market in which prices adjust frictionlessly to an equilibrium in which consumer is indifferent among all the housing alternatives. Then housing prices is carrier of all information on consumer tastes for public services, accessibility and dwelling characteristics. [McFadden, D. (1978)]. Discrete choice models are based on random utility theory. The choice of the residence of households generally involves tradeoff among several factors which gives the household the highest possible utility. [Sanit, P. (2013)]. The multinomial logit model is one of the families of discrete choice models and the estimates are drawn from maximum likelihood estimation. McFadden, D. (1978) study for modeling the choice of residential location highlights two major problems in modeling the choices. Firstly, similarities among the attributes and secondly the large number of alternatives. The multinomial logit model can be carried out with limited data set. 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 modeled. [Sanit, P. (2013)]. Thus, the probability of choosing the h from the  $i^{\text{th}}$  alternative is

$$pr(ih) = \frac{\exp^{u(zih)}}{\sum_{j=1}^J \exp^{u(zjh)}} \quad \text{----- (1)}$$

$$Uih = \beta Zih + \varepsilon ih \quad \text{----- (2)}$$

Thus, utility ( $Uih$ ) can be derived from the observed variables ( $Zih$ ) and unobserved variables ( $\varepsilon ih$ ). The probability of choosing a house is represented by  $pr(ih)$  which is equal to utility derived from choosing the house with ( $zih$ ) characteristics of house from all other alternatives of housing location with different characteristics ( $Zjh$ ).

Unobserved random variables may enter the determination of utility for each consumer as well as between consumer this is known as psychology as the random utility model. [McFadden, D. (1978)].

Multinomial logit regression can be used only when the dependent variable is nominal in nature. It means that they are categorical and does not follow any sequence of either increasing or decreasing or neither can they be rank in orders. There are four outcomes in our analysis the first outcome is households choose to reside in Mumbai and near to railway station. Second outcome is households choose to reside in Mumbai and far from railway station. Third outcome is households choose to reside outside Mumbai and near to the railway station. Fourth outcome is households choose to reside outside Mumbai and also far from railway station. The households have a set of choices available *i.e.* all four outcomes but he chooses one of them. Thus, the household choose to reside in Mumbai and near to the railway station he rejects the other location. So, the location is based on choice where a household make a decision of residing and choosing a particular location knowing all other location choices.

## **5. EMPIRICAL RESULTS:**

We have analyzed the housing location decision on the basis of housing characteristics, socio-economic and location factors including the travelling time and cost while commuting for work. The multinomial logistic in our analysis is based on four outcomes where generally the last outcome is taken as the reference category or base outcome. For Multinomial logit model the STATA software is been used for estimating the model. The coefficient and estimates are presented in table 1 as below.

Distance to CBD and income have significant impact on choosing a house location for all three outcomes relative to the fourth outcome. The CBD and income are significant at one percent level in choosing a house within Mumbai near to railway station and far to railway station than the significant at five percent level at outside the Mumbai.

**Table 1: Multinomial logistic regression**

Variable	Coefficient	Std. Err.	Z	P> Z
1.				
CBD	-0.5919	0.1164	-5.08	0.000***
Price	2.0697	0.3478	5.95	0.000***
Income	0.9377	0.3353	2.80	0.005**
House Type	-0.1975	0.2473	-0.80	0.424
Area Per Sq.ft.	-0.7620	0.2212	-3.45	0.001***
Nearby School	0.8086	0.4766	1.70	0.090
Nearby Hospital	1.7221	0.7374	2.34	0.020**
Duration of Water supply	-0.6198	0.3322	-1.87	0.062
Toilet Facilities	0.2580	0.5015	0.51	0.607
Parking Facilities	-0.4850	0.4798	-1.01	0.312
Travelling Time	-0.0084	0.0074	-1.15	0.250
Travelling Cost	-0.0006	0.0003	-1.80	0.072
2.				
CBD	-0.4164	0.1284	-3.24	0.001***
Price	2.2457	0.4347	5.17	0.000***
Income	0.8887	0.3674	2.42	0.016**
House Type	-0.1957	0.2745	-0.71	0.476
Area Per Sq.ft.	-0.2666	0.2336	-1.14	0.254
Nearby School	1.1264	0.5408	2.08	0.037**
Nearby Hospital	1.0128	0.7255	1.40	0.163
Duration of Water supply	-0.2574	0.3667	-0.70	0.483
Toilet Facilities	0.1202	0.5736	0.21	0.834
Parking Facilities	-0.6113	0.5407	-1.13	0.258
Travelling Time	-0.0207	0.0096	-2.15	0.032**
Travelling Cost	-0.0003	0.0003	-0.79	0.431
3.				
CBD	-0.1676	0.0864	-1.94	0.052*
Price	0.2727	0.2571	1.06	0.289
Income	0.5423	0.2699	2.01	0.044*
House Type	0.0258	0.2001	0.13	0.897
Area Per Sq.ft.	-0.1179	0.1524	-0.77	0.439
Nearby School	0.9123	0.3771	2.42	0.016**
Nearby Hospital	0.9106	0.5486	1.66	0.097
Duration of Water supply	0.2310	0.2450	0.94	0.346
Toilet Facilities	0.0031	0.3932	0.01	0.994
Parking Facilities	0.4867	0.3696	1.32	0.188
Travelling Time	0.0031	0.0050	0.63	0.531
Travelling Cost	-0.0001	0.0002	-0.37	0.714
4 (base outcome)				
LR chi2(36) = 197.33				
Prob > chi2 = 0.0000***				
Log likelihood = -283.27186				
Pseudo R2 = 0.2583				

*Note:* \*\*\* Significant at one percent level. \*\* Significant at five percent level. \* Significant at ten percent level.

These indicate that households prefer housing location that depends on CBD location and income while choosing to stay inside Mumbai than the outside Mumbai. The prices are significant at one percent level in deciding the location within the Mumbai. The prices are not significant outside the Mumbai as the prices are lower compared to the Mumbai. One of the major reasons could be the unaffordability homes in Mumbai that affects the purchasing and income affordability of the households. Area per sq. ft. and near hospital has the impact in locating within Mumbai and near to the railway station. Duration of water supply, toilet facilities, house type and parking facilities are statistically insignificant in all the location choices. Due to the problem of unaffordable housing, housing shortages and congestion the households are ready to live in slums with lack of living area, lack of access to drinking and sanitation facilities. Housing nearby school has significant impact in both outcomes houses located far from the railway station and houses located outside the Mumbai as it affects the accessibility to school. Travelling time has a significant impact on the housing preferences which are located far from the railway stations. Travelling cost are not significant factor determining as the overall transportation cost in Mumbai Metropolitan region (MMR) is lower due to suburban rail fares are relatively low. Our results found that the distance to the CBD, price of the house and income are most important factors that influence the housing decisions than the house type, duration of water supply, toilet facilities and parking facilities. Area per sq. ft., nearby school, nearby hospital, travelling time are important and but less significant factors compared to the distance to CBD, price and income that influence the location decisions.

## **6. CONCLUSIONS:**

Housing decisions are long term which depends on the many factors which are closely associated with these location decisions. We have tried to analyze the residential location decisions with characteristics of house and attributes related housing choice. Discrete model one of the family multinomial logit models are used for the analysis purpose. We have found that distance to CBD, price of the house and income are significant factors that affect the residential location choice. Other than this factors Area

per sq. ft., nearby school, nearby hospital, travelling time are important, but less significant factors compared to the distance to CBD, price of house and income. Type of house, duration of water supply, toilet facilities and parking facilities are not significant factors in residential location choice. The residents in Mumbai Metropolitan Region (MMR) are forced to live in slums with inadequate living area and lack of access to drinking and sanitation facilities due to unaffordable prices and housing shortages. Thus, household's choices in MMR are not significantly impacted by the type of house as most of the households live in informal housing.

We can conclude that characteristics of house are less important than the attributes located near the house like accessibility to transport facility which affects the access to work, school and hospital. Work places are crucial for the determining the location choice of the house in MMR. Thus, Employment, price of house and income influences residential location choice in Mumbai Metropolitan Region (MMR). Transportation facilities have impact on residential location because households value travelling time than the travelling cost. The travelling cost in MMR is relatively lower due to the suburban railways and is much lower compared to the price of house. Thus, households shift to the outskirts of Mumbai with more space, area per sq. ft., less pollution and affordable prices.

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