# Development of Valuation Model for Residential Property, integrating Self-declaration, Dhaka City.

Mizanur Rahman

March, 2006

# Errata for the thesis

The typing mistakes from the thesis ‘Development of Valuation Model for Residential Property, integrating Self-declaration, Dhaka City’ would be corrected in following ways.

## Chapter 3

- Page 21, section 3.5.2: Change "Appendix - A" to "Appendix - C".
- Page 23, section 3.6.2: Change “Figure 3-5” to “Figure 3-3.”
- Page 25: section 3.8: Change "Appendix - B" to "Appendix - A".

## Chapter 4

- Page 31, section 4.4: Change "Appendix - C" to "Appendix - B".

## Chapter 6

- Page 50, section 6.4: Change "Table 6-4" to "Figure 6-1" and “Table 6-5” to “Figure 6-2.”
- Page 52, section 6.5.1: Change "Eskaton" to "Mogh Bazar"
- Page 53, section 6.5.1: Change "Appendix – B, Table-B3" to "Appendix – E, Table-E3."
- Page 54, section 6.5.2: Change "Eskaton" to "Mogh Bazar"
- Page 58, section 6.5.4.3: Change "Table 6-13" to "Table 6-11."
- Page 59, section 6.6.3: Change "Table 6-12" to "Table 6-10."
- Page 60, section 6.6.5: Change "Table 6-12" to "Table 6-10."
- Page 62, section 6.9: Change "Map 6-3" to "Map 6-1."
- Page 65, section 6.10: Change "Figure 6-2" to "Figure 6-6."
- Page 68, section 7.4: Change "Eskaton" to "Mogh Bazar"

# Development of Valuation Model for Residential Property, integrating Self-declaration, Dhaka City.

by

Mizanur Rahman

Thesis submitted to the International Institute for Geo-information Science and Earth Observation in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation, Specialisation: Urban Land Administration

Thesis Assessment Board

Prof. Ir. P. van der Molen (Chairman)
Prof. Dr. A. van der Veen (UT, External Examiner )
Dr. A.M. Tuladhar (Supervisor)
Drs. E.J.M. Dopheide (Supervisor

ITC

INTERNATIONAL INSTITUTE FOR GEO-INFORMATION SCIENCE AND EARTH OBSERVATION
ENSCHEDE, THE NETHERLANDS

**Disclaimer**

# Abstract

Property tax is one of the major revenue sources of Dhaka City Corporation. But the key problem of present tax assessment system is lack of rationalization and standardization in valuation. Properties are valued on the annual rental value basis but lack of qualified and quantified data, in many cases cause imperfect valuation. As a result tax payers face problems and difficulties.

The collection and analysis of adequate information on property is crucial to ensure taxable properties to be effectively assessed. A vital first exercise is to review the currently available information on property and its suitability for use as the basis for a property tax. In Dhaka city, the self declaration of property can supply major information for valuation. It should be an integral part of the initial exercise. But self declared data needs further verifications by some other techniques. For Dhaka, no institutional capacity is yet built on proper qualification and quantification of self declared data, but in this stage it can be verified through sample field visit. Then available data can be integrated for valuation. The integrated form of valuation model is investigated through this study.

The valuation model describes the relationship between physical and locational characteristics of property, and its value. Through this study models are developed for residential property of Dhaka city integrating self declared and field data from three neighbourhoods. In the processes several models are developed and tested. The empirical evidences reveal that integration of property data increases the accuracy and predictive power of the valuation model and thus effective valuation system.

The stepwise multiple regression method is used in this research, which have the advantage to include the most significant variables in the model and makes the model simple. The study shows, the important characteristics of property to determine the value in Dhaka are: condition of buildings, total floor area, number of rooms, and date of valuation. The additive type model structure is used in the study and the statistical tests show this type of model is well fit to the residential properties valuation.

The immobility of property causes a strong relationship between location attributes and values. An alternative approach; trend surface analysis (TSA) is considered to measure the location attribute, which is a convenient approach, for measuring spatial relationships in regression models, and has a further advantage to permit the usual significance tests for the individual variable. In this study, spatial position of property is determined by the X, Y co-ordinates, which are generated through interpolation technique in GIS using digital maps of study area. To add the location variable further increases the accuracy and predictive power of model. The spatial pattern of the property values is also studied. The pattern describes the property value changes with the physical characteristics of neighbourhood and its location. Property value is very much influenced by its spatial distributions.

The research is carried out in selected areas of Dhaka city for residential properties, which demonstrates the improvement of accuracy in valuation through data integration from self declaration and field collection. The integrated model gives a standard and rationalized valuation system. In this research GIS has become an important and useful tool with multiple regression analysis to develop the valuation model.

# Acknowledgements

Many people have contributed in many ways in accomplishing my study. Therefore, I must express my sincere gratitude to them. Unfortunately, it is not possible to name them all here, but surely they are not forgotten.

I wish to thank the people and the Government of the Netherlands for awarding the Fellowship and also the Government of Bangladesh for sanctioning the deputation of one and a half year for the study programme.

I would like to express my gratitude and thanks to Dr. A. M. Tuladhar, my first supervisor for his valuable suggestions, guidance, new ideas and constant support as well as encouragement, all of which has contributed significantly in this work. I am very grateful to Drs. E.J.M. Dopheide, co-supervisor, for valuable suggestions, critical comments and making me aware of the purpose, structure and logic of research.

I extend my sincere gratitude to my colleagues in Dhaka City Corporation especially in revenue department to help me a lot in data collection during the field work. My special appreciation to Mr. Aktar Uzzaman Khan, Deputy Chief Revenue Officer and Mr. Mohammad Sirajul Islam, Chief Town Planner, for their help in data collection. Their cooperation contributed greatly in the successful completion of this work. I take this opportunity also to thank Nurul Alam, my friend and collegue, for his hospitality during my visit to DCC.

I am grateful to Ms. Refat Fatema and Mr. Mazhaharul Islam of Ganibangla Limited, for their hospitality during their stay in the Netherlands, and took keen interest in this work and helped me by giving some useful information. I also thank Ms. Ishrat Islam, Assistant Professor and Dr.K.M.Maniruzzaman, Professor and Head, Department of Urban and Regional Planning, Bangladesh University of Engineering and Technology providing me support during the field work in Dhaka. I would like to extend my best thanks to Dr. Tariq Bin Yusuf, for his sincere friendship, help, suggestions and advice, which contributed my study in the Netherlands. Many thanks are also due to Liton and Bekim for their sincere help.

Sincere gratitude and appreciation to all my classmates, colleagues and friends –especially the cluster: 3-137 family of Saut, Budi, Yudha, Ramesh, Theodora, Wang, Jessica; many hours of discourses, academic and general discussions, coffee break and of course for making my stay memorable at ITC. I valued the friendships of Dawit, Benjamin, Hui Pan, Michael, Zeng Jhao and Joahna

I appreciate the company of the Bangladeshi students and community in Enschede. I would like to take this opportunity to express my sincere thanks and gratitude to all of the ITC staffs, managers and employees for their pleasure behaviours and kindness.

Last but not the least my family, I feel very indebted to my dearest wife Bani, and my beloved daughters, Mahi and Raisa, who had to endure my absence from home for a long time. My mother, her prayers, moral support and love are a precious asset for me.

Mizanur Rahman
March, 2006
Enschede, The Netherlands

# Table of contents

1. Introduction ... 1
1.1. Issues and Justification ... 1
1.2. Research Problem ... 2
1.3. Main Objective ... 3
1.4. Specific Objectives ... 3
1.5. Research Questions ... 4
1.6. Research Design ... 4
1.7. Time Management ... 5
1.8. Structure of thesis ... 6
1.9. Summary ... 6
2. Concept of Property Tax and Valuation ... 7
2.1. Introduction ... 7
2.2. Property Taxation ... 7
2.2.1. Tax Base ... 8
2.2.2. The Tax Assessment ... 9
2.3. The Valuation of Property ... 9
2.4. Approaches and Methods of Valuation ... 9
2.4.1. Market value comparison approach ... 9
2.4.2. Income capitalization approach ... 10
2.4.3. Cost approach ... 10
2.4.4. Rental Value Assessment ... 11
2.5. Self Declaration of Property ... 11
2.5.1. Principles of Self Declaration System ... 12
2.5.2. Merits and Demerits of Self Declaration System ... 12
2.6. Mass Appraisal System (MAS) of Property Valuation ... 12
2.6.1. Principles of Mass Appraisal ... 13
2.6.2. Functions of Mass Appraisal ... 13
2.6.3. Components of Mass Appraisal ... 14
2.6.4. Limitations of Mass Appraisal ... 15
2.7. Summary ... 15
3. Research Methodology ... 16
3.1. Introduction ... 16
3.2. The research approach ... 16
3.3. The research process ... 17
3.4. Selection of study area ... 17
3.4.1. Selection of Property ... 18
3.5. Data Collection ... 19
3.5.1. Secondary data collection ... 20
3.5.2. Primary data collection ... 21
3.5.3. General examination of the data ... 22
3.6. Data exploration ... 23

3.6.1. Exploration and transformation of data using visualization and statistics ................ 23
3.6.2. Attribute subset selection for model ................ 23
3.7. Methods of Selecting Variables for Model ................ 24
3.7.1. Forward selection ................ 24
3.7.2. Backward Elimination ................ 24
3.7.3. Stepwise variable selection ................ 24
3.8. Limitations of the study ................ 25
3.9. Summary ................ 26
4. Background of Study Area and Present Valuation System ................ 27
4.1. Introduction ................ 27
4.2. Brief History of Dhaka city ................ 27
4.2.1. Dhaka City Corporation ................ 28
4.3. Study Area ................ 28
4.3.1. Ward 49 (Dhanmondi) ................ 29
4.3.2. Ward 54 (Mog Bazar) ................ 29
4.3.3. Ward 74 (Nawabpur) ................ 30
4.4. Present Valuation System ................ 31
4.4.1. Users of the system ................ 32
4.4.2. Discussion Meeting with Officials ................ 33
4.4.3. Interview of the Property Owners ................ 33
4.4.4. Problem Analysis ................ 33
4.4.5. Objective Analysis ................ 34
4.4.6. Solution finding ................ 35
4.5. SWOT Analysis ................ 36
4.5.1. SWOT Matrix ................ 36
4.5.2. Findings for valuation system ................ 38
4.6. Summary ................ 38
5. Integrated Property Valuation Model ................ 39
5.1. Introduction ................ 39
5.2. The Model ................ 39
5.3. Types of Model ................ 40
5.4. The Model Type for the Study ................ 40
5.5. General Structure of Model ................ 40
5.5.1. Model Specification ................ 41
5.5.2. Model Calibration ................ 41
5.6. Variables and Multiple Regression Model ................ 42
5.6.1. The MRA Equation with Spatial Components ................ 42
5.6.2. Evaluating and interpreting regression model ................ 43
5.7. Summary ................ 46
6. Development and Testing of Property valuation Model ................ 47
6.1. Introduction ................ 47
6.2. Description of main variables ................ 47
6.3. Data exploration ................ 48
6.3.1. Descriptive statistic ................ 48
6.3.2. Correlation matrix of Variables ................ 49

6.4. Examining the Variables for Linear Relationship ..... 50
6.5. Multiple Regression Analysis (MRA) and Models ..... 52
6.5.1. Model with Self declared Data ..... 52
6.5.2. Model for Field Data ..... 53
6.5.3. Model for combined data ..... 54
6.5.4. The Final Model for Study Area ..... 55
6.6. The Evaluation of Model ..... 59
6.6.1. Complete and accurate data ..... 59
6.6.2. Linearity ..... 59
6.6.3. Additivity ..... 59
6.6.4. Examining the Normality ..... 59
6.6.5. Test for Multicollinearity ..... 60
6.6.6. Sample Representativeness ..... 60
6.7. The Validation of Final Model ..... 60
6.8. Further analysis and comments on the models ..... 62
6.9. The spatial analysis of property value ..... 62
6.10. Summary ..... 65
7. Conclusions and Recommendations ..... 67
7.1. Introduction ..... 67
7.2. Analysis of present valuation system of Dhaka ..... 67
7.3. The spatial variability of property value ..... 67
7.4. Property valuation model ..... 68
7.5. Role of self declaration into the model ..... 69
7.6. Final remarks ..... 70
7.7. Recommendations ..... 70
References ..... 72
APPENDICES ..... 75

# List of figures

Figure 3-1 Diagram of research approach ..... 16
Figure 3-2 Diagram for method of data collection ..... 20
Figure 3-3 Filter approach to attribute selection ..... 24
Figure 3-4 Stepwise regression (adapted from Linne, et. el. 2000) ..... 25
Figure 4-1 Problem tree ..... 34
Figure 4-2 Objective tree ..... 35
Figure 4-3 SWOT matrix of present valuation system ..... 37
Figure 6-1 Scatter matrix before transformation ..... 51
Figure 6-2 Scatter matrix after transformation of variables ..... 51
Figure 6-3 Histogram of regression standardized residual of final model ..... 60
Figure 6-4 Histogram of Error Term ..... 61
Figure 6-5 Scatterplot of Residuals and Property Value ..... 62
Figure 6-6 Scatterplot of predicted and observed value ..... 65

# List of tables

Table 1-1 Summary table to materialized research questions ........ 5
Table 1-2 Approximate Time Management Chart ........ 5
Table 2-1 Steps in property tax administration ........ 8
Table 3-1 Description of data sampling of Ward-49, Dhanmondi ........ 18
Table 3-2 Description of data sampling of Ward-54, Mogh Bazar ........ 18
Table 3-3 Description of data sampling of Ward-74, Nawabpur ........ 19
Table 3-4 Types of collected data ........ 20
Table 6-1 List of variables and their definitions ........ 48
Table 6-2 Descriptive Statistics of Independent and Dependent Variables ........ 48
Table 6-3 Correlations Matrix of variables ........ 49
Table 6-4 Model Summary ........ 52
Table 6-5 Model Summary ........ 53
Table6-6 Model Summary ........ 54
Table 6-7 Model Summary ........ 55
Table 6-8 Model Coefficients ........ 55
Table 6-9 Model Summary ........ 57
Table 6-10 Model Coefficients ........ 57
Table 6-11 Comparison between two models with location and no location ........ 58
Table 6-12 Descriptive Statistics of Error Term ........ 61

# List of maps

Map 4-1 Location of study area in Dhaka city (Source – DCC)........................................................ 28
Map 4-2 Study area ward-49; Dhanmondi (source: DCC) .............................................................. 29
Map 4-3 Study area ward-54; Mogh Bazar (source: DCC) ............................................................ 30
Map 4-4 Study area ward-74; Nawabpur (source: DCC)................................................................. 31
Map 6-1 Property value map ............................................................................................................ 63

# List of charts

Chart 3-1 Pie chart for collected data ............................................................................................. 21
Chart 6-1 Average property value of three neighbourhoods............................................................. 49
Chart 6-2 Property values of different neighbourhoods.................................................................... 64

## ACRONYMS

| | |
|---|---|
| ADB | Asian Development Bank |
| ANOVA | Analysis of Variance |
| BBS | Bangladesh Bureau of Statistics |
| COD | Coefficient of Dispersion |
| CRO | Chief Revenue Officer |
| DCC | Dhaka City Corporation |
| DCRO | Deputy Chief Revenue Officer |
| DTO | Deputy Taxation Officer |
| MAS | Mass Appraisal System |
| MIS | Municipal Information System |
| MRA | Multiple Regression Analysis |
| RAJUK | Rajdhani Unnayan Kartipakhya (The capital development authority) |
| RD | Revenue Department |
| SEE | Standard Error of Estimation |
| SWOT | Strengths, Weakness, Opportunities and Threats |
| TO | Taxation Officer |
| TSA | Trend Surface Analysis |
| UN | United Nations |
| WB | World Bank |

# 1. Introduction

## 1.1. Issues and Justification

Taxes on property exist almost all over the world. The primary role of property taxes is to provide a local source of revenue to finance municipal services. Property taxes include a variety of taxes on land, buildings and other immovable property (UN, 1995). The tax base differs from country to country. According to Eckert et al. (1990), in some countries the tax base is the market value of land together with improvements; other countries use only the market value of land (not improvements); and some countries use the annual rental value of land and buildings as the base. The key issue in assessing the tax is the available information of rent or sale prices of property. The valuation in property taxation system can be calculated on either the annual (rental) value based on the actual or estimated annual rent or the capital (market/sales) value based on the value of property which has recently been sold or an estimate thereof. The rental value reflects the value of the property in its current use, while the capital (market) value system includes a bigger element of the market's expectations on its future use. The fluctuations of the capital values may therefore be bigger than with the rental value system because of future growth pattern of urban area. It has been argued that it may be an advantage in fast growing areas to use the capital value system in order to tie tax burdens closer to urban growth. The implementing authority has to decide on what to tax (the tax base), how to value the property (Valuation) and what extent the property should be taxed (the tax rate). The other important factors in valuation include (UN, 1995):

- Property should be taxed using a mass appraisal rather than plot-by-plot for economic reason on equitable basis.
- The system should be transparent and clear to avoid disputes and ensure a consistency.
- The methodology used should be appropriate to local knowledge.
- Values should be indexed to reduce the negative effects of inflation.

In Bangladesh the property tax base is the annual rental value of land and buildings (DCC, 1986). In Dhaka city the municipal authority Dhaka City Corporation (DCC) is mandated to impose and collect property tax. Its revenue department (RD) is responsible for property valuation and taxation. The assessment of valuation process is done by an assessor who starts a process with issuing a notice to the owner or occupier of a building and land asking to submit true and correct returns of the rent or annual value, and a true and correct description of the building and land. After receipt of the documents submitted by owners or occupiers, assessor may physically inspect the site in order to verify the supplied documents. All data related to the valuation process are thus collected from taxpayers and field surveys. The effectiveness of self declaration system depends upon the cooperativeness of taxpayers-on the willingness of all property owners to file full and accurate property declarations and in practice it's difficult to get them to do so. By far the common approach is to 100 percent audit of own declaration by field verification. The drawback is its cost (Dilinger, 1992).

In present system of DCC, the valuation process is done manually on the basis of the data available from taxpayers and field survey. The annual value of buildings and lands are calculated in following three categories (DCC, 1986).

a. For wholly let-out buildings: The annual value is taken to be the gross annual rental minus two months rent as maintenance allowance; and if the property is mortgaged to the Government, Bangladesh House Building Finance Corporation, scheduled bank or any other financial institution under registered instrument, then the annual interest payable on account of such mortgage-debt also be deducted.
b. For wholly occupied buildings by owner: The annual value is the probable annual rent at which the buildings and lands of similar description and with similar advantages in the locality may be let out minus the following: (i) two months rent as maintenance allowance; (ii) 40 percent of the annual value after deduction of the amount mentioned in item (i); (iii) if the property is mortgaged to the Government, Bangladesh House Building Finance Corporation, scheduled bank or any other financial, then the annual interest payable on such mortgage-debt.
c. For partly rented and partly occupied buildings: The annual value of the rented portion is calculated in the manner as specified in clause (a) and that of the occupied portion as in clause (b)

At present the DCC area is 302 $km^2$ and population is about 8.0 million (DCC, 2004). Within this area there are 1107474 house holds (BBS, 2001). On contrast, the revenue department of DCC has limited number of staff. So, it is not possible for them to survey every house hold. However, the accurate information is essential to carry out the valuation correctly. In practice it is really impossible to verify all information given by property owners or occupiers doing field survey. At the same time, the taxation procedure is lengthy and time consuming, includes many repeated works, and nor efficient neither transparent. All having as a consequence that expected revenue is not earned. Moreover, there are many disputes, and long court cases. To overcome these difficulties(ADB, 1999), it is suggested that there should be an integrated approach to combine all related data from different sources by which the accurate valuation can be done. In this context, the use of GIS could be useful with regards to property valuation as well as improve the efficiency and effectiveness of the valuation process of DCC.

## 1.2. Research Problem

Property tax is one of the major revenue sources of Dhaka City Corporation. In the financial year 2003-04, DCC earned 1000 million Taka (Bangladeshi currency) from property tax, which was 12% of total revenue income (DCC, 2004). But the present tax assessment system is not transparent to the taxpayers. As a result many taxpayers resent this and are reluctant to pay taxes. The prevailing methods of property valuation are lack of rationalization and standardization that is, the rate of taxation varies from house to house within and between areas, although houses are of same type and market rates are similar (ADB, 1999). The present property valuation is done manually with the information collected by assessors and the returns of declaration of annual rental value submitted by the property owners themselves. According to rules, the general valuation is to conduct every five years interval but, DCC valued the property last time in the year 1989. Since then, no general valuation was conducted. Only property is revalued in case of any additions or alteration.

Property valuation is the process of identifying and qualifying the value factors. The property characteristics, location, construction cost, rent, sale price etc. are factors, which contributed to the valuation (UN, 1995). The collection and analysis of these evidences of values are crucial to accurate property values and thus an effective assessment system. Comparable evidence is fundamental to all valuation methods. A lack of data is a significant factor affecting property valuation (Wyatt, 1997).

The determination of the property tax depends on the correct, appropriate and up-to-date information and data on property. In present system, the main data for valuation come from tax-payer returns and field survey. In these processes large amount of spatial and non-spatial data are handled. But there is no system or procedure to verify and identify accurately the quality and quantity of data used. As a result the property tax is associated with the fact that the assessed value is an imperfect estimate of the annual rental value, based on rather limited information. Consequently, the valuation system is confusing in individual cases, particular in case of owner occupying houses, especially in areas with few comparable prices. Therefore, a need is felt to use an assessment procedure that reduces such risk.

However, property valuation, requires a wide range of data (such as cadastre, land use, building) from different sources, collected and maintained independently in different departments or organizations. But in the present assessment system, it is not possible to identify, qualify and quantify all available information from different sources and keeping it up to date. So, in this research, the aim is to develop a valuation procedure for residential property tax assessment in Dhaka city within mass appraisal system using GIS which can integrate process and update a large amount of data from different sources.

## 1.3. Main Objective

To study and develop a valuation method within mass appraisal system integrating self declaration in order to assess the residential property tax in Dhaka city.

## 1.4. Specific Objectives

a. To describe and analyse the present valuation system.
b. To investigate the spatial pattern of residential property value using GIS
c. To develop a valuation model for mass appraisal incorporating self declared rental values and other property related data sets.

## 1.5. Research Questions

The research questions are derived from the specific objectives and these are enlisted below.

| Specific Objectives | Research Questions |
|---|---|
| a. To describe and analyse the present valuation system. | i. How does the present valuation system work?<br>ii. What are the problems with present valuation system? What are the solutions?<br>iii. How does 'self declaration' work in present system? What is the possible scope for 'self declaration'? |
| b. To investigate the spatial pattern of residential property value using GIS. | i. What are the spatial patterns of residential property value?<br>ii. Which spatial factors influence the property value for Dhaka city? |
| c. To develop valuation model for mass appraisal incorporating self declared rental values and other property related data sets. | i. What are components of Mass Appraisal System (MAS)?<br>ii. What are the methods for property valuation?<br>iii. How to incorporate self declared rental values and other property data sets in valuation model?<br>iv. What is the integrated model for Dhaka city? |

## 1.6. Research Design

The research design follows the research questions, how it will be materialized in the study is summarized in tabular form. Detailed research methodology is given in chapter three. The approximate time management chart for the total research period is given in next section.

| Research Questions | Data requirements | Data source | Methods or Tools |
|---|---|---|---|
| How does the present valuation system work? | Organizational setup, documents of valuation | DCC | Study the DCC office documents, interview |
| What are the problems with present valuation system? What are the solutions? | Users of the present system | DCC, Study of the other research organization | Interviews of officials and property owners, internet |
| How does 'self declaration' work in present system? What is the possible scope for 'self declaration'? | Literature, organizational setup, documents of valuation | Internet, research papers, study area survey, DCC | Literature review , study office documents, interviews |

| Research Questions | Data requirements | Data source | Methods or Tools |
|---|---|---|---|
| What are the spatial patterns of residential property value? | Property data | DCC | Generate value map using ArcGIS |
| Which spatial factors influence the property value for Dhaka city? | Digital map of the study area, valuation models | DCC, results of the previous step | Data analysis using ArcGIS and SPSS software |
| What are components of Mass Appraisal System (MAS)? | literature | ITC Library, internet, research papers | Literature review |
| What are the methods for property valuation? | Literature | ITC Library, internet, research papers, DCC | Literature review, study office documents |
| How to incorporate self declared rental values and other property data sets in valuation model? | Valuations procedures, Literature, model development | DCC, ITC Library, internet | Study relevant documents, literature review, statistical analysis of data in SPSS |
| What is the integrated model for Dhaka city? | Model development | Fieldwork | Data analysis of in SPSS, Excels, ArcGIS and Validation of model |

**Table 1-1 Summary table to materialized research questions**

## 1.7. Time Management

| Major Tasks | 2005-2006 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | May-Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| Research Proposal Preparation | | | | | | | | | |
| Literature Review | | | | | | | | | |
| Preparation for field work | | | | | | | | | |
| Field work and data collection | | | | | | | | | |
| Data analysis and modeling | | | | | | | | | |
| Thesis writing | | | | | | | | | |
| Revision and corrections | | | | | | | | | |
| Final presentation | | | | | | | | | |

**Table 1-2 Approximate Time Management Chart**

## 1.8. Structure of thesis

The thesis comprises with seven chapters.

This first chapter provides a general over view of the study including research issues and justification, research problem, objectives and research questions. Further indications of works and time management are presented in this chapter.

Chapter two gives a comprehensive and critical review of the literature on the theory of property tax and valuation. The literature includes different approaches of valuation, principles of self declaration system and mass appraisal system.

Chapter three explains the research methodology. It includes research process, selection of study area, data collection. Further data exploration using statistics and variables selection for model are presented.

Chapter four includes the background of study area and present valuation system. The brief history of Dhaka city and characteristics of study areas are described. Present valuation system is studied to find out the problems and solutions, and also studied the further scope for self declaration.

Chapter five deals with integrated property valuation model. In this chapter the theory of different models is given with model specification and calibration. Multiple regression analysis and statistical tests for MRA models are described.

Chapter six describes the different process of data analysis and valuation model development. This includes multiple regression analysis, and test and validation of research results for three study areas and investigates the spatial property value pattern.

Chapter seven provides the conclusions and recommendations of the research. Conclusions are drawn from the research results and findings with respect to research objectives. Some recommendations are given including suggestion for further research.

## 1.9. Summary

This chapter has presented the research issues and justification, problem statement and outlined the research objectives. This thesis aims to develop a valuation method and study the spatial variability of property value. The information about data requirements, data sources in respect to research questions are summarized in tabular form. The provable time management and outline of the thesis is given to understand the research work.

# 2. Concept of Property Tax and Valuation

## 2.1. Introduction

The property tax has historically been associated with local government in most of countries. The primary role of property taxes is to provide a local source of revenue to finance municipal services. Property taxes include a variety of taxes on land, buildings and other immovable property (UN, 1995). In both principle and practice, property tax can have important fiscal and non-fiscal effects. In turn, the extent to which the local governments have control over property taxes is often an important determinant of the extent to which they are able to make autonomous expenditure decisions. At least four characteristics of the property tax differentiate it to some extent from other taxes: its visibility, its inelasticity, its inherent arbitrariness and the extent to which it reflects local autonomy (Bird and Slack, 2004).

In this chapter, the property tax, its bases, different systems of valuation and self declaration of property are discussed.

## 2.2. Property Taxation

Property taxation is an ad valorem (according to value) base tax. It is based on the principal that the amount of tax paid should be based on the value of property owned. There are two basic forms of property taxation: the property tax may be levied on the annual or rental value of the property, and the capital value of land and improvements. The annual or rental value system is the property assessment according to some estimate of rental or net rent, whereas the capital value system is based on market price. The property tax is regarded as the fairest possible tax (Eckert et. el.1990). The tax on land and property has been considered to be especially appropriate as a local revenue source to finance the local services. This is the primary argument for the property tax. The property tax is difficult to administer, especially in developing countries. Because the quality of tax administration is poor, the burden of the tax falls haphazardly on those to exploit its weaknesses (Dillenger, 1992). This aspect becomes more critical when the process attaches simultaneously valuation of large number of properties, regarding as mass appraisal. Dillenger (1992) suggested the steps to overcome the problem in administering property tax as shown in figure next page.

| Steps | Main activities |
|---|---|
| Property Identification | Find all taxable properties |
| Valuation | Calculate relative value |
| Assessment | Calculate amount of tax |
| Billing | Inform taxpayer of liability |
| Collection | Collect tax payment |

**Table 2-1 Steps in property tax administration**

### 2.2.1. Tax Base

The tax base is the object being taxed (Eckert et. el., 1990). It can vary, and some countries have several different taxes on property, each with a different base. In some countries, land and improvements are taxed; in other countries, only land. The value taxed may be market value (the highest price a property will bring in a competitive and open market) or annual rental value. The United States and Canada have one property tax, and the tax base is the market value of land and improvements. The United Kingdom has one property tax with the annual rental value of land and buildings as the base. France has three different property taxes, all based on annual rental values. Denmark has a land tax, based on market value of the land alone and supplemented by a service tax based on the market value of buildings. Japan uses market value as base of taxes both land and improvements.

Opinions about which tax base and value is best – land and improvements, or only land, annual rental or market value – differ. The choice between annual rental and market values may not make a big difference if evidences are available of rent information or sales prices. However, annual rental values do not include the value of future development, and vacant land is not usually taxed. The usual standard of market value is that the properties should be valued at their highest and best economic use but there are many exceptions of it. Some countries value all property at current use; others reserve that standard for certain types of property only, such as agriculture land.

### 2.2.2. The Tax Assessment

The assessment function is the integral part of a property tax structure. The terms assessment and assessed value are often interchangeable (Eckert et. el., 1990). Assessment may refer to the assessed value of a single parcel of property, the total assessed value of all properties within the boundaries of tax jurisdiction, or the assessed value of group of properties. Assessed values of property are usually based on the appraised value of property. The appraised value of property is an appraiser's judgment as to the full market value on a specific appraisal date. According to various laws, the assessed value of property for tax purpose must represent either the full fair market, or cash, value of the property or a specific percentage of such value. Whether assessments are at full value or a proportion thereof is usually a constitutional or legislative policy decision, not an administrative one.

## 2.3. The Valuation of Property

Property value can be denominated in two ways: either on the basis of the rent of the property would be expected to yield (its annual rental value or ARV) or according to its expected sales price (termed capital or market value). Both definitions are widely used. The choice of a system is largely a reflection of historical association as the United Kingdom and France, in general, their one-time colonies in Asia and Africa have traditionally valued property on the rental value basis and countries influenced by the USA have defined value on the basis of capital value. In practice, the economic consequences of two definitions are not as different as theory would suggest (Eckert et. el., 1990). In adapting to the limitations on market data for various classes of property, one system borrows liberally from the techniques from the opposite camp. In ARV systems, classes of property for which no rental market exists are valued on a capital basis and then converted into rental value using a capitalization factor. In capital value systems, similarly rental value is capitalized to yield a capital value for classes of property which other methods of determining capital value cannot be used.
The purpose of tax valuation is to provide a basis for distributing the burden of property tax. It requires only a determination of relative value of properties at a common point of time.

## 2.4. Approaches and Methods of Valuation

The following methods are used for property valuation.

### 2.4.1. Market value comparison approach

It includes analysis of data from sales of similar property units and proper adjustment of obtained data to provide value estimates for groups of real estate units that are been apprised. The process of estimating value by the use of this approach includes four principal steps.

(1) Analysis of the property under consideration: The property under consideration is analyzed in terms of its use and potential uses, characteristics of the land, characteristics of the structure or potential new structures, location factor, market trends, regulations and restriction affecting the property and related factors. In making comparison it is important to consider the time of sale, the condition of the sale, the characteristics of the property, its location and selected market and governmental factors.

(2) Selection of comparable properties: Generally properties are selected for comparative purposes which have been bought in the open market for which price information can be obtained. Other information which is used in absence of price data includes listings or offers to sell, offers to purchase, and rentals. Recent sales data are much more reliable than those going back a year or more.
(3) Analysis of comparable properties: The information about the comparable properties are analyzed carefully e.g. sales data are considered with respect to number of sales involved, the period of time covered, the terms of the sales, the motivating forces back of the sales, if discoverable, and the degree of market activity, including the rate of turn over of properties.

(4) Comparison of the subject and selected property: Comparisons between the subject property and the comparable properties are made, either on an over-all ("chunk") basis or by the use of cubic or square foot units or other units of comparison. Typically, comparisons are made at least with respect to physical factors, location, market and related economic factors, and governmental and regulatory influences.

Although market value comparison is the most common and preferred approach, results provided by mass valuation models depend on the number of market transactions that can be used during the analysis and the accuracy of source data (sale prices). These obstacles seriously limit the potential to use market value comparison approach in economies where markets do not provide sufficient market data or transacting parties are interested in hiding true sales prices.

### 2.4.2. Income capitalization approach

This approach measures the present value of the future benefits of property ownership. This approach employs a variety of decision-making tools. Most commonly the value is assessed using actual or estimated income derived from a property with application of capitalization factor. The three main steps (Weimer, et. el., 1972) are usually involved in this process. First, gross income is estimated by computing the total possible income at cent percent occupancy of the building and deducting for vacancies and collection loses. In the second step, expenses are estimated, including allowances for replacement of certain items of equipment and parts of the building for physical deterioration. The third step in use of the income method is capitalizing the net income resulting from the deduction of estimated expenses from gross effective earnings by applying the appropriate capitalization rate or rates. The selection of appropriate capitalization rate usually means the difference between a sound and an unsound decision.

### 2.4.3. Cost approach

It is based on estimation of reproduction or replacement costs of a real property unit with subtraction of depreciation sustained by improvements. A market value of land as if vacant is added to the amount of improvements value gaining the amount of a total assessed market value. The steps in the cost approach (Weimer, et. el., 1972) are:

1) Market value of the land (is usually estimated by the comparable method)
2) Cost to produce new buildings (include all of the expenditures required to construct a building)

3) Less accrued depreciation
4) Indicated value of the building 'as is'
5) Indicated market value of the property

The success of this approach is subject to the availability of information on construction costs and depreciation rates.

#### 2.4.4. Rental Value Assessment

Under the rental value (or annual value) approach, property is assessed according to estimated (not actual) rental value or net rent. One rationale for using rental value is that taxes are paid from income (a flow) rather than from wealth (a stock) and thus it is appropriate to tax the net rental value of real property. In theory, however, there should be no difference between a tax on market value and a tax on rental value. When a property is put to its highest and best use and is expected to continue to do so, rental value will bear a predictable relationship to market value – the discounted net stream of net rental payments will be approximately equal to market value (Bird, et. el., 2004). This relationship does not always hold, however. First, gross rents are often used rather than the economically relevant "net" rents that build in an allowance for maintenance expenditures, insurance costs, and other expenses. Second, most countries tend to assess rental value on the basis of current use. There can thus be an important difference between market value and rental value. A property that is under-utilized – that is, currently used for a purpose less productive than other possible uses -- would be assessed much lower under the rental value approach than under the market value approach. From a land use perspective, a tax based on value in highest and best use is more efficient than a tax based on current use because it stimulates use to its highest potential by increasing the cost of holding unused or under-used land (as compared to developed land). There are some problems with the use of rental value assessment. First, it is difficult to estimate rental value when there is rent control. Controlled or subsidized rents cannot be directly used to assess market rents unless the majority of properties are rent controlled. Second, because vacant land is not taxable under a tax based on rental value in current use (since there is no current use!), an incentive is created in favour of low return uses over high return uses and to withhold rental properties from the market altogether. If vacant properties are not taxed, the tax has to be higher on occupied properties to yield the same amount of revenue. In terms of the administration of the tax, there are some additional difficulties with using rental value (Netzer, 1966). First, rental value is difficult to estimate because there is not much information on the annual rent of comparable properties for unique commercial and industrial properties such as steel mills, for example. Second, it is difficult to calculate net rents because the distribution of expenses between landlords and tenants differs for different properties. Third, assessors may not have access to rental income information because rental income is not always in the public domain in the same way as are sales prices.

### 2.5. Self Declaration of Property

Self declaration requires property owners to place annual value (rental value) and description of their own property in a prescribed form. In Dhaka city, for example, the current property tax system is based on the principle of self-declaration of rental value. Taxpayers are obliged to submit true and correct returns of the rent or annual value and a true and correct description of the building in form 'B' to the local assessors who assess the self-declared value.

### 2.5.1. Principles of Self Declaration System

Adequate information on property is needed to enable taxable properties to be effectively assessed. The first step in levying a property tax is to identify the property and to determine the owner (or other person responsible for tax liability). It is necessary to establish a complete inventory of all properties and to assign a unique property identification number to allow for the tracking of all properties. It also allows for the linking of the assessment and the billing process. A vital first exercise is to review the currently available information on property and its suitability for use as the basis for a property tax. In most cases, there is limited or no accurate data to enable real estate market values to be identified. The practicalities of how to overcome the problem of lack of data need to be tested by looking at what data is available from all sources. The systematic securing, verifying and analysing of market and other data, whether at present formal or informal, as the basis for the tax valuation is a very important aspect of the process of considering alternative property taxation policies. Information that needs to be collected for each property includes, for example: an assessment roll number of the property, the address, the owner of the property, type of building, nature of construction, floor space, age and condition of buildings. This information can be gathered from self declaration of property. It should be an integral part of the initial exercise. It will be a factor in selecting the most appropriate tax base, which will in turn help to identify what real estate information is necessary on each taxable property for compiling valuation lists and verifying supporting evidence for valuations.

### 2.5.2. Merits and Demerits of Self Declaration System

The effective use of self declaration will increase the capacity for efficiently and effectively collection of both existing retained taxes and new property taxes. In this process the tax paying public and the tax administration all understand why and what amount of tax is given and collected. The determination of value of property would be easier as the work and time for property data collection is reduced. But it may also require verification of the self-declared returns submitted by the taxpayers. The lack of personnel to make field inspections of each property means that verification is inadequate and it can make difference (Bird and Slack, 2004) in value which may contribute the laggings in valuation. The information collected has to be reported in a consistent way and a process needs to be established to update it on an annual basis. Mass Appraisal Valuation process can updated and determined the property value correctly integrating the self-declared information with valuation model. The detailed strengths and weaknesses of self declaration on the basis of the study are given in chapter four.

## 2.6. Mass Appraisal System (MAS) of Property Valuation

The science of valuation began to be developed in Europe in the 18th century. By the beginning of the 20th century the new science of valuation had been applied ‘en masse’ to the appraisal of all taxable property in an assessment district-hence the term "mass appraisal." When computers became available to assessors in the late 1960s, mass appraisal began to be referred to as "computer-assisted mass appraisal" or "CAMA." (Almy, et el. 1996). Mass property valuation means (Bagdonavicius and Ramanauskas, 2004) the way of property valuation, when value is estimated not for an individual property, but value margins are estimated, employing the analysis of information collected about all the properties being valued. Data are collected, analysed and calculations are done on the grounds of systematisation. Mass appraisal valuation of real estate is defined as a systematic valuation of groups of real estate units performed on a certain date with the help of standard procedures and statistical analysis while individual valuation is focused on determining the value of individual property units. It is performed in public interests (UNECE, 2001). It is the systematic method for arriving at estimates of value.

### 2.6.1. Principles of Mass Appraisal

In mass appraisal many people work on the process and this requires synchronization of both task and appraisal judgments. It requires standardized procedures across many properties. Thus, valuation models developed for mass appraisal purposes must represent supply and demand patterns of group of properties rather than a single property. In mass appraisal, statistical methods are used to measure deviations of all sales within the population database from their mass appraised values. If most mass appraised values for properties with sales fall within a predetermined average deviation from actual sales prices, the quality of work is considered good. It represents a set of logical, systematic methods for collecting, analyzing, and processing data to produce intelligent, well-reasoned value estimates. Valuation accuracy can be improved through 'mass appraisal' which is formula-driven valuation method that minimizes reliance on the judgment of valuers and the honesty of taxpayers (Dillinger, 1992). Mass appraisal techniques emphasize equations, tables, and schedules, collectively called models. Constructing such models can be viewed as a two-step process: (1) specification of the basic model structure and (2) model calibration.

***Specification of the General Model:*** A general model provides a frame work to simulate supply and demand forces operating in a real estate market and inadaptable to many uses. The model builder specifies the variables, or property characteristics, to be used in the model and their relationships. A simple general model can be expanded to reflect the complexities of the market by expansion of each variable and reflects the way property is valued in the local market. Model specification is the first step in the development of any mass appraisal model.

***Model Calibration:*** Model calibration is the process of adjusting mass appraisal formulas, tables, and schedules to the current market. The structure of a model may be valid for several years but it is usually calibrated or updated every year. To update for short periods, trend factors may suffice. Over longer periods, complete market analyses are required (Eckert et. el., 1990). The goal for mass appraisal equations and schedules is to reflect current local market conditions.

### 2.6.2. Functions of Mass Appraisal

There are three basic functions of mass appraisal system; reappraisal, data maintenance, and value update (Eckert et. el., 1990).

**Reappraisal:** A reappraisal provides an opportunity to develop a mass appraisal system and to introduce appraisal procedures. Once the reappraisal is done, the new system simplifies data maintenance and annual value updates. To determine the need of reappraisal, it is necessary to do the performance analysis first.

***Performance Analysis**:* A performance analysis determines whether values are equitable and consistent with the market. In mass appraisal, the primary tool for analysis is ratio study, which should be conducted at least annually. If performance is poor, a reappraisal is needed, particularly if one has not been done an appraisal for a long time.

***Ratio Study:*** A ratio study compares appraised values to market values. It measures two primary aspects of mass appraisal accuracy: level and uniformity. Appraisal levels refer to the overall, or typical, ratio at which the properties are appraised. In mass appraisal, the typical ratio is near 100 percent. Appraisal uniformity relates to the fair and equitable treatment of individual properties. That is, appraisal uniformity requires equity within groups and between groups. The result of the ratio studies are used by the valuation system for evaluating the accuracy of different valuation approaches.

**Data Maintenance:** Data maintenance is the process of capturing and valuing new construction and other changes to the property base. A good maintenance programme will have two components. The first centres on building permits and subdivision of plots. The second component of a good maintenance programme is periodic reinspection of all properties in the jurisdiction.

**Value Updates:** Updates are annual adjustments applied to properties between reappraisals. A mass appraisal system can use ratio studies or other market analyses to drive trend factors based on property type, location, size, age and the like.

### 2.6.3. Components of Mass Appraisal

Mass appraisal techniques, however, emphasize valuation models, standardized practices, and statistical quality control. It has four subsystems: (1) a data management system, (2) a sales analysis system, (3) a valuation system, and (4) an administrative system. The four subsystems are independent.

***Data Management System:*** The data management system has components for collection, entry, editing, organization, conversion, and storage and security of property and ownership data. This data management system is the heart of the mass appraisal system and should be carefully planned and designed. Quality control is the vital, because the accuracy of valuation depends on the reliability of the data from which they are generated. Property characteristic data are used in the valuation system to conduct research and generate values. System designers decide what data elements to collect and maintain. Because data are expensive to collect and process, a jurisdiction should capture those property characteristics important in the estimation of values and minimize those that are redundant or insignificant.

***Sales Analysis System:*** The sales analysis system has components for sales data collection, sales screening and processing, ratio studies, and sales reporting. Ratio studies, the primary product of this system, generally provide the best available measures of appraisal performance and are a valuable tool for monitoring appraisal results, identifying reappraisal priorities, adjusting valuation to the market, and assisting management in planning and scheduling.

***Valuation System:*** The valuation system consists of mass appraisal application of the sales comparison, cost, and income approaches to value. Values produced by these three approaches should be reviewed and reconciled to select a final value for assessment purposes. The valuation system uses property characteristics maintained in the data management system, along with sales data and ratio study results from the sales data analysis system. This system indicates which data item are required to support effective valuation methods.

***Administrative System:*** The administrative system is composed of a variety of functions and activities subject to varying degrees of automation. Each activity in the administrative system requires information from the sales analysis, valuation, or data management systems and produces products used by one or more of these other systems.

### 2.6.4. Limitations of Mass Appraisal

In traditional mass appraisal system, the main limitation is location modelling. There are various methods of incorporating location as a factor within mass appraisal technique, all which require the delineation of neighbourhood or sub-markets. It is possible to derive individual models for each discrete sub-market or alternatively to employ an overall model encompassing several neighbourhoods, where each neighbourhood enters into the model as a dummy variable. According to McCluskey, et el. (2000) the application of separate models for stratified homogeneous market subsets induces a problem of sample size, which could result in statistically unsound and biased results. Alternatively, the use of dummy neighbourhood variables reflects the influence of location is uniform for all properties within a particular neighbourhood. In addition, this form of delineation can be construed as static, which results in ignoring the potential effect of spatial trends. The use of neighbourhood variables which effectively act as proxies for location (Schuler, 1990) produces two major problems: first, measurement error given that neighbourhood as a discrete variable is unobservable and second, the presence of multi-centric effects. To overcome these limitations in this study, the location is modelled with spatial analysis, which is given in chapter five.

## 2.7. Summary

In this chapter the basic concepts of property taxation and mass valuation system are discussed. The tax on land and property has been considered as a local revenue source to finance the local services. To maintain the good taxation system, it is required a good tax administration and valuation system. The mass valuation system is an integrated approach of valuation, including statistical analysis of property characteristics. By developing market, income, and cost models, it can be generated multiple estimates of a property's value, evaluate them and choose the best, and evaluate overall valuation performance. The detailed mass valuation system and its limitations are studied in this chapter.

# 3. Research Methodology

## 3.1. Introduction

This chapter describes the research methodology and details of the methods used in data collection, data measurement and data analysis needed to accomplish the research objectives. Technological advances have facilitated the process of information gathering, storing, handling and utilization. The statistical parameters and other techniques used to analyze the data are explained in this chapter.

## 3.2. The research approach

The research approach is described by the following conceptual diagram.

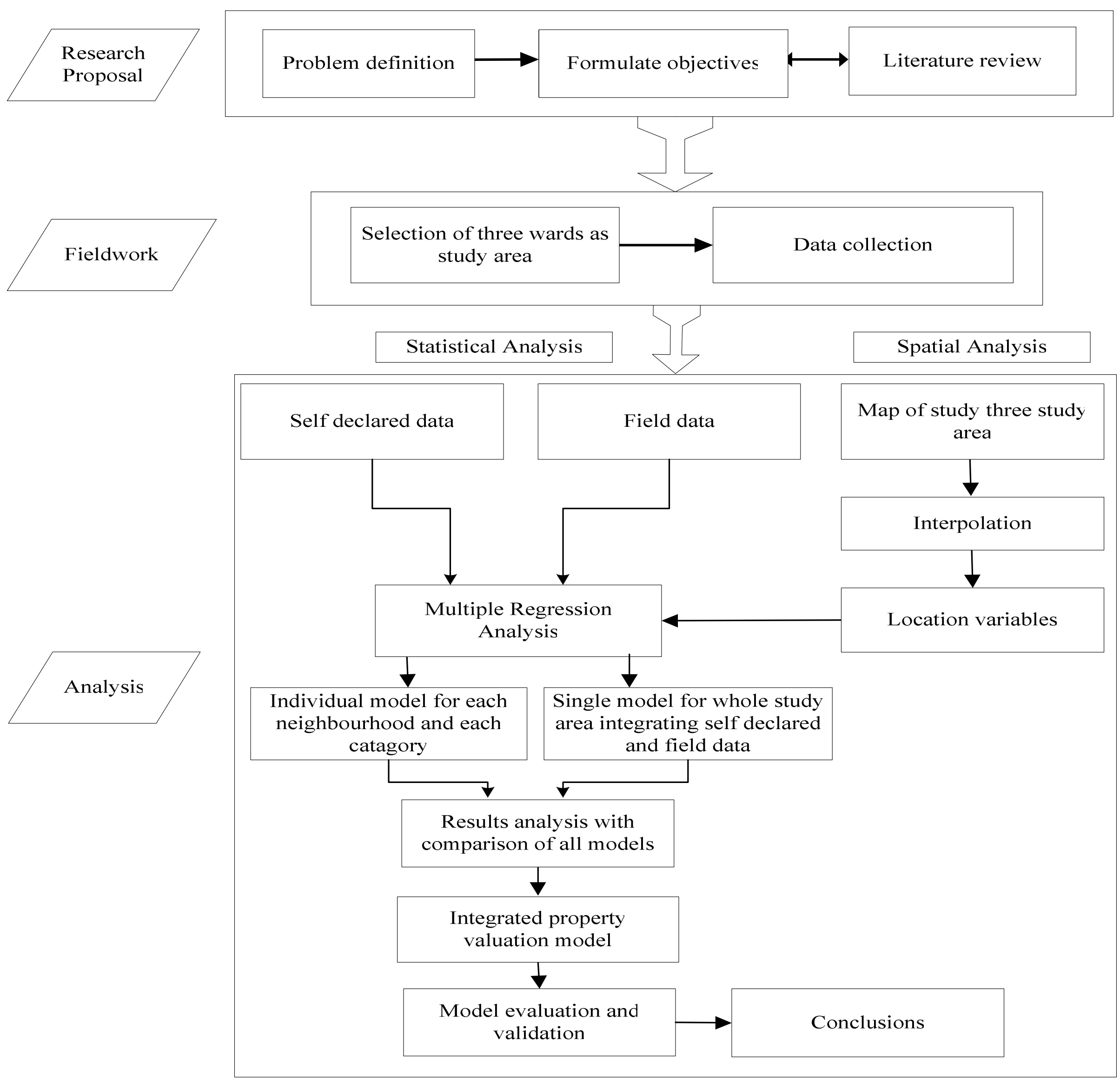



**Figure 3-1 Diagram of research approach**

## 3.3. The research process

The empirical part of this study; the valuation model is developed using Multiple Regression Analysis (MRA) in SPSS software and other statistical analysis of data is done to achieve the research objectives. MRA measures the relative influence of independent variables on a dependent variable. In MRA a dependent variable is regressed against the set of independent influencing variables. The model is tested with various parameters including coefficient of determination, coefficient of correlation, unstandardized coefficients, standardized coefficients, F-statistic**,** and t-statistic, which would be explained later in the model development chapter. The user needs are analyzed using planning and management tools like problem and objective tree analysis and SWOT analysis. The test of prototype model in Municipal Information System (MIS) is done using ArcGIS software.

## 3.4. Selection of study area

Dhaka city is administratively divided into 90 wards (neighbourhood). Among them three wards were selected on the basis of the following criteria: i) population density and housing quality, ii) planning scenario, iii) roads and street quality, iv) greenness of surroundings, v) level of infrastructures and services provided to the dwellers. And also a discussion took place with the concern officials of revenue department of DCC about this selection. Three wards are: ward-49 Dhanmondi, ward-54 Mogbazar and ward-74 Nawabpur. The characteristics of three study areas are described on the basis of these criteria.

The DCC area is divided into seven (RAJUK, 1995b) strategic planning zones (SPZ). The ward-49 (Dhanmondi) is located in SPZ-2 (central business district north), ward-54 (Mogbazar) is located in SPZ-1 (central business district south) and ward-74 (Nawabpur) is in SPZ-3 (old city).

**Ward-49 (Dhanmondi):** The population density is 267/ha, and average household size is 6.1(BBS, 1998). Most of the houses are four to six storeys with good quality. This area is established as a planned residential area. Roads are mostly straight and widening from 10m to 30m and total area is 191.3 ha, and field, park, open space, recreational and lake area is about 37% (RAJUK, 1993). All types of services such as electricity, water, gas, telephone, sewage are available and infrastructures of in good condition in this area. The inhabitants of this area are upper and upper-middle class people.

**Ward-54:** This area is the home of mostly middle class and upper-middle class people. The population density is 324/ha, average house hold size is 6.3, and ward area is 152 ha (BBS, 1998). The area is characterised as mixed up of planned and spontaneously growth areas. Some roads are accessible and some are narrow with traffic congestions. Dhaka city's biggest park named Ramna is near to this area. Water and electricity are found to be short supply (RAJUK, 1995b).

**Ward-74:** It is a high density populated area. The density of population is 1395/ha, average household size is 6.5, and ward area is 33 ha (BBS, 1998). Most of the houses are old with two to four storeys almost 100% plot coverage. Generally roads are very narrow and zigzag shaped, access is very limited and traffic congestion is regular phenomenon. Poor drainage, shortage of water, gas, and electricity is the characteristics of whole area (RAJUK, 1995b).

### 3.4.1. Selection of Property

This step consists of sampling definitions, identifying the properties for data collection to achieve the research objectives. For this study residential properties are selected. The sample size is 150. This size can be maintained in ward 49 and 54, but due to time limitation of the field work, the sample size in ward – 74, is 86. As a general rule (Eckert et. El. 1990), there should be fifty or more properties include per model or at least four times of the number of independent variables. So, this sample size is enough to develop a model. The sample of property was selected in homogeneous characteristics. According to field work plan it was decided to select the properties randomly, but the properties were not selected randomly because of the following causes; in the DCC's property register: i). Properties are not serially listed , these are listed with different serial number according to roads and para (locality) name wise. ii). Practically in Dhaka city there is no absolute residential area, every ward is mixed with residential, commercial etc. Actually no proper sample frame was available for property selection. So, according to sample size, the properties were selected from each ward by cluster and quota sampling basis from residential properties. It was divided each ward into several cluster areas on map and from every cluster the proportionately defined sample quota was filled up and in these cases it were tried to ensure the representativeness of spatial distribution of property. The cluster wise quota sampling is given in the following tables 3-1, 3-2 & 3-3.

| Sample size | Cluster area | Number of property | Number of Collected property data |
|---|---|---|---|
| 150 | Road No # 1-16 | 2126 | 70 |
| | Road No # 2A-15A | 2371 | 76 |
| | Satmasjid Road | 56 | 2 |
| | Shikkha Samprasaron Kendra Road | 52 | 2 |
| Total | | 4,609 | 150 |

**Table 3-1 Description of data sampling of Ward-49, Dhanmondi**

| Sample size | Cluster area | Number of property | Number of Collected property data |
|---|---|---|---|
| 150 | Boro Moghbazar | 1768 | 76 |
| | Eskaton Road | 680 | 29 |
| | New Eskaton Dilu Road | 390 | 17 |
| | Noyatola | 665 | 28 |
| Total | | 3,503 | 150 |

**Table 3-2 Description of data sampling of Ward-54, Mogh Bazar**

| Sample size | Cluster area | Number of property | Number of Collected property data |
|---|---|---|---|
| 86 | Bonogram Lane | 38 | 3 |
| | Chandramohan Basak Street | 25 | 2 |
| | Gongaram Saha Lane | 65 | 5 |
| | Gopi Krishan Road | 15 | 1 |
| | Gopimohon Basak Road | 42 | 3 |
| | Gour Nitai Saha Street | 170 | 10 |
| | Goylghat Lane | 119 | 6 |
| | Jadunath Basak Road | 21 | 2 |
| | Juriatuly Lane | 66 | 4 |
| | Kaptan Bazar | 112 | 8 |
| | Lalchand Mokim Lane | 99 | 5 |
| | Modon Mohon Pal Lane | 143 | 11 |
| | Mohajonpur Lane | 66 | 7 |
| | Norendranath Bosak Road | 76 | 4 |
| | Rankin Street | 100 | 6 |
| | Soshimohan Basak Street | 34 | 2 |
| | Taherbag Lane | 105 | 7 |
| Total | | 1,196 | 86 |

**Table 3-3 Description of data sampling of Ward-74, Nawabpur**
(Source – DCC)

The attributes set were selected according to self-declaration form (B Form). In the form, eight characteristics of property are to describe and accordingly, DCC property register includes those variables. So, the following attributes of the property were collected; Nature of Construction (NAC), Condition of Building (COB), Number of Room (NOR), Number of Bathroom (NOB), Total Floor area (TFA, in sqft), Number of Storey (NOS), Date of valuation (DAV), Annual rental value (ANV, in Bangladesh Taka; BDT)

## 3.5. Data Collection

This step consists of extracting data from the official's documents and other sources. Total 386 properties data has been collected from the property tax registers of Dhaka City Corporation, which are in the time period from 1989 to 2005. In the property registers information is gathered from the self declaration of property owners and also from field data collection by deputy taxation officers (DTOs) of revenue department. During the general assessment in 1989s, self-declared data were used for valuation purposes other than field data were collected from spot verification for valuation.
The primary and secondary data were collected for the study in following way.

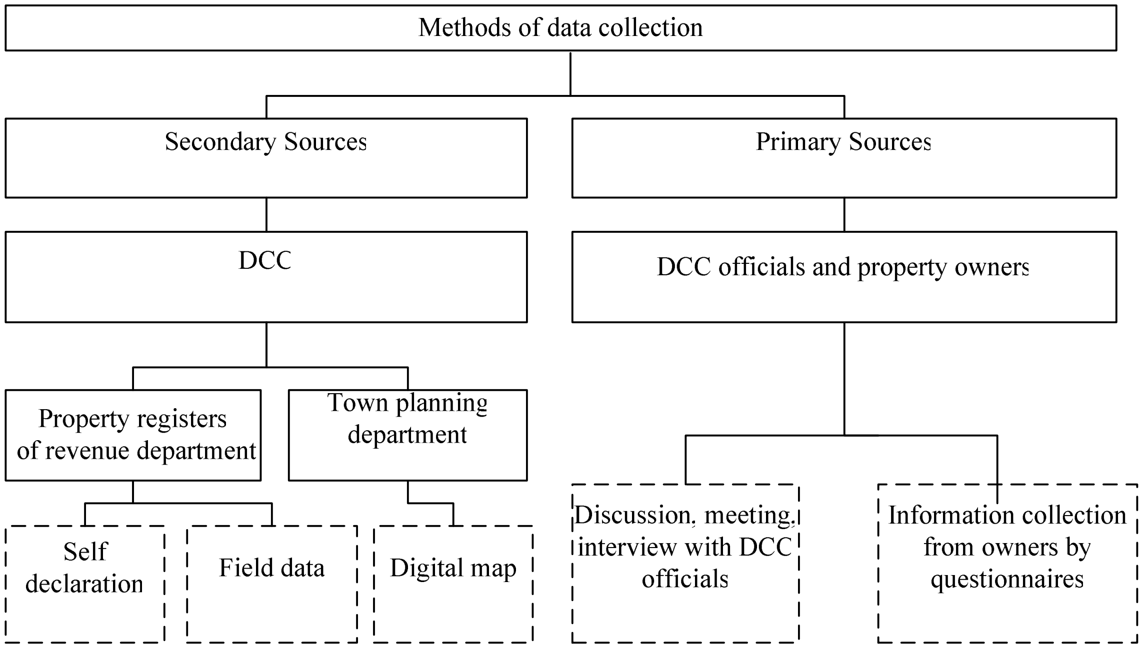



**Figure 3-2 Diagram for method of data collection**

### 3.5.1. Secondary data collection

The field work was carried out for data collection selecting three wards as study area in Dhaka city. The secondary data about property were collected from property registers of revenue department of Dhaka City Corporation (DCC), which were gathered from self declaration and field data collection. The source of collected property data are shown below in table and chart:

| Data source | Ward - 49 Dhanmondi | Ward - 54 Mog Bazar | Ward - 74 Nawabpur | Overall study area |
|---|---|---|---|---|
| Self declaration | 58% | 33% | 23% | 156 |
| Field data | 42% | 67% | 77% | 230 |
| Total number | 150 | 150 | 86 | 386 |

**Table 3-4 Types of collected data**

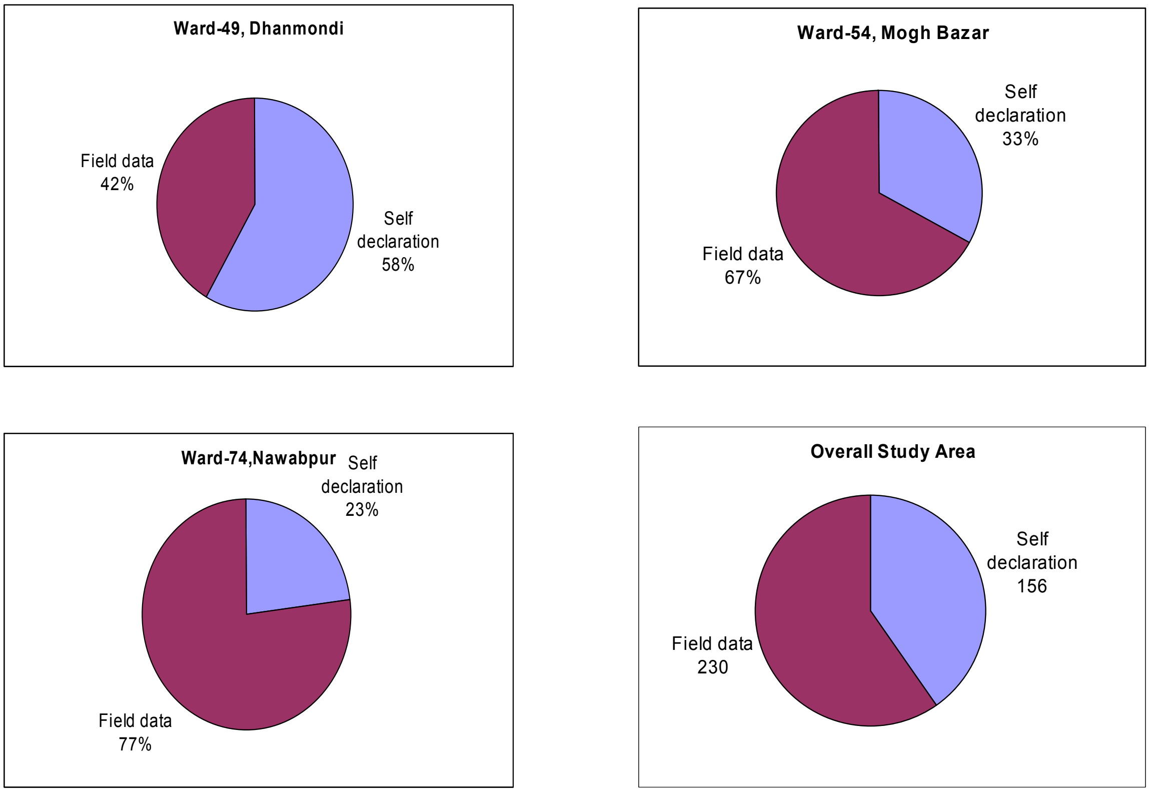



**Chart 3-1 Pie chart for collected data**

The digital map of study area, buildings, roads information and related data are collected from the Town Planning Department of the DCC.

### 3.5.2. Primary data collection

The primary data is collected from the officials and property owners through meetings and interviews. These interviews and meetings were conducted using selected questionnaires (Appendix - A) to collect information about the present valuation system, its merits and demerits, problems, and user needs with regards to valuation of property.

*Discussion Meeting with Officials:* Three discussion meetings were conducted with the officials of revenue department of DCC who are engaged in property valuation and tax collection. These meetings were on issue basis with earlier designed questionnaires. In these discussion meetings the following officials took part: Chief Revenue Officer (CRO), Deputy Chief Revenue Officers (DCRO), Taxation officers (TO), and Deputy Taxation officers (DTO).

*Interview with the Property Owners:* The interviews were conducted with twenty five property owners fifteen from ward no. 49 Dhanmondi and ten from ward no. 54 Mogbazar with the designed questionnaire. During the interview period, some of the variables of property data such as storey, room numbers, and condition of the building were checked. The study areas were visited to see the residential housing location and get overall idea about the study area.

### 3.5.3. General examination of the data

In this step the collected data are examined to understand and learn the meaning of the attribute of property. In the property registers of DCC the following information are recorded; holding number, Owners name, road/mahalla name, ward number, ward name , property type, nature of construction, condition of building, number of room, number of bathroom, total floor area (in sqft), number of storey, date of valuation, annual rental value (in BDT). All these information were collected during field work. From the collected information the following attributes are selected to build the models of valuation in chapter five:

a) Nature of construction (NAC): The quality of the construction, according to internal standards of the DCC, in a four level categorization. They are: building; which is fully made of concrete or brick, pucca; which is made of brick but roof, is made from other materials such as tin, poly sheet, woods etc. tin-shed; only basement is made from brick and all other parts are made from CI sheets or other materials, and kutcha; in which no brick is used in construction. Property is evaluated during the official inspection, and also come from self declare form, and the conferred category is recorded in the property register.

b) Condition of Building (COB): The over all quality of a property is described in the property register. This is done at the time of inspection of the houses by the staffs of DCC and also from the self declaration. There are four level of qualifications are designated according to DCC's internal standard and those are: good; construction condition is well and fixture-fittings are fully equipped, fair; construction and fixture-fittings are reasonably good, average; construction condition and fixture-fittings are old, and poor; construction condition is very old and quality is bad. This data is collected as COB.

c) Number of Rooms (NOR): Total number of rooms in a property is recorded in the register. This data is collected as NOR.

d) Number of Bathrooms (NOB): Total number of bathrooms in a property is recorded in the register. This data is collected as NOB.

e) Total floor area (TFA): Total space of dwelling area of a property used by inhabitants, which is measured in square feet. This attribute is collected as TFA.

f) Number of Storeys**:** Total number of storey (i.e. floors) of a property is recorded in the register. This data is collected as NOS.

g) Date of valuation (DAV): In the property register the date of imposing the tax is recorded and which is collected as DAV.

h) Assessed annual rental value (ANV): The assessors assess the annual gross rent of the property. They assess the gross ten months rent as the annual rental value. The value is given in Bangladeshi currency Taka (BDT). This attribute is collected as ANV.

i) The coordinates of the property (X, Y): The spatial position a property, in terms of a regular grid. This is produced using interpolation technique in consulting the maps of study area.

## 3.6. Data exploration

Data exploration involves carying out the descriptive and correlation analysis to get a better understanding of the data. Since the research is intended to test whether the variables from multilevel factors are significant to determine the value of property, statistic analysis is considered as a potentially useful tool to fulfil this intention.

### 3.6.1. Exploration and transformation of data using visualization and statistics

The data exploration is done using visualization and statistical analysis. During this step histograms, scatter plots and descriptive statistics are used to explore the data. Basic statistical measures from the collected database are presented, which allows the examination of the data's relative distribution, whether it is normally distributed or skewed and completeness. This can indicate whether there are missing values, extreme elements, deviated significantly from the others, or whether there is continuity in the values. In the graphic presentation of data, it is possible to identify suspicious cases. To benefit the subsequent analysis, an initial cleaning is performed, removing spurious data (gross mistakes or hard errors in cases or attributes). Before estimating the coefficients of variables in MRA, it is making sure that the independents variables are linearly related to the dependent variable. The data is transformed (Norušis, 2000) taking logs or square roots of one or both of a pair of variables to make the relationship linear.

The following sections describe the techniques to identify a subset of independent variables that results in a good regression model. None of the methods is the best in absolute sense but it may help to identify the independent variables that predict the dependent variable reasonably well.

### 3.6.2. Attribute subset selection for model

Attribute subset selection is one of the most addressed issues in model building and relevancy measurement is a key element. Attributes may be classified as strongly relevant, weakly relevant, or irrelevant. There are several ways to select attributes, ways that are basically grouped into filter and wrapper approaches (Soibelman and Gonzalez, 2002, cited by Blum and Langley, 1997; John et al., 1994; Kohavi and John, 1997).

In this study filter approach is used. Because of this approach is done in statistical analysis and model is developed in MRA for this research. Filter approach consist of identifying or classifying the attributes, and then only relevant attributes are used for model building algorithm. The most common example of a filter is the correlation matrix, which identifies closer relationships between dependent and independent variables and also identifies potentially collinear attributes (independent attributes that present approximately the same information). The general process is viewed in Figure 3-5 (Soibelman and Gonzalez, 2002) next page.

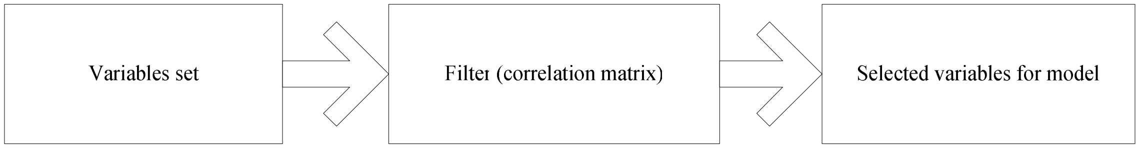



**Figure 3-3 Filter approach to attribute selection**

## 3.7. Methods of Selecting Variables for Model

Many different models can be built from the same set of independent variables. As the number of independent variables increases, so the number of possible models also increases. The decision to enter or remove a variable into the model is based on how much it changes squared multiple correlation ($R^2$). Whenever an independent variable is added to the model, $R^2$ increases or remain same but never decreases. Similarly, a variable is removed; $R^2$ decreases or remain the same. The following methods (Norušis, 2000) are used to sequentially add or remove independent variables from a model.

### 3.7.1. Forward selection

Forward selection starts with a model that contains only the constant term. At each step, the Variable is added that results in the largest increase in multiple $R^2$, provided that the change in $R^2$ is large enough for reject the null hypothesis (i.e. there is no linear relation). The entering variables into the model are stopped when there are no more variables that result in a significant increase in $R^2$.

### 3.7.2. Backward Elimination

The backward elimination starts with a regression model that contains all of the independent variables. At each step the variable is removed which changes $R^2$ least. The removing of variable is stopped when removal of any variable in the model results in a significant change in $R^2$.

### 3.7.3. Stepwise variable selection

The most commonly used method for model building is stepwise variable selection. According to Eckert et el. (1990), in MRA stepwise variable selection is one of the most effective one for mass appraisal. The algorithm prevents the redundant and insignificant variables from making the model more complex than necessary. It resembles forward selection except that after entering a variable into the model, it can be removed any existing variables that are no longer significant predictors. This means that variables whose importance diminishes as additional predictors are added are removed. Stepwise variable selection is a combination of forward selection and backward elimination. There are two criteria: one for entering a variable and one for removing a variable. First two variables are selected for entry the same way in forward selection and then examine the variables already in the model for removal, using the same rules in backward elimination. The entry of variable is stopped when no more variables meet the entry criterion. (The significance level for entering a variable should be smaller than the significance level of removing a variable.)

In this research the stepwise regression is used for variable selection. This is summarized in the following figure:

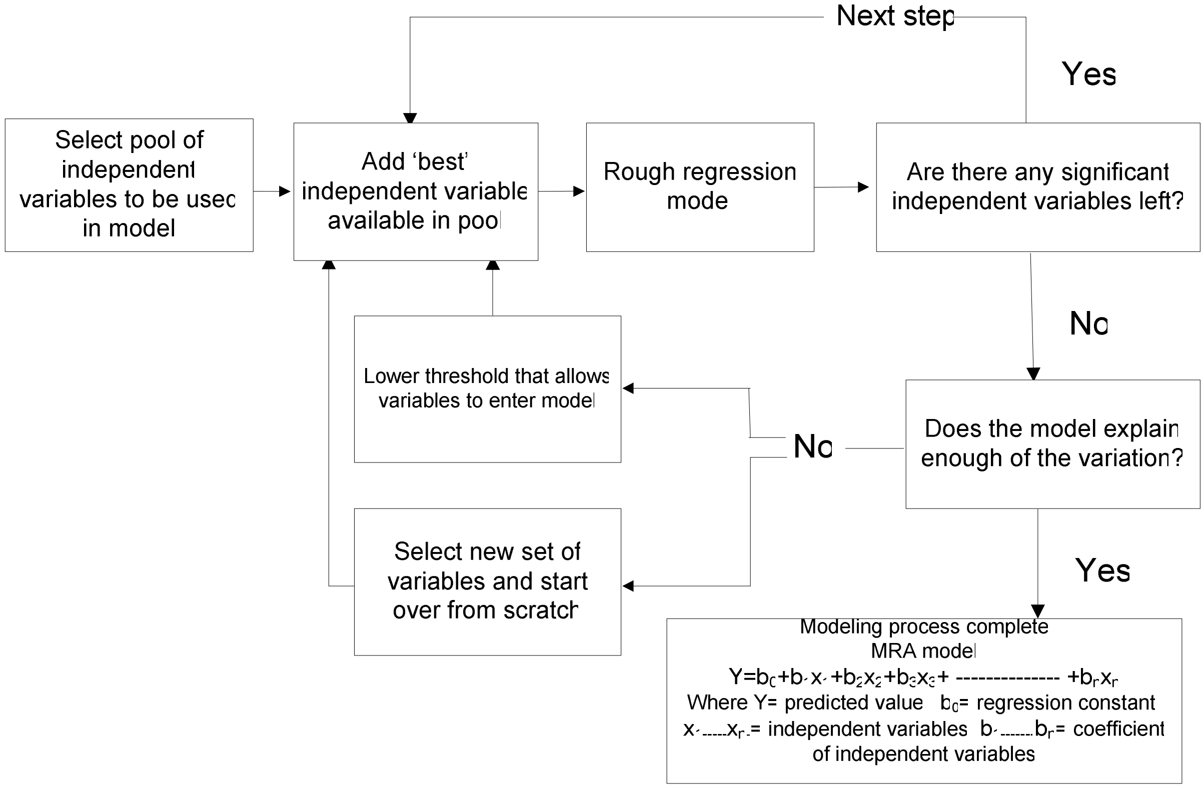



**Figure 3-4 Stepwise regression (adapted from Linne, et. el. 2000)**

## 3.8. Limitations of the study

Property valuation model development is task that always depends largely on data quality. The lack of a large, complete, representative and accurate data is a limitation for this valuation model. Data has been collected from the secondary sources of property registers of DCC, in which data were gathered after some alterations and modifications especially in case of property's annual value. Because the property's value was determined within different level (which is described in chapter four) and then finally assessed one was entered into property resister. But it was not also possible to collect all data from the primary source within the time limit and scope of the fieldwork.

In this study no methodology can be developed for data qualification for valuation model. The valuation model for Dhaka city is developed integrating self declaration. But self declared data needs further verifications by some other techniques. These can be compared with the database of cadastre and building control authority. In Dhaka city, cadastre system is still on paper based maps (Appendix – B) and documentation, and also the building control authority RAJUK's (The capital development authority) documentation system is on files and papers. So, it is very difficult to compare the self declared data with those organizational databases in digital environment. No institutional capacity is yet built on proper qualification of self declare data, but in this stage it can be verified through sample field visit.

The spatial components of model (X, Y coordinates) are generated from the digital maps of the study area by interpolation. The maps are collected from the urban planning department of DCC but it is found some incompleteness of the maps. Some properties are not included in the map as a result their spatial locations are not included so in SPSS those are treated as missing values.

Time constraint is another factor which affected the research works. To learn, understand and get familiar with all operational aspects of different software and then to implement it into the research works for proper analysis for data requires a quite considerable amount of time.

## 3.9. Summary

In this chapter research methodologies are described, which will be followed during the further carrying out the research procedures. A description is given on selection of study area, property and data collection. To understand and explore the data is important for model development. It is also important methodology to select procedures of variables, which are significant for prediction of values. The stepwise variable selection is common procedure to determine significant variables. The limitations of the research are also described.

# 4. Background of Study Area and Present Valuation System

## 4.1. Introduction

This chapter contains a brief description of Dhaka city, its characteristics, history, and brief description of Dhaka City Corporation (DCC) and describes a profile of the study area selected for this research. A general profile of the area has been drawn on the basis of secondary information collected from Dhaka City Corporation. In the second part, present valuation systems in Dhaka is presented. For this purpose, during the field work a survey was done with the designed questionnaires among the officials and the property owners. This section gives emphasis on the valuation system, its problems and solutions, strengths and weaknesses on the basis of that survey from the perspective of user needs. To discuss these issues, different planning tools and techniques like problem and objective tree, SWOT analysis are used in this chapter.

## 4.2. Brief History of Dhaka city

Dhaka was under the Buddhist Kingdom of Kamrup in the 7th and 8th centuries. From about the 9th century A.D. is was governed by the Sena Kings of Vikrampur. Dhaka was successively under the Turks and Pathans for a long time (1299 to 1608) before the arrival of the Mughals. Islam Khan (1608-1613) was appointed the first Mughal Viceroy of Bengal in 1608. He shifted his capital from Rajmahal to Dhaka in 1610. However, the greatest development of the city took place under Shaista Khan (1662-1677 and 1679-1689). The city then stretched for 12 miles in length and 8 miles in breadth and is said to have nearly a million people.

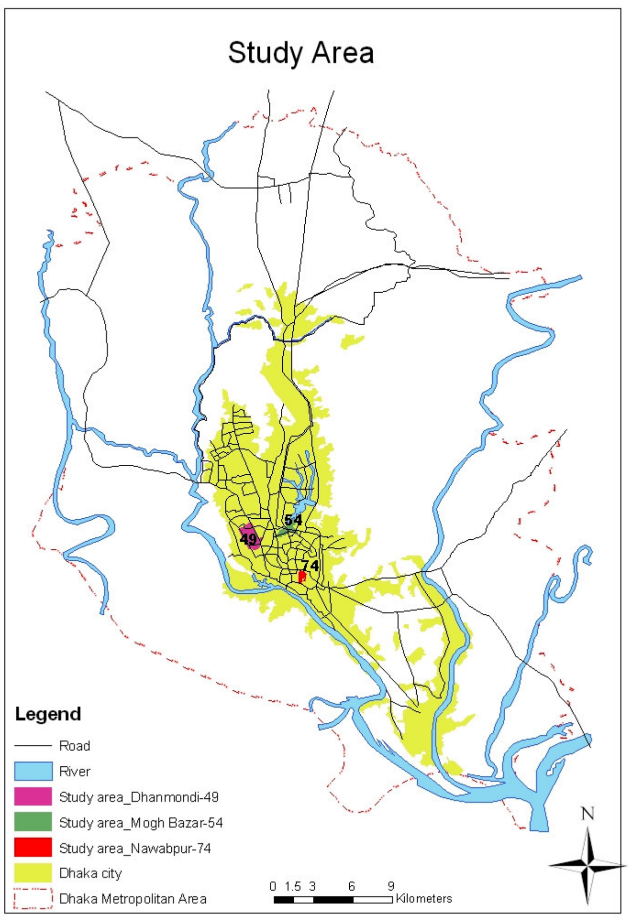
The European settlers came in the late 17$^{th}$ century. They were largely Portuguese, Dutch, English and French traders. At the tail end of the Mughal rule and the inception of British power around 1765, Dhaka began to decline in importance and contract in size. The city experienced disastrous famines, floods and fires and the declining urban centre under the control of the East India Company. Dhaka City was for the first time electrified in 1878 and facilities of water supply started to be offered to the residences since 1874. The development of the city continued under British rule. In 1947 Dhaka was made the provincial capital. After the independence of Bangladesh on December 16, 1971, Dhaka became the capital of new country. The city's population rose to about 1, 6100,000 in 1974 (Census of Bangladesh, 1974). The urbanization activities have been achieving tremendous growth for the needs of the newly independent country's capital. The city began to expand in all directions including over the low-lying areas. In 1995, the new Master Plan for Dhaka was prepared for the further development of Dhaka City. The city is mainly governed by the municipal authority Dhaka City Corporation.

### 4.2.1. Dhaka City Corporation

Dhaka City Corporation is the single municipal authority of Dhaka city. The written history of the municipal management has started with the formal introduction of Dhaka Municipality on August 01, 1864. From the beginning, it is the property tax that has provided the basic foundation for survival and sustenance of the municipality. The first assessment was done in 1865 and the last one in 1989. Its first chairman was elected in 1885 (DCC, 2004). Municipality was entrusted upon with the responsibility of roads and street development, conservancy, water supply, electricity generation, street lighting etc. from its creation. However, the growth of the municipal population, area and demand for the urban public services are more pronounced in the later half of twentieth century. In 1978 Dhaka Municipality was upgraded as Municipal Corporation. Municipality boundary was considerably expanded in 1982 when two adjacent municipalities, Gulshan and Mirpur were merged with it. In 1983 a separate statute Dhaka City Corporation Ordinance came into effect which is relevant till date and DCC area was divided into 90 wards. However, a lot of amendments of ordinance were made among those the most important one is the provision of direct election of Mayor and Commissioners on the basis of adult franchise. With time DCC area and population is increasingly growing. At present Dhaka City Corporation area is 302 sq km and population is 5.4 millions and household size is 4.8 (BBS, 2001).

## 4.3. Study Area

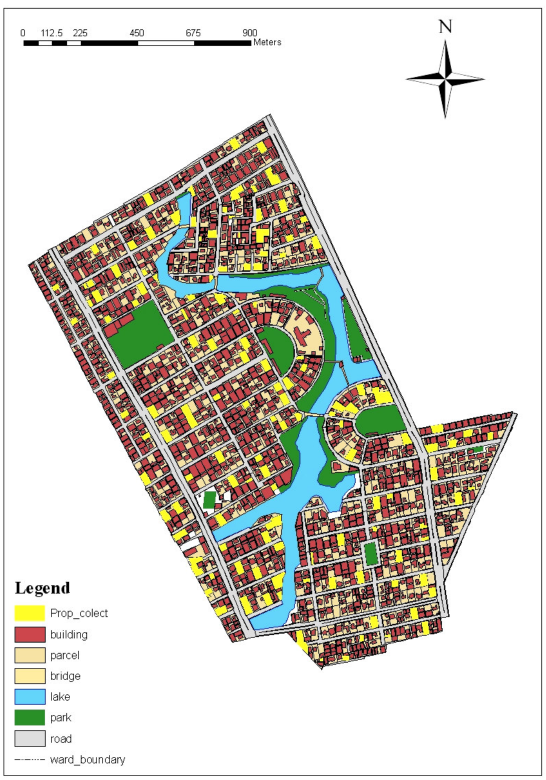
Dhaka city is administratively divided into 90 wards (neighbourhoods). Among them three wards were selected as study area and they are described below.




**Map 4-1 Location of study area in Dhaka city (Source – DCC)**

### 4.3.1. Ward 49 (Dhanmondi)

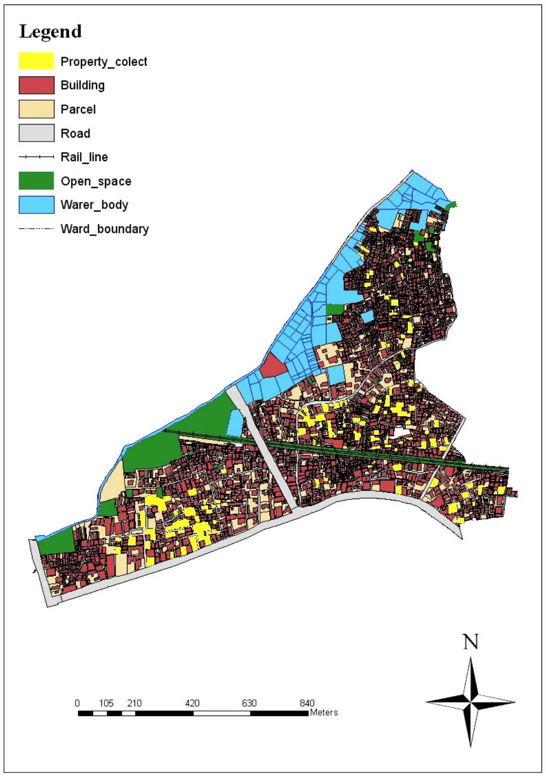
Dhanmondi is one of the prime planned residential areas of Dhaka city. To develop an ideal residential area in 1952 the then government acquired 472.64 acres (1912708 m2) of land of seven mouzas (smallest unit are in cadastre) as named Dhanmondi, Taliperbag, Eidgah, Sukrabad, Shibpur, Shorai Zafarabad and Shorai Begumpur for Dhanmondi residential area. According to plan it was developed for upper class and upper-middle class people with 1084 plots. Roads from 10 to 30 meters with adequate open and green space, play ground and lake were created for this area. At the early stage the residential usage was 63%, open space, lake and roads were 37% and all buildings were one or two storeys (RAJUK, 1993). It was an ideal place for living for upper class people. After the independence of Bangladesh Dhaka became the capital, its population increase and for new development activities demand of land increased as a result the residential characteristics of Dhanmondi changes with time. In 1985, the permission was given to sub-divide the plots of Dhanmondi and commercial usages of some parts and to build multi-storey buildings up to five storeys, which in 1992 was increased to six storeys. At present this ward is totally mixed land use area. There are different commercial usages of offices, clinics, hospitals, shopping malls, educational institutes, community centers etc.




**Map 4-2 Study area ward-49; Dhanmondi (source: DCC)**

### 4.3.2. Ward 54 (Mog Bazar)

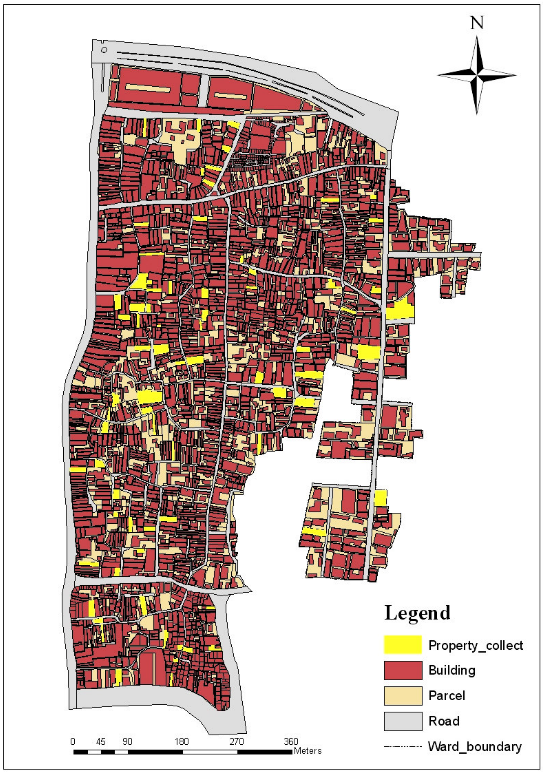
Originally this area is mainly spontaneous residential area. Now it is mixed use but predominantly residential area. Mostly the upper-middle class and middle class people live here. This ward resembles the major part of Dhaka city. The area, mahalla and roads are included in this ward are Boro Mogh Bazar, Eskaton Dilu Road, New Eskaton Road, Noyatola (Khan, 2000). The infrastructure and civic facilities are not adequate and the road system is regularly congested as the local area traffic is mixed with traffic on commuter corridors passing through this ward (RAJUK, 1995b). Most of the houses are two to five storeys building. Some high rise commercial buildings are seen along side of the main road.




**Map 4-3 Study area ward-54; Mogh Bazar (source: DCC)**

### 4.3.3. Ward 74 (Nawabpur)

This ward lies with the old part of Dhaka city. The old city is the historical centre of Dhaka which was established on the beginning of 1600 A.D. as capital of Bengal province. The main areas and streets of this ward (Khan, 2000) are Nawabpur Road, Kaptan Bazar , Norendra Bosak Road, Gopimohon Basak Road, Jadunath Basak Road, Modon Mohon Pal Lane, Juriatuly Lane, Mohajonpur Lane, Gour Nitai Saha Street, Taherbag Lane, Gongaram Saha Street, Chandramohan Basak Street, Soshimohan Basak Street, Ramacharan Chakrabarti Road, Lalchand Mokim Lane, Goalghat Lane, Modon Mohon Basak Lane, Jadunath Bashak Lane. This area is densely populated; most of the houses are one to four storeys almost 100% plot coverage. Generally roads are narrow and encroachments on the limited space, poor drainage system, shortage of water, gas, electricity are the characteristics of whole area (RAJUK, 1995b). Squatter settlements and slums are spreading without adequate access and infrastructure facilities and services. The area is mixed use mainly commercial and residential houses. Kaptan Bazar and Nawabpur Road are two major business area of old Dhaka.




**Map 4-4 Study area ward-74; Nawabpur (source: DCC)**

## 4.4. Present Valuation System

Present valuation system in Dhaka city is done in accordance with the City Corporations (taxation) Rules, 1986. The assessment procedures take several steps, which are as follows:

**Step one:** The assessment of valuation process is done by an assessor who starts the process with issuing a notice to the owner or occupier of a property asking to submit true and correct returns of the rent or annual value, and a true and correct description of the building.

**Step two:** The property owners have to submit these descriptions through B-Form (Appendix- C), which is actually self declaration of property. But in practice this form is seldom submitted. During the fieldwork this was investigated and discussed with the officials but it was found that only in last major valuation of property in 1989 a few cases self declaration was used. In all other cases field data were collected for valuation purposes. In present practice, the assessor asks property owner to submit the following documents for valuation purposes:

- Record of rights, ownership deeds, rent receipt
- Monthly rents
- Loan documents (if any)
- Total floor area of the property
- Area of owner occupied portion and rental portion

**Step three:** After receiving those documents submitted by owners/occupiers, the assessor takes the following actions:

- Issue a notice to the owner for hearing
- During hearing time the owner has to submit the all original documents and his arguments are recorded

**Step four:** After hearing the assessor (deputy taxation officer) physically inspect the site in order to verify the supplied documents and to collect other relevant data.

**Step five:** After inspection and verification, the annual value of a property is calculated in following three categories (DCC, 1986).

(a) For wholly let-out buildings: The annual value is taken to be the gross annual rental minus two months rent as maintenance allowance; and if the property is mortgaged to the Government, Bangladesh House Building Finance Corporation, scheduled bank or any other financial institution under registered instrument, then the annual interest payable on account of such mortgage-debt also be deducted.

(b) For wholly occupied buildings by owner: The annual value is the probable annual rent at which the buildings and lands of similar description and with similar advantages in the locality may be let out minus the following: (i) two months rent as maintenance allowance; (ii) 40 percent of the annual value after deduction of the amount mentioned in item (i); (iii) if the property is mortgaged to the Government, Bangladesh House Building Finance Corporation, scheduled bank or any other financial, then the annual interest payable on such mortgage-debt.

(c) For partly rented and partly occupied buildings: The annual value of the rented portion shall be calculated in the manner as specified in clause (a) and that of the occupied portion as in clause (b)

**Step six:** The owner is then given written information about assessed value of property and tax.

**Step seven:** Any person who has been assessed to a tax may raise objection to the valuation or assessment by a petition in prescribed form to the City Corporation within thirty days from the date of receipt the notice. The petition is heard and decision is given by an assessment review board (ARV).

**Step eight:** Any person aggrieved by an order of ARB may appeal to the Divisional Commissioner within sixty days from the date of receipt of the order. The divisional commissioner disposes of appeal and gives his decision within 120 working days from the date of filing of an appeal and the decision of the Divisional Commissioner is final.

In the following sections problems of the present valuation system are defined on the view point of property owners and officials, and finding solutions introducing valuation system.

### 4.4.1. Users of the system

DCC provides services to the city dwellers. For providing the services, it needs resources which mainly come from the property taxes. The property taxes are its main source of revenue. Property taxes are collected from the city dwellers who own the properties within city area. The valuation of property is done by the staffs of the revenue department of DCC. For this purpose, it needs property related data and also to collect taxes from the city dwellers. Citizens pay taxes and they need information from the DCC in these regards. On the basis of the property data the officials do the valuation of properties and impose taxes. In the valuation process two categories of users are directly related with the system; officials and owners of properties. So, discussion meetings with officials and interviews with house owners were conducted.

### 4.4.2. Discussion Meeting with Officials

Three discussion meetings were held with the officials of revenue department of DCC who are engaged in property valuation and tax collection. Nine officials took part in the discussions and gave the written answers of the questionnaires (Appendix – C:1). Ten questions and an optional comment were asked. Among them, four were on the present valuation system (question no. 1- 4) and rest six were on the self declaration (question no. 4-10). First two questions were on description of present valuation system and data/information needs for the valuation. In response to these questions all respondents answer in same manner, which is described in section 4.4. About the present valuation system, a description is given on above section-4.5. The question 3 was related to merits and demerits of present valuation system and question 4 was on improvement of the valuation system. In response to these questions, the officials pointed out the litigation over valuation is the main problem and introduce a valuation system with self assessment can overcome this problem.

### 4.4.3. Interview of the Property Owners

The interviews were conducted with twenty five property owners fifteen from ward no. 49 Dhanmondi area and ten from ward no. 54 Mogbazar area with the earlier designed questionnaire. The questionnaire (Appendix – C:2) was semi structured and it is given in. Eight questions were asked to the interviewees. Among them four questions (1- 4) were on their knowledge on valuation and payment of taxes and four questions (5 – 8) were on the problem they are facing on. The majority of respondents (20 respondents) have idea about valuation and major portions (17 respondents) think present valuation system should be changed and 21 respondents answer that the present amount of tax (i.e. 7% of property value) is ok.

From the discussion meeting and interview with the owners, it is tried to find out problem and solution relating to present valuation system. In the following sections *problem and objective tree* are discussed on the basis of the respondents' answers.

### 4.4.4. Problem Analysis

The two categories of users identify problems with the present valuation system. Taxpayers find taxes are imposed irrational way and there are lack of skills, harassment and corruption in the valuation process. On the other hand, officials find many appeal cases and less collection of taxes. The core problem is defined as *a lot of dispute and litigation over valuation*. The problems are analyzed and displayed in the problem tree below. In problem tree all problems are grouped in a hierarchical structure reflecting causal relationships.

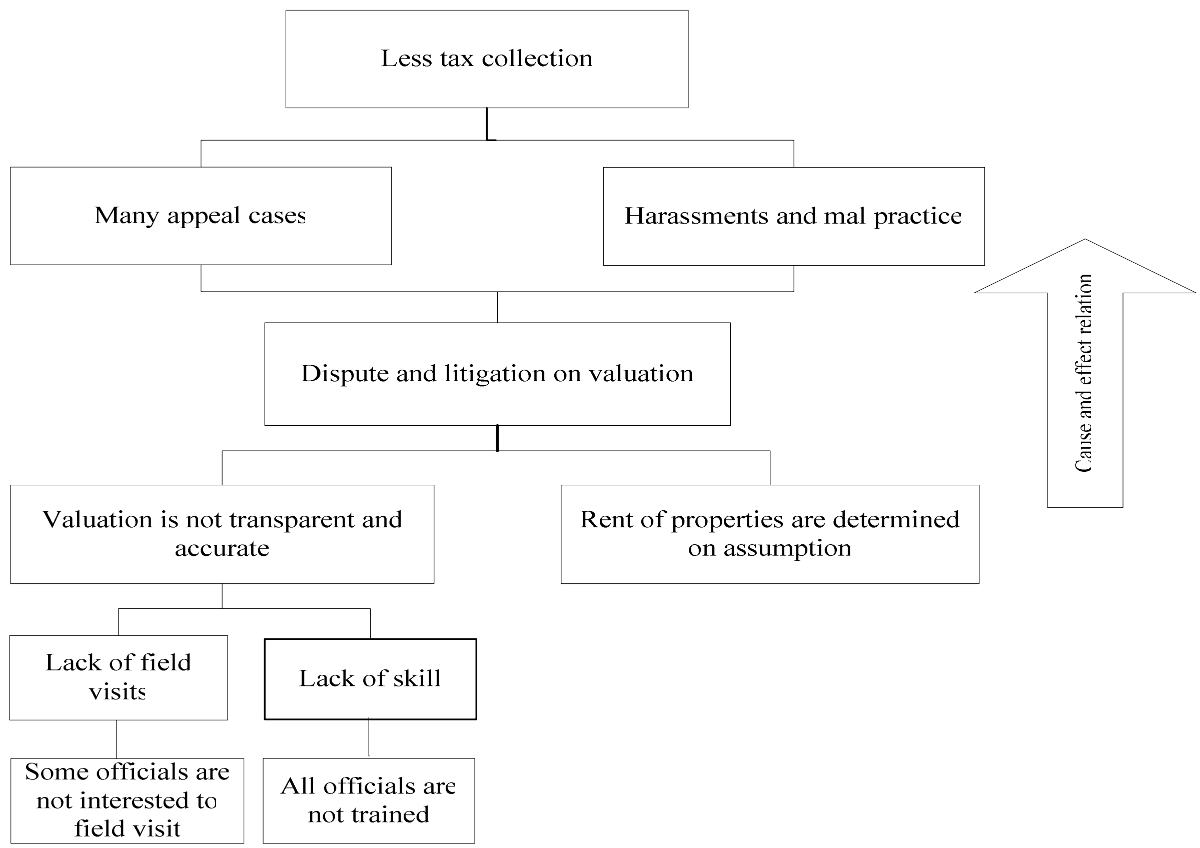



**Figure 4-1 Problem tree**

### 4.4.5. Objective Analysis

The main idea of the objective analysis is to find out the solution of core problem. Since citizens are facing problems with the valuation system and staffs behaviour, so, it can be introduced a better valuation system to meet up the problems. According to discussion meetings and interviews, it reveals that the people participation through self declaration can increase their confidence on taxing system. On that basis the findings the objective tree is analyzed below. In the objective tree, problem tree is transformed into a set of future solutions of problems.

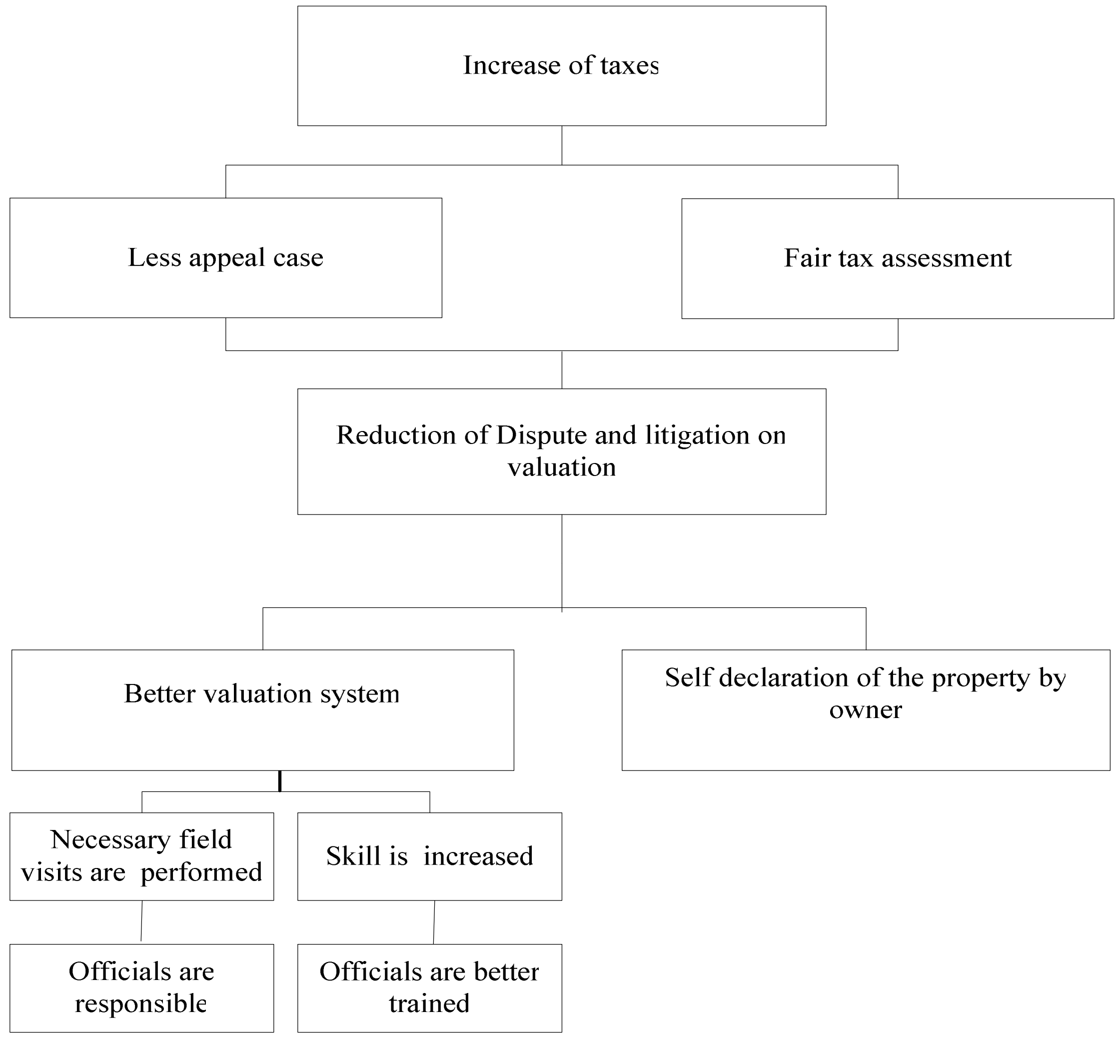



**Figure 4-2 Objective tree**

### 4.4.6. Solution finding

We find it earlier discussion of problem analysis that the core problem is *lot of dispute and litigation on valuation.* This problem is mainly derived from the present system of valuation. The present valuation system mainly depends on the personal skill of the valuer. There is no visible market of rent in Dhaka city, so in many cases the annual rent of houses are determined on assumption of surrounding conditions. The solution of the problem is to introduce a valuation system which can incorporate people participation. Solution is found from the objective tree analysis. Self declaration can do this in proper way through valuation system. But *self declaration* itself is not alone a solution. What its implication and how it can be introduced to the valuation system, it was discussed with the users. From the discussion meeting we got strong and weak points of self declaration and also its opportunity and threat of use. On the basis of these points the SWOT analysis is done below to meet users' satisfaction.

## 4.5. SWOT Analysis

SWOT is a technique which is often used to help organizations arrive at a realistic definition of their mission statement (Reeve and Petch 1999). The mission statement here for DCC is to introduce a fair, efficient and effective property valuation system in order to collect more taxes. 'SWOT' stands for Strengths, Weaknesses, Opportunities and Threats. Strengths and Weaknesses relate primarily to internal and current issues. On the other hand Opportunities and Threats primary to do with external and future issues. In the discussion questionnaire with officials, the questions 7, 8 & 9 were on the strengths, Weaknesses, Opportunities and Threats of using self declaration in valuation. On the basis of their answers the 'SWOT' of present valuation system is discussed below.

**Strengths:** The present valuation system is done on annual rental value of the property. Mostly property information is collected from field visit. Gross rental of ten months are calculated as annual value of property, which is a assessment procedure. The strong points of present valuation are grouped below.

- Valuation done on annual rental value
- Field visit for information collection
- Easy assessment

**Weakness:** According to rules, general assessment of property needs every five years interval but it is a long pending issue; for last seventeen years it was not done. The present methods of assessment lacks standardization and not transparent. As a result a lot of compliance against valuation and in appeal process takes a long time. On the other hand there is acute shortage of trained staff.

The weak points are:

- No general assessment for long period
- No standardization
- Lack of transparency in valuation and identification of property
- Shortage of trained staffs
- Appeal procedure of tax assessment takes long time

**Opportunities:** The DCC has self declaration system of property value. The planning department of DCC is doing the ward base map using GIS. At present about 38 wards (DCC, 2004) has been completed. So, these are the good opportunity to make proper use of them in property valuation.

The Opportunities are:

- Self declaration
- Ward base map including spatial data

**Threats:** Threats come from both inside and out side of the organization. Less trained staff can harm the valuation system. It also adds the illegitimate association with vested interest groups. Political interference sometimes affects the valuation process.

The threats are:

- Less training for the staff
- Vested interested groups
- Political interference in tax assessment

### 4.5.1. SWOT Matrix

A strategic choice is made on user requirements for valuation system by using the SWOT matrix (Groenendijk and Dopheide, 2003), which is given below.

| Internal Factors<br><br>External Factors | STRENGTHS<br>• Valuation done on annual rental value<br>• Field visit for information collection<br>• Easy assessment | WEAKNESSES<br>• No reassessment for long period<br>• No standardization<br>• Lack of transparency in valuation and identification of property<br>• Shortage of trained staffs<br>• Appeal hearing of tax assessment takes a long time | |
|---|---|---|---|
| OPPORTUNITIES<br>• Self declaration<br>• Ward base map with spatial data | **SO Strategies:**<br>• Ready available information from self declaration<br>• Property data base can be made with GIS based information<br>• Verify information by field visit | **WO Strategies:**<br>• Update information with self declared data<br>• GIS can use to find new property information | **OT Strategies:**<br>• Good and authentic information reduce political interference and vested interests |
| THREATS<br>• Less training for the staff<br>• Vested interested groups<br>• Political interference in tax assessment | **ST Strategies:**<br>• Regular field visit can increase payments<br>• Easy valuation can complement to training deficiency | **WT Strategies:** A valuation system with self declared information | |
| | **SW Strategies:** A transparent and effective valuation system | | **Synthesis**: In the valuation system self declared data can be verified with sample field visit. So, a valuation system can be developed using data from self declaration and field collected data. |

**Figure 4-3 SWOT matrix of present valuation system**

### 4.5.2. Findings for valuation system

We find from the SWOT-matrix a new valuation system is required for Dhaka city. This valuation system can be developed integrating self declaration. But self declared data needs further verification to ensure its correctness. So, it requires some technique to qualify those data. It can be compared with the database of cadastre and building control authority. In Dhaka city, cadastre system is still on paper based maps and documentation and it does not have a digital database. The building control authority RAJUK's documentation system is also on files and papers and has no digital database. So, it is very difficult to compare the self declared data with those organizational databases. It is found that no institutional capacity is yet built on proper qualification of self declared data, but it can be verified through sample field visit.

## 4.6. Summary

The background of the study area and present valuation system are discussed in this chapter. A sample is drawn of study area from where field data were collected. The present valuation system is investigated with the perspective of user needs for both organizations and taxpayers. It is seen that both officials and property owners find the problem of valuation from different perspective. Finally evaluating both sides' view points, it is tried to accommodate all views by new means of valuation system. It is found out through different planning tools and techniques. These techniques and tools use the information from two groups of users which is gathered from discussion meetings with officials and interviews with property owners. In problem and objective analysis, a core problem could be identified and also its solution. From SWOT analysis we find, how the solution part adapt to the present situation of the organization.

# 5. Integrated Property Valuation Model

## 5.1. Introduction

The management issues to introduce and implement technology in an organization are often crucial to success than the technological issues. People are significantly influenced not only by the facts pertaining to the technology but also by the context of the situation. This is the case for many technologies, especially when a new technology is introduced into an organization, the organizational impacts and implications must be addressed as carefully as the technological ones (Somers 1998). The present valuation system is investigated in chapter four. On the basis of those findings, the valuation model is developed in this chapter which might fit to Dhaka city. The valuation model attempts to explain as good as possible the relationships between a dependent variable, such as price of property and independent variables, such as physical characteristics of property that reflect factors of supply and demand (Linne et el, 2000). It describes the underlying logical structure, mathematical relationship and the behaviour of the agents of system (buyers, sellers, agents, lenders and regulators). It can be single-equation model with one or more independent variables, or it can be a system of equations. In this chapter the integrated valuation models are developed from the property data of self-declaration and field collection.

## 5.2. The Model

A model is designed to test theories and predict the out come of events (Eckert, et. el., 1990). Models may be physical, conceptual or mathematical. Property valuation models seek to explain or predict the market value of properties from real estate data. It deals with the purely logical aspects of valuation theory. Property valuation models seek to explain or predict the values of properties from real estate data. Models are constructed to represent the operation of forces of supply and demand in a particular market and have evolved from three broad theories of value: the cost approach, the sales comparison approach, and the income approach. From the three approaches of valuation in this research for models development, the income approach is used which is based on annual value or rental value of property as because in Dhaka city property valuation is done on rental value. In theory, there should be no difference between a tax on market value and a tax on rental value. When a property is put to its highest and best use and is expected to continue to do so, rental value will bear a predictable relationship to market value – the net rental payments will be approximately equal to market value (Bird, et. el., 2004). The model structure developed in mass appraisal is open, flexible and reflects the market and simple structure to produce satisfactory results. The types of models are described in latter sections.

## 5.3. Types of Model

Three types of model structures (Eckert, et. el., 1990) are used in different valuation approaches. They are; a) Additive models, b) Multiplicative models, and c) Hybrid models.

a) Additive Models: In an additive model, the dependent variable is estimated by multiplying each independent variable by its coefficient and adding results to the constant. These models are of the form:

$$\mathbf{y} = b_0 + b_1x_1 + b_2x_2 + \dots\dots\dots + b_px_p \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \mathbf{5\text{-}1}$$

Where y is dependent variable,

$x_1, x_2, \dots\dots\dots x_p$ are the independent variables ( p is the number of independent variables)

$b_0$, is a constant,

$b_1, b_2 \dots\dots\dots b_p$ are the coefficient of independent variables

The dependent and independent variables are specified during model specification and coefficients of independent variables are determined during model calibration.

b) Multiplicative Models: In a multiplicative model, the variables are not multiplied by their coefficients. Instead they are either raised to powers or themselves serve as powers; the results are then multiplied. The general structure of this model is

y = $b_0 \times x_1^{b1} \times x_2^{b2} \times \dots\dots\dots \times x_p^{bp}$ , where variables are defined as same as above.

c) Hybrid Models: A hybrid model is one that incorporates both additive and multiplicative components. The general structure of this model is

$$\mathbf{y} = [\, b_0 + b_1x_1 + b_2x_2 + \dots\dots\dots \,] \times [\, x_1^{b1} \times x_2^{b2} \times \dots\dots\dots \,] \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \mathbf{5\text{-}2}$$

## 5.4. The Model Type for the Study

An appraisal model must reflect appraisal theory and market behaviour. Successful modelling begins with market analysis, including a profile of the properties being modelled. In this research, model is being used for residential properties and for this purpose, additive type model is developed. The additive or linear model is primarily used in the appraisal practice, because it is simple and does not require a complicated statistical theory. Although this model is additive in structure, but it can also include nonlinear variables. It works well for residential properties. Their results can usually be improved through interactive and nonlinear terms. The model builders can often obtain highly satisfactory results with additive models, particularly in relatively homogeneous property type (Eckert et el., 1990). In this model, market value is estimated as a total amount without separation between land and building. In the case of Dhaka city, the annual value is calculated on the building, no separate value is imposed on land. However, this type of model is appropriate for Dhaka city. So, additive type of model is selected for this research study. This model will be determined from the multiple regression analysis of residential property data.

## 5.5. General Structure of Model

In mass appraisal, multiple regression analysis (MRA) is commonly used to estimate the value of properties. An MRA model is composed of one dependent and one or more independent variables. The dependent variable is the value to be estimated and independent variables are items or characteristics of properties used to predict the dependent variable. The general form of the regression equation (Linne et el., 2000) is

Dependent Variable = Constant + (coefficient × Independent Var1) + (coefficient × Independent Var2) + ………… + (coefficient × Independent Var n); 'n' is number of variables.

The prime goal of model building is to build a simple model that predicts well. The simpler model is better. If irrelevant variables are included in a model, it increases the standard errors of the coefficients without improving prediction and the variables that are important predictors are excluded then the model would be biased (Norušis, 2000). That is, it doesn't represent the true underlying model. To determine the model structure, firstly need to specify the model from data analysis.

The conceptual diagram of model is given below.

### 5.5.1. Model Specification

Model specification is the designing of models base on economic and appraisal theory and market analysis. It depends on type of data and variables. For this study, the basis of model building is income approach. The income approach is based on the principal of anticipation i.e. present value is a function of future benefits. The income approach begins with the development of typical market current rents, expressed on per property basis. Rents can be developed income data obtained from the property owners or, in some cases, local third party sources. In the case of Dhaka city market rents are developed from the property owners through self declarations and also from local third party sources, by field data collection. In the valuation process to predict value of the property, it is important to select the refine and meaningful small set of variables those have actual effect on valuation. The goal of the appraiser should be to develop the simplest, most straightforward model possible than to the most complex (Linne, et. el., 2000). In case of Dhaka city from self-declaration (Appendix- B), we get the following data and variables:

Qualitative data: i. Type of property, ii. Nature of Construction: (a) building, (b) pucca (without concrete roof), (c) tin shed (only basement is brick built) (d) kutcha (no brick is used), iii. Condition of building

Quantitative data: i. Number of storeys, ii. Number of rooms, iii. Number of bath-rooms, iv. Total floor space, v. Date of valuation, vi. Annual rental value

These variables will be used to develop the valuation models.

### 5.5.2. Model Calibration

Calibration of the model is the process of estimating the coefficients in a mass valuation model. The calibration uses the multiple regression analysis (the MRA) and other statistical methods. For the calibration of models the SPSS software will be used. The independent variables i.e. physical characteristics of property will be regressed on dependent variable; rental value in linear regression analysis. The model will be calibrated using additive and stepwise MRA. Stepwise MRA is particularly effective because it automatically eliminates the redundant and ineffective variables. The reliability of the estimated coefficients shall be evaluated using the statistical indices estimated in the MRA. The goal of is to create the property value estimation algorithms as precise as possible.

## 5.6. Variables and Multiple Regression Model

The Multiple Regression Analysis (MRA) is a statistical technique for estimating unknown data on the basis of known and available data. In these models the unknown data are property values. The known and available data are annual rental value and property characteristics. The major concern in model estimation is to identify those variables that explain the maximum variance in property value. All these variables can be estimated from statistical models using multiple regression analysis (MRA). These variables will be regressed on the dependent variable. A hedonic regression is used to estimate the property value equation for residential properties. The property value is a function of its hedonic characteristics that is the physical characteristics of property such as number of bed rooms, or number of storeys (Wachter, et el. 2005). In hedonic price analysis, house price is regressed on a package of inherent attributes. Specially, a hedonic equation helps to explain property value in terms of the property's own characteristics (Tse, 2002) i.e. physical characteristics of the property.

The additive MRA model is used for this research. The objective of MRA, as applied to mass appraisal, is to model the relationship between property characteristics (independent variables) to property value (dependent variable), so that the latter can be estimated from the former**.** The goal of modelling is to explain a lot with a little. The modelling of residential properties one should be careful not to make the models so large and complex that they become difficult to explain and manage. From the basic model types, we use variables that were thought to influence value in the study area. So, the general structure of property valuation model can be formulated as follows:

$$\hat{Y} = b_0 + b_1 NOR + b_2 NOB + b_3 TFA + b_4 NOS + b_5 NAC + b_6 COB + b_7 DAV \quad \text{..................... 5-3}$$

Where, $\hat{Y}$ is the estimated value of the property; the dependent variable

$b_0$ is the constant and $b_1$ to $b_7$ are the regression coefficient of independent variables. The independent variables are:

NOR is the number of rooms

NOB is the number of bathrooms

TFA is the total floor area

NOS is the number of storeys

NAC is the nature of construction

COB is the condition of the building

DAV is the date of valuation

### 5.6.1. The MRA Equation with Spatial Components

There are some important attributes of property that differentiate it from other commodities. Housing is fixed in geographic space, highly durable and expensive, and it is very heterogeneous. The simultaneous influence of these characteristics in a particular way defines the market behaviour in each local (Gonzalez et el. 2002 cited by Harvey, 1996; Lavender, 1990; Robinson, 1979; Sheppard, 1999). Location is one of the major factors influencing property value. The immobility of it causes a strong relationship (Gonzalez et el. 2002) between location attributes and values. So, the property value is spatially dependent. This spatial effect is referred to as 'spatial autocorrelation: locations that are close are more likely to have similar values than location that are far apart' (de By et. el, 2004). Spatial autocorrelation in real estate data has recently become an important topic for researchers interested in features associated with property location; which is usually studied for the statistical improvements of hedonic models. So statistical techniques designed to correct for spatial autocorrelation can improve estimates (Nzau, 2003).

Location can be represented by fixed neighbourhood boundaries or as a continuous value surface. A continuous valuation surface is represented by the concept of trend surface analysis (TSA). In TSA, the assumption is that the entire (continuous) geographic field can be represented by $f(x, y)$ that for given location with coordinates (x, y) will give the approximated value of the field in that location (de By et. el, 2004). TSA is a convenient approach, for measuring spatial relationships in regression models (Soibelman and Gonzalez, 2002). It is a useful way to location modelling, which uses the technique based on regression analysis in describing spatially continuous variables as spatial surfaces. TSA model consists on polynomial regression models, adding power series of coordinates to the common variables. Data collected is used to find a best fit polynomial, generally using stepwise approach in regression (Gonzalea, et. el, 2002). TSA is a type of response surface analysis, but has an explicit model, which is adjusted in a single step, and has a further advantage of permit the usual significance tests for the individual component.

So, the general structure of property valuation model with spatial components can be described as;

$$\hat{Y} = b_0 + b_1NOR + b_2NOB + b_3TFA + b_4NOS + b_5NAC + b_6COB + b_7DAV + c_if(x, y) \quad \ldots\ldots\ldots\ldots \textbf{5-4}$$

$c_i$ *is coefficients*

The coordinates are generated through spatial interpolation technique. Spatial Analysis of data in GIS software using spatial analyst tool creates a set of small grid cells (based on x, y coordinates) that completely covers the City's map layer. It performs a comparable property value search to find and adjust the nearest user-specified number of relative value reference points. The grid becomes the continuous, relative location adjustment surface. Data files are compared to the location value response surface based on each records x, y coordinate creating a location adjustment file. This location adjustment file is match merged to the original modelling data file to add the location variable to the modelling or application file. This requires the location adjustment factor to be determined directly from the spatial analysis of the selling prices by using an interpolation technique (McCluskey et el. 2000). A sales point theme can be used to interpolate a surface and to assign an estimated value to all other locations. The variables used in this study are annual rental value and spatial position as determined by the x, y co-ordinates.

### 5.6.2. Evaluating and interpreting regression model

The MRA model is evaluated by eight statistics (Eckert, et. el., 1990). Four are measures of 'goodness of fit' and relate to evaluation of the predictive accuracy of the equation. They are the coefficient of determination ($R^2$), the standard error of estimate (SEE), the coefficient of variation (COV), and the average percent error. In different ways, each indicates how well the equation succeeds in minimizing $\sum e_i^2$, Where $e_i$ is the *i*th residual (Moore, McCabe, 2003), the difference between the observed and predicted response,

$e_i$ = observed response – predicted response

$$= y_i - \hat{y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{5-5}$$

The other four statistics relate to the importance of individual variables in the model. They are the coefficient of correlation (R), the t-statistic, the F-statistic, and the beta coefficient (β).
All eight statistics are described in following sections.

### 5.6.2.1. Coefficient of determination (R²)

The coefficient of determination (COD) or the squared multiple correlation;
$R^2$ = Sum of squares model (SSM) / Sum of squares total (SST)

$$=\sum(\hat{y}_i - \bar{y}) / \sum(y_i - \bar{y}) \quad \text{……………………………………5-6}$$

is the proportion of variation of the response variable *y* that is explained by the explanatory variables $x_1, x_2, \ldots\ldots$ in a multiple linear regression (Moore, McCabe, 2003).

The COD is the percentage of variance in property values explained by the regression model. The $R^2$ statistic ranges from 0.00 to 1.00. Small value indicates that the model does not fit the data well. On the other side, when $R^2$ equals 1, all variations in values are explained by the regression equation. If $R^2$ equals 1 in a one variable model, it means if value is plotted against the variable, all values would lie on a straight line. The general rule of thumb is that any regression model used in real estate valuation with an $R^2$ greater than 60% explains a lot (Linne, et. el. 2000).

### 5.6.2.2. Standard error of the estimate (SEE)

The standard error of the estimate measures the amount of deviation between actual and predicted property value. It is computed as:

$$\textbf{\textit{SEE}} = \left[\frac{\sum(y_i - \hat{y}_i)^2}{n - p - 1}\right]^{1/2} \quad \text{……………………………………………5-7}$$

Where *n* is the number of observations and *p* is the number of independent variables.
The *SEE* is the sum of squared errors divided by its degrees of freedom (n – p - 1). This yields a measure of the squared error or variance of the regression model. The *SEE* is calculated in a manner that analogous to the standard deviation, and indeed can be viewed as the standard deviation of the standard errors. Thus, if the errors are normally distributed, two-thirds of actual values will fall within 1 *SEE* of their predicted values, 95 percent within 2 *SEEs* and so on (Eckert, et. el. 1990).

### 5.6.2.3. Coefficient of Variation (COV)

In regression analysis (Eckert, et. el., 1990), the regression of variation (COV) is the SSE expressed as a percentage of the average observed value multiplied by 100;

$$\textbf{COV} = \frac{(100)(SEE)}{\bar{y}} \quad \text{……………………………………………..5-8}$$

The COV is preferred for assessment purposes, because its interpretation is independent of the average observed value.

#### 5.6.2.4. Average Percentage Error

The average percent error is analogous to the Coefficient of Determination (COD) in ratio studies. It is calculated as the average absolute percent error between actual and predicted values multiplied by 100.

#### 5.6.2.5. Coefficient of correlation (R)

The square root of $R^2$, called multiple correlation coefficient, is the correlation (Moore, McCabe, 2003) between the observed value ($y_i$) of the dependent variable and the predicted value ($\hat{y}_i$) based on the regression model. Correlation analysis is used to quantify the degree of linearity between two variables. The correlation coefficient (R) ranges from -1 to +1. If two variables are perfectly linearly related, plotting one against the other will produce a straight line and R will be either -1 or +1, depending on the direction of relationship. If the variables bear no linear relationship to each other, the value of R will be zero. A value of 1 tells that the dependent variable can be perfectly predicted from the independent variables. A value close to 0 tells that the independent variables are not linearly related to the dependent variable.

#### 5.6.2.6. T-statistic

This is a measure of the significance or importance of a regression variable in explaining differences in the dependent variable (Property value). It is calculated as the ratio of the regression coefficient to its standard error. When t is large, one can be confident that the variable is significant in the prediction of value. Conversely, when t is small, one cannot reject the hypothesis that regression coefficient equals 0 and that independent variable is unimportant in explaining dependent variable (Eckert, et. el. 1990). It should be emphasized, however, that this does not mean that variable is not correlated with property value.

The t-value measures the marginal contribution of a variable in predicting value when all other variables included in the equation are held constant. Because some variables duplicate information provided by others, they may be highly correlated with property value, but insignificant predictors as indicated by their t-values.

The significance of t-statistic can be evaluated by referencing to the t-table where degrees of freedom is equal to n-p-1, where n is the number of samples and p is the number of independent variables. In general, provided that sample size is large (at least fifty), a t-statistic in excess of ±2.00 indicates that one can be 95 percent confident that regression co-efficient is not equal to zero and therefore that independent variable is significant in predicting property value. Similarly, a t-statistic in excess of ±2.58 indicates that one can be 99 percent confident that independent variable is significant in prediction of property value.

#### 5.6.2.7. F-Statistic

The F-Statistic is related to the t-statistic and is also used to test whether or not individual regression variables are significant in predicting the dependent variable. Regression F test is the test of null hypothesis based on the ratio of the regression mean square to the residual mean square (Norusis, 2000). As with the t-statistic, however, it should be understood that F-statistic provides a measure of the marginal importance of an individual variable in explaining the dependent variable when all other variables are also taken into account (by including them in regression equation). In MRA, the F and t-statistics are mathematically related: $F = t^2$ In general, an F-statistic of 4.0 or larger indicates that a variable is significant in predicting property value at the 95 percent confidence level, provided that sample size is large.

#### 5.6.2.8. Standardized coefficients (β)

Beta coefficients are standardized regression coefficients that measure the relative importance of individual variables, in explaining differences in the dependent variable. These are obtained by transforming the dependent and independent variables so that they have means of zero and standard deviations of one. For each variable, this is accomplished by subtracting its mean and dividing by its standard deviation. Beta measures the percentage change in a property value associated with a percentage change in an independent variable with all other factors held constant. It is, therefore, useful in comparing the relative importance of independent variables. The sign of the coefficient indicates whether an increase or decrease of an independent variable increases or decreases the dependent variable. It is useful to compare the relative importance of independent variables.

#### 5.6.2.9. Unstandardized coefficients (B)

The unstandardized coefficients are the coefficients of the estimated regression model, which tell how much the dependent variable changes in response to a one unit change in the independent variable.

## 5.7. Summary

In this chapter the property valuation model is developed for this research. For this model the additive type structure is used and this type of model is well fit to the residential properties valuation. In the basic model, those variables are included, which are come from self declaration form and also collected by the assessors from field visit. These variables are included in the property registers. The model evaluating statistics are also discussed. This will be further implemented in the subsequent chapter.

# 6. Development and Testing of Property valuation Model

## 6.1. Introduction

This chapter concentrates on residential property valuation model development and testing with data analysis. In this chapter statistical analysis techniques are used to model development and test the significance of individual variables in the model. Results for multiple regression analysis are presented. The SPSS software package is used for data analysis and model calibration.

## 6.2. Description of main variables

The data from all study area (three wards) are used to model development. The variables are property characteristics falling into two groups; quantitative e.g. number of rooms and qualitative such as condition of building. The quantitative data is measured in consistent scale but qualitative data needs to transform giving some 'dummy' values for statistical analysis. According to Eckert et el. (1990), qualitative data can be converted to numbers or values that express their relative value or desirability. It is advisable to use the low value to mean a bad thing and the high value to mean a good thing. The table below gives the descriptions and transformation of variables, which are used in development of models.

| Variable code | Name of variable | Type of variable | Definition of variable | Type of data |
|---|---|---|---|---|
| ANV | Annual value | Dependent | Gross rental value of the property in BDT*** | Ratio* |
| NOR | Number of Rooms | Independent | Number of room in numeric value | Ratio |
| NOB | Number of Bathrooms | Independent | Number of bathroom in numeric value | Ratio |
| TFA | Total Floor Area | Independent | Total floor area of a property in square foot | Ratio |
| NOS | Number of Storey | Independent | Total number of storey in a property in numeric value | Ratio |
| NAC | Nature of Construction | Independent | Construction quality of a property; a four level variable with 4= building, 3= pucca, 2= tinshed, 1= kutcha | Ordinal** |
| COB | Condition of Building | independent | Physical condition of a property; a four level variable with 4= good, 3= fair, 2= average and 1= poor | Ordinal |

| Variable code | Name of variable | Type of variable | Definition of variable | Type of data |
|---|---|---|---|---|
| DAV | Date of Valuation | independent | The date of imposing tax, counted as year in numeric value. | Ratio |
| X_cord | X_Coordinate | independent | The spatial position of a property, measure in meter. | Ratio |
| Y_cord | Y_Coordinate | independent | The spatial position of a property, measure in meter. | Ratio |

**Table 6-1 List of variables and their definitions**

*Ratio: A variable takes numerical values for which it makes sense to do arithmetic operations.
**Ordinal: A variable whose values indicate only order or rank.
***BDT is Bangladesh Taka (currency)

## 6.3. Data exploration

Data exploration involves carrying out the descriptive and correlation analysis and examination of linear relationship of variables to get a better understanding of the data. It intends to do different tests whether the variables are significant to determine the value of property. The statistical analysis is considered as a potentially useful tool to fulfil this intention. In the following analyses data are used from the whole study area with both self declared and field data. The descriptive and correlation statistics for individual ward (neighbourhood) are given in appendices (Appendix-D & E, table D-1, D-2, D-3 and E-1, E-2, E-3).

### 6.3.1. Descriptive statistic

Descriptive statistic is the first step to explore and understand the data set. The objective of this step is to summarize statistically the principal characteristics of relevant distribution, to make it simple to explain and test the completeness of data. It tells the central tendency and variability of data. The tables below show the descriptive statistics of dependent and independent variables for whole study area.

| | NAC | COB | NOR | NOB | NOS | TFA | DAV | ANV |
|---|---|---|---|---|---|---|---|---|
| Mean | 3.98 | 3.35 | 10.07 | 5.34 | 2.43 | 3,926 | 1991 | 92,477 |
| Median | 4.00 | 4.00 | 8.00 | 4.00 | 2.00 | 3,200 | 1989 | 60,000 |
| Mode | 4 | 4 | 8 | 3 | 2 | 3,000 | 1989 | 60,000 |
| Std. Deviation | .176 | .865 | 8.666 | 5.425 | 1.41 | 2953.927 | 4.875 | 168,807 |
| Minimum | 2 | 1 | 1 | 1 | 1 | 220 | 1988 | 900 |
| Maximum | 4 | 4 | 88 | 66 | 12 | 26,400 | 2005 | 2,538,000 |
| Valid N | 386 | | | | | | | |

**Table 6-2 Descriptive Statistics of Independent and Dependent Variables**

From the above table, looking into mean, median and mode it is observed that the distributions of variables are skewed (which measure the deviation of the distribution from symmetry) and we also get the following characteristics of different variables for three neighbourhoods:

The mean, median and mode indicate the nature of construction (NAC) for whole study area is 'building'. Those statistics describe the physical condition of building (COB) is 'good'. The average number of rooms (NOR) in a property is ten and majority of properties have eight rooms. Average number of bath rooms (NOB) in a property is five and majority of properties have four bath rooms. The most of the houses are two storeys (NOS) with average floor area (TFA) 3,926 $ft^2$. The mode shows that the most of property were assessed in 1989 and average value is Tk. 92,477. The standard deviation shows that total floor area (TFA) and annual values (ANV) differ more between properties. There is no missing value and shows the completeness of data. Here the chart 6-1 shows average annual rental value of property of ward Dhanmondi is much higher than other two wards and lowest value in Nawabpur. It is relevant with the neighbourhoods' physical characteristics as we see in chapter four background of three study area: Dhanmondi is much better than other two areas. Descriptive statistics provide some simple information relevant to further analysis.

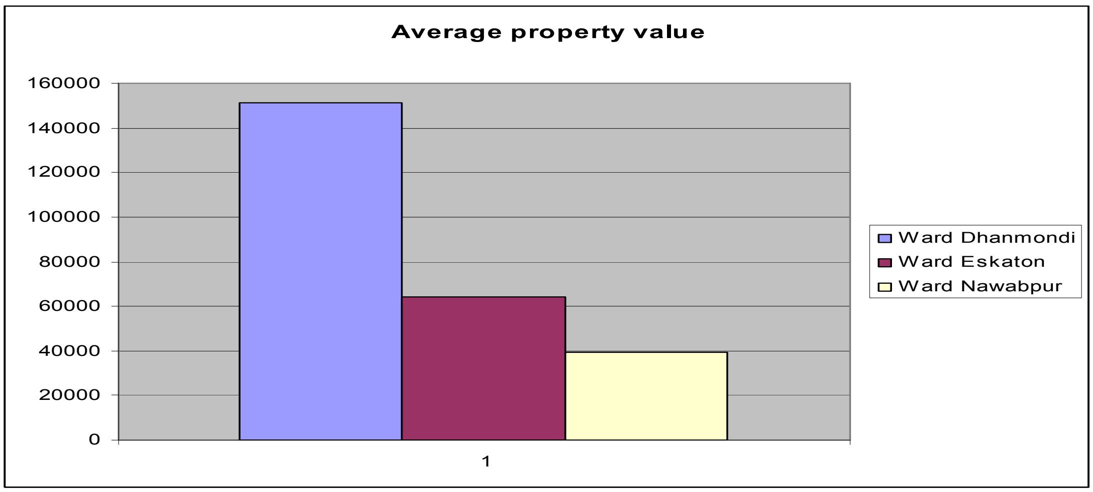



**Chart 6-1 Average property value of three neighbourhoods**

### 6.3.2. Correlation matrix of Variables

The correlation matrix shows how the variables are related and how they can explain each other. It is measured by coefficient of correlation (R). The value of R ranges from -1 to +1 with both extremes indicating a perfect correlation. A correlation close to 0 indicates the both variables are not related. During the correlation analysis, the spatial position of the property is included as variable.

| | ANV | NAC | COB | NOR | NOB | NOS | TFA | DAV | X_cord | Y_cord |
|---|---|---|---|---|---|---|---|---|---|---|
| ANV | 1.000 | .022 | .205(**) | .656(**) | .797(**) | .486(**) | .610(**) | .299(**) | -.291(**) | .167(**) |
| NAC | | 1.000 | .173(**) | .072 | .060 | .069 | .024 | -.096 | .041 | .043 |
| COB | | | 1.000 | .178(**) | .196(**) | .231(**) | .104(*) | .279(**) | -.183(**) | .471(**) |
| NOR | | | | 1.000 | .917(**) | .745(**) | .484(**) | .177(**) | -.020 | -.006 |
| NOB | | | | | 1.000 | .683(**) | .556(**) | .222(**) | -.198(**) | .071 |
| NOS | | | | | | 1.000 | .366(**) | .071 | .094 | .087 |
| TFA | | | | | | | 1.000 | .059 | -.098 | .085 |
| DAV | | | | | | | | 1.000 | -.310(**) | .035 |
| X_cord | | | | | | | | | 1.000 | -.416(**) |
| Y_cord | | | | | | | | | | 1.000 |

** Significant at the 0.01 level (2-tailed), * Significant at the 0.05 level (2-tailed).

**Table 6-3 Correlations Matrix of variables**

The table above shows a matrix of correlation coefficients for all pairs of variables. The correlation is obtained in bivariate method with Pearson correlation coefficients, which describe the strength of the linear association between variables. All independent variables show positive correlation except X_cord with the dependent variable annual value (ANV). According to Nzau, 2003 (cited by Murphy, 1989), if correlation coefficient is more than or equal to 0.7 then two variables are highly correlated. The variable number of rooms (NOB), and total floor area (TFA) show high correlation, and nature of construction (NAC) has insignificant correlation and all other variables are moderately correlated with the dependent variable. Some independent variables show strong multicollinearity. This is a problem for MRA models, which is checked during model building and analysis. Table 6-3 shows that some independent variables are less linearly associated with the dependent variable. Further discussions on linear relationships between the variables are given in the following section. The correlation analysis for each neighbourhood is also done.

## 6.4. Examining the Variables for Linear Relationship

Before estimating the coefficients in linear regression, it is make sure that the independent variables are linearly related to the dependent variable. If they are not , it is needed to transform the data taking logs or square roots of one or both of a pair of variables to make the relationship linear (Norušis, 2000). Table 6-4 below shows, the scatter plot matrix of the independent variables and the dependent variable, and it indicates that all independent variables are not linearly related to the annual value, ANV. So, it is needed to transformation of data. Before using these variables in regression model, the data are transformed taking natural logarithm and checked the linearity in Table 6-5 which shows, the linear association increases after transformation of data. Now it makes sense to compute the multiple regression equation using the values of the transformed variables in place of the original variables. In the case of each neighbourhood correlation matrix is given in appendices. For simplicity, in the rest of the chapter it will usually refer to the variables using their original names. As for example, instead of always saying the natural log of the number of room, it will refer as NOR or number of rooms. The models are developed in the following sections

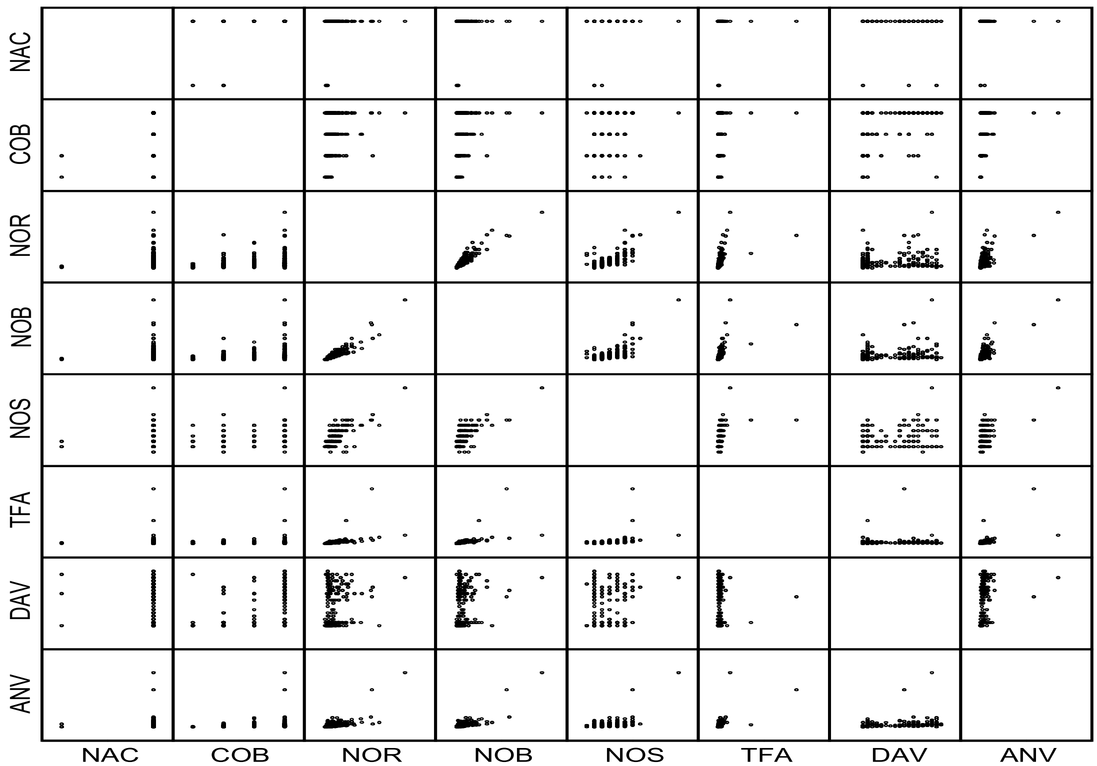



**Figure 6-1 Scatter matrix before transformation**

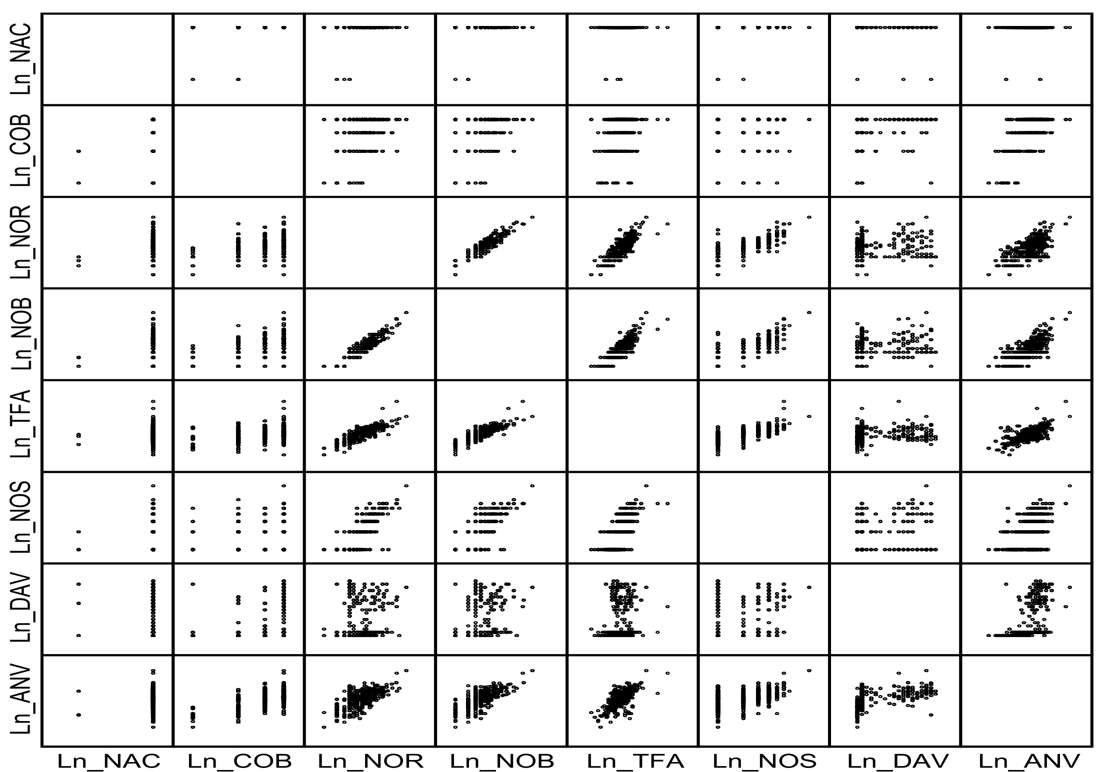



**Figure 6-2 Scatter matrix after transformation of variables**

## 6.5. Multiple Regression Analysis (MRA) and Models

The MRA is statistical approach of estimating the unknown data, using the known and available information. The stepwise regression method, which is described in chapter three, is applied for the development of models. This algorithm prevents the redundant and insignificant variables from making the model more complex. In this method, the variables are removed from the model those are no longer significant predictors for dependent variable. The stepwise MRA also eliminate highly correlated independent variables (Eckert et el. 1990), which add multicollinearity problem. For statistical analysis SPSS 12.0.1 software is used. During the fieldwork property data were collected from secondary source, and the collected data were from two categories: self declared data and field data. The models are built from both types of data. Firstly, the models are built and analysed for self declared data, and then field data from each neighbourhood. Finally, the models are developed integrating both categories of data for whole study area. The location attributes are added to final model and then model validity is checked with different statistical tests. In stepwise regression approach there are several models are produced for a set of data and the final model is accepted on the basis of the value of $R^2$ and standard error of estimates (SEE). The $R^2$ tells what proportion of variability of the property value is "explained' by the regression model and SEE is the difference between observed and predicted property value. It is always desired that the accepted model would be the higher $R^2$ value and lower SEE value. The adjusted $R^2$ is an estimate of how well the model would fit different data set from the same population and its value is always smaller than the value of $R^2$ (Norušis, 2000). The adjusted $R^2$ is commonly used as the best measure of a model's goodness of fit. So, when a regression is run, the first thing is to look at how well the model fits. The $R^2$ statistics describes the general explanatory power of a model, but error statistic describes the predictive power of a model (Linne et el. 2000). Here, $\hat{Y}$ is used as the predicted value of the property. The different models are described in following sections.

### 6.5.1. Model with Self declared Data

In this section models are developed from self declared data. The sample size is for Dhanmondi: 87, Eskaton: 49, Nawabpur: 20 and whole study area: 156. Here regressions are run with self declared data and four models are developed three with data from individual neighbourhood and fourth one is combined all data together. Models summary tables are given here but coefficients and ANOVA tables are given in Appendix - F.

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .792 | .627 | .618 | 46375.969 |
| 2 | .839 | .703 | .684 | .45595 |
| 3 | .859 | .738 | .723 | .47187 |
| 4 | .782 | .611 | .603 | .63358 |

**Table 6-4 Model Summary**

**Model – 1: Neighbourhood – Dhanmondi**

$\hat{Y}$ = -33753.912 + 19.947*TFA + 13535.337*COB

**Model – 2: Neighbourhood – Mogh Bazar**

$Log_e (\hat{Y}) = -1468.290 -1468.290*Ln\_NOS + .408*Ln\_TFA + 194.177*Ln\_DAV$

**Model – 3: Neighbourhood – Nawabpur**

$Log_e (\hat{Y}) = 6.937 + 1.308*Ln\_NOR$

**Model – 4: Whole Study Area**

$Log_e (\hat{Y}) = 4.589 + .610*Ln\_TFA + .488*Ln\_NOB + .520*Ln\_COB$

Four models are accepted on the basis of $R^2$ value and SEE. For neighbourhood Dhanmondi, the scatter matrix shows that the correlations between independent and dependent variables are linear. So, the variables are not transformed for regression. The variables NAC and DAV have constant values, so they are excluded from regression. In neighbourhood one, in stepwise regression approach only two variables (TFA & COB) are included with constant in the model and other variables are excluded. In neighbourhood Mogh Bazar, three variables (NOS, TFA & DAV) are included and the adjusted $R^2$ = 0.684. And in neighbourhood-3 Nawabpur, only variable NOR is included in the model and adjusted $R^2$ is 0.723. The model- 4 for whole study area including combined data from three neighbourhoods has included variables TFA, NOB & COB and adjusted $R^2$ is 0.603.

**Result analysis:** The three models of individual neighbourhood show that model – 1 has the less explanatory power with 61.8%, model – 2 has 68.4% and model – 3 has the larger explanatory power with 72.3%. This may happened as in model-1 variables are not transformed and in model three sample size is very small (N=20). In model three only one variable, NOR is included and correlation matrix (Appendix-B, table B3) shows this variable has the highest correlation with property value. The model of whole study area with combined data has lowest explanatory power with 60.3% and highest standard error of estimation (SEE) among four models. This means that a combined model with self declared data does not predict property value well rather individual model for each neighbourhood predicts better.

### 6.5.2. Model for Field Data

In this section models are developed from field data. The sample size for Dhanmondi is 63, Eskaton is 101, Nawabpur is 66 and for whole study area is 230. Models summary tables are given here but coefficients and ANOVA tables are given in appendices (Appendix – G).

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .853 | .727 | .708 | .50083 |
| 2 | .868 | .753 | .743 | .38064 |
| 3 | .940 | .883 | .877 | .46930 |
| 4 | .895 | .801 | .796 | .54030 |

**Table 6-5 Model Summary**

**Model - 1 Neighbourhood Dhanmondi**

$Log_e (\hat{Y}) = -562.475 + 1.282* Ln\_TFA + 1.089* Ln\_COB + 74.047* Ln\_DAV - .466* Ln\_NOS$

**Model -2 Neighbourhood Mogh Bazar**
7.562 - 987.562*Ln_TFA + 130.636*Ln_DAV + .641* $Log_e$ ($\hat{Y}$) = -98Ln_COB + .346*Ln_NOB

**Model - 3 Neighbourhood Nawabpur**
$Log_e$ ($\hat{Y}$) = -461.762 + .958*Ln_NOR + 1.008*Ln_COB + 61.700*Ln_DAV
**Model - 4 Whole Study Area**
$Log_e$ ($\hat{Y}$) = -927.163 + .491*Ln_NOB + 1.403*Ln_COB + 122.566*Ln_DAV + .647*Ln_TFA - .314*Ln_NOR

The second set of models are obtained by running stepwise regressions with field data from three neighbourhoods that give three different models for three neighbourhood and also one model for the whole study area. In neighbourhood Dhanmondi, the model's adjusted $R^2$ value is 0.708 and four variables (TFA, COB, NOS & DAV) are included in it and other variables are excluded. In neighbourhood Mogh Bazar, four variables (NOB, COB, TFA & DAV) are included and coefficient of determination is adjusted $R^2$ = 0.743. And in neighbourhood Nawabpur, three variables (NOR, COB & DAV) are included in the model and adjusted $R^2$ = 0.877. The model with field data from three neighbourhoods has included variables TFA, NOB, COB, NOR & DAV and adjusted $R^2$ is 0.796.

**Result analysis:** In the second set of models, it is observed that in all cases models explanatory power increases those from the models with self declared data. In case of Dhanmondi, it increases about 9%, in Eskaton 5% and in Nawabpur 15.4% and for combined model 19.3%. The standard error (SEE) also decreases in every model. The results show that the model with field data predicts property value better than that of self declare data. In these model set, the combined model's explanatory power increases from individual model except Nawabpur but SEE is higher value than individual model. $R^2$ measures the total fit of the equation and SEE indicates how accurate the model is for a specific property. Standard error is useful statistics in respect to predictive power of regression based model (Linne, et el. 2000). So, it would be interesting to look at what happen when both categories of data are combined in a model in next section.

### 6.5.3. Model for combined data

In this section regression models are run with combined data of self declared and field data. The sample size for Dhanmondi and Eskaton is 150 and for Nawabpur is 86. Three different models are constructed with those data. The integrated model for whole study area is developed in section 6.5.4.

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .812 | .659 | .652 | .48356 |
| 2 | .842 | .709 | .701 | .43522 |
| 3 | .935 | .874 | .868 | .45824 |

**Table6-6 Model Summary**

**Model - 1Neighbourhood Dhanmondi**
$Log_e$ ($\hat{Y}$) = -809.437 + 107.025*Ln_DAV + .864*Ln_TFA + .620*Ln_COB

**Model - 2Neighbourhood Mogh Bazar**

$Log_e(\hat{Y})$ = -1131.863 + .503*Ln_TFA + 149.742*Ln_DAV + .451*Ln_NOB + .496*Ln_COB

**Model – 3 Neighbourhood Nawabpur**

$Log_e(\hat{Y})$ = -460.906 + .890*Ln_NOR + .928*Ln_COB + 61.589*Ln_DAV + .242*Ln_NOS

The third set of models are developed by running stepwise regressions with combined self declared and field data from three neighbourhoods that give three different models. In neighbourhood one, the model includes three variables (TFA, COB & DAV) with adjusted $R^2 = 0.652$. In neighbourhood-2, four variables (NOB, COB, TFA & DAV) are included and adjusted $R^2$ is 0.701. And in neighbourhood-3, four variables (NOR, COB, NOS & DAV) are included in the model and adjusted $R^2 = 0.868$.

**Result analysis:** The main observation is that although the value of $R^2$ decreases than models with field data in every case but SEE reduces in these models with combined data. The reduction of the value of SEE indicates the increase of prediction power of the model that means the difference between predicted property value and actual value is less than that of in first and second set of models. The models predictive power increase with the integration of self declared with field data.

### 6.5.4. The Final Model for Study Area

The model is run with integrating data from three neighbourhoods. First the stepwise regression is run without location element and then with locations components. Here the sample size is 386. The empirical results are tested with different statistical analysis.

#### 6.5.4.1. Model without location

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| Step 1 | .701 | .492 | .490 | .80101 |
| Step 2 | .792 | .627 | .625 | .68712 |
| Step 3 | .818 | .669 | .667 | .64788 |
| Step 4 | .847 | .718 | .715 | .59892 |
| Step 5 | .851 | .724 | .720 | .59349 |

**Table 6-7 Model Summary**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound | Tolerance | VIF |
| | (Constant) | -881.708 | 103.087 | | -8.553 | .000 | -1084.406 | -679.010 | | |
| | Ln_NOB | .568 | .126 | .347 | 4.522 | .000 | .321 | .815 | .124 | 8.051 |
| | Ln_COB | 1.086 | .099 | .321 | 10.930 | .000 | .891 | 1.282 | .847 | 1.180 |
| | Ln_DAV | 116.621 | 13.559 | .253 | 8.601 | .000 | 89.961 | 143.282 | .844 | 1.184 |
| | Ln_TFA | .652 | .077 | .444 | 8.516 | .000 | .501 | .802 | .269 | 3.720 |
| | Ln_NOR | -.321 | .114 | -.192 | -2.819 | .005 | -.544 | -.097 | .157 | 6.362 |

**Table 6-8 Model Coefficients**

The regression is run with combined self declared and field data from three neighbourhoods without location variables that gives five models and accepted model is 5th one with constant and five variables (NOR, COB, NOS & DAV). The explanatory power of model increases to 72.0% and standard error of estimation reduces to .59349. The F ratio is 197.714 much larger than critical f-value, which indicates a greater confidence in the regression equation (ANOVA and Coefficients tables are given in Appendix – H, table H1 & H2). The model is given below.

**$Log_e$ (Ŷ) = -881.708 + .568*Ln_NOB + 1.086*Ln_COB + 116.621*Ln_DAV + .652*Ln_TFA - .321*Ln_NOR**

The regression is run with seven variables but in the final equation, the variables NAC & NOS are excluded as those variables are insignificant predictors, and t- values are less than critical t and also collinearity statistics indicate (Excluded variables: Appendix – H, table H3) they are highly correlated (tolerance statistics are higher value i.e. greater than 0.1).

### 6.5.4.2. Model with spatial data

Adding spatial location into model is an important work. The immobility of property causes a strong relationship (Gonzalez et el. 2002) between location attributes and values. Location is modelled as a continuous value surface which is represented by the concept of trend surface analysis (TSA). In TSA, the assumption is that the entire (continuous) geographic field can be represented by $f(x, y)$ that for given location with coordinates (x, y) will give the approximated value of the field in that location (de By et. el, 2004). TSA is a convenient approach, for measuring spatial relationships in regression models (Soibelman and Gonzalez, 2002). TSA model consists on polynomial regression models, adding power series of coordinates to the common variables, generally using stepwise approach in regression (Gonzalez, et. el, 2002), and has a further advantage of permit the usual significance tests for the individual component.
So, the general structure of property valuation model with spatial components can be described as;

$\hat{Y} = b_0 + b_1NOR + b_2NOB + b_3TFA + b_4NOS + b_5NAC + b_6COB + b_7DAV + c_i f(x, y)$ ……….. 6-1

$c_i$ is coefficients of polynomial equation generated by regression

Spatial Analysis of data in GIS software using spatial analyst tool creates a set of small grid cells (based on x, y coordinates) that completely covers the whole map layer. This requires the location adjustment factor to be determined directly from the spatial analysis of the property value and spatial position is determined by the X, Y co-ordinates. In this study the coordinates are generated through interpolation technique using ArcGIS software and digital maps of study area.

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| Step 1 | .709 | .502 | .501 | .80082 |
| Step 2 | .801 | .641 | .639 | .68080 |
| Step 3 | .864 | .747 | .745 | .57277 |
| Step 4 | .877 | .769 | .766 | .54807 |
| Step 5 | .894 | .799 | .796 | .51186 |
| Step 6 | .900 | .810 | .807 | .49820 |
| Step 7 | .905 | .819 | .816 | .48660 |
| Step 8 | .905 | .819 | .816 | .48593 |

**Table 6-9 Model Summary**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound | Tolerance | VIF |
| | (Constant) | -720.102 | 95.705 | | -7.524 | .000 | -908.309 | -531.894 | | |
| | X_cord | -.0002 | .000 | -.308 | -11.215 | .000 | .000 | .000 | .663 | 1.508 |
| | Ln_COB | .817 | .092 | .242 | 8.863 | .000 | .636 | .998 | .671 | 1.490 |
| | Ln_TFA | .391 | .064 | .267 | 6.134 | .000 | .266 | .516 | .263 | 3.805 |
| | Ln_DAV | 101.630 | 11.515 | .219 | 8.826 | .000 | 78.985 | 124.275 | .813 | 1.230 |
| | Y_cord | .0001 | .000 | .135 | 4.769 | .000 | .000 | .000 | .628 | 1.593 |
| | Ln_NOR | .486 | .072 | .286 | 6.735 | .000 | .344 | .628 | .278 | 3.597 |

**Table 6-10 Model Coefficients**

In this model, the power series of coordinates (X, Y) are added to other attributes. Selection of components in the models is made using stepwise algorithm in SPSS at significance level of 95%. The value surfaces are investigated from $1^{st}$ to $8^{th}$ degrees and obtained results are same. So, in the final model the $1^{st}$ degree of X and Y coordinates are added as spatial variable. Soibelman and Gonzalez (2002) and Gonzalez, et el. (2002) got their best result using $6^{th}$ degree power to coordinates (X, Y) in their surface investigation.

The step wise regression produces eight models and after analyzing the model summary, the eighth one is accepted. (ANOVA and Coefficients tables are given in Appendix – E, table E4 & E5)
The model stands as-

**$Log_e(\hat{Y})$ = -720.102 - .0002*X_cord + .817*Ln_COB + .391*Ln_TFA + 101.630Ln_DAV + .0001*Y_cord + .486*Ln_NOR**

**Result analysis:** The model includes six variables, they are: condition of buildings (COB), total floor area (TFA), number of rooms (NOR), date of valuation (DAV) and X, Y coordinates. The direction of X_cord is negative, with increase of this value decreases the property value. All other variables have positive coefficients. The increase in X values decrease the property value and increase in Y values increase property values. From the data, we see that X coordinates has lowest value in Dhanmondi and highest value in Nawabpur among three neighbourhoods and that is opposite to Y_cord. In the real situation average property value of neighbourhood Dhanmodi is higher than Mogh Bazar and lowest average value in neighbourhood Nawabpur, which we observe in descriptive statistics. This model accounts for 81.6% of total property value variability with included variables. The F-value of model is 273.266, which is much larger than critical F-value. The t-statistics of individual variables is also larger than critical t-value within 95% confidence interval. The included variables are significant to predict property values of residential areas.

Three variables (NAC,NOS & NOB) are excluded from the model as they are insignificant predictors, and partial correlation shows their marginal contribution to the model are very less. The t-values of NOS & NOB are less than significant level and collinearity statistics shows, the variables NAC & NOS are highly correlated (Excluded variables: Appendix – H, table H6).

#### 6.5.4.3. Analysis of results for final model

Two models are developed with integrated self declared and field data. Now one would be accepted for the final valuation model for residential property in Dhaka city. To select final model the results of two models (without location and with location variables) are analysed with different statistical tests. In the table 6-13 below, the results are summarized.

| Models | Adjusted $R^2$ | SEE | COV* | COD** |
|---|---|---|---|---|
| Model without location | .720 | .59349 | 5.8% | 4.3% |
| Model with location | .816 | .48593 | 4.6% | 3.5% |

**Table 6-11 Comparison between two models with location and no location**

The two models are compared with their explanatory power, standard error, accuracy and variability. It has been observed (Table 6-13) that addition of location variables increases the explanatory power of model by about 10% and reduces the standard error of estimation (SEE) by 18.12%. The coefficient of variation (COV) is used to evaluate the accuracy of model in predicting values, which is expressed in percentage. The less percentage value of COV indicates more accurate the model is. The coefficient of variance shows that the model with spatial variable is more accurate in predicting value than model without location. The coefficient of dispersion (COD) measures the variability of the model. The less value of COD indicates the predicted value of property is less deviated from the actual value. This value also demonstrates the accuracy of model with location data is better than without location model. The results show that the estimated property value would be more accurate with the model of locational variables. So, the model with spatial variables is accepted as final model for valuation of residential property in Dhaka city. This model is further tested and validated.

*Coefficient of Variation (COV): The coefficient of variation is used to evaluate the accuracy of model in predicting values. The COV is the ratio of standard error of estimation (SEE) to mean predicted values (Eckert et el. 1990), which is expressed in percentage.
COV = (SEE/mean predicted value)*100

**Coefficient of Dispersion (COD): The COD is the most useful measure of variability. It measures the average percentage deviation of ratios from the median ratio of the sample.

COD = (Absolute average deviation / Median property value)*100

The performance standard applied by the International Association of Assessing Officers (IAAO, 1990) suggests that for newer, homogeneous residential areas the COD should be less than 10 percent (McCluskey, et el. 2000).

## 6.6. The Evaluation of Model

The final model is checked to ensure that the assumptions for multiple regressions are met. The most important in the context of mass appraisal valuation model are complete and accurate data, linearity, additivity, normally distributed errors, uncorrelated independent variables, and sample representativeness (Eckert et el. 11990). These assumptions are checked in the following sections.

### 6.6.1. Complete and accurate data

The MRA model is data dependent. Complete and accurate data are checked through identification of missing, inconsistent or unusual data. This has been investigated through descriptive statistics in section 6.3.1.

### 6.6.2. Linearity

Linearity means that the marginal contribution to value of an independent variable is constant over the entire range of the variable. This is the assumption of the relationship between the dependent variable (annual value of property) and the independent variables (characteristics of property) are linear. This has already been taken care of through the logarithmic transformation of variables earlier and makes the relationship linear, which is given in table 6-4 & 6-5.

### 6.6.3. Additivity

Additivity means that the marginal contribution of any independent variable is unaffected by the other variables in the model. The additivity assumption of the model is met through checking the multicollinearity of variables. This is examined through tolerance statistics (table 6-12) as there are no two variables are highly correlated.

### 6.6.4. Examining the Normality

MRA assumes that the regression residuals are normally distributed. The basic aim of prediction model is to reduce its standard errors as to produce accurate values. It can be ensured by plotting their residuals (difference between observed value and predicted value). For a model with accurate results, the standardized residual (the residual divided by an estimate of its standard error) should have a mean of 0 and standard deviation of 1, which means that the residuals are normally distributed. Figure below shows the residuals are all most normally distributed.

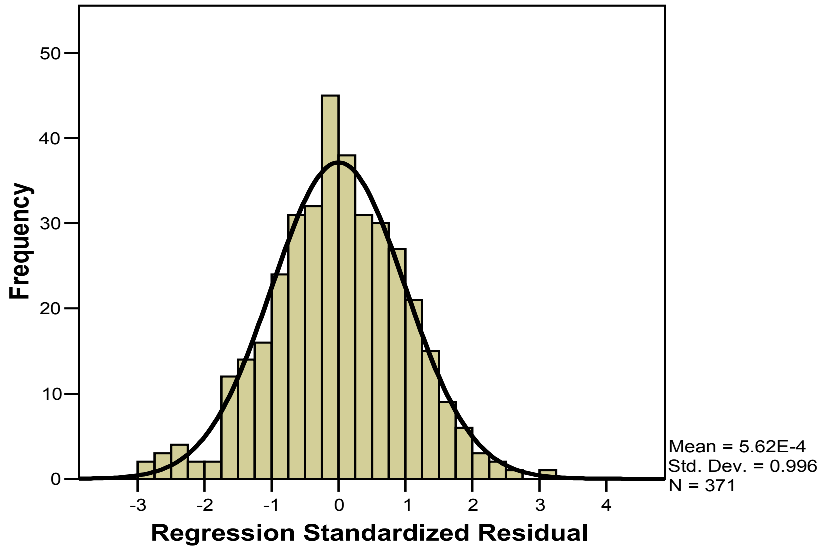



**Figure 6-3 Histogram of regression standardized residual of final model**

### 6.6.5. Test for Multicollinearity

In the MRA model, it is assumed that the independent variables are uncorrelated. Violation of this assumption is known as multicollinearity. Multicollinearity occurs when two or more independent variables are highly correlated (Smith et el. 1999). When it exists, the regression coefficient become less reliable and confidence in the accuracy of the equation is weakened. For multicollinearity, the regression model may encounter coefficients with wrong sign. It is tested by the collinearity statistics called tolerance. The strength of the linear relationships among the independent variables is measured by the tolerance. Its values range from 0 to 1. A value close to 1 indicates that an independent variable has little of its variability explained by the other independent variables and a value close to 0 indicates that a variable is almost a linear combination of the other independent variables. If any of the tolerances are less than 0.1 then, multicollinearity is a problem (Norušis, 2000). From the coefficients table – 6-12, looking at the tolerance test, it is seen that the final model is free of multicollinearity.

### 6.6.6. Sample Representativeness

The model should be developed with a data set to be representative of properties to which they are applied. This has been ensured during the data collection which is described in chapter three.
From the above analysis, it has been evaluated that the final model meets the regression assumptions.

## 6.7. The Validation of Final Model

The error term is used to validate the model. It is defined as the unstandardized residuals of the model which is the value of dependent variable i.e. observed value of property minus its predicted value (Norušis, 2000). In a good regression model, the error term is normally distributed with a mean of zero and has constant variance (Eckert et el. 1990). Constant variance of error term implies that the residuals are uncorrelated with the dependent variable i.e. property value. Violation of this analogy is called heteroscedasticity. Dalgiesh et el. (1998) noted that the error term should show no identifiable pattern with dependent variable. Test of normal distribution and heteroscedasticity are checked through descriptive statistics, histogram and scatterplot of residuals of the final model.

| | N | Minimum | Maximum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|
| Unstandardized Residual | 369 | -1.35733 | 1.48081 | .0000000 | .48099692 | .231 |
| Valid N (listwise) | 369 | | | | | |

**Table 6-12 Descriptive Statistics of Error Term**

The descriptive statistics in Table 6-12 and histogram in Figure-6-4 of error term show that the residuals are normally distributed with a mean of zero and have constant variance. The scatterplot of error term in Figure-6-5 shows on identifiable pattern i.e. there is no correlation between the residual and the dependent variable i.e. property value.

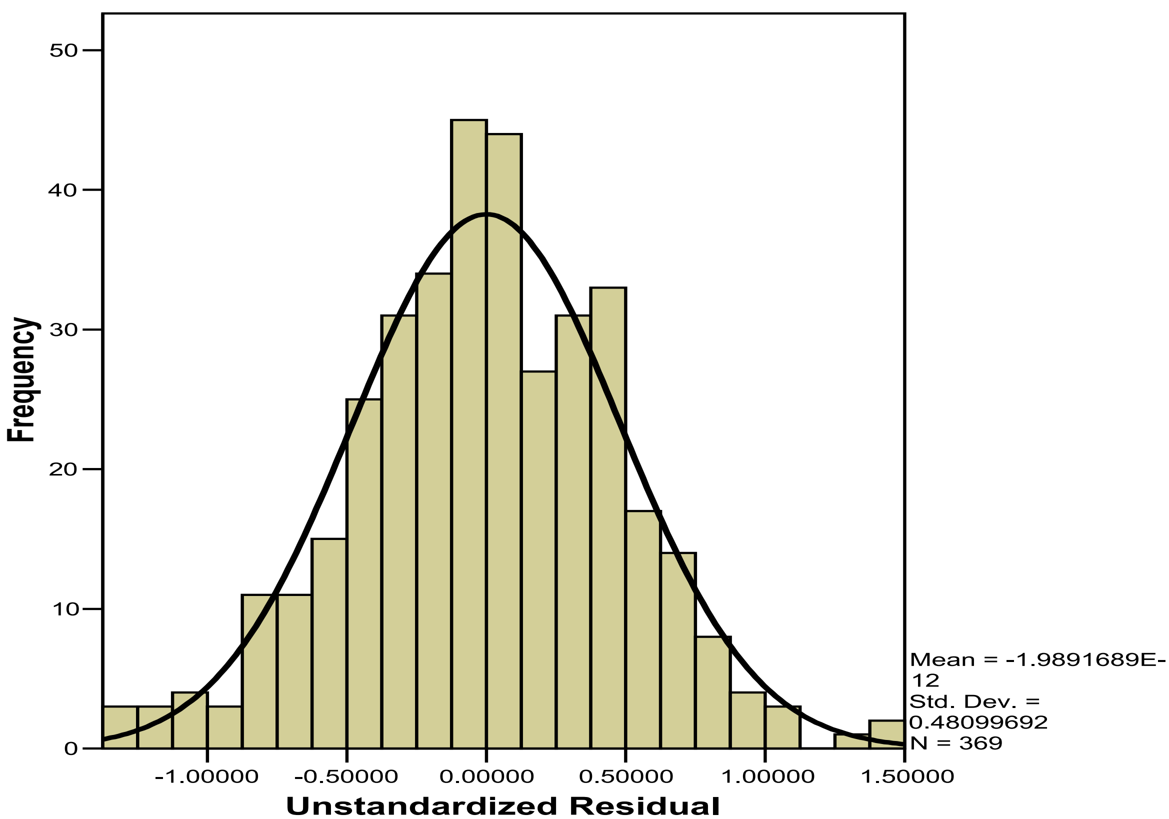



**Figure 6-4 Histogram of Error Term**

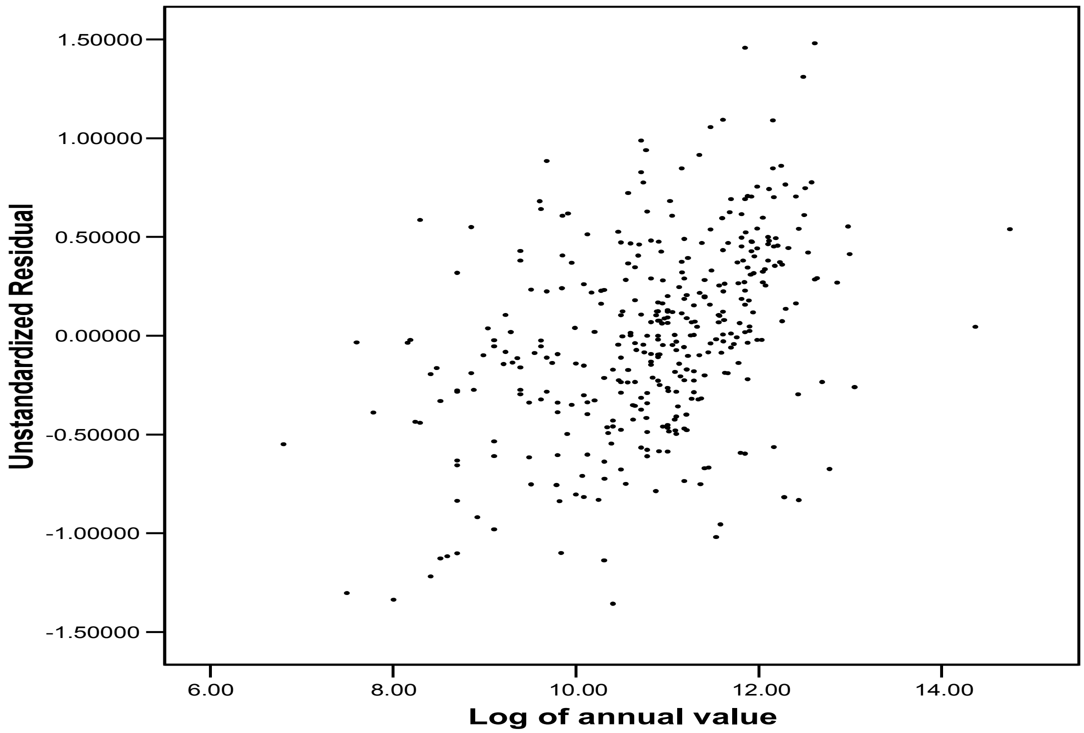



**Figure 6-5 Scatterplot of Residuals and Property Value**

## 6.8. Further analysis and comments on the models

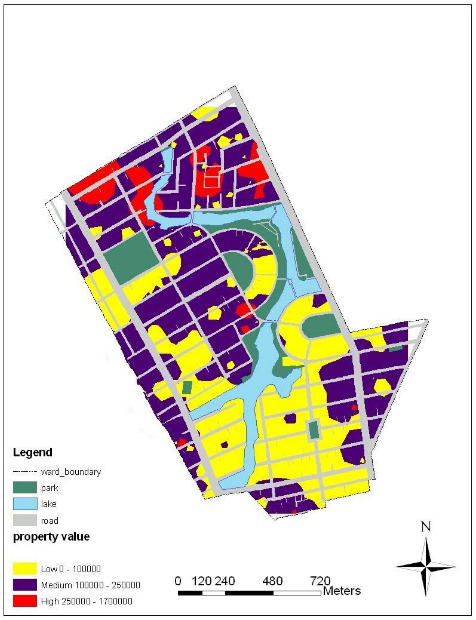
The quality of the model may be appreciated by the precision (or error) level obtained in each approach. It is observed in correlation matrix that there is insignificant correlation of independent variable NAC with the dependent variable, and further we noticed from the models calibrations that this variable is not included in any model.

It is observed in different set of models that the principal changes are into coefficients, but changes in the inclusion of attribute set in model also occurs, probably due to variations of data from different neighbourhoods, multicollinearity, correlation and other factors. The statistical tests (t, F) reach expected levels. The attributes X_cord, COB, DAV and NOR are principally responsible for explaining values, which is also an expected result, because of their high correlation with the dependent variable annual property value (ANV). The coefficients of the X_cord attribute indicate a decrease in value levels in the prediction. Overall assessment (including graphical examination of residuals and other common procedures) offers no evidence against the final model and thus it would be used in predictions in property value.

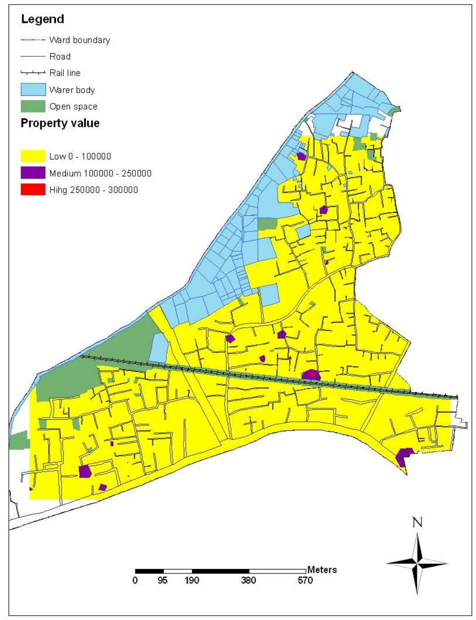
## 6.9. The spatial analysis of property value

The statistical significance of the location attributes in regression model provides empirical evidence of the importance of location to property values. The location attributes used in regression model are X, Y coordinates. The coordinates are generated through trend surface analysis in GIS. The three property value maps of three neighbourhoods are generated using inverse distance weighted (IDW) interpolations technique in ArcGIS software. The map 6-3 shows the property value map for each of the three neighbourhoods. The properties are categorised in three levels: low, medium and high according to their values (Bangladesh currency: Taka). Low value ranges 0 to 100,000; medium from 100,000 to 250,000 and high is 250,000 to above values.

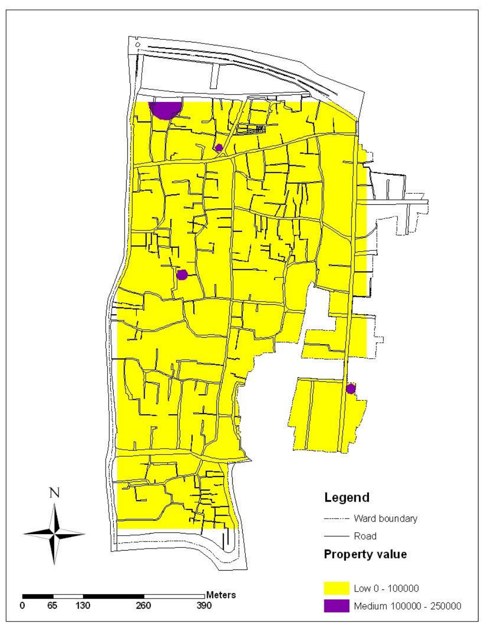
**Map 6-1 Property value map**




**(a)Neighbourhood Dhanmondi**




**(b) Neighbourhood Mogh Bazar**




**(c) Neighbourhood Nawabpur**

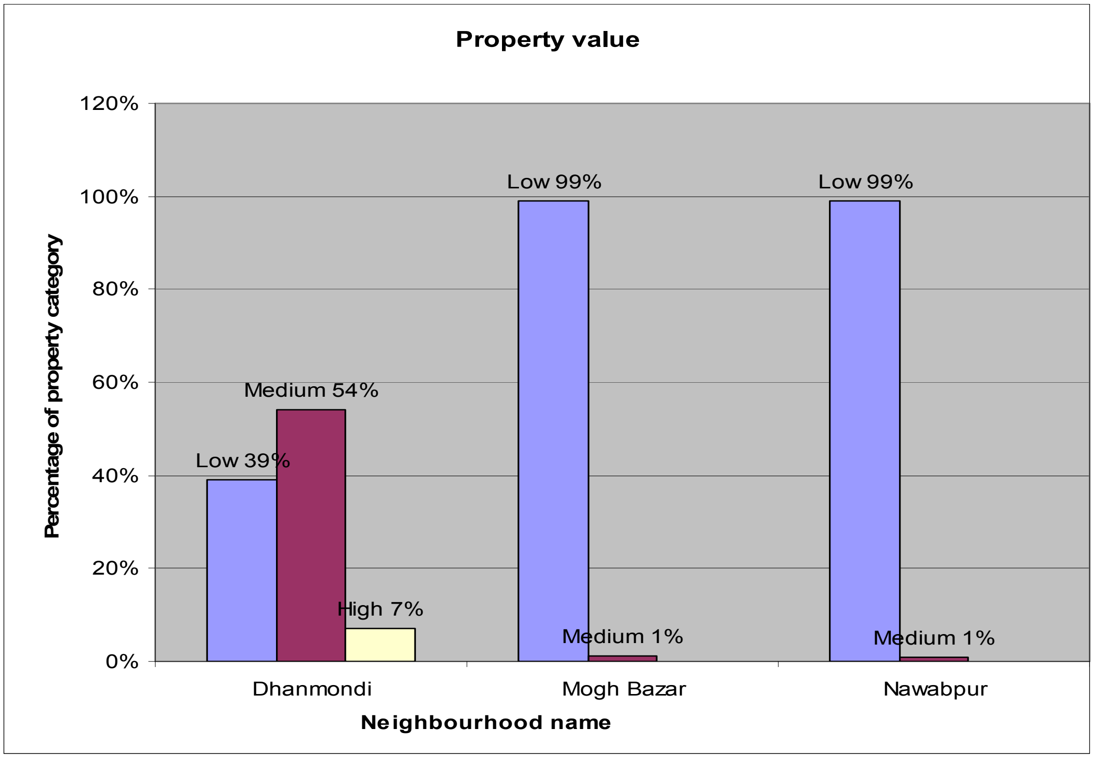



**Chart 6-2 Property values of different neighbourhoods**

The property values of different categories in three neighbourhoods are shown in the chart 6-2. The property values show differences within the neighbourhood and also among three neighbourhoods. In neighbourhood Dhanmondi property values are 7% high, 53% medium and 40% in low categories. The map 6-3 (a) shows the value trends of Dhanmondi: in north-east side the property values are high and south-west are low. In real situation Dhanmondi has a mixed land use of residential and commercial. Big shopping malls and offices are located in north-east and comparatively roads are wider in that area. In the south of this neighbourhood, there is very big and busy market place in the adjacent neighbourhood. As a result traffic congestion is high in the south part. The property value trend reflects the ground situation. In neighbourhood Mogh Bazar about 99% low values properties and a few properties are medium and high value categories. Actually the property values in this neighbourhood do not show any pattern within the value classifications. There is very negligible amount of medium value category houses and 99% are low valued in Nawabpur. The medium value properties are located to the north near the major road.

The property value maps illustrate disparity of values among the neighbourhoods. If we look into the physical characteristics of three neighbourhoods, the value maps fit into the real situation. Dhanmondi is a planned residential area. Roads are wide, and field, park, lake, open space and recreational facilities are there. All types of services are available and infrastructures are good condition. In Mogh Bazar the population density is higher than Dhanmondi and the area is mixed up with planned and spontaneously growth areas. Roads are mostly narrow with traffic congestions, and services and infrastructures are not good quality. The neighbourhood Nawabpur is a high density populated area. Most of the houses are old with two to four storeys almost 100% plot coverage. Roads are very narrow with limited access. There is poor drainage system and also shortage of water, gas, and electricity. The value maps interpret overall characteristics of the neighbourhoods.

## 6.10. Summary

The valuation model is developed in this chapter and it is tested with different statistical tools. The empirical results shows that some variables are excluded from the regression models especially those are not good predictors. The models with only self declare data do not give good result but when self declare data is integrated with field data obtains good results. Statistical test validate the final model with good prediction performance. Based on the quality statistics the best one is the model with spatial data. In step wise regression additive model including location attribute predicts the property value more accurately. This is also obtained from the scatterplots of predicted and observed values of property. In the figure 6-2 below, it gives a good linear relationship and almost all the predicted values fall within confidence interval of 95%. The $R^2$ for the regression line of the predicted and observed property value is the same as the multiple $R^2$ from the final model.

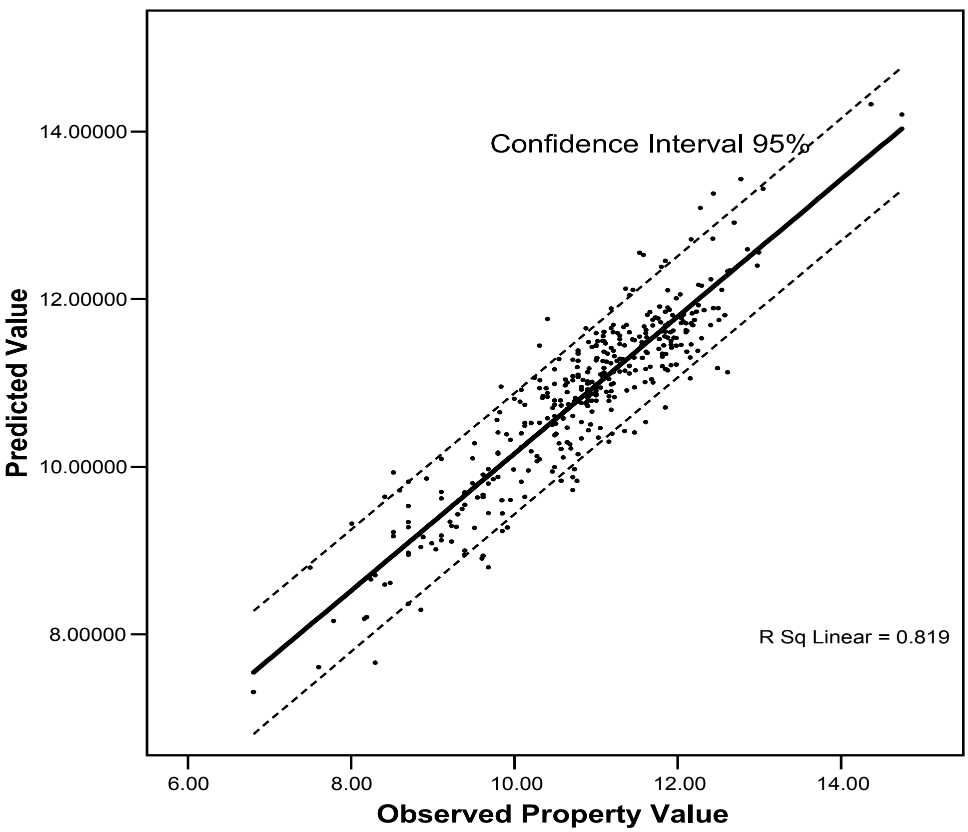



**Figure 6-6 Scatterplot of predicted and observed value**

The strength and importance of various variables in estimating the property values are examined through the different set of models. It is observed the quality of data is very important factor for value estimation. To provide enhanced reliability in the MRA model, it is need to integration of self declare and field data. The property value maps are generated with the estimated property values of three neighbourhoods. The maps illustrate the variation of value within and among the neighbourhoods. Property value is very much influenced by its spatial distributions.

# 7. Conclusions and Recommendations

## 7.1. Introduction

The primary purpose and also empirical part of this study was to develop a valuation model for residential property. This research has demonstrated techniques to enable this task using statistics and GIS. The conclusions are drawn on the basis of evaluating the results of the study and recommendations are made on further useful use of findings.

## 7.2. Analysis of present valuation system of Dhaka

The present valuation system of Dhaka City Corporation is analyzed. At present the valuation system lacks standardization and is not transparent and experiencing the following problems: (a) No general assessment for long period, (b) Lack of transparency in valuation and identification of property, (c) Shortage of trained staffs, and (d) Appeal procedure of tax assessment takes a long time. The strengths of the system are in particular the assessment is based on annual rental value; field visit for information collection, and easy assessment procedure. These problems of the system are not typically in Dhaka but are also common in developing countries. Dillinger (1992) describes these as poor tax administration, badly deteriorated valuation system; large number of properties are missing from tax rolls and information used are not up to date. The core problem for tax assessment arises a lot of disputes over valuations. The DCC has the opportunity to overcome the problem to use self declaration of property and digital ward base map. Potential threats are: lack of well trained staff, vested groups interested and political interference. In this context, the proposed strategy for valuation system is to integrate self declared data with field collected data.

From the analysis of the present system a valuation method was developed using data from self declaration and field collection like in Tunisia (Bird and Slack, 2004) in 1997, the information for tax bill were collected from self declaration form and spot visit by municipal employees.

## 7.3. The spatial variability of property value

The property values are estimated with the model and displayed in the value maps; the results show the differences of value within the neighbourhood and also among three neighbourhoods. In neighbourhood Dhanmondi property values increase from south-west to north-east direction reflecting the real situation. In the reality big shopping malls and offices are located in the north-east and roads are wider in that area. In the south of this neighbourhood, there is very big and busy market place in the adjacent neighbourhood. As a result traffic congestion is high in the south part. The property value trend reflects the ground situation. In neighbourhood Mogh Bazar property values do not show any pattern within the value classifications but 99% properties fall in low categories same with Nawabpur.

The property value patterns demonstrate differences among the neighbourhoods. If we look into the physical characteristics of the three neighbourhoods, the spatial variability fits into the real situation. Dhanmondi is a planned residential area with wide roads, park, lake, open space and recreational facilities. All types of services are available and infrastructures are in good condition. In Eskaton the population density is higher than Dhanmondi and the area is mixed up with limited planned and mostly spontaneously growth areas. Roads are narrow with traffic congestions, and infrastructures are not good quality. The neighbourhood Nawabpur is a high density populated area. Most of the houses are old with almost 100% plot coverage. Roads are very narrow with limited access. There is poor infrastructures and also shortage of water, gas, and electricity.

## 7.4. Property valuation model

The empirical part of this research is to develop a valuation model. The model is developed with stepwise method. In this research several sets of models have been developed and then comparing their results, one is accepted final valuation model.

### 1. Individual model

**Self declared Data:** The models are developed with self declared data from three neighbourhoods. Firstly individual model is calibrated with data from each neighbourhood and then combined data all together. Seven variables are used to the regression but number of rooms, number of bathrooms, condition of building and total floor area appear as most significant variables to predict the value. For the self declared data individual model shows better result than a single model with combined data from three neighbourhoods. The model of whole study area with combined data has lowest explanatory power with 60.3% and highest standard error of estimation (SEE) than individual model. Thus it can be concluded that a combined model with self declared data does not predict property value well rather individual model for each neighbourhood predicts better.

**Field Data:** The models are developed with field data from three neighbourhoods. Three different models for three neighbourhoods and one for the whole study area are developed. In these models, in all cases explanatory power increases those from the models with self declared data. In case of Dhanmondi, it increases about 9%, in Eskaton 5% and in Nawabpur 15.4% and for combined model, it is 19.3% and standard error (SEE) also decreases in every model. The explanatory variables; condition of building (COB), total floor area (TFA), and date of valuation (DAV) are the major contributing factors for all neighbourhoods. The results show that the model with field data predicts property value better than that of self declared data. Evaluating the results, we also observe it here, the individual model predicts property value better than combined model with field data.

**Combination of data for each neighbourhood:** Three separate models for three neighbourhoods are generated combined with self declared and field data. In these model set the variables total floor area, condition of building & date of valuation are the dominating factors for determining value. The combination of data reduces the standard error of estimation (SEE). This indicates the increase of prediction power of the model, which means the less difference between predicted property value and actual value. So, it can be said that the models predictive power increases with the combination of data from two categories.

### 2. Integrated model

A single model is developed integrating self declared and field data from the three neighbourhoods. Model is calibrated without location and with location variables with other attributes. The model with spatial variables is accepted as integrated model for valuation on the basis of analysis of their results. The integrated model includes six explanatory variables. Its explanatory power is high about 82%, indicating the key factors are included into model, which explains the variability of property value. The results of final model show that the four factors: spatial position, number of room, condition of building and date of valuation of property stand most influential in determining the value.

The multiple regression analysis (MRA) model without location element is good but adding spatial variables to the MRA improves the explanatory power of model by 9.5%, and reduces the standard error 18.12% which is very significant for residential property valuation. The combination of spatial data analysis and GIS thus provide better insights that remain hidden in traditional regression analysis.

The model is evaluated and validated with different statistical analysis, and it shows great reliability. Therefore, we conclude that the integrated model shows the improvement and strength of integration of data from self declaration with field data, in terms of the explanatory power, standard error, accuracy and variability.

## 7.5. Role of self declaration into the model

The regression analysis methodology is used in this study. In general, the explanatory power of MRA model is high, indicting that key factors in explaining the property value. From the results analysis, it has been observed that models with only self declared data has much variation among the study areas from that of field collected data for all three study areas. In terms of explanatory power ($R^2$), the self declared data model has less explanatory power than model with field data but standard error of estimation (SEE) does not vary so much. However, it is presumed that one of the influential variable date of valuation (DAV) is not included in the model of self declared data as those are all from same year 1989, so $R^2$ value is lower in this model. The $R^2$ statistics measure the total fit of the equation and SEE indicates how accurate the model is for a specific property. Standard error is useful statistics in respect to predictive power of regression based model (Linne, et el. 2000). The evidences show that the models used both types of data give more stability, and more predictive power. It has been determined in data analysis to produce empirical evidences that both self declare and field data are complimentary for correctly specified model development to avoid bias and incorrect results.

In comparison of results of all models, we observe that the best one is integrated model with data from self declaration. The evaluation and validation of model proves it accuracy and better prediction power. Further, in respect of Dhaka city, self declaration would be the major source of property information.

## 7.6. Final remarks

1. The present valuation system of DCC is experiencing problems with lot of disputes and litigations. This can be overcome by exploiting the opportunity to use self declaration in valuation model.
2. The property values show the spatial pattern with physical characteristics of neighbourhoods and locational factors.
3. In this study, the potential applicability of alternative location modelling paradigms is examined; in particular utilizing the x, y coordinates as spatial characteristics of residential property values.
4. Trend surface analysis (TSA) approach is used for measuring spatial relationships in regression models. This introduces in this study as the applicability of spatial analysis to assist in more accurately determining the influence of locations.
5. The empirical results show that the intergraded model predicts property value well and accurately. The validation of model proves it accuracy and MRA assumptions.

## 7.7. Recommendations

The research has found that the discrete measurement of location is a complex process employed in the traditional appraisal techniques such as adding neighbourhood quality or weighted variables to the model. Because of these variables arise from a number of sources like accessibility, environmental factors, and neighbourhood amenity, which act as proxies for location but actually unobservable. One of the constraints of regression analysis in measuring location but from this study it is suggested that trend surface analysis (TSA) can generate location attributes like x, y coordinates through interpolation. TSA is an alternative way to location modelling. These location attributes can be added to the regression analysis as independent variables with other variables.

Property valuation is a task that depends largely on data quality. In order to improve the valuation model it is necessary to develop a sound methodology on data qualification and quantification, which could not be demonstrated in current research field. In this study valuation model for Dhaka city is developed integrating self declared data. But self declared data needs further verifications by some other techniques. These can be compared with the databases of cadastre and building control authority but the databases of both organizations are still on paper based systems. No institutional capacity is yet built on proper qualification and quantification of data. Further research can be undertaken on institutional capacity building in this regard.

One of the problems of present valuation system is no general assessment for a long period; still tax is assessed on the basis of seventeen years old valuation. So, periodic revaluation for every four years cycle can be used with the model to reflect the changes in property value. This would further reduce the risk of sudden and dramatic shifts in tax burdens from large increase in assessed values.

The empirical results of this study confirmed that the integrated model with self declared and field data estimates property value with better accuracy. The valuation model can be used for residential property in Dhaka city. In this study the model is developed with residential property data from three wards of Dhaka city. So, further studies may be carried out for other types of land use.

# References

Almy, Gloudemans,& Jacobs, 1996, Analysis of Assessment Practices, (http://scholar.google.com, 30/07/05)

Bagdonavicius, Arvydas and Ramanauskas, Rimantas, 2004, Introducing a Computerised Market Value-Based Mass Appraisal System for Real Property Taxation in Lithuania, FIG Working Week 2004, May 22-27, Athens, Greece.

BBS, 2001, Population Census 2001: Preliminary Report, Bangladesh Bureau of Statistics, Dhaka, Bangladesh.

BBS, 1998, Statistical Pocket Book, Bangladesh Bureau of Statistics, Dhaka, Bangladesh.

Bird, Richard, M. and Slack, Enid, 2004, International Handbook of Land and Property Taxation, Edward Elgar, Cheltenham, UK.

DCC, 1986, The City Corporations (taxation) Rules, 1986, Dhaka, Bangladesh.

DCC, 2004, Profile of Dhaka City Corporation, published by Urban Planning Department, Dhaka City Corporation, Dhaka, Bangladesh.

De By, Rolf, A, Georgiadou, Yola, Knippers, R, A, Kraak, M, J, Weir, M, J, C, Westen, C, J, v, and Sun, Y, 2004, Principles of Geographic Information Systems, ITC, Enschede, The Netherlands.

Dillinger, W., 1992, Urban Property Tax Reform: Guidelines and Recommendations, The World Bank, Washington, D.C.

Eckert, J. K., Gloudemans, R. J. and Almy, R. R., 1990, Property Appraisal and Assessment Administration, International Association of Assessing Officers, Chicago, USA.

Gonzalez, M, A, S, Soibelman, Lucio, and Formoso, C, Torres, 2002, Anew Approach to Spatial Analysis in CAMA, 9th European Real Estate Society Conference, June 4-7, Glasgow, Scotland. (Google Scholar 16/01/2006)

Groenendijk, Liza and Dopheide, Emile, 2003, Planning and Management Tools, ITC, Enschede, The Netherlands.

Hofstede G, 1997, Cultures and Organization: Software of the mind, McGraw-Hill, New York

Hendriks P. H. J., 2000, An Organizational Learning Perspective of GIS, Int. J. Geographical Information System, 14(4) 373-396.

Jessen, Christian, Söderberg, Bo,1999, Estimating Market Prices and Assessed Values for Income Properties, Urban Studies, 36 (2) 359-376.

Khah, Md., Ansar, Ali, 2000, The Dhaka City Corporation Laws Manual, Bangladesh Law Book Company, Dhaka, Bangladesh.

Keith H., Simon, 1993, 'Property Tax in Anglophone Africa: A practical Manual', WB Technical Paper Number 209, The World Bank, Washington, D.C., U.S.A.

Linne, Mark R., Kane, M. Steven, and Dell, George, 2000, A Guide to Appraisal Valuation Modelling, Appraisal Institute, USA.

McCluskey, W, J, Deddis, W, G, Lamont, Ian, G, and Borst, Richard, A, 2000, The Application of Surface Generated Interpolation Models for the Prediction of Residential Property Values, Journal of Property and Finance, Vol. 18(2), 162-176.

Moore, David, S. and McCabe, George, P. 2003, Introduction to the Practice of Statistics, W. H. Freeman and Company, NY, USA.

Nzau, Bernard, M, 2003, Modelling the Influence of Urban Sub-centres on Spatial and Temporal Urban Land Value Patterns: Case Study of Nairobi, Kenya, Unpublished M Sc Thesis, ITC, The Netherlands.

Norušis, J. Marija, 2000, 'SPSS 10.0 Guide to Data Analysis', Prentice Hall, New Jersey, USA.

RAJUK, 1993, The Report of the Committee on Dhanmondi Residential Area (Formed by Ministry of Works; vide memo no. 6/dcmda-1/83/1820, dated 26/12/1992), Dhaka.

RAJUK, 1995a, Dhaka Metropolitan Development Plan (DMDP), Volume I, Structure Plan, Dhaka, Bangladesh.

RAJUK, 1995b, Dhaka Metropolitan Development Plan (DMDP), Volume II, Urban Area Plan, Dhaka, Bangladesh.

Reeve D. E. and Petch J. R., 1999, GIS Organization and People: A Socio-technical Approach, Taylor & Francis Ltd, London, U K.

Slack, Enid, 2002, Municipal Finance and the Pattern of Urban Growth, Commentary No. 160, C.D. Howe Institute, Toronto, Canada.

Somers, Rebecca, 1998, Developing GIS Management Strategies for an Organization, Journal of Housing Research Vol. 9(1), 157-177.

Soibelman, Lucio and Gonzalez, Marco, A, S, 2002, A Knowledge Discovery in Databases Framework for Property Valuation, International Journal of Property Tax Assessment and Administration, Vol. 7(2), 77-106.

Tse, Raymond, Y, C, 2002, Estimating Neighbourhood Effects in House Prices: Towards a New Hedonic Model Approach, Urban Studies, Vol. 39(7), 1165-1180.

UN, 1995, Municipal Land Management in Asia, United Nations, New York. USA.

Wachter, Susan, M, Dr, Thompson, Michelle, M, Dr, Gillen, Kevin, C, 2005, Geospatial Analysis for Real Estate Valuation Models, Google Scholar (24/12/05).

Weimer, Arthur, M., Hoyt, Homer, Bloom, George, F., 1972, Real Estate, The Ronald Press Company, New York, USA.

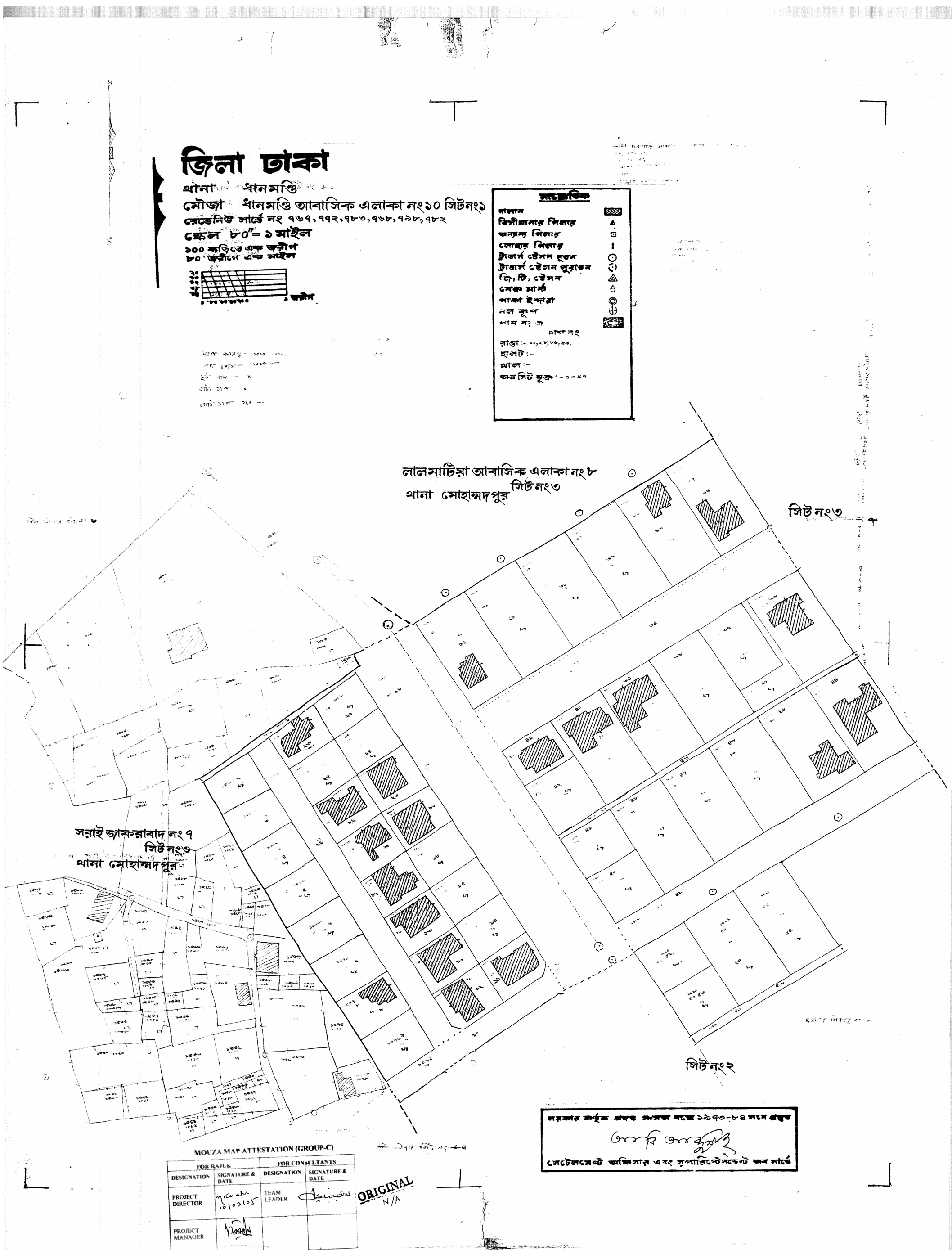
Wyatt, Peter, J., 1997, 'The Development of a GIS-based Property Information System for real estate Valuation', Int. J. Geographical Information Science, Vol. 11(5), 435-450.

www.dhakacity.org (27/05/2005)

**http://www2.una.edu/geography/classes/ge424/class_notes/ch8gis.html** (19/4/05)

# APPENDICES

## Appendix – A: Cadastral map of Dhanmondi (part)



# Appendix – B: Self declaration form (B-Form)



FORM 'B'

[*see* rule 22]

..............................Municipal Corporation

**Return of rent or annual value of buildings and lands and true and correct description of buildings and lands for the purpose of assessment or revision of assessment of Municipal taxes.**

[To be filled up by the owner or occupier]

1. Name of Ward ..............................
2. Name of Mahalla/Road/Street ..............................
3. Present number of building/land (holding) in the assessment list ..............................
4. (a) Name(s) of owner(s) with father's or husband's name(s) ..............................

   (b) Name's of occupier(s) with father's or husbands name(s) ..............................
5. Area covered by building/land—

   (a) by building .. (i) Masonry buildings ..............................

   (ii) Semi-pucca ..............................

   (iii) Kutcha ..............................

   (iv) Total ..............................

   (b) by vacant land (i) Tanks/Ditches ..............................

   (ii) Khal ..............................

   (iii) Garden ..............................

   (iv) Kutcha Privy ..............................

   (v) Other use ..............................
6. Description of building (To be furnished in the Sheet attached hereto).

(*Signature of person making the return*)



[To be filled up by the Assessor]

7. New number, if any, allotted to the building/land (holding) ..............................
8. Annual value determined by the Assessor.

| | Residential building. | Godown/ Workshop. | Vacant land (if separately assessed.) | Total. |
|---|---|---|---|---|
| (a) Owner's possession .. | | | | |
| (b) Occupier's possession .. | | | | |
| Total | | | | |

9. Assessor's remarks showing the basis of determination of annual value together with brief reasons why the assessment differs, if it does, from the assessment of similar property in the same area or street.



A. Owner's possession :

**Description of buildings**

(*Vide* column 6 overpage)

| Type of building | Nature of construction, whether a masonry building, kutcha, pucca frames or a hut, whether flat terraced or tiled roof or of hogla or thatched corrugated tin shed or pitched, etc. | Age and condition of building | Number of storeys | Number, dimension and description of— Rooms | Verandah (open or closed) | Bathrooms. | Steps | Total floor space | Present value/ annual rental of building and adjacent land in owner's/ occupier's possession | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| (a) Residential buildings. | | | | | | | | | | |
| (b) Godown Workshop. | | | | | | | | | | |
| B. Occupier's possession: | | | | | | | | | | |
| (a) Residential buildings. | | | | | | | | | | |
| (b) Godown/ Workshop. | | | | | | | | | | |

# Appendix – C: Questionnaires

**C: 1 Officials**

Name: Designation: Date:

Q1: Please describe the present valuation system in brief.

Q2: What types of data/information are needed for present valuation?

Q3: What are the merits and demerits of present system?

Merits: 1. …………………..
2. ……………………
3. ……………………

Demerits: 1. …………………..
2. ……………………
3. ……………………

Q4: How can be improved the valuation system?

Q5: According to the Municipal Corporation (Taxation) Rules 1986 do you use the 'B-Form' (self-declaration) in annual valuation/re-valuation of property?

a. No b. Yes

Q6: If 'yes' then please mention do you use the characteristics of property described in the form to valuation?

Q7: If 'No' then please mention why do you not use the 'B-Form' (self-declaration) to property valuation?

Q8: Write five strong and five week points of using of 'B-Form' (self-declaration)

Strong points: 1. …………………..
2. ……………………
3. ……………………

Weak points: 1. …………………..
2. ……………………
3. ……………………

Q9: Write five opportunities of using 'B-Form' (self-declaration).

points: 1. …………………..
2. ……………………
3. ……………………

Q10: What are the threats (external difficulties) of using 'B-Form' (self-declaration)?

points: 1. …………………..
2. ……………………
3. ……………………

Q11: Further comments (If any)

**C: 2 Taxpayers**

Name:
Address:
Date:
Q1: Do you have any idea about the valuation system of property?

a. Yes    b. No

Q2: What do you think about Present valuation system?

1. Good
2. Bad
3. No comments

Q3: How do you pay your tax?

a. Bank
b. DCC office
c. Tehshilder (tax collector)

Q4: Do you think the amount of tax is appropriate at present?

a. Yes
b. No

If answer is 'No' then mention why not?

Q5: Do you think present valuation system should be changed?

a. No
b. Yes

If 'yes' please mention the changes:

1. ……………………..
2. ……………………..
3. ……………………..

Q6: What type of information do you need for tax purposes from DCC?

a. ………………………….
b. ………………………….
c. ………………………….

Q7: Do you face any problem or difficulty to get that information from DCC?

a. No    b. Yes

If 'yes' mention name

a. ……………………..
b. ……………………..
c. ……………………..

Q8: Please mention your comments or recommendations on property assessment process.

# Appendix-D: Descriptive statistics

**Table D 1 Descriptive Statistics Neighbourhood one Dhanmondi**

| | | ANV | NAC | COB | NOR | NOB | TFA | NOS | DAV |
|---|---|---|---|---|---|---|---|---|---|
| N | Statistic | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Range | Statistic | 2533000 | 2 | 3 | 86 | 65 | 25800 | 11 | 16 |
| Minimum | Statistic | 5000 | 2 | 1 | 2 | 1 | 600 | 1 | 1989 |
| Maximum | Statistic | 2538000 | 4 | 4 | 88 | 66 | 26400 | 12 | 2005 |
| Mean | Statistic | 151079.75 | 3.97 | 3.43 | 10.13 | 6.62 | 4572.67 | 2.20 | 1993.26 |
| | Std. Error | 20627.513 | .019 | .060 | .824 | .600 | 288.698 | .117 | .479 |
| Std. Deviation | Statistic | 252634.407 | .230 | .737 | 10.095 | 7.349 | 3535.817 | 1.428 | 5.864 |
| Variance | Statistic | 63824143755.355 | .053 | .543 | 101.910 | 54.009 | 12502003.136 | 2.040 | 34.382 |
| Skewness | Statistic | 7.454 | -8.572 | -1.197 | 4.392 | 5.041 | 2.667 | 2.806 | .875 |
| | Std. Error | .198 | .198 | .198 | .198 | .198 | .198 | .198 | .198 |

**Table D 2 Descriptive Statistics Neighbourhood two Mogh Bazar**

| | | NAC | COB | NOR | NOB | TFA | NOS | DAV | ANV |
|---|---|---|---|---|---|---|---|---|---|
| N | Statistic | 150 | 150 | 150 | 150 | 149 | 150 | 150 | 150 |
| Minimum | Statistic | 4 | 1 | 2 | 1 | 400 | 1 | 1989 | 5400 |
| Maximum | Statistic | 4 | 4 | 32 | 18 | 72000 | 6 | 2002 | 279200 |
| Mean | Statistic | 4.00 | 3.65 | 9.19 | 4.24 | 4105.29 | 2.72 | 1989.73 | 64361.70 |
| | Std. Error | .000 | .057 | .415 | .216 | 489.667 | .105 | .213 | 3898.561 |
| Std. Deviation | Statistic | .000 | .696 | 5.080 | 2.646 | 5977.146 | 1.280 | 2.603 | 47747.425 |
| Skewness | Statistic | . | -1.928 | 1.342 | 2.146 | 10.050 | .384 | 3.499 | 1.376 |
| | Std. Error | . | .198 | .198 | .198 | .199 | .198 | .198 | .198 |

**Table D 3 Descriptive Statistics Neighbourhood three Nawabpur**

| | | NAC | COB | NOR | NOB | TFA | NOS | DAV | ANV |
|---|---|---|---|---|---|---|---|---|---|
| N | Statistic | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 |
| Minimum | Statistic | 2 | 1 | 1 | 1 | 220 | 1 | 1988 | 900 |
| Maximum | Statistic | 4 | 4 | 60 | 28 | 20000 | 7 | 2004 | 245400 |
| Mean | Statistic | 3.98 | 2.67 | 11.50 | 5.03 | 3221.05 | 2.44 | 1991.05 | 39303.99 |
| | Std. Error | .023 | .109 | 1.145 | .497 | 313.396 | .165 | .532 | 5784.560 |
| Std. Deviation | Statistic | .216 | 1.011 | 10.623 | 4.605 | 2906.313 | 1.531 | 4.935 | 53643.805 |
| Skewness | Statistic | -9.274 | .068 | 2.314 | 2.624 | 2.702 | .948 | 1.166 | 2.411 |
| | Std. Error | .260 | .260 | .260 | .260 | .260 | .260 | .260 | .260 |

# Appendix E: Correlations of variables

**Table E 1 Correlation matrix neighborhood one Dhanmondi**

| | | NAC | COB | NOR | NOB | TFA | NOS | DAV | ANV |
|---|---|---|---|---|---|---|---|---|---|
| NAC | Pearson Correlation | 1 | .306(**) | .088 | .081 | .091 | .098 | -.154 | .036 |
| | Sig. (2-tailed) | | .000 | .284 | .323 | .266 | .233 | .060 | .659 |
| | N | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| COB | Pearson Correlation | .306(**) | 1 | .151 | .203(*) | .124 | .134 | .330(**) | .186(*) |
| | Sig. (2-tailed) | .000 | | .064 | .013 | .132 | .102 | .000 | .023 |
| | N | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| NOR | Pearson Correlation | .088 | .151 | 1 | .970(**) | .912(**) | .923(**) | .064 | .812(**) |
| | Sig. (2-tailed) | .284 | .064 | | .000 | .000 | .000 | .435 | .000 |
| | N | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| NOB | Pearson Correlation | .081 | .203(*) | .970(**) | 1 | .885(**) | .899(**) | .129 | .850(**) |
| | Sig. (2-tailed) | .323 | .013 | .000 | | .000 | .000 | .116 | .000 |
| | N | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| TFA | Pearson Correlation | .091 | .124 | .912(**) | .885(**) | 1 | .893(**) | -.091 | .727(**) |
| | Sig. (2-tailed) | .266 | .132 | .000 | .000 | | .000 | .266 | .000 |
| | N | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| NOS | Pearson Correlation | .098 | .134 | .923(**) | .899(**) | .893(**) | 1 | -.010 | .704(**) |
| | Sig. (2-tailed) | .233 | .102 | .000 | .000 | .000 | | .901 | .000 |
| | N | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| DAV | Pearson Correlation | -.154 | .330(**) | .064 | .129 | -.091 | -.010 | 1 | .230(**) |
| | Sig. (2-tailed) | .060 | .000 | .435 | .116 | .266 | .901 | | .005 |
| | N | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| ANV | Pearson Correlation | .036 | .186(*) | .812(**) | .850(**) | .727(**) | .704(**) | .230(**) | 1 |
| | Sig. (2-tailed) | .659 | .023 | .000 | .000 | .000 | .000 | .005 | |
| | N | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

**Table E 2 Correlation matrix neighborhood two Mogh Bazar**

| | | NAC | COB | NOR | NOB | TFA | NOS | DAV | ANV |
|---|---|---|---|---|---|---|---|---|---|
| NAC | Pearson Correlation | .(a) | .(a) | .(a) | .(a) | .(a) | .(a) | .(a) | .(a) |
| | Sig. (2-tailed) | | . | . | . | . | . | . | . |
| | N | 150 | 150 | 150 | 150 | 149 | 150 | 150 | 150 |
| COB | Pearson Correlation | .(a) | 1 | .133 | .137 | .110 | .219(**) | .144 | .296(**) |
| | Sig. (2-tailed) | . | | .106 | .094 | .183 | .007 | .079 | .000 |
| | N | 150 | 150 | 150 | 150 | 149 | 150 | 150 | 150 |
| NOR | Pearson Correlation | .(a) | .133 | 1 | .872(**) | .490(**) | .752(**) | .044 | .645(**) |
| | Sig. (2-tailed) | . | .106 | | .000 | .000 | .000 | .594 | .000 |
| | N | 150 | 150 | 150 | 150 | 149 | 150 | 150 | 150 |
| NOB | Pearson Correlation | .(a) | .137 | .872(**) | 1 | .638(**) | .690(**) | .020 | .625(**) |
| | Sig. (2-tailed) | . | .094 | .000 | | .000 | .000 | .807 | .000 |
| | N | 150 | 150 | 150 | 150 | 149 | 150 | 150 | 150 |
| TFA | Pearson Correlation | .(a) | .110 | .490(**) | .638(**) | 1 | .438(**) | .016 | .330(**) |
| | Sig. (2-tailed) | . | .183 | .000 | .000 | | .000 | .842 | .000 |
| | N | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 |
| NOS | Pearson Correlation | .(a) | .219(**) | .752(**) | .690(**) | .438(**) | 1 | .149 | .579(**) |
| | Sig. (2-tailed) | . | .007 | .000 | .000 | .000 | | .069 | .000 |
| | N | 150 | 150 | 150 | 150 | 149 | 150 | 150 | 150 |
| DAV | Pearson Correlation | .(a) | .144 | .044 | .020 | .016 | .149 | 1 | .386(**) |
| | Sig. (2-tailed) | . | .079 | .594 | .807 | .842 | .069 | | .000 |
| | N | 150 | 150 | 150 | 150 | 149 | 150 | 150 | 150 |
| ANV | Pearson Correlation | .(a) | .296(**) | .645(**) | .625(**) | .330(**) | .579(**) | .386(**) | 1 |
| | Sig. (2-tailed) | . | .000 | .000 | .000 | .000 | .000 | .000 | |
| | N | 150 | 150 | 150 | 150 | 149 | 150 | 150 | 150 |

** Correlation is significant at the 0.01 level (2-tailed).
a Cannot be computed because at least one of the variables is constant.

**Table E 3 Correlation matrix neighborhood three Nawabpur**

| | | NAC | COB | NOR | NOB | TFA | NOS | DAV | ANV |
|---|---|---|---|---|---|---|---|---|---|
| NAC | Pearson Correlation | 1 | .073 | .077 | .072 | .038 | .031 | .067 | .070 |
| | Sig. (2-tailed) | | .505 | .481 | .511 | .726 | .773 | .538 | .523 |
| | N | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 |
| COB | Pearson Correlation | .073 | 1 | .401(**) | .381(**) | .246(*) | .322(**) | .564(**) | .499(**) |
| | Sig. (2-tailed) | .505 | | .000 | .000 | .022 | .002 | .000 | .000 |
| | N | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 |
| NOR | Pearson Correlation | .077 | .401(**) | 1 | .962(**) | .801(**) | .698(**) | .458(**) | .833(**) |
| | Sig. (2-tailed) | .481 | .000 | | .000 | .000 | .000 | .000 | .000 |
| | N | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 |
| NOB | Pearson Correlation | .072 | .381(**) | .962(**) | 1 | .826(**) | .644(**) | .398(**) | .794(**) |
| | Sig. (2-tailed) | .511 | .000 | .000 | | .000 | .000 | .000 | .000 |
| | N | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 |
| TFA | Pearson Correlation | .038 | .246(*) | .801(**) | .826(**) | 1 | .602(**) | .243(*) | .666(**) |
| | Sig. (2-tailed) | .726 | .022 | .000 | .000 | | .000 | .024 | .000 |
| | N | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 |
| NOS | Pearson Correlation | .031 | .322(**) | .698(**) | .644(**) | .602(**) | 1 | .463(**) | .663(**) |
| | Sig. (2-tailed) | .773 | .002 | .000 | .000 | .000 | | .000 | .000 |
| | N | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 |
| DAV | Pearson Correlation | .067 | .564(**) | .458(**) | .398(**) | .243(*) | .463(**) | 1 | .531(**) |
| | Sig. (2-tailed) | .538 | .000 | .000 | .000 | .024 | .000 | | .000 |
| | N | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 |
| ANV | Pearson Correlation | .070 | .499(**) | .833(**) | .794(**) | .666(**) | .663(**) | .531(**) | 1 |
| | Sig. (2-tailed) | .523 | .000 | .000 | .000 | .000 | .000 | .000 | |
| | N | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

# Appendix – F: Model with self declared data

**Table F 1 ANOVA table of neighbourhood one Dhanmondi**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 295109491047.337 | 1 | 295109491047.337 | 132.502 | .000(a) |
| | Residual | 189312223196.410 | 85 | 2227202625.840 | | |
| | Total | 484421714243.747 | 86 | | | |
| 2 | Regression | 303760352956.878 | 2 | 151880176478.439 | 70.618 | .000(b) |
| | Residual | 180661361286.869 | 84 | 2150730491.510 | | |
| | Total | 484421714243.747 | 86 | | | |

**Table F 2 Model coefficients of neighbourhood one Dhanmondi**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound | Tolerance | VIF |
| 1 | (Constant) | 6855.797 | 10194.038 | | .673 | .503 | -13412.682 | 27124.277 | | |
| | TFA | 20.705 | 1.799 | .781 | 11.511 | .000 | 17.129 | 24.282 | 1.000 | 1.000 |
| 2 | (Constant) | -33753.912 | 22590.987 | | -1.494 | .139 | -78678.568 | 11170.744 | | |
| | TFA | 19.947 | 1.808 | .752 | 11.035 | .000 | 16.353 | 23.542 | .956 | 1.046 |
| | COB | 13535.337 | 6748.891 | .137 | 2.006 | .048 | 114.428 | 26956.246 | .956 | 1.046 |

**Table F 3 ANOVA table of neighbourhood two Mogh Bazar**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 18.814 | 1 | 18.814 | 69.521 | .000(a) |
| | Residual | 12.719 | 47 | .271 | | |
| | Total | 31.533 | 48 | | | |
| 2 | Regression | 20.295 | 2 | 10.148 | 41.539 | .000(b) |
| | Residual | 11.237 | 46 | .244 | | |
| | Total | 31.533 | 48 | | | |
| 3 | Regression | 21.386 | 3 | 7.129 | 31.613 | .000(c) |
| | Residual | 10.147 | 45 | .225 | | |
| | Total | 31.533 | 48 | | | |
| 4 | Regression | 21.315 | 2 | 10.658 | 47.980 | .000(d) |
| | Residual | 10.218 | 46 | .222 | | |
| | Total | 31.533 | 48 | | | |
| 5 | Regression | 22.178 | 3 | 7.393 | 35.560 | .000(e) |
| | Residual | 9.355 | 45 | .208 | | |
| | Total | 31.533 | 48 | | | |

**Table F 4 Model Coefficients neighbourhood two Mogh Bazar**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 9.310 | .161 | | 57.751 | .000 |
| | Ln_NOB | .984 | .118 | .772 | 8.338 | .000 |
| 2 | (Constant) | 9.286 | .154 | | 60.491 | .000 |
| | Ln_NOB | .563 | .205 | .442 | 2.751 | .008 |
| | Ln_NOS | .596 | .242 | .395 | 2.463 | .018 |
| 3 | (Constant) | 6.543 | 1.256 | | 5.209 | .000 |
| | Ln_NOB | .152 | .271 | .119 | .559 | .579 |
| | Ln_NOS | .571 | .233 | .379 | 2.456 | .018 |
| | Ln_TFA | .408 | .185 | .384 | 2.199 | .033 |
| 4 | (Constant) | 6.088 | .950 | | 6.410 | .000 |
| | Ln_NOS | .646 | .189 | .429 | 3.413 | .001 |
| | Ln_TFA | .479 | .133 | .452 | 3.594 | .001 |
| 5 | (Constant) | -1468.290 | 723.779 | | -2.029 | .048 |
| | Ln_NOS | -1468.290 | .188 | .488 | 3.906 | .000 |
| | Ln_TFA | .408 | .134 | .384 | 3.052 | .004 |
| | Ln_DAV | 194.177 | 95.322 | .172 | 2.037 | .048 |

**Table F 5 ANOVA table Neighbourhood three Nawabpur**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 11.269 | 1 | 11.269 | 50.609 | .000(a) |
| | Residual | 4.008 | 18 | .223 | | |
| | Total | 15.277 | 19 | | | |

**Table F 6 Model Coefficients Neighbourhood three Nawabpur**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 6.937 | .372 | | 18.672 | .000 |
| | Ln_NOR | 1.308 | .184 | .859 | 7.114 | .000 |

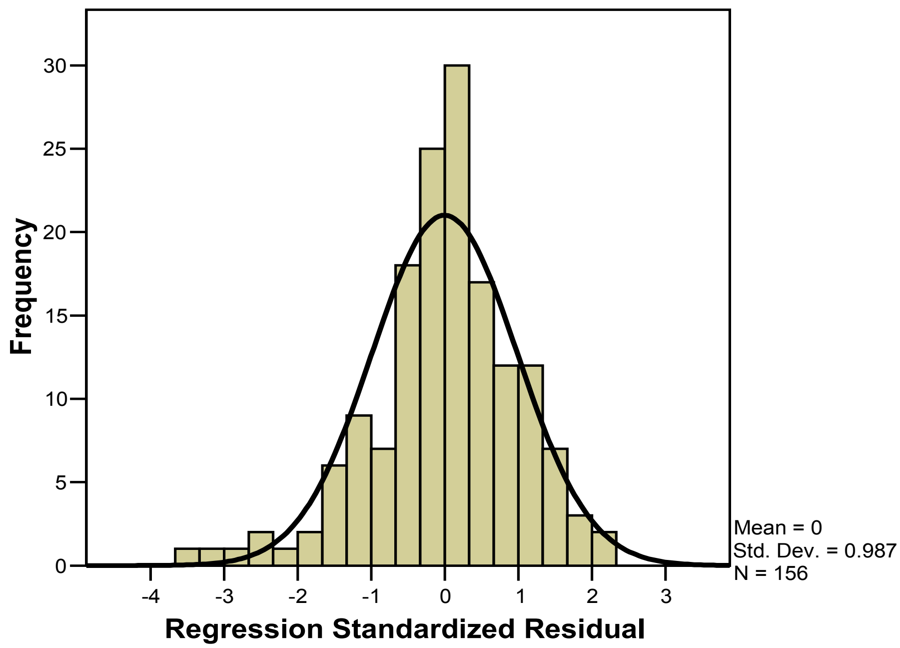
**Table F 7 ANOVA table of whole study area**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 87.002 | 1 | 87.002 | 193.338 | .000(a) |
| | Residual | 68.850 | 153 | .450 | | |
| | Total | 155.851 | 154 | | | |
| 2 | Regression | 91.817 | 2 | 45.908 | 108.974 | .000(b) |
| | Residual | 64.035 | 152 | .421 | | |
| | Total | 155.851 | 154 | | | |
| 3 | Regression | 95.237 | 3 | 31.746 | 79.084 | .000(c) |
| | Residual | 60.614 | 151 | .401 | | |
| | Total | 155.851 | 154 | | | |

**Table F 8 Model Coefficients of whole study area**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 2.265 | .620 | | 3.654 | .000 | | |
| | Ln_TFA | 1.054 | .076 | .747 | 13.905 | .000 | 1.000 | 1.000 |
| 2 | (Constant) | 4.772 | .954 | | 5.003 | .000 | | |
| | Ln_TFA | .652 | .140 | .462 | 4.665 | .000 | .275 | 3.630 |
| | Ln_NOB | .538 | .159 | .335 | 3.381 | .001 | .275 | 3.630 |
| 3 | (Constant) | 4.589 | .933 | | 4.918 | .000 | | |
| | Ln_TFA | .610 | .137 | .432 | 4.447 | .000 | .272 | 3.670 |
| | Ln_NOB | .488 | .156 | .304 | 3.126 | .002 | .272 | 3.673 |
| | Ln_COB | .520 | .178 | .159 | 2.919 | .004 | .866 | 1.155 |

**Figure F 1 Histogram of standardized residual of model of whole stydy area with self declared data**



# Appendix – G: Model with field data

**Table G 1 ANOVA table of neighbourhood one Dhanmondi**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 29.031 | 1 | 29.031 | 73.072 | .000(a) |
| | Residual | 24.235 | 61 | .397 | | |
| | Total | 53.265 | 62 | | | |
| 2 | Regression | 35.854 | 2 | 17.927 | 61.779 | .000(b) |
| | Residual | 17.411 | 60 | .290 | | |
| | Total | 53.265 | 62 | | | |
| 3 | Regression | 37.351 | 3 | 12.450 | 46.157 | .000(c) |
| | Residual | 15.915 | 59 | .270 | | |
| | Total | 53.265 | 62 | | | |
| 4 | Regression | 38.717 | 4 | 9.679 | 38.589 | .000(d) |
| | Residual | 14.548 | 58 | .251 | | |
| | Total | 53.265 | 62 | | | |

**Table G 2 Coefficients of neighbourhood one Dhanmondi**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 4.194 | .886 | | 4.737 | .000 | | |
| | Ln_TFA | .942 | .110 | .738 | 8.548 | .000 | 1.000 | 1.000 |
| 2 | (Constant) | 2.980 | .797 | | 3.739 | .000 | | |
| | Ln_TFA | .872 | .095 | .684 | 9.164 | .000 | .978 | 1.023 |
| | Ln_COB | 1.390 | .287 | .362 | 4.849 | .000 | .978 | 1.023 |
| 3 | (Constant) | -526.262 | 224.694 | | -2.342 | .023 | | |
| | Ln_TFA | .899 | .092 | .705 | 9.719 | .000 | .963 | 1.038 |
| | Ln_COB | 1.182 | .290 | .308 | 4.074 | .000 | .887 | 1.127 |
| | Ln_DAV | 69.640 | 29.566 | .176 | 2.355 | .022 | .903 | 1.108 |
| 4 | (Constant) | -562.475 | 217.230 | | -2.589 | .012 | | |
| | Ln_TFA | 1.282 | .187 | 1.005 | 6.864 | .000 | .220 | 4.551 |
| | Ln_COB | 1.089 | .283 | .284 | 3.853 | .000 | .869 | 1.150 |
| | Ln_DAV | 74.047 | 28.573 | .188 | 2.591 | .012 | .899 | 1.112 |
| | Ln_NOS | -.466 | .200 | -.337 | -2.334 | .023 | .226 | 4.431 |

### Table G 3 ANOVA table of neighbourhood two Mogh Bazar

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 34.740 | 1 | 34.740 | 159.574 | .000(a) |
| | Residual | 21.553 | 99 | .218 | | |
| | Total | 56.293 | 100 | | | |
| 2 | Regression | 39.067 | 2 | 19.533 | 111.125 | .000(b) |
| | Residual | 17.226 | 98 | .176 | | |
| | Total | 56.293 | 100 | | | |
| 3 | Regression | 40.994 | 3 | 13.665 | 86.639 | .000(c) |
| | Residual | 15.299 | 97 | .158 | | |
| | Total | 56.293 | 100 | | | |
| 4 | Regression | 42.384 | 4 | 10.596 | 73.132 | .000(d) |
| | Residual | 13.909 | 96 | .145 | | |
| | Total | 56.293 | 100 | | | |

### Table G 4 Coefficients of neighbourhood two Mogh Bazar

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 3.388 | .599 | | 5.657 | .000 | | |
| | Ln_TFA | .935 | .074 | .786 | 12.632 | .000 | 1.000 | 1.000 |
| 2 | (Constant) | -1055.146 | 213.361 | | -4.945 | .000 | | |
| | Ln_TFA | .909 | .067 | .764 | 13.634 | .000 | .994 | 1.006 |
| | Ln_DAV | 139.383 | 28.094 | .278 | 4.961 | .000 | .994 | 1.006 |
| 3 | (Constant) | -957.834 | 204.012 | | -4.695 | .000 | | |
| | Ln_TFA | .846 | .066 | .711 | 12.891 | .000 | .920 | 1.087 |
| | Ln_DAV | 126.515 | 26.865 | .252 | 4.709 | .000 | .975 | 1.025 |
| | Ln_COB | .724 | .207 | .195 | 3.496 | .001 | .904 | 1.106 |
| 4 | (Constant) | -987.562 | 195.772 | | -5.044 | .000 | | |
| | Ln_TFA | -987.562 | .099 | .512 | 6.141 | .000 | .370 | 2.700 |
| | Ln_DAV | 130.636 | 25.784 | .261 | 5.067 | .000 | .973 | 1.028 |
| | Ln_COB | .641 | .200 | .172 | 3.198 | .002 | .887 | 1.127 |
| | Ln_NOB | .346 | .112 | .259 | 3.097 | .003 | .367 | 2.725 |

### Table G 5 ANOVA table Neighbourhood three Nawabpur

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 88.336 | 1 | 88.336 | 199.067 | .000(a) |
| | Residual | 28.400 | 64 | .444 | | |
| | Total | 116.737 | 65 | | | |
| 2 | Regression | 102.027 | 2 | 51.013 | 218.482 | .000(b) |
| | Residual | 14.710 | 63 | .233 | | |
| | Total | 116.737 | 65 | | | |
| 3 | Regression | 103.082 | 3 | 34.361 | 156.016 | .000(c) |
| | Residual | 13.655 | 62 | .220 | | |
| | Total | 116.737 | 65 | | | |

**Table G 6 Coefficients Neighbourhood three Nawabpur**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 7.144 | .214 | | 33.306 | .000 |
| | Ln_NOR | 1.298 | .092 | .870 | 14.109 | .000 |
| 2 | (Constant) | 6.694 | .166 | | 40.252 | .000 |
| | Ln_NOR | 1.019 | .076 | .683 | 13.391 | .000 |
| | Ln_COB | 1.153 | .151 | .390 | 7.657 | .000 |
| 3 | (Constant) | -461.762 | 214.028 | | -2.157 | .035 |
| | Ln_NOR | .958 | .079 | .642 | 12.130 | .000 |
| | Ln_COB | 1.008 | .161 | .341 | 6.280 | .000 |
| | Ln_DAV | 61.700 | 28.189 | .123 | 2.189 | .032 |

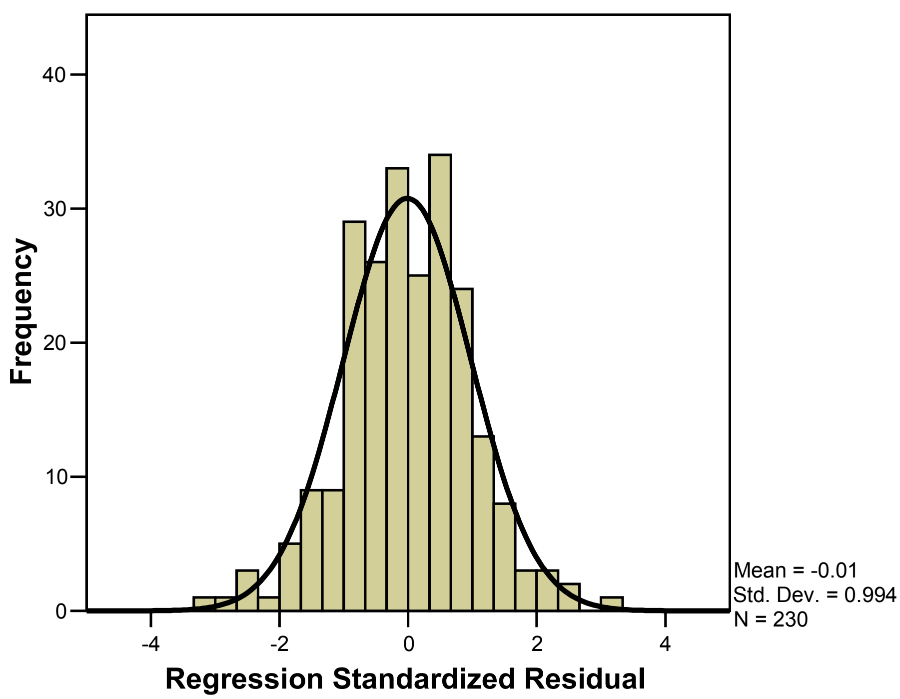
**Table G 7 ANOVA table of Whole study area**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 154.154 | 1 | 154.154 | 203.813 | .000(a) |
| | Residual | 170.936 | 226 | .756 | | |
| | Total | 325.090 | 227 | | | |
| 2 | Regression | 224.165 | 2 | 112.082 | 249.874 | .000(b) |
| | Residual | 100.925 | 225 | .449 | | |
| | Total | 325.090 | 227 | | | |
| 3 | Regression | 244.421 | 3 | 81.474 | 226.233 | .000(c) |
| | Residual | 80.670 | 224 | .360 | | |
| | Total | 325.090 | 227 | | | |
| 4 | Regression | 258.726 | 4 | 64.682 | 217.347 | .000(d) |
| | Residual | 66.364 | 223 | .298 | | |
| | Total | 325.090 | 227 | | | |
| 5 | Regression | 260.283 | 5 | 52.057 | 178.322 | .000(e) |
| | Residual | 64.807 | 222 | .292 | | |
| | Total | 325.090 | 227 | | | |

**Table G 8 Coefficients whole study area**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 9.280 | .126 | | 73.793 | .000 | | |
| | Ln_NOB | 1.138 | .080 | .689 | 14.276 | .000 | 1.000 | 1.000 |
| 2 | (Constant) | 7.652 | .162 | | 47.135 | .000 | | |
| | Ln_NOB | .878 | .065 | .531 | 13.543 | .000 | .897 | 1.115 |
| | Ln_COB | 1.689 | .135 | .490 | 12.493 | .000 | .897 | 1.115 |
| 3 | (Constant) | -839.361 | 112.940 | | -7.432 | .000 | | |
| | Ln_NOB | .794 | .059 | .481 | 13.436 | .000 | .865 | 1.156 |
| | Ln_COB | 1.470 | .125 | .426 | 11.796 | .000 | .848 | 1.180 |
| | Ln_DAV | 111.537 | 14.872 | .266 | 7.500 | .000 | .878 | 1.139 |
| 4 | (Constant) | -1002.942 | 105.343 | | -9.521 | .000 | | |
| | Ln_NOB | .231 | .097 | .140 | 2.376 | .018 | .264 | 3.795 |
| | Ln_COB | 1.399 | .114 | .406 | 12.302 | .000 | .841 | 1.189 |
| | Ln_DAV | 132.554 | 13.855 | .317 | 9.567 | .000 | .836 | 1.196 |
| | Ln_TFA | .599 | .086 | .397 | 6.933 | .000 | .279 | 3.587 |
| 5 | (Constant) | -927.163 | 109.373 | | -8.477 | .000 | | |
| | Ln_NOB | .491 | .148 | .297 | 3.315 | .001 | .112 | 8.932 |
| | Ln_COB | 1.403 | .113 | .407 | 12.450 | .000 | .841 | 1.190 |
| | Ln_DAV | 122.566 | 14.388 | .293 | 8.519 | .000 | .761 | 1.315 |
| | Ln_TFA | .647 | .088 | .429 | 7.347 | .000 | .263 | 3.796 |
| | Ln_NOR | -.314 | .136 | -.193 | -2.309 | .022 | .129 | 7.778 |

**Figure G 2 Histogram of standardized residual of model of whole study area with field data**



# Appendix-H: Model with integrated self declared and field data combined three neighbourhoods

**Table H 1ANOVA table model without location**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| | Regression | 348.208 | 5 | 69.642 | 197.714 | .000 |
| | Residual | 132.792 | 377 | .352 | | |
| | Total | 481.000 | 382 | | | |

**Table H 2 Coefficients of model without location**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound | Tolerance | VIF |
| 1 | (Constant) | 9.244 | .094 | | 98.486 | .000 | 9.059 | 9.428 | | |
| | Ln_NOB | 1.148 | .060 | .701 | 19.201 | .000 | 1.030 | 1.265 | 1.000 | 1.000 |
| 2 | (Constant) | 8.005 | .133 | | 60.316 | .000 | 7.744 | 8.266 | | |
| | Ln_NOB | .937 | .054 | .572 | 17.245 | .000 | .830 | 1.044 | .891 | 1.123 |
| | Ln_COB | 1.317 | .112 | .390 | 11.737 | .000 | 1.097 | 1.538 | .891 | 1.123 |
| 3 | (Constant) | -739.773 | 107.453 | | -6.885 | .000 | -951.051 | -528.495 | | |
| | Ln_NOB | .893 | .052 | .546 | 17.297 | .000 | .791 | .994 | .877 | 1.140 |
| | Ln_COB | 1.167 | .108 | .345 | 10.810 | .000 | .955 | 1.380 | .855 | 1.169 |
| | Ln_DAV | 98.467 | 14.149 | .214 | 6.959 | .000 | 70.646 | 126.288 | .924 | 1.082 |
| 4 | (Constant) | -935.477 | 102.235 | | -9.150 | .000 | -1136.497 | -734.456 | | |
| | Ln_NOB | .309 | .086 | .189 | 3.575 | .000 | .139 | .479 | .267 | 3.744 |
| | Ln_COB | 1.088 | .100 | .322 | 10.847 | .000 | .891 | 1.285 | .847 | 1.180 |
| | Ln_DAV | 123.697 | 13.447 | .269 | 9.199 | .000 | 97.258 | 150.137 | .874 | 1.144 |
| | Ln_TFA | .617 | .076 | .421 | 8.092 | .000 | .467 | .766 | .276 | 3.622 |
| 5 | (Constant) | -881.708 | 103.087 | | -8.553 | .000 | -1084.406 | -679.010 | | |
| | Ln_NOB | .568 | .126 | .347 | 4.522 | .000 | .321 | .815 | .124 | 8.051 |
| | Ln_COB | 1.086 | .099 | .321 | 10.930 | .000 | .891 | 1.282 | .847 | 1.180 |
| | Ln_DAV | 116.621 | 13.559 | .253 | 8.601 | .000 | 89.961 | 143.282 | .844 | 1.184 |
| | Ln_TFA | .652 | .077 | .444 | 8.516 | .000 | .501 | .802 | .269 | 3.720 |
| | Ln_NOR | -.321 | .114 | -.192 | -2.819 | .005 | -.544 | -.097 | .157 | 6.362 |

**Table H 3 Excluded variables of model without location**

| Model | | Beta In | t | Sig. | Partial Correlation | Collinearity Statistics | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Tolerance | VIF | Minimum Tolerance |
| 5 | Ln_NAC | .015(e) | .518 | .605 | .027 | .922 | 1.085 | .124 |
| | Ln_NOS | -.048(e) | -1.048 | .295 | -.054 | .356 | 2.812 | .120 |

**Table H 4 ANOVA table for model with spatial data**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 8 | Regression | 387.149 | 6 | 64.525 | 273.266 | .000(h) |
| | Residual | 85.477 | 362 | .236 | | |
| | Total | 472.626 | 368 | | | |

**Table H 5 Coefficients model with spatial data**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound | Tolerance | VIF |
| 1 | (Constant) | 9.222 | .095 | | 97.169 | .000 | 9.036 | 9.409 | | |
| | Ln_NOB | 1.176 | .061 | .709 | 19.235 | .000 | 1.056 | 1.296 | 1.000 | 1.000 |
| 2 | (Constant) | 151.928 | 11.984 | | 12.677 | .000 | 128.362 | 175.495 | | |
| | Ln_NOB | .997 | .054 | .601 | 18.440 | .000 | .891 | 1.104 | .923 | 1.083 |
| | X_cord | .000 | .000 | -.388 | -11.908 | .000 | .000 | .000 | .923 | 1.083 |
| 3 | (Constant) | 137.026 | 10.155 | | 13.494 | .000 | 117.057 | 156.995 | | |
| | Ln_NOB | .824 | .048 | .497 | 17.308 | .000 | .731 | .918 | .843 | 1.186 |
| | X_cord | .000 | .000 | -.351 | -12.707 | .000 | .000 | .000 | .912 | 1.097 |
| | Ln_COB | 1.170 | .095 | .346 | 12.332 | .000 | .984 | 1.357 | .879 | 1.137 |
| 4 | (Constant) | 132.738 | 9.744 | | 13.622 | .000 | 113.576 | 151.900 | | |
| | Ln_NOB | .435 | .080 | .262 | 5.417 | .000 | .277 | .593 | .271 | 3.685 |
| | X_cord | .000 | .000 | -.346 | -13.113 | .000 | .000 | .000 | .911 | 1.097 |
| | Ln_COB | 1.150 | .091 | .340 | 12.653 | .000 | .971 | 1.329 | .878 | 1.139 |
| | Ln_TFA | .410 | .070 | .280 | 5.886 | .000 | .273 | .547 | .280 | 3.569 |
| 5 | (Constant) | -563.593 | 94.922 | | -5.937 | .000 | -750.258 | -376.928 | | |
| | Ln_NOB | .307 | .077 | .185 | 3.995 | .000 | .156 | .459 | .258 | 3.881 |
| | X_cord | .000 | .000 | -.295 | -11.523 | .000 | .000 | .000 | .845 | 1.184 |
| | Ln_COB | 1.028 | .086 | .304 | 11.891 | .000 | .858 | 1.198 | .846 | 1.182 |
| | Ln_TFA | .528 | .067 | .361 | 7.886 | .000 | .396 | .660 | .264 | 3.787 |
| | Ln_DAV | 89.113 | 12.092 | .192 | 7.370 | .000 | 65.334 | 112.891 | .818 | 1.222 |
| 6 | (Constant) | -719.679 | 98.412 | | -7.313 | .000 | -913.211 | -526.148 | | |
| | Ln_NOB | .389 | .077 | .234 | 5.054 | .000 | .238 | .540 | .244 | 4.098 |
| | X_cord | .000 | .000 | -.242 | -8.828 | .000 | .000 | .000 | .697 | 1.435 |
| | Ln_COB | .826 | .095 | .244 | 8.699 | .000 | .639 | 1.013 | .665 | 1.504 |
| | Ln_TFA | .466 | .067 | .319 | 7.001 | .000 | .335 | .597 | .253 | 3.949 |
| | Ln_DAV | 98.385 | 11.940 | .212 | 8.240 | .000 | 74.905 | 121.865 | .795 | 1.258 |

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound | Tolerance | VIF |
| | Y_cord | .000 | .000 | .135 | 4.603 | .000 | .000 | .000 | .614 | 1.629 |
| 7 | (Constant) | -720.080 | 96.121 | | -7.491 | .000 | -909.109 | -531.052 | | |
| | Ln_NOB | .000 | .118 | .000 | .003 | .998 | -.231 | .232 | .100 | 10.032 |
| | X_cord | .000 | .000 | -.308 | -9.981 | .000 | .000 | .000 | .527 | 1.898 |
| | Ln_COB | .817 | .093 | .242 | 8.807 | .000 | .635 | .999 | .665 | 1.505 |
| | Ln_TFA | .391 | .067 | .267 | 5.805 | .000 | .258 | .523 | .236 | 4.235 |
| | Ln_DAV | 101.625 | 11.686 | .219 | 8.696 | .000 | 78.643 | 124.606 | .792 | 1.263 |
| | Y_cord | .000 | .000 | .135 | 4.711 | .000 | .000 | .000 | .614 | 1.629 |
| | Ln_NOR | .486 | .113 | .285 | 4.297 | .000 | .263 | .708 | .114 | 8.806 |
| 8 | (Constant) | -720.102 | 95.705 | | -7.524 | .000 | -908.309 | -531.894 | | |
| | X_cord | -.0002 | .000 | -.308 | -11.215 | .000 | .000 | .000 | .663 | 1.508 |
| | Ln_COB | .817 | .092 | .242 | 8.863 | .000 | .636 | .998 | .671 | 1.490 |
| | Ln_TFA | .391 | .064 | .267 | 6.134 | .000 | .266 | .516 | .263 | 3.805 |
| | Ln_DAV | 101.630 | 11.515 | .219 | 8.826 | .000 | 78.985 | 124.275 | .813 | 1.230 |
| | Y_cord | .0001 | .000 | .135 | 4.769 | .000 | .000 | .000 | .628 | 1.593 |
| | Ln_NOR | .486 | .072 | .286 | 6.735 | .000 | .344 | .628 | .278 | 3.597 |

**Table H 6 Excluded variables model with spatial data**

| Model | | Beta In | t | Sig. | Partial Correlation | Collinearity Statistics | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Tolerance | VIF | Minimum Tolerance |
| 8 | Ln_NAC | .027 | 1.143 | .254 | .060 | .925 | 1.082 | .261 |
| | Ln_NOS | .011 | .274 | .785 | .014 | .290 | 3.453 | .199 |
| | Ln_NOB | .000 | .003 | .998 | .000 | .100 | 10.032 | .100 |

## Figure H 1 SPSS data view: neighbourhood Dhanmondi

Edit View Data Transform Analyze Graphs Utilities Window Help

49001

| | Address | WardNo | WardName | PropertyType | NAC | COB | NOR | NOB | NOS | TFA | DAV | ANV | X_cord | Y_cord | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Road # 1 | 49 | Dhanmondi | Residential | 4 | 3 | 6 | 4 | 1 | 2700 | 1989 | 36000 | 538905.0 | 625118.6 | |
| 2 | Road # 1 | 49 | Dhanmondi | Residential | 4 | 3 | 8 | 4 | 2 | 3000 | 1989 | 50000 | 538755.9 | 625087.2 | |
| 3 | Road # 1 | 49 | Dhanmondi | Residential | 4 | 4 | 9 | 6 | 3 | 3264 | 1993 | 66000 | 538651.4 | 625078.2 | |
| 4 | Road # 1 | 49 | Dhanmondi | Residential | 4 | 4 | 10 | 6 | 2 | 4000 | 1989 | 72000 | 538702.4 | 625130.1 | |
| 5 | Road # 1 | 49 | Dhanmondi | Residential | 4 | 4 | 8 | 6 | 2 | 2500 | 1989 | 66000 | 538422.9 | 625044.8 | |
| 6 | Road # 10 | 49 | Dhanmondi | Residential | 4 | 3 | 4 | 2 | 1 | 1500 | 1989 | 42000 | 538648.9 | 626062.3 | |
| 7 | Road # 10 | 49 | Dhanmondi | Residential | 4 | 4 | 5 | 5 | 1 | 4000 | 2003 | 252000 | 538706.2 | 626059.5 | |
| 8 | Road # 10 | 49 | Dhanmondi | Residential | 4 | 3 | 7 | 4 | 2 | 5000 | 1989 | 160000 | 538560.6 | 625994.2 | |
| 9 | Road # 10 | 49 | Dhanmondi | Residential | 4 | 3 | 5 | 3 | 1 | 3000 | 1990 | 87200 | 538534.1 | 625967.1 | |
| 10 | Road # 10/A | 49 | Dhanmondi | Residential | 4 | 4 | 9 | 8 | 2 | 7000 | 1989 | 290000 | 538187.9 | 626191.4 | |
| 11 | Road # 10/A | 49 | Dhanmondi | Residential | 4 | 4 | 4 | 4 | 1 | 2636 | 2003 | 270000 | 538078.4 | 626031.7 | |
| 12 | Road # 10/A | 49 | Dhanmondi | Residential | 4 | 4 | 4 | 3 | 1 | 1800 | 2003 | 182000 | 537957.5 | 625980.2 | |
| 13 | Road # 10/A | 49 | Dhanmondi | Residential | 4 | 3 | 9 | 8 | 3 | 6000 | 1989 | 80000 | 537826.4 | 625974.7 | |
| 14 | Road # 10/A | 49 | Dhanmondi | Residential | 4 | 3 | 8 | 5 | 2 | 4300 | 1989 | 190000 | 538272.8 | 626158.1 | |
| 15 | Road # 11 | 49 | Dhanmondi | Residential | 4 | 4 | 4 | 3 | 1 | 2233 | 2004 | 153000 | 538060.4 | 626676.3 | |
| 16 | Road # 11 | 49 | Dhanmondi | Residential | 4 | 3 | 5 | 4 | 1 | 2500 | 1989 | 50000 | 538198.8 | 626546.7 | |
| 17 | Road # 11 | 49 | Dhanmondi | Residential | 4 | 4 | 4 | 3 | 1 | 2960 | 2004 | 225000 | 538241.9 | 626547.2 | |
| 18 | Road # 11 | 49 | Dhanmondi | Residential | 4 | 4 | 13 | 8 | 3 | 5150 | 1998 | 133354 | 538055.6 | 626502.9 | |
| 19 | Road # 11 | 49 | Dhanmondi | Residential | 4 | 3 | 8 | 4 | 2 | 4000 | 1989 | 48000 | 538102.9 | 626537.3 | |
| 20 | Road # 11/A | 49 | Dhanmondi | Residential | 4 | 4 | 17 | 9 | 3 | 12000 | 1989 | 300000 | 538190.7 | 626246.7 | |
| 21 | Road # 11/A | 49 | Dhanmondi | Residential | 4 | 4 | 10 | 6 | 2 | 7000 | 1989 | 267400 | 538059.1 | 626240.4 | |
| 22 | Road # 11/A | 49 | Dhanmondi | Residential | 4 | 2 | 6 | 4 | 2 | 2400 | 1989 | 40000 | 538409.2 | 626187.7 | |
| 23 | Road # 11/A | 49 | Dhanmondi | Residential | 4 | 3 | 5 | 4 | 1 | 2000 | 1991 | 55000 | 538422.6 | 626149.6 | |
| 24 | Road # 11/A | 49 | Dhanmondi | Residential | 4 | 1 | 2 | 1 | 1 | 600 | 1989 | 15000 | 538359.9 | 626087.3 | |
| 25 | Road # 12 | 49 | Dhanmondi | Residential | 4 | 4 | 4 | 3 | 1 | 1200 | 2003 | 105000 | 538366.7 | 626661.9 | |
| 26 | Road # 12 | 49 | Dhanmondi | Residential | 4 | 3 | 10 | 6 | 2 | 6000 | 1989 | 102000 | 538471.0 | 626642.0 | |
| 27 | Road # 12 | 49 | Dhanmondi | Residential | 4 | 4 | 6 | 4 | 1 | 2000 | 1999 | 84000 | 538250.1 | 626655.5 | |
| 28 | Road # 12 | 49 | Dhanmondi | Residential | 4 | 3 | 14 | 11 | 4 | 6000 | 2002 | 432000 | 538339.0 | 626593.7 | |
| 29 | Road # 12 | 49 | Dhanmondi | Residential | 4 | 4 | 5 | 4 | 2 | 2600 | 1989 | 36000 | 538265.8 | 626598.9 | |
| 30 | Road # 12/A | 49 | Dhanmondi | Residential | 4 | 3 | 8 | 4 | 2 | 4200 | 1989 | 112000 | 538099.0 | 626408.7 | |
| 31 | Road # 12/A | 49 | Dhanmondi | Residential | 4 | 4 | 12 | 6 | 2 | 2288 | 1989 | 130000 | 538229.1 | 626398.5 | |
| 32 | Road # 12/A | 49 | Dhanmondi | Residential | 4 | 3 | 12 | 6 | 3 | 4150 | 1989 | 65200 | 538041.2 | 626378.5 | |
| 33 | Road # 12/A | 49 | Dhanmondi | Residential | 4 | 4 | 9 | 4 | 2 | 4800 | 1989 | 120000 | 538154.0 | 626370.5 | |