Factors Affecting Mode Choice:
A Case Study in Dhaka

By

Sudipto Khatib

Md. Rezwan Azom

Asifuzzaman Sontu

A Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of Bachelor of Science in Civil Engineering

at

The Islamic University of Technology

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ABSTRACT

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Transportation is one of the most important but also hardest-to-solve problems of modern-day cities. In developed countries, the transportation sector contributes a lot to the GDP and its services are a precondition for economic activities as well as leisure activities. It is one of the vital sectors supporting human activity because without any movement it is impossible for people to fulfill their needs; however, the scenario is not the same for developing countries.

 For a city like Dhaka which is one of the least motorized cities in the world, its traffic congestion is one of the highest. Unplanned urbanization, poor transportation planning, and lower land utilization efficiency has turned the city into a dangerous urban jungle. So to clean up this mess new transportation system should be adopted .To make the system adaptable to people it is very important to know about their particular mode of transport they choose for major trip on daily basis. More or less, the choice of transportation mode is affected by many factors such as: gender, income, travel time, convenience, safety etc. All of these factors are related with the socio economic and service attributes. This study identified the factors affecting transportation mode choice from internal factor (traveler aspects) and from the external side (service attributes).This was done by conducting a questionnaire survey

particularly the people who live and work in Dhaka .The questionnaire included both factors from the traveler aspect and service attributes .

Discrete choice model have been developed using the survey data and the the coefficients of the utility functions have been estimated using maximum likelihood approach. In addition to this, graphical analysis has been done to reflect the influence of factors over particular mode of transport.

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Supervisor Signature   **Date**

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CHAPTER ONE

INTRODUCTION

1.1 Background:

The capital city of Bangladesh Dhaka is one of the most populous cities of the world having a population which is exceeding 12 million (Nagari, 2010). Rapid population growth has affected the transportation service and is no longer available to meet the travel demands of this mass population. The most common transport modes in Dhaka city are Public bus, private car, CNG/TAXI, Rickshaw, Bicycle, Tempo etc. The public transport modes of Dhaka consist of double decker bus, single deck large bus, minibus, collective transport (staff bus, school/college/university bus), Tempo, railway etc. A brief overview of the transport systems of Dhaka city is provided below.

Public transports compose the highest number of vehicles and are mostly responsible for movement of the general population of Dhaka city. The majority of vehicle that runs on the road is generally the bus . Although significant portion of other haulers like Tempo, Leguna etc. composes a major portion of Public transport. But they are not providing the up to the mark service due the lack of maintenance.

Several operational weaknesses can be identified in terms of route planning, for example, deficient number of routes, competition of numerous small operators in the same route, absence of fixed schedule and passenger information system, etc Moreover, no advantage is practiced by these buses in terms of separate right of way or signal priority. Also, the bus passengers are vulnerable to accidents, since the bus drivers often carry false driving license leading to increased congestion and indiscipline in the road.

During the last decade the personal automobile ownership expanded rapidly. Although the growth in car ownership did signify strong economic growth and technological innovation, it also contributed to the increasing of traffic jam owing to the lack of routes.

The rail transport scenario is also not good .Although there are 10 stations located within the city from Tongi to Kamlapur in the north region and from Narayangonj to Kamlapur in the south region. The rails in the north region carry small amount of local traffic and that of the south region are grossly underutilized (Hoque and Choudhury, 2009).

The deteriorating traffic conditions are causing increasing delays and worsening air pollution, and seriously compromise the ability of the transport sector to serve and sustain economic growth and quality of life. Traffic congestion is an issue of great concern for the inhabitants of the city resulting in commuter's frustration, longer travel times, lost productivity, increased accidents, more fuel consumption, and deterioration in air quality. A recent study by Roads and Highways Department (RHD) has estimated that, the traffic congestion in Dhaka causes a loss of Taka 19,555cr a year (The Daily Star, 2010).

The externalities of transport are more severe if every individual prefers one transport mode over the other for example choosing car over public transport there has to be a balance otherwise transportation problem will increase. One of the efforts to solve this problem is by improving the transport quality, and to help improve this effort the factors affecting individual to choose mode of transport should be identified. Understanding mode choice is important since it affects how efficiently we can travel, how much urban space is devoted to transportation functions as well as the range of alternatives available to the traveler (Ortu´zar & Willumsen 1999).

The Government has undertaken massive steps for solving transportation problems in Dhaka city. Currently a number of flyovers are being constructed in Kuril Bishwaroad, Jatrabari and Banani Railcrossing. Also, Elevated Expressway is being constructed from Uttara to Motijheel. The Metro rail and other Rapid transport facilities are duly considered by the Government of Bangladesh.

The Government of Bangladesh has taken the policy of implementing Public transport as the primary and main mode of transport for Dhaka city. This policy can be easily ascertained by steps taken such as high import duty on private cars, constructing rapid transport facilities, improving present mass transport facilities like "Shuchona" bus service through PPP(Public

Private Partnership). However, for developing sustainable transportation system, the first step is to know the mode choice pattern of the residents of this city.

1.1 Significance of the Research:

Our study will contribute to the research literature and policy maker in several ways:

1. The principal objective of this research is to predict the mode choice of transportation of general people from different socio economic background.

2. It will extend the research of Habib (2002), DITS (1993), Aftabuzzaman et al. (2010) by examining the probable significant factors that may cause effect on mode choice.

3. It will develop and estimate probability of different factors that affect the particular   mode choice of transportation by using multinomial logit model.

4. Unlike previous mode choice studies, this study incorporates the impacts of socio-economic condition to the mode choice.

5. It is necessary to know the significance of level of service (LOS) attributes, associated trade off and public willingness-to-pay (WTP) for various travel attributes to plan and develop a successful transportation plan of a new transport system. This study although will not include this studies but there are plans to incorporate them in future researches. The study hence will help the decision makers to make decision about new facility or upgrading any old facility by providing information of mode choice preference of general people.

6. In addition to that, the graphical analysis of various socio-economic components for individual mode will help decision maker to understand the perception of individual for their present mode of transport.

1.3 Research Objective:

The purpose of examining transportation needs can be described to recognize the presence of various economic and social classes (user groups) that react differently to transportation systems and have to be served differently.

The overall objective of this research is to develop a mode choice model for Dhaka city using mutinomial logit regression that can capture the significant factors in choosing particular mode based on the socio economic background of the mass population.

In addition this study will also show the perception of user groups on various service attributes for individual modes (e.g. Car, Public Transport , Para transit, Non motorized vehicles).

1.4 Scope of Work:

This research focuses on finding significant factors from different socio economic background of individuals and it is limited to the metropolitan city Dhaka. The reason behind choosing Dhaka city as study area is due to the presence of distinct socio-economic structure characterized by wide differences in affordability and accessibility.

Two types of analysis will be performed. In the first analysis, the effect of socio economic background of individuals on mode choice will be explored. The analysis will give an overall idea about the most significant factors that contributes to the choice of a particular mode.

In the second part graphical representation of different factors related to individual modes will be analyzed which will highlight the response of the users regarding their particular mode of transport used in Dhaka city.

1.5 Thesis Organization:

The thesis is outlined into five chapters. After the introduction in first chapter, the other four chapters will be covered by the following topics:

Chapter 2- Literature Review:

In this chapter, factors associated with mode choice of transport which were studied in the previous research are reviewed. Important information from the previous studies are documented. Limitations of previous studies are identified and new potential factors are incorporated in this study.

Chapter 3- Data and Methodology

The data characteristics and the limitations of the survey data are presented in this chapter, Which are followed by methodology used for statistical analysis. The chapter also describes the basis on which the questionnaire is prepared.

Chapter 4- Estimation of Model Component and Result

This chapter contains the mode choice analysis and graphical representation of various socio-economic components considered in the study. The reasons for considering significant factors derived from the statistical analysis are described in this chapter. The cause of insignificance of **other** factor is also briefly discussed in that chapter.

Chapter 5-Conclusion and Future Research

This chapter describes the summary of the main result .The major contributions of the research and the future research recommendations are also described in this Chapter

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview:

The review of different literature related to previous research on mode choice will be discussed below. As this research is based on Dhaka city, the main focus will be given to the previous research work related to Dhaka city. Significant findings of the research works will be discussed at the end.

2.2 Mode Choice Studies in Dhaka City:

Dhaka is the 11th largest city in the world with a population of about 12 million and per-capita income less than $700/yr (BBS 2010) with settlements dating back to 7th century and development of township dating back to 17th century. However, very few mode choice models have been developed for the city so far. In many cases these mode choice analyses were limited to exploratory analysis of factors affecting travel demand. For example, Ahsan (1990) explored the mass transit (bus) operating conditions (routes, fare, etc.) of the city and identified the bus passenger characteristics (gender, age, income, etc.)

Aftabuzzaman et al. (2010) developed a mode choice model for the work trips of the middle income group of Dhaka city. The primary data source was the house hold interview survey of about 200 people.. The model development was started with three trip attributes i.e. in-vehicle travel time, out of vehicle travel time and travel cost and later coefficients to the travel and socio-economic interaction variables were introduced into the model in terms of travel cost/ household income and out of vehicle travel time/ O-D distance. The research work also presented three policy scenarios in terms of decrease in bus fare, decrease in out of vehicle travel time of bus and the increase in rickshaw fare. All the scenarios resulted in a rise in the modal share of bus and fall in the share of rickshaw and auto rickshaw. It was concluded that, people perceive roughly three out-of-vehicle minutes per minute of in-vehicle

time and the rate of substitution approximates 30 Taka per hour of in-vehicle time which seems to be a generalization for all modes in Dhaka.

The Greater Dhaka Metropolitan Area Integrated Transport Study (DITS, 1993) was an initiative of the Government of Bangladesh with the assistance from United Nations Development Programme (UNDP). The major sources of data for the development of the model were Home Interview Survey (HIS), roadside Origin-Destination (O-D) survey and traffic count survey. The choice among multi-modes was simplified into binary choices between walking versus public transport or rickshaw, car versus public transport or rickshaw and finally rickshaw versus public transport.

Habib (2002) used a traditional four step travel demand model for Dhaka city (Dhaka urban transport model, DUTM) where a modal split model was calibrated using aggregate mode share data. The modes considered for the modeling are rickshaw, car, bus and auto-rickshaw DUTM used three explanatory variables for the mode choice model viz. travel time, travel cost and comfort The parameters of the model were calibrated to get the best match with the observed modal shares. The calibrated coefficients of travel time, travel cost and comfort were 0.06, 0.15 and 0.21 respectively the coefficients of travel time and travel cost were positive which is counter intuitive.

Louis Berger Inc. and Bangladesh Consultants Ltd. (BCL) have conducted a wide scale house hold survey with the financial contribution from World Bank in 2004 to collect RP data from the travelers. In that project a Strategic Transport Plan (STP, 2005) was proposed which followed a traditional four step travel demand modeling procedure For the modal split step the available modes of Dhaka have been divided in two groups, i.e. transit modes and auto modes. Non-motorized modes (rickshaws) were not considered in the modal split model, though rickshaws constitute 37% of the person trip of Dhaka city as reported by the same study (STP, 2005). In the auto mode group cars and taxis were grouped together overlooking their very different attribute values (e.g. running cost, availability, accessibility, etc.). Only two explanatory variables viz. travel time and travel cost were used for the modal split model and three different models were estimated for three income segments of Dhaka city In the middle income segment the people with monthly income of Taka 12,500 to Taka 55,000 were grouped together. But, there are substantial variations in the lifestyle in terms of monthly transport expenditure, car availability in this wide range of income.

2.3 Limitation of Previous Studies and Possible Future Extensions:

All the models discussed above was adopted to improve the transport condition as well to get an overview of the factors contributing to different mode choice .But none of them was fully effective due to some limitations. For example Ahsan's model only considered a limited number of socio-economic parameters. Only 3 attributes of users were considered for evaluating the socio-economic features whereas a number of factors may significantly affect the mode choice of individuals.

Also Aftabuzzaman (2010) analyzed with only three modes i.e. rickshaw, bus and auto rickshaw were considered in the multinomial logit model development. But Private Car was not considered in the study which is one of its major limitations.

DITs(1990) predicted 60% trips for Dhaka city to be walking trips, which seems unrealistically high. For a city like Dhaka trips generated by various modes should be more or less in parity.

According to Habib(2002) the coefficient for comfort was greater than that of time and cost implying that the people are more sensitive towards the comfort provided by the mode than the travel time and travel cost of the mode . However, other factors are not considered.

In the louise berger inc and BCL survey(2003) shows that the absolute values of the time coefficient was greatest for the low income group of people and were smallest for the high income group of people implying that the low income people are more sensitive towards travel time than the high income people which is counterintuitive.

From the above discussion, it is clear that not much socio-economic and demographic features of individuals were examined in the previous studies while exploring their relationship with mode choice.

CHAPTER THREE

DATA AND METHODOLOGY

3.1 Overview:

In this chapter, Data used for the model development is described . In addition to that the preparation of questionnaire, problem faced and limitation of model is also discussed .This chapter also contains the description methodology that has been used to do statistical analysis

3.2 Main Steps in Methodology:

In order to achieve the objectives of the study, statistical model need to be developed. The models will be developed using socio-economic data which was collected by performing a survey on people from different socio-economic background. As it was necessary to reflect the total population of Dhaka city, the survey of at least 600 samples was needed to be conducted.

Then statistically significant socio-economic factors affecting mode choice by user groups were identified by the analyzing survey data.

The major steps to achieve the objectives were as follows:

1. The questionnaire was prepared by going through different Literature and using engineering judgment. The aim of the questionnaire was to know about the travelers socio economic background and the various problems faced in choosing a particular type of transport.

2. Collection of the socio-economic survey data from travelers aspects and service attributes and processing of those data to develop a discreet model and utility functions.

3.   The Data collected will be analysed using Statistical analysis (Multinomial Logit Regression) to identify the significant factors. Also relative graphical representation will help evaluating the service attributes of the individual modes.

3.3 Description of Data:

In order to develop utility function for mode choice analysis , a data set is needed that includes the relevant socio-economic, demographic factors such as age, gender, income range, profession, housing condition, no. of family members etc .

Fig 1: Map of Dhaka city

The survey data was obtained by conducting a survey of general people of Dhaka city from different location keeping in mind the socio economic background. For example, Data were

collected from all the 15 Thanas in Dhaka city. Also an approximation was used as to what percentage of students, service holders, businessman, housewife, manual worker will be interviewed from different locations of Dhaka city. The prime target areas for different Areas/Thana's were its significant bus stop, shopping mall, marketplace, schools, colleges, government installments and office buildings, industry, private facilities etc. The accuracy of the data was largely depended on the perception and understanding the questionnaire and response to that.

The questionnaire was divided into two parts. The first part includes the general information of individuals and the second part included the questions of individual mode choice .The first part was common for all and the second part was specific to individual user depending on their mode choice. The second part was subdivided into four subcategory based on the different mode such as private transport, public transport, para transit and non-motorized vehicles .

3.4 Statistical model for mode choice analysis:

3.4.1 Multinomial Logit Model:

The mode choice of transport by an individual based on socioeconomic and demographic factors could involve complex decision making processes which are context-dependent, where the context can be classified into individual-specific context, alternative-specific context and circumstantial context.

The most common model for mode choice of an individual is Multinomial Logit Model (MNLM) which is used to ascertain individuals mode choice preference under various mode availability options. The objective of the multinomial logit (MNL) model is to estimate a function that determines outcome probabilities. As an example, for choice models based on utility theory this function is the indirect utility.

The basic technique for development of multinomial logit model is to construct a linear prediction function.

That is

$$\text{Score } f(k,i) = \beta_{0,k} + \beta_{1,k}.x_{1,i} + \beta_{2,k}.x_{2,i} + ... + \beta_{M,k}.x_{M,i}$$

where X_i is the vector of explanatory variables describing observation i, $_k$ is a vector of weights or regression coefficients corresponding to outcome k.

Specifically, it is assumed that we have a series of N observed data points. Each data point i (ranging from 1 to N) consists of a set of M explanatory variables $x_{1,i}$ ... $x_{M,i}$ (aka independent variables, predictor variables, features, etc.), and an associated categorical outcome Y_i (aka dependent_variable, response variable), which can take on one of K possible values. These possible values represent logically separate categories (e.g. different political parties, blood types, etc.)

$$f(k,i) = \beta_{0,k} + \beta_{1,k}.x_{1,i} + \beta_{2,k}.x_{2,i} + ... + \beta_{M,k}.x_{M,i}$$

Where $\beta_{M,k}$ is a regression coefficient.

The goal of multinomial logistic regression is to construct a model that explains the relationship between the explanatory variables and the outcome, so that the outcome of a new "experiment" can be correctly predicted for a new data point for which the explanatory variables, but not the outcome, are available.

Then for obtaining the probabilistic value of a definite choice with respect to others can be given as:

$$P(Y_i) = \frac{e^{Y_i}}{\sum_{n=1} e^{Y_k}}$$

The advantage of MNLM is the difference between this model and numerous other methods, models, algorithms, etc. which is the procedure for determining the optimal weights/coefficients and the way that the score is interpreted. In particular, in the multinomial logit model, the score can directly be converted to a probability value. But if the multinomial logit is used to model choices, it relies on the assumption of independence of irrelevant alternatives (IIA), which is not always desirable. This assumption states that the odds of preferring one class over another do not depend on the presence or absence of other irrelevant alternatives.

CHAPTER FOUR

ESTIMATION OF MODEL COMPONENT AND RESULT

4.1 Overview:

This chapter focuses on the analysis of the survey data for model development .The main objective of the mode choice analysis is to determine the socio-economic factors based on which individual chooses a particular mode of transport. The secondary objective was to explore factors relationship for individual mode based on percentage analysis.

4.2 MODEL DEVELOPMENT:

4.2.1 Mode choice model analysis:

Since mode choice analysis provides a discreet outcome, so multinomial logit regression technique has been implemented. The reasons for choosing this model, it's assumptions and mathematical formulations of it are detail presented and discussed in previous chapters.

In this study ,four competitive main modes (i.e private car ,public transport, CNG/Taxi ,NMV) have been considered whether all the modes may or may not be available in the choice set for any individual i ,Then for example the probability equation for each individual I can be written as:

$$u_{bus} = \beta_{\cos t} * Cost_{bus} + \beta_{time} * Time_{bus} + \beta_{comfort} * Comfort_{bus}$$

Based on survey data , 56 variables from 15 factors were considered in this study. The omitted variables include O-D ,people age group 8-18, profession such as businessman, housewife, manual worker ,temporarily unemployed ,family income less than 15000, major travel purpose (shopping ,education). And the omitted factors are level of education and number of family members After some preliminary analyses, 22 variables from 13 factors are retained in the final model.

The estimation results for the multinomial logit regression models are shown in Table. In

general, the models fitted the data well, with large chi-square statistics for goodness-of-fit. The over-dispersion parameters ( ) in the model were statistically significant (p-value < 0.1) which showed the validity of using the multinomial logit model. In this study, any variable with a ninety percent confidence level was considered to be marginally significant and retained in the models.

4.2.2 Estimation Results:

TABLE 1: LOGISTIC REGRESSION STATISTICS FOR MODE CHOICE						
Number of Observation= 486						
Log Likelihood = -295.66768						
Chi-square= 235.63						
P-value < 0.1						
	CAR		**CNG/TAXI**		**NMV**	
VARIABLES	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Gender	-0.60	0.205215	-2.86	0.0339	-1.8799	0.06655
Age 19-28	omitted	Omitted	Omitted	Omitted	-4.329	0.01158
Age 28-40	omitted	Omitted	Omitted	Omitted	-1.69	0.1506
Age 40-60	omitted	Omitted	Omitted	Omitted	-2.59	0.0674
Service holder	-1.183	0.12652	Omitted	Omitted	Omitted	Omitted
Student	-0.159250	0.06972	Omitted	Omitted	Omitted	Omitted
Income 5000-15000	Omitted	Omitted	Omitted	Omitted	-1.900	0.11879
Income 15000-30000	Omitted	Omitted	2.3899	6.6185	Omitted	Omitted
Income 30000-50000	-1.003	1.5773	Omitted	Omitted	Omitted	Omitted
Income >50000	1.299	1.5464	Omitted	Omitted	Omitted	Omitted
F.Income 30000-50000	Omitted	Omitted	2.674	12.67515	Omitted	Omitted
F.Income >50000	1.8829	2.2366	2.644	11.5141	Omitted	Omitted
Distance travel 6-10 km	0.621	0.58882	Omitted	Omitted	-3.91	0.0121
Distance travel 11-20 km	Omitted	Omitted	Omitted	Omitted	-2.64	0.0489
P. Job	-1.167	0.155371	Omitted	Omitted	-1.11	0.1671
P.Recreation	Omitted	Omitted	1.7888	4.84	-2.866	0.056
MPU traffic jam	Omitted	Omitted	Omitted	Omitted	-1.967	0.0617
MPU expensive	1.768	3.299536	3.979	37.939	Omitted	Omitted
MPU failure schedule	-1.829	0.0960	Omitted	Omitted	-2.023	0.0731
LP 5-10 yrs	Omitted	Omitted	Omitted	Omitted	-0.9269	2.177
LP >15 yrs	-1.077	1.061	Omitted	Omitted	0.988	1.2433
Housing condition	1.0876	0.83625	Omitted	Omitted	Omitted	Omitted
Switch to new mode	-0.916	0.1325	Omitted	Omitted	0.940	1.1099

In the model analysis, the base outcome is taken as public transport. As such the coefficients of all the dependent variables in the case of other outcomes (private car, CNG/Taxi, NMV) are derived in reference to public transport. Let us consider a scenario where the coefficient obtained for a dependant variable in case of any other mode is negative , it implies that in case of increase of the vector (or value) of that variable results in a net decrease of the probability of choosing that particular mode over public transport . Alternately a positive value of a variable would imply that an increase in that variable would increase the probability of choosing that mode of transport.

In case of car, variables that have positive coefficient are income greater than 50000 taka , family income greater than 50000 taka , distance travel 6-10 km ,housing condition which indicate that the increase in vector will increase the probability of choosing car over public transport .On the other hand negative vector values of variables such as gender, service holder ,student etc indicate that potential increase of them will cause decrease th probability of choosing private car over public transport.

In case of para-transit (CNG/Taxi), variables that have positive coefficient are income 15000-30000 taka , family income 30000-50000 taka ,family income greater than 50000,purpose of travel (recreation) which indicate that the increase in vector will increase the probability of choosing CNG/Taxi over public transport .On the other hand negative vector value of variable such as gender indicates that potential increase of that will cause decrease the probability of choosing CNG/ Taxi over public transport.

In case of NMV, variable that have positive coefficient is living period in Dhaka greater than 15 years which indicate that the increase in vector will increase the probability of choosing NMV over public transport .On the other hand negative vectors value of variable such as gender, people age etc indicate that potential increase of them will cause decrease the probability of choosing NMV over public transport.

Therefore the derived utility functions for different mode of transport are:

For CAR,

$$u_{car} = 0.7350979 - 0.60 * Gender_{car}$$
$$-1.183 * Serviceholder_{car} - 0.15925 * Student_{car}$$
$$-1.003 * Income_{30000-50000_{car}} + 1.299 * Income_{>50000_{car}} + 1.8829 * F.inc_{>50000_{car}} + 0.621 * dist_{6-10_{car}} - 1.167 * p.job_{car}$$
$$+1.768 * MPUex_{car} - 1.829 * Mpu.Fail.s_{car} - 1.077 * LP_{>15_{car}}$$
$$-1.0876 * hous.c_{car} - 0.916 switch_{car}$$

For CNG/TAXI,

$$u_{taxi} = 0.0324136 - 2.86 * Gender_{taxi} + 2.3899 * Income_{15000-30000_{taxi}} + 2.674 * F.inc_{30000-50000_{taxi}} + 2.644 * F.inc_{>50000_{taxi}}$$
$$-1.788 * p.recreation_{taxi} + 3.979 * MPUex_{taxi}$$

For NMV,

$$u_{NMV} = 238.9307 + 0.06655 * Gender_{NMV} + 0.0115 * Age_{19-28_{NMV}}$$
$$+0.1506 * Age_{28-40_{NMV}} + 0.0674 * Age_{40-60_{NMV}} + 0.11879 * Income_{5000-15000_{NMV}}$$
$$+0.0121 * Dist_{6-10_{NMV}} + 0.0489 * Dist_{11-20_{NMV}} + 0.1671 * P.job_{NMV}$$
$$+0.056 * P.recreation_{NMV} + 0.061 * 7 MPUt.jam_{NMV} + 0.0731 * MPUFail_{NMV} + 2.177 * LP_{5-10_{NMV}}$$
$$+1.2433 * LP_{>15_{nmv}} + 1.1099 * Switching_{NMV}$$

4.3 Analysis of individual modes on the basis of perception of users:

Car:

Table 2: Data inventory for car (service attributes)		
Total Response Count	190	**Fig 2: Response of Service Attributes**
Answer Options	Response Count	
Security	68	
Accessibility	12	
Time of Travel	11	
Comfort	98	

Summary: The respondents of the survey was asked that why do they prefer personal car over other mode of transport. The following answer options were given. The majority of the respondents were counted in favour of comfort (52%) and security(36%) getting second highest priority.

TABLE 3 :Survey data related to driving license for Car		
Total Count	190	
Answer Options	Response count	
Yes	76	
No	114	

Figure 3: Response to driving License

Summary: The respondents of the survey were inquired about their driving license. The answer options were given as "YES" or "NO". The response indicated majority of car users have personal drivers. The percentage of "NO" was 60%.

TABLE 4:Survey Data for Car ownership		
Total Count	190	
Answer Options	Response Count	
1	137	
2	44	
Above 2	9	
		Figure 4 :Response to car ownership

Summary: The number of car possession by the users were estimated and response counted for single(1) car was dominant(72%).

TABLE 5:Survey data for Driving condition		
Total Count	190	
Answer Options	Response Count	
Driver	148	
Self	42	

Figure 5: Response to Driving condition

Summary: Also respondents were inquired about whether they personally drive their car or not. Majority of the feedback came in favour of using drivers(78%) instead of self-drive(22%)

TABLE 6: Survey Data for type of Fuel used

Total Count	190
Answer Option	Response Count
Octane	46
Diesel	0
CNG	6
CNG+ OCTANE	133
Patrol	11
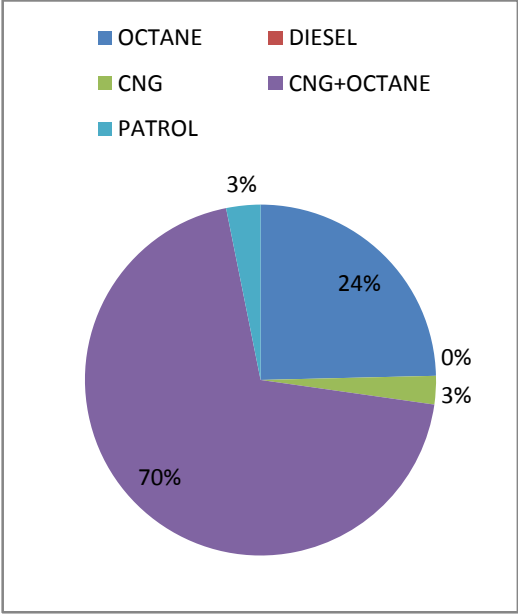
Figure 6: Response to type of fuel used

Summary: The respondents were asked about the fuel use. Majority of the interviewee(70%) indicated use of combination of CNG and OCTANE.

TABLE 7: Survey Data for Major Problem faced by Private Car User		
Total Count	190	
Answer Option	Response Count	
Price Hike Of Fuel	93	
Price Hike Of Repairing And Spare Parts	11	
Lack Of Parking Facility	32	
Congestion	54	
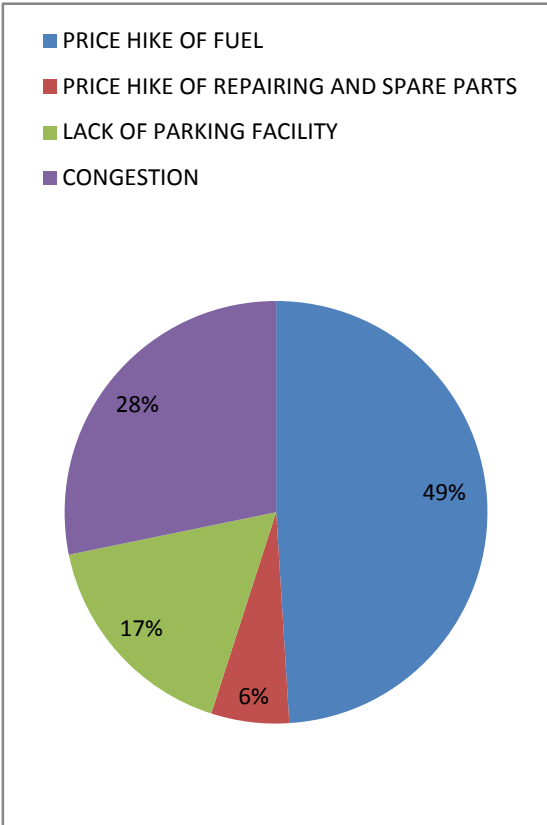
Figure 7: Representation for Major Problem faced by Private Car User

Summary: The respondents were asked the major constraints they face in using private car as mode of transport. Price hike of fuel had the highest percentage of vote(49%).

TABLE 8: Survey Data for private car users about switching to new mode		
Total count	190	Figure 8: Response for private car users about switching to new mode
Answer options	Response count	
Improvement of socio-ecomic condition/Negative	112	
Improvement of transport facility	78	
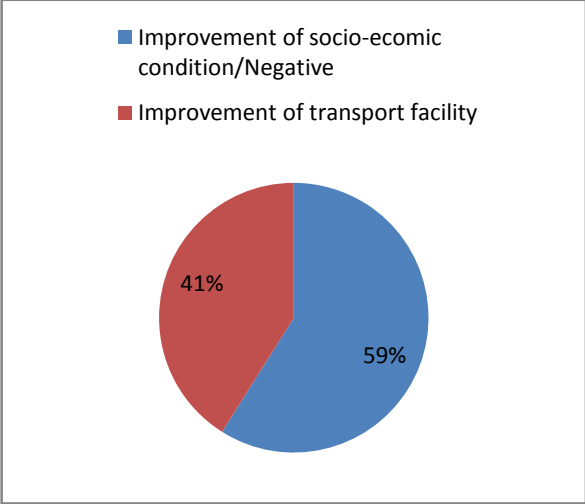
Summary: The respondents were asked that whether they want to switch to another mode of transport if following answer options were possible. Majority (59%) answered in favour of not changing their existing mode.

Public Transport:

TABLE 9: Survey Data for Type of Public Transport used		
Total Count	278	
Answer Option	Response Count	
Local Bus	186	
Sitting Service	86	
Tempo	6	
		Figure 9: Response to type of Public Transport used

Summary: The public were inquired about which type of public transport they use. Majority of the response came in favour of local bus(67%)

TABLE 10: Survey Data for Distance Traversed from Residence to the Nearest Bus Stop	
Total Count	278
Answer Count	Response Count
0-50m	72
50-200m	142
200-500m	44
Above 500m	20

Figure 10: Response for Distance Traversed from Residence to the Nearest Bus Stop

Summary: The interviewee's were asked about the distance they have to traverse from residence to the nearest bus stop. The outcome was 51% in favour of 50-200m.

TABLE 11: Survey data for the distance they have to traverse from bus stop to their destination		
Total Count	278	
Answer Count	Response Count	
0-50m	67	
50-200m	125	
200-500m	75	
Above 500m	11	

Figure 11: Response for the distance they have to traverse

Summary: The interviewee's were asked about the distance they have to traverse from bus stop to their destination. The outcome was 45% in favour of 50-200m.

TABLE 12: Survey Data for Major Problem Faced in Public Transport

Total Count	278
Answer Options	Response Count
Poor Maintenance	36
High Accident Risk	28
Lack of Manners & Misconduct	53
High Frequency of Pick-Pocketing	11
Over Crowded	3
Failure of Schedule Maintaining	147

Legend:
- POOR MAINTAINANCE
- HIGH ACCIDENT RISK
- LACK OF MANNERS AND MISCONDUCT
- HIGH FREQUENCY OF PICK-POCKETING
- OVER CROWDED
- FAILURE OF SCHEDULE MAINTAINING

Figure 12: Response for Major Problem Faced in Public Transport

Summary: The respondents were inquired the major problem they face in public transport. Failure of schedule maintaining got highest number of response(53%).

TABLE 13: Survey Data for Schedule Maintaining in Public Transport

Total Count	278
Answer Options	Response Count
Yes	11
No	206
Sometimes	61
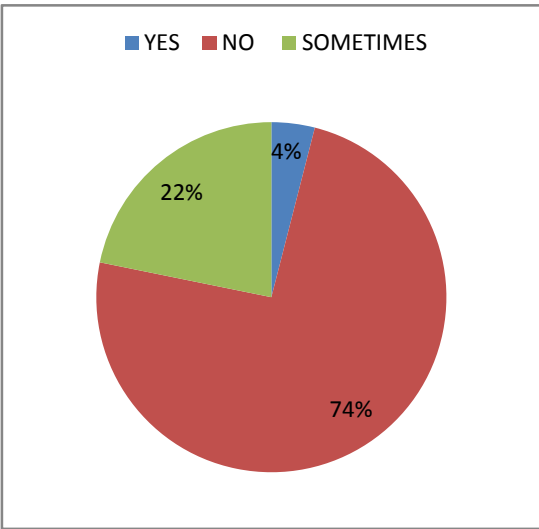
Figure 13: Response for Schedule Maintaining in Public Transport

Summary: The interviewee were asked where they get public transport on time or not. 74% gave their response in favour of "NO".

TABLE 14: Survey Data for public transport users about switching to new mode		
Total count	278	
Answer options	Response count	
Improvement of socio-ecomic condition	78	
Improvement of transport facility	200	
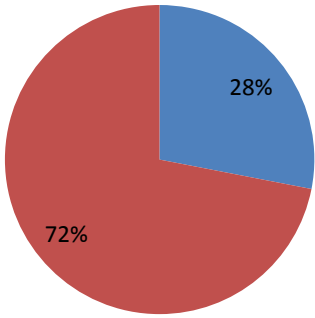
Figure 14: Survey Data for public transport users about switching to new mode

Summary: The respondents were asked that whether they want to switch to another mode of transport if following answer options were possible. Majority (72%) answered in favour of changing their existing mode if improved transport facilities are provided.

CNG:

TABLE 15: Survey Data for how far respondents have to travel to get a CNG/TAXI		
Total Count	37	
Answer Options	Response Count	
0-20 m	16	
20-100 m	10	
100-400 m	10	
Above	1	
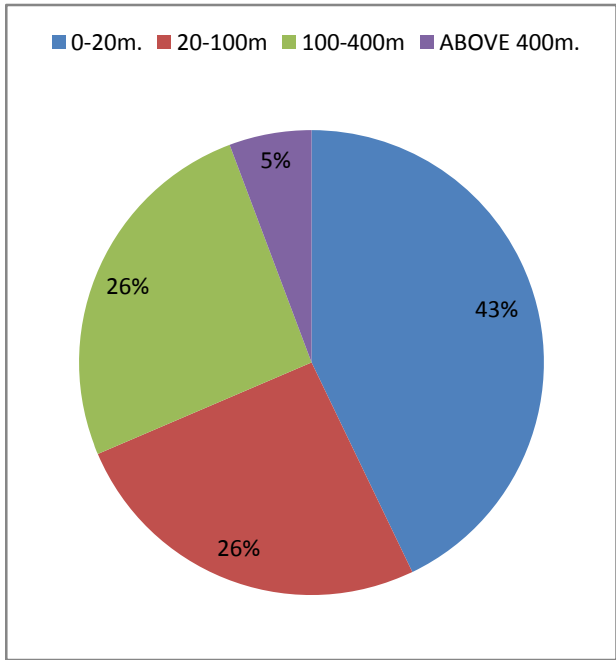
Figure 15: Response for how far users have to travel to get a CNG/TAXI

Summary: The respondents were asked how far they have to travel to get a CNG/TAXI. The result showed variation between 0-20m, 20-100m, 100-400m.

TABLE 16: Survey Data for Fair Selection	
Total Count	37
Answer Options	Response Count
Negotiation	5
Meter	32
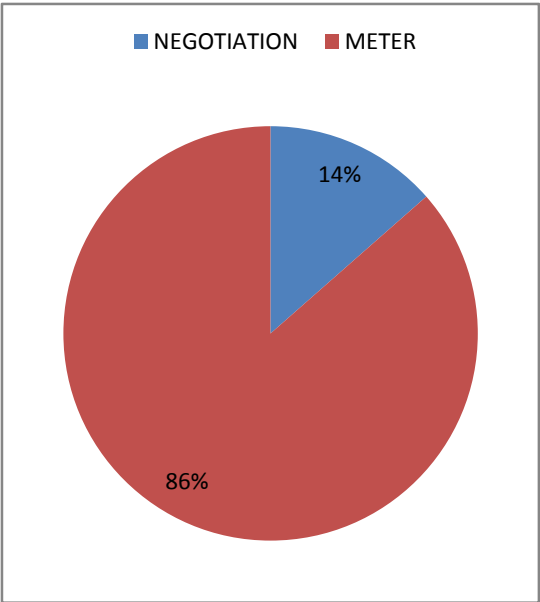
Figure 16: Response for Fair Selection

Summary: The respondents were asked whether they prefer negotiation or Meter reading for fair selection. 86% of the para-transit users responded in favour of Meter reading.

TABLE 17: Survey Data for Major Problem Faced in CNG/TAXI		
Total Count	37	
Answer Options	Response Count	
Fluctuation of Trip Fare	14	
Lack of Personal Security	4	
High Accidental Risk	0	
Poor Behavior of Driver	2	
Poor Vehicle Maintainance	0	
Less availability / Frequency /Less number of vehicles	17	
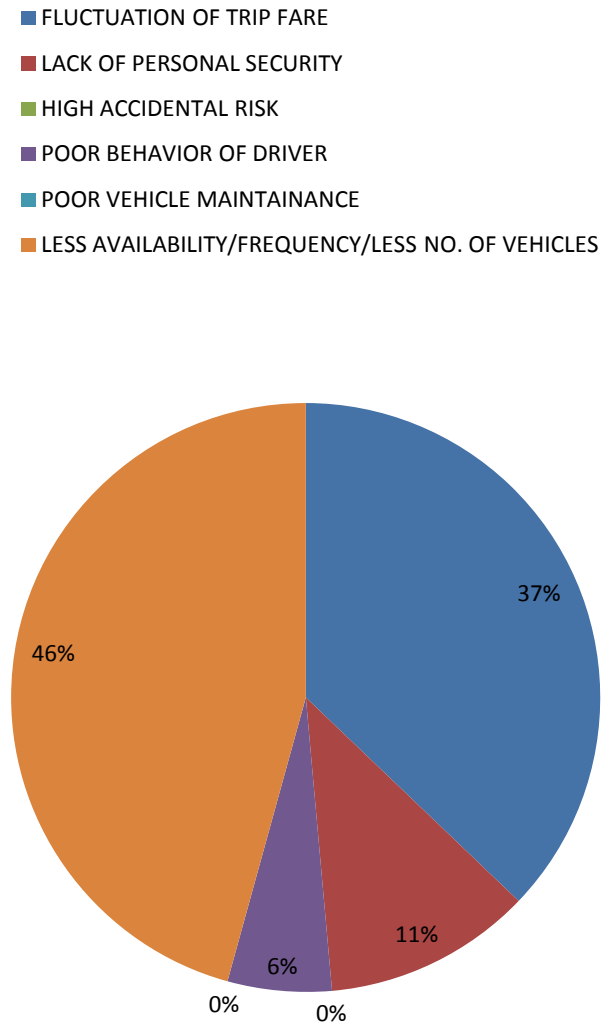
Figure 17: Response for Major Problem Faced in CNG/TAXI

Summary: The respondents were asked about the major problem they face in Para-transits. 46% and 37% voted for less availability and fluctuation of trip fare.

TABLE 18: Survey Data for CNG/TAXI users about switching to new mode		
Total count	37	
Answer options	Response count	**CNG/TAXI**
Improvement of socio-ecomic condition	12	
Improvement of transport facility	25	Figure 18: Survey Data for CNG/TAXI users about switching to new mode
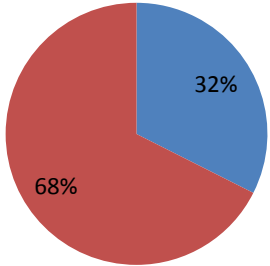
Summary: The respondents were asked that whether they want to switch to another mode of transport if following answer options were possible. Majority (68%) answered in favour of changing their existing mode if improved facilities are provided.

Walking/ Rickshaw/ Bicycle:

TABLE 19: Survey Data for time of walking/Rickshaw/Bicycle		
Total Count	95	
Answer Options	Response Count	
During Peak Time	75	
During Off-Peak Time	18	
During Intermediate Time	2	
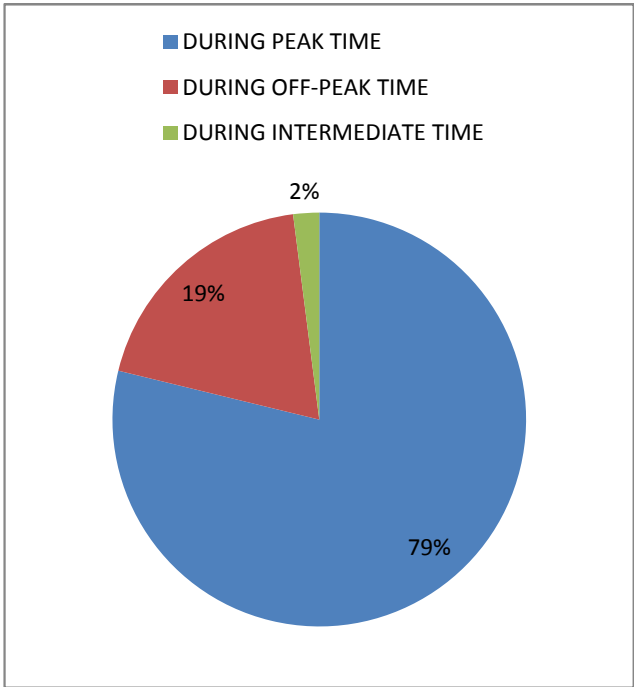
Figure 19: Response for time of walking/Rickshaw/Bicycle

Summary: The interviewee's were asked about which time of the day they usually walk/use Rickshaw or use Bicycle. 75% responded in favour of "During Peak Time."

TABLE 20: Survey Data For Reason of Using NMV(Non-motorized vehicle)		
Total Count	95	
Answer Options	Response Count	
Relatively Cheap	19	
Environment Friendly	21	
Good For Health	29	
Convenient for Reaching Destination	26	

Figure 20: Response For Reason of Using NMV(Non-motorized vehicle)

Summary: The reason for choosing NMV were asked to the users and the answers varied dispersely between all four answer options with 30% answering in favour of "good for health".

TABLE 21: Survey Data for Major Problem Faced in NMV(Non-motorized vehicle)	
Total Count	95
Answer Options	Response Count
Lack of pedestrian crossing facility etc.	16
Lack of pedestrian barrier & medians.	11
High Frequency of Vehicles	44
Lack of Personal Security	24

- LACK OF PEDESTRIAN CROSSING FACILITY,INDIVIDUAL LANE ETC.
- LACK OF PEDESTRIAN BARRIER & MEDIAN
- HIGH FREQUENCY OF VEHICLES
- LACK OF PERSONAL SECURITY FROM PICKPOCKETS, HIJACKERS ETC.
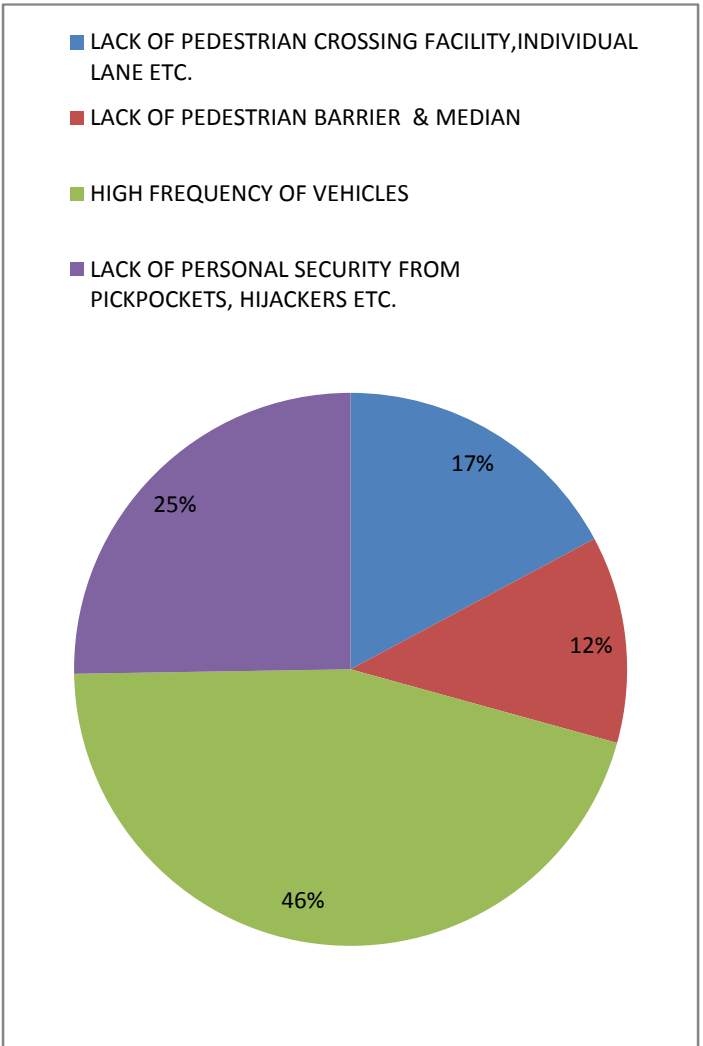
Figure 21: Response for Major Problem Faced in NMV(Non-motorized vehicle)

Summary: The users were asked about the major problem they face in using NMV. 44% voted in favour of "High frequency of Vehicles".

TABLE 22: Survey Data for Walking/ Rickshaw/ Bicycle users about switching to new mode

Total count	95
Answer options	Response count
Improvement of socio-ecomic condition	65
Improvement of transport facility	30

Rickshaw/Walking/Bicycle

- Improvement of Economic Condition
- Improvement of Public Transport Facilities

32%

68%

Figure 22: Survey Data for Walking/ Rickshaw/ Bicycle users about switching to new mode

Summary: The respondents were asked that whether they want to switch to another mode of transport if following answer options were possible. Majority (68%) answered in favour of changing their existing mode if improved facilities are provided.

Chapter Five

CONCLUSION AND FUTURE RESEARCH

5.1 Summary of Main Results:

In summary, the results from Multi Nomial Logit Model analysis suggest that factors, such as income,gender,housing condition etc have significant effect in choosing a particular mode. Therefore, for designing a efficient transport facility policy makers, designer and developers should incorporate these factors into account while planning for a new facility or upgrading a old transport facility.

The developed model helps to determine the probability of choosing a particular mode for a particular situation over other mode of transport .All though the fitness of this developed model is totally depended on the response of the general public. As mentioned earlier ,for this 600 data samples were collected randomly which might not reflect the total population of Dhaka city and their perception   .

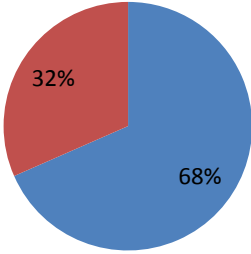The second part of the analysis represented the perception of users of various modes. This representation helps in identifying various attributes which if improved may significantly the enabling of a newly co-ordinated and developed transportation plan. Also the analysis provides a overview of the existing travel pattern and condition in Dhaka City.

The findings of this research can be useful for Dhaka Transport Coordination Board as well as private players trying to implement a rapid transit system to improve the traffic situation in Dhaka City.

However, this study has several limitations. To capture the entire heterogeneity of the population, more dispersed collection of data from different locations of Dhaka City should be considered. Further, the model created in this project is based on the basic multinomial

logit, and it can be improved by studying other kind of models such as mixed logit models which have more flexible error structures.

5.2 Future Research & Recommendation:

The study has dealt with socio economic and demographic factors to understand the mode choice behavior. The following recommendations can be taken into consideration to increase the dependability of the developed mode choice model.

(i) It would be beneficial to look at the proportion of people and their respective travel pattern from one location to another in Dhaka City. This information would provide an idea of the importance of a regional transit system and which areas are most in need of connection by public transit.

(iii) More advanced model structures (nested logit, cross nested logit, mixed logit) models can be estimated to better forecast the mode choice behavior. The effects of attitudes and perception on the mode choice of the respondents can also be explored.

(iv) "Ridership" may be defined as the number of persons who ride a system of public transportation. In our model Ridership was not considered. Ridership can be estimated in the future using population synthesis. Estimation and evaluation of Ridership of various modes of transport in Dhaka city may significantly assist in an effective transportation plan.

(v) Comprehensive demand model can be developed by incorporating trip generation, trip distribution and trip assignment steps of the four step model with the mode choice model to better forecast the ridership of the diverse existing and proposed new modes such as Metro rail, elevated expressway for Dhaka city.

(vi) In this research, people's willingness to pay (WTP) has not been calculated , WTP for travel time can have significant effect on mode choice behavior other attributes like comfort, cleanliness of the vehicles, air-condition in the vehicles can be calculated by the design of more robust SP survey. Also, computer based adaptive surveys can be designed to present personalized choice scenarios to respondents.

(viii) A market segment refers to a subgroup of the respondents who share one or more characteristic that causes them to have similar needs. A market segmentation test is performed to verify whether a market segment in the model is significant. There can be several different market segments according to socio-economic characteristics of the respondent. In our model no market segmentation was considered. In future research its addition may significantly increase its accuracy.

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APPENDIX

ISLAMIC UNIVERSITY OF TECHNOLOGY

Dept. of Civil & Environmental Engineering

[Hello. I am a Civil Engineering student at the Islamic University of Technology. I am conducting interviews to collect information for a class project. The survey is about <u>The Factors Affecting Mode Choice</u>. Participation as a respondent is entirely voluntary. You can stop the interview at any time and can choose to not answer any question or questions. The interview is entirely anonymous. You are not asked for any name or address information – and no such information is sought – in order to ensure anonymity.]

Interview No: _____   *Date:* _____

(Please answer the following questions)

1. What is your Gender?

    Male   Female

2. Which age group do you belong?

    8-18   19-28   28-40   40-60   Above 60

3. What is your Profession?

    Service holder (Government/Private)   Businessman   Student

House wife.   Manual   Worker   (Garments/Industrial/Day labourer)

Temporarily Unemployed.

4. How many Family members do you have?

1-3   4   5   Above 5

5. Your monthly Income?

< 5000   5000-15000   15000-30000   30000-50000

>50000

6. What is your family income ?

< 5000   5000-15000   15000-30000   30000-50000

>50000

7. Distance travelled everyday for major purpose from origin to destination?

0- 5 km   6- 10 km   11-20 km   above 20 km

8. What is the Major purpose of your travel?

Shopping   Job   Education   Recreation

9. What is your major mode of transport you use on daily basis?

Private Car   Public Transport (bus /mini bus/tempo)   CNG/ Taxi

Motor cycle   Non Motorized Vehicle (Rickshaw /Bicycle)

(Assuming the following options are considered to be the reasons behind choosing your transport. How would you order them in a scale of 1 to 6 in terms of importance to you, where 1 represent the highest preference? Note: Don't use one number more than once)

Security   1   2   3   4   5   6

Comfort   1   2   3   4   5   6

Reliability   1   2   3   4   5   6

Accessibility   1   2   3   4   5   6

Cost   1   2   3   4   5   6

Travel Time   1   2   3   4   5   6

9. Your level of Education?

Primary   Secondary   University   Post Graduate

Vocational/Technical training   Received no formal educatio

10. What are the problems you face using your major mode of Transport?

Traffic Jam   High accident Probability   Relatively expensive

Failure to maintain schedule

11. How long have you been living in Dhaka?

    0-5 year   5-10 years   10-15 years   Above 15 years

12. What is your housing condition?

    Owned   Rented

13. Your Major trip daily starts

    FROM----   **TO-----**

(Answer the following questions if your major mode of transport is car)

1. Why do you prefer personal car over other mode of Transport?

    Security   Accessibility   Time of Travel   Comfort

2. Do you have a driving license?

    Yes   No

3. How many cars do you have?

    1   2   above 3

4. Your car is driven by…

   Driver   Self

5. Which kind of fuel do you use for car?

   Octane   Diesel   CNG   CNG+OCTANE
Patrol

6. Which Problem do you feel to be the major obstruction for private car use?

   Price hike of fuel   Price hike of repairing and spare parts

   Lack of Parking facility   Congestion

7. Would you like to switch to a new mode of transport from your current one if there
   is

   Improvement of your economic condition
   Improvement of public transport facilities (i.e. metro rail) where cost does not
   matter

***(Answer the following questions if your major mode of transport is Public
Transport)***

1. Which type of Public transport do you use?

   Local Bus   Sitting service   Tempo

2. How far is the nearest bus stop from your residence?

0-50m   50-200m   200-500m   Above 500 m

3. How far is the nearest Bus stop from your destination?

   0-50m   50-200m   200-500 m   Above 500 m

4. What are the Major problems of Public Transport in Dhaka city?

   Poor Maintenance   High Accident Risk
   Lack of Manners and Misconduct   High Frequency of Pick pocketing
   Over crowded   Failure of schedule maintaining

5. Do you get your Bus as expected time?

   Yes   No   Sometimes

6. Would you like to switch to a new mode of transport from your current one if there is

   Improvement of your economic condition
   Improvement of public transport facilities (i.e. metro rail) where cost does not matter

(Answer the following questions if your major mode of transport is CNG/TAXI)

1. How far do you need to travel to hire CNG/TAXI?

   0- 20 m   20 -100 m   100 – 400 m   Above

2. When it comes to CNG/TAXI fare what do you prefer?

   Negotiation   Meter

3. What are the Major problems you face using CNG/TAXI ?

Fluctuation of Trip fare
Lack of personal security
High accidental risk
Poor behaviour of driver
Poor vehicle maintenance
Less availability / Frequency /Less number of vehicles

4. Would you like to switch to a new mode of transport from your current one if there is

Improvement of your economic condition
Improvement of public transport facilities (i.e. metro rail) where cost does not matt

(Answer the following questions if your major mode of transport is Walking/rickshaw/bicycle)

1. What is the hour of the day you walk usually ?

During peak time [From 8.30am -10.30am & 5.00pm -7.30pm]
During off –peak time [From 12.30pm -3.00pm & 9.30pm -11.00pm]
During intermediate time [From 3.00pm -5.00pm & 7.30pm -9.30pm]

2. Why do you prefer walking / riding rickshaw /bicycle over other transport ?

Relatively cheap.
Environment friendly.
Good for health.
Convenient for reaching to the destination point for complex road network of Dhaka city.

3. What are problems do you face usually while walking /riding rickshaw / bicycle?

Lack of pedestrian crossing facility, lack of individual lane for rickshaw or bicycle.
Lack of pedestrian barrier & medians.
High frequency of vehicles.
Lack of personal security from pickpockets, hijackers, burglars etc.

4. Would you like to switch to a new mode of transport from your current one if there is

Improvement of your economic condition

Improvement of public transport facilities (i.e. metro rail) where cost does not matter .