IDENTIFYING THE DEFICIENCIES OF LANDUSE-TRANSPORT DEVELOPMENT IN DHAKA CITY

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October 2009

S. M. Sohel Mahmud

DEDICATION

This thesis is dedicated to my parents. Their uninterrupted inspiration, support, guidance made this effort possible.

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LIST OF ABBREVIATIONS

ADB	: Asian Development Bank
AHP	: Analytic Hierarchy Process
ARI	: Accident Research Institute
BBS	: Bangladesh Bureau of Statistics
BIWTC	: Bangladesh Inland Water Transport Corporation
BDR	: Bangladesh Rifles
BR	: Bangladesh Railway
BRT	: Bus Rapid Transit
BRTA	: Bangladesh Road Transport Authority
BRTC	: Bangladesh Road Transport
BUET	: Bangladesh University of Engineering and Technology
BURP	: Bachelor of Urban and Regional Planning
CAT	: Countryside around Town
CBD	: Center Business District
CBO	: Community Based Organizations
CDA	: Capital Development Authority
CNG	: Compressed Natural Authority
DAMERA	: Dhaka Metropolitan Regional Authority
DCC	: Dhaka City Corporation
DESA	: Dhaka Electric Supply Authority
DIT	: Dhaka Improvement Trust
DITS	: Dhaka Integrated Transport Study
DMA	: Dhaka Metropolitan Authority
DMAIUP	: Dhaka Metropolitan Area Integrated Urban Development Plan
DMDP	: Dhaka Metropolitan Development Plan
DMP	: Dhaka Metropolitan Police
DOE	: Department of Environment
DRA	:Dhanmondi Residential Area
DTCB	: Dhaka Transport Coordination Board
DND	: Dhaka Narayangong Dam
DUTP	: Dhaka Urban Transport Project
DWASA	: Dhaka Water and Sewerage Authority
EIA	: Environmental Impact Assessment
EMR	: Extended Metropolitan Region

GDTPCB	: Greater Dhaka Transport Planning Coordination Board
GIS	: Geographic Information System
GNP	: Gross National Product
JBIC	: Japan Bank of International Co-operation
JICA	: Japan International Co-operation Authority
TIA	: Transport Impact Assessment
LRT	: Light Rail Transit
MAAP	: Micro-computer Accident Analysis Package
MRT	: Mass Rapid Transit
MURP	: Masters of Urban and Regional Planning
NGO	: Non Government Organization
NMV	: Non-Motorized Vehicle
NMT	: Non-Motorized Traffic
PDB	: Power Development Board
PLDHPR	: Private Land Development Housing Project Rules
RAJUK	: Rajdhani Unnayan Kartripakka
RHD	: Roads arid Highways Departments
RMMS	: Road Maintenance and Management Survey
RTC	: Road Transport Committee
SOB	: Survey of Bangladesh
STP	: Strategic Transport Planning
TDM	: Travel Demand Management
TIA	: Transport Impact Assessment
T & T	: Telephone & Telegraph
TITAS :	Titas Gas Transmission and Distribution Committee
TIA	: Town Improvement Act
TOP	: Town out Posts
TSM	: Traffic System Management
UAP	: Urban Area Plan
URP	: Urban and Regional Planning
WASA	: Water and Sewerage Authority
WDB	: Water Development Board

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ABSTRACT

Dhaka, the capital of Bangladesh and the nation's gateway, has now been turned into the 26th Mega city and 10th most populous city in the world. The development processes of Dhaka city rapidly increased with tremendous growth of population and physical expansion, over 30 and 20 times respectively within the period of 1951 to 2001. Unfortunately, the city experiences the proliferation of scattered and unplanned development without appropriate guidance resulting in immense landuse and transport deficiencies in the city. In this study, an attempt has been made to identify the deficiencies of landuse-transport development in Dhaka city. Though, the study emphasis has been made on the identification of landuse and transport development, road network, operational and function deficiencies, finally a set of short and medium term recommendations also have been proposed for improving the situation.

After liberation, for the centralization of development works, political & administrative power, high investment in already developed areas, potential employment opportunities, discrepancy of income level between the city and other regions of the country, the city population has been increased in an uncontrolled and unpredictable way (8% per annum, 3.5 times higher than the prediction). Whereas, for the lack of proper plan and regulation (though 3 plans and 7 construction and improvement acts have been developed since 1952, no completed master plan yet) the city has developed almost unguided and unplanned way. Indeed, lack of buildable land for the causes of low topography (75% are below the natural water level and 95% within 5 to 7 meters flood level) aggravated the problems and forced to densify unplanned settlement (73% fully unplanned) of these huge populations (around 6 millions in DCC area and over 10 millions in DMA area) in the marshy land. Immense densification (around 45 thousands per sq.km) and mushrooming development of residential (62%), commercial (8%) and other infrastructure trimmed down the opportunity to construct new road infrastructure or to introduce modern system for improving overall transportation system. There are only 1286 km road in the DCC area including 52 percent inaccessible road for motorized vehicles which covered around 6.5 percent of the city area but actually the functional road is only 2 percent of the city area. This scarcity of the road (0.21 meters per capita, whereas many other cities it varies between 4.5 to 0.5 meters) is one of the fundamental inherent weaknesses of the city of Dhaka for their deficient landuse and transport panning.

The unplanned and haphazard orientation of road networks viz. no east-west continuous road, huge missing links (9 major strategic links are missing in the major roads), staggered & T-junction (six staggered junctions within the 5.19 kilometer of Mipur road and 19 major T-junctions in major three roads), right angle bend (5 in major roads), no classical and functional hierarchy, lack of functional gateway, discontinuity of the main road also leads to built-in problems on the operational and management aspects of the transportation system and functionally sabotages the entire street network performance. Continuous focus on road based network system has also weakened potentials and attractiveness of other types of transportation system like rail or water transport (approximately 18.7 millions intra city trips per day, among them the share of intra city commuter train and launch are only 5000 and 2000 passengers respectively). Indeed, there has no integration between different modes, whereas one is depriving others (altogether 51 railway level crossings are interrupting on road vehicle on both sides of rail gates on an average of 5 to 6.0 hours in each day in each level crossing, 14 low bridges are cutting off the circular waterway facility). The interchange or interface facilities between different modes are also very poor (no direct connectivity between bus station to rail station or launch station to

bus station). On the other hand, mix mode of traffic (though-local, MT-NMT, large-small), excessive dependency on rickshaws (0.5 millions) reduces the functional efficiency of the road transport system. At present, the elimination or proper management of these massive number of rickshaws is almost impossible because of fully ignorance of traffic rules and regulations of the rickshaw pullers (92%), lack of basic minimum education and training (90%), huge number of families' economically dependency on rickshaws (0.8 millions), lack of alternative sufficient job facilities in the local market (around 0.9 millions are employed in providing rickshaw services) as well as inaccessible road in the local area (around 52%), poor public transport and mixed landuse pattern in all over the city. For the improvement of the existing road transport system, there have also very limited scope to apply traditional low cost but very cost-effective traffic management measures viz. one-way operation (only 0.31% road at present), tidal flow, signal co-ordination, right turn restriction along with reduction of signal phasing (among 59 signalized intersections, 47 (80%) intersections phases are equal to its approaches), access control (around 10 side road per km per side in the main roads), exclusive bus lane etc. in the present landuse and transportation system of the Mega city Dhaka. Even, high cost management tools like grade separated interchanges, construction of well design flyovers, implementation of BRT, MRT is also difficult for the causes of haphazard densification and unplanned development, road side and junction corner points development, inconsistent road width (44 m to 17 m is a major road), conflict between other utility services, conflict between different existing and proposed road projects as well as wrong policies for the transport system.

Buses are the main player of the mass transit system in Dhaka city but the total road length of the bus operating route is only 120 km comprising 22 east-west links which is covering only around one third of the metropolitan areas. The performance of this service is not quite good and seems very difficult to improve the condition in present situation. In spite of having huge benefit and large potentials, successfully implementation of BRT would be very challenging tasks particularly for the causes of insufficient road width in different segments of major roads (17 m in some segments), insufficient space for BRT station and interface facilities, overlapping bus routes (120 km road but 149 routes, 57 routes in one segment, varied between 100% to 5% at start and end segment in some proposed BRT routes), fragmented ownership (around 5000 buses but 1200 owners), huge pedestrians movements (10,000 to 20,000 in some busy points), huge number of bus operators (57.6% buses are owned by individuals), less productive intersections (96% are equal phases of its approaches) etc. Almost all of those deficiencies initiated from the initial planning problems, it is almost impossible to change the preliminary planning and development deficiencies at the present condition of the city. Indeed, incomplete understanding of the inherent weaknesses of the city couple with lack of long term vision, the authorities are providing piecemeal solution without a long term vision which is becoming an extra burden on the overall systems of the city and the city is now growing with a pattern of decaying growth. However, the ultimate solution could be gradually shifting of the capital city of Bangladesh like many other countries of the world viz. Pakistan, India, South Korea etc.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND AND PRESENT STATUS OF THE PROBLEM

Dhaka City, being the administrative, commercial and cultural capital of Bangladesh and the nation's gateway, has now been turned into 26th Mega City and 10th most populous city of the world (Habib et al., 2005). Entire socioeconomic development and poverty reduction of Bangladesh is largely depends on Dhaka city. Dhaka city is the centroid of major national and international (based on Bangladesh) activities. It is the nerve center of the country and focus of all major activities.

Urbanization in Dhaka is essentially a process of migration from rural and smaller towns. After the liberation of Bangladesh in 1971, the development processes of Dhaka City rapidly increased. Dhaka City has also been witnessing a tremendous growth in population and physical expansion. The population of Dhaka has grown from only 0.34 million in 1951 to 10.71 million in 2001 – a growth of 10.36 million in 50 years (Census, 2001) and its share of national urban population was 25% in 1981, 31% in 1991 and 34% in 2001 respectively. The population of the city grew at an alarming rate and unprecedented way, from 1974 to 1981 become more than doubled and 53% increased during 1981 to 1991 inter censual period and this rising volume was marked by the physical expansion of the city by inclusion of fringe areas. The population of this megacity is estimated to be 12.19 million by 2006 and 15.69 million by 2016 (DMDP, 1995). As per future prediction, this population will further grow to about 20 million by the year 2020 and to 25 million by 2025 (STP, 2004).

The city experiences the proliferation of scattered development without appropriate guidance which resulted in huge urban system difficulties. In 1959, a partial master plan was prepared for the city but the city has been developed with the minimum assistance of that plan. Indeed, the plan was not updated in the following four decade with the boom of population after the liberation and consequent demand of the land and transport facilities results unplanned and haphazard development of the city. Even, the fringe areas of the city are progressing without any guidance, control and regulation yet which will be one of the main integral parts of the city in the near future.

At present, Dhaka city is axially expanding in the north-south direction, mainly north direction for the causes of marshy land in east-west fringe area and riverine flood flow land in the south. For the lack of buildable land along with high construction cost in marshy land and most importantly due to lack accessibility, the city is expanding towards northern direction. Sporadic residential, commercial and other socio-economic infrastructures like super markets, high-rise buildings or apartments/complexes, garments factories etc. are being constructed at various parts of the city without appropriate consideration of planning principles, resulting indisciplined trip generation. Unplanned mixed landuse pattern, presence of cantonment, BDR, airport within the core area of capital city, heavily centralized government frame structure are directly and indirectly affecting the entire transportation system of the Dhaka city. Inefficient and malfunctioning traffic management is also one of the major problems of Dhaka city transportation system, which is

highly responsible for making the existing system more unproductive. Indeed, for the causes of unplanned and non-integrated road network development, there have very limited scope to apply traditional low cost but very cost-effective traffic management measures.

Crisis in the transportation system has considerably affecting the physical form and functional performance of the city. It is progressively deteriorating the entire social and physical environment causing suffering and inconveniences to the people. In future the situation would likely to be out of control unless effective measures are taken right now. With ever growing increasing travel demand resulting from phenomenal growth of urban population as well as high densified landuse pattern, it is a great concern and required urgent attention to prepare Dhaka city as a sustainable mega city. However, for the misunderstanding of the factual and root causes of the problems of Dhaka city, every uncoordinated approach whichever is taken for improving the condition is pushing the city in worse condition gradually. Most of the improvement initiatives are undertaking considering mainly the short term need without any long term vision, which often becomes an extra burden or constraint to the city's overall transport infrastructure development potential. If this trend of transport development approach continues, the city will not be able to sustain ever growing travel demand and eventually will not be a livable city. Therefore, there is no time to sit idle. There is a need for undertaking comprehensive study to realize or identify the root causes of the problems and inherent weaknesses of the city relating to the landuse and transportation system. So far, a few researches have been performed with a limited scope on the individual component of these problems like landuse scenario or road network problems or particular fringe area development or mass transit facilities or particular route performance or transport operation and maintenance etc. But, all these topics are interconnected with each other. In order to identify the inherent weaknesses of the city by analyzing most of the interrelated fields of unban landuse and transport system a comprehensive research need to be carried out. In view of the above, this study will be an exploratory work identifying the inherent weaknesses of Dhaka city in particular relation to transportation system.

1.2 OBJECTIVES WITH SPECIFIC AIMS AND POSSIBLE OUTCOMES:

The main objective of this investigation is to evaluate the present condition of the Dhaka city with a view to find out the root causes of landuse and transportation problems of city. The specific aims and possible out comes are stated below.

- To review the prevailing landuse planning, transport infrastructures development process and traffic management measures
- To assess the performance of existing transportation system
- To identify the underlying causes of landuse and transport deficiencies
- To prepare recommendations for pragmatic and scientific solution to improve overall city transportation facilities as well as to make a livable modern city for all.

It is expected that the outcome of this research will help city authorities, policy makers as well as professionals to understand the real causes of the transport and landuse problems of Dhaka city and to take appropriate policy for improving the current deteriorating situation and to make it a livable city.

1.3 SCOPE OF THE STUDY

1.3.1 The Study Area

The general area included in the thesis encompasses the Dhaka Metropolitan Area (360 Sq.Km). Particular emphasis has been made on the Dhaka City Corporation area comprising 90 wards in the 10 zones (134 sq. km) (DCC, 2004).

1.3.2 Field of the Study

To identify the inherent weaknesses of transportation system in Dhaka Metropolitan City including landuse and transport system demands in-depth study on the landuse pattern, transport network system, traffic operation and management condition, transport infrastructure development, transport policies and guidelines, travel demand and supply as well as general requirements of city transportation system. To carry out comprehensive study comprising all of the above features and facts requires a considerable amount of time, economic and human resources. But the time and resources was very limited to fulfill this study. Considering the above constraints, this study only focused on the broader landuse pattern; road quantity, quality, layout and function, traffic operation and management. The study is mostly based on secondary data and information. Due to the large area concerned, in-depth evaluation to fulfill the objectives in these topics is a complicated and difficult issue within the limited amount of manpower, resource, expertise and time. To overcome these difficulties, the study elaborated in breath but in depth it is shallow.

1.4 ORGANIZATION OF THE THESIS

The contents of the thesis are arranged into nine chapters. These are summarized as follows:

CHAPTER 1
INTRODUCTION

CHAPTER 2
LITERATURE REVIEW

CHAPTER 3
METHODOLOGY AND DATA COLLECTION

CHAPTER 4
PROFILE OF DHAKA METROPOLITAN CITY

CHAPTER 5
LANDUSE DEFECIENCIES

CHAPTER 6
ROAD NETWORK DEFECIENCIES

CHAPTER 7
TRAFFIC MANAGEMENT AND OPERATIONAL DEFECIENCIES

CHAPTER 8
CONCLUSIONS AND
RECOMMANDATIONS

Figure 1.1: Structure of the Thesis

Chapter 1: Introduction: This chapter contains the general background and present status of the problem, scope of the study, objectives of the study and the thesis organization.

Chapter 2: Literature Review: The relevant literatures on landuse and transportation system from home and abroad that were studied are represented in this chapter. Efforts have been made to describe the different parameter of land and transportation planning, urban road network, traffic management, operations etc.

Chapter 3: Methodology and Data Collection: In this chapter, outlines the overall design of the study and research methodology that were followed for this thesis is presented here. The tasks include the process of data collection, sources and sectors of data and data analysis procedure are also described in this chapter. Limitation of the study and the problem face during the data collection has been expressed.

Chapter 4: Profile of Dhaka Metropolitan City: This chapter summarized historical development process of Dhaka city. The prevailing landuse and transportation system in Dhaka Metropolitan city with the emphasis on city development pattern, landuse scenario, road network system and traffic management and operational conditions are also discussed.

Chapters 5: Landuse and Transport Planning Deficiencies: In this chapter, the overall landuse and transport scenario in the city are highlighted. Deficiencies related to the landuse development at macro and micro levels are also evaluated.

Chapter 6: Road Network Deficiencies: In this chapter, the deficiencies of road network including road layout, road quantity, quality, functional problems are discussed.

Chapter 7: Operational and Management Deficiencies: Operational and Management deficiencies of transport system in the city are discussed in this chapter.

Chapter 8: Conclusions and Recommendations: This chapter summarized the outcomes of the study. Some recommendations for improving the transportation system including integrated landuse and transportation planning, accessible road network system, affordable and sustainable traffic operation and management system in Dhaka Metropolitan city are provided. Direction for future research and major policy issues are also highlighted here.

1.5 OVERVIEW

In this chapter, a general statement regarding the research work has been provided. The existing scenario of the city transport system and the magnitude of the problem have been highlighted. The objectives of this study and the scope of the research work have also been pointed out. Finally, the structure of the thesis documentation work is presented.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

An extensive literature review is carried out to get the basic understanding and to acquire knowledge on landuse and transportation system of a modern, efficient and sustainable city as whole and basic elements of landuse transportation system. A brief summary of that review is provided in this chapter.

Finally, in this chapter, a summary of former research works on landuse transport planning, road network, operation and management, and institutional setup of metropolitan Dhaka city conducted in home and abroad are also discussed with relevant research approach and their findings and discussion on those works. A brief review of historical and present development plans for Dhaka, urban planning legislations and policies in Bangladesh are also provided.

2.2 URBAN LANDUSE

In a general sense, urban landuse means the spatial distribution or geographical pattern of city functions- residential areas, industry, commercial areas, retail business and the spaces set aside for governmental, institutional and leisure functions. For analytical purpose, we have to treat landuse in terms of detailed landuse activity, its spatial distribution and associated measures of activity levels. Table 2.l represents a simple landuse activity classification and associated measures.

2.3 INTERACTION BETWEEN URBAN LANDUSE AND TRANSPORT SYSTEM

The urban landuse and transport are closely inter-linked is common wisdom among planners and the public. That the spatial separation of human activities creates the need for travel is the underlying principle of transport analysis and forecasting. Following this principle, it is easily understood that the suburbanization is connected with increasing spatial division of labor and hence with increasing mobility. The reverse impact from transport to landuse can be understood by fact that the evolution from the dense urban fabric of medieval cities where daily mobility was on foot to the vast expansion of modern metropolitan areas with their massive volume of interregional traffic would not have been possible without the fast railway and then the private automobile[1].

[1] Blunden, W. R., and Black, J. A.(1984)

Table 2.1: A General Classification of Landuse Activity and Measure

Activity	Measure of activity level
Extraction activities (includig stockpiling and assembly of material incidental to these activities)	Agricultural hectares, head of stock, reserve of ore, output capacity
Processing activities (including refining, fabricating, assembly storage, parking and other space uses incidental to these activities)	Floor-space area, number of factory employees, production units
Communication activities (including related rights-of-way, storage, parking and other areas incidental to these activities)	Parking spaces, number of platforms, berths or service channels
Wholesale-retail distribution activities (including customer or employee parking, loading, service and other related areas)	Floor-space area, retail sales, number of customer parking spaces, service channels
Service activities (including customer or employee parking, loading, service an other related areas)	Seating capacity, office employees, number of motel beds, parking spaces
General welfare, community service and non-commercial leisure-time activities (including parking, service an other related areas)	Student enrolment, hospital beds, number of church pews, parking spaces
Residential activities	Population, dwelling units, vehicle ownership, resident workforce
Employment centers (the central business district, industrial estates)	Number of jobs
Unused space (unimproved and improved land, water areas)	None

Source: Blunden and Black, 1984

The recognition that trip and location decisions co-determine each other and therefore transport and landuse planning needed to be coordinated led to the notion of the *landuse transport feedback cycle*. The set of interrelationship implied by this term can be briefly summarized as follows:

- The distribution of landuses such as residential, industrial or commercial over the urban area determines the location of human activities such as living, working, shopping, education or leisure.
- The distribution of human activities in space requires spatial interaction or trips in the transport system to overcome the distance between the location of activities.
- The distribution of infrastructure in the transport system creates opportunities for spatial interactions and can be measured as accessibility
- The distribution of accessibility in space co-determines location decisions and so results in the changes of the landuse system (Blunden & Black, 1984) .

2.4 INTERDEPENDENCE OF THE LANDUSE AND TRAFFIC

In 1954, Mitchell and Rapkin[2] made a statement that urban traffic was a function of landuse. Though it appears now that there is nothing spectacular or startling in this statement, yet it paved the way for a new line of thinking in urban transportation and land-use planning. Till then, transportation planning was limited to the measurement of traffic using streets, identifying those

[2] Mitchell R.B. and Rapkin C (1954)

sections were the present traffic had exceeded the capacity and undertaking improvement measures to relieve the congestion and bottlenecks in the smooth flow of traffic. This simplistic approach failed to deal with the crux of the transportation problem and only supplied the engineers with short-term palliatives to deal with the transport malady. This approach has now been virtually abandoned.

Mitchell and Rapkin[2] observed that various kinds of activities based on the land-called landuse-"generated" different amounts and kinds of traffic. They concluded that though measures such as (i) regulation and control of traffic and (ii) provision and improvement of physical channels of movement were effective in dealing with urban traffic, the most basic level of action for a long-run solution of the traffic problems is the planning, guidance and control in the pattern of landuse. More recently, Buchanan (1963) has also emphasized the inter-relationship between traffic and buildings in a town. He states that in towns, traffic takes place because of buildings, and in fact all movements in a town have an origin and destination in a building. The pattern traced by traffic is thus closely related to the manner in which buildings are arranged. Commuter flows are closely dependent upon the location and size of the work-places and of the home-areas. School traffic is governed by the location of the schools and the home areas.

Just as transport is a function of land-use, the reciprocal statement that land-use is a function of transport is also true. As new systems of transport are built, the land-use pattern that follows has a close relation to the accessibility that has been made possible.

The above interdependence is the key-note of modern transport planning. The early Detroit Area Transportation Study demonstrated the empirical validity of the proposition that transport was a function of landuse. The Penn-Jersey Transportation Study tested the reciprocal proposition that landuse was a function of transportation. These concepts have by now been used in a number of important transportation studies in many of the principal towns and cities all over the world (Buchanan, 1963).

2.5 CONCEPT OF LANDUSE PLANNING

Landuse planning is generally recognized as a scheme for future development of an area indicating final use of land and structure built up on that land. Urban landuse planning means the spatial distribution of city functions-its residential areas, its industrial, commercial, and retail business districts, and the spaces set aside for institutional and leisure-time functions.

A landuse plan reflects an analysis of urban activity system. It estimates future land requirements for expansion and renewal and shows how development in the urban area should proceed in future[3].

An effective landuse plan ensures

- best possible physical environment for urban living
- convenience and welfare for urban community
- most economic use of land, and
- proper balance in use from a cost-revenue point of view (Rahim, 2001)

2.6 FUNDAMENTAL PROCESS AND CRITERIA OF PLANNING

The planning is that where development is progressed from lowers level to upper level or bottom to top. The fundamental process of planning is to acquisition of land, land filling with maintaining

[3] Rahim A (2001)

natural slop on the flood level, alignment of road, location of access, plot size, life line, guide line and planning control with stick law and enforcement[4].

From this we can identify some measuring criteria for a pre-planning project

- Land acquisition
- Land filling
- Provide sufficient slop
- Provide road alignment
- Show Access
- Show plot size with detail map
- Life line
- Guide line
- Control and enforcement (Rahim, 2001)

2.7 MAJOR LANDUSE COMPONENTS OF A CITY/TOWN

There are various types of activities and functions in a town. The spatial location of functions and activities are called landuse. The major activities are living, work, recreation, movement etc. For living we need residential area, for work we have offices, commercial area, industrial area etc., for recreation we need play ground, stadium, park etc., for movement we need roads, footpaths, railways etc. Broadly there are some distinct major types of landuses in a town. These are as follows.[5]:

- The Town Centre (also called C.B.D, Down Town or Heart of the City)
- The Residential Area
- The Industrial Area
- Open Space
- Urban Fringe or Town Periphery
- Transport System (Moniruzzaman, 2003)

2.8 OBJECTIVES OF LANDUSE PLANNING AND CONTROL

Landuse planning and control is done to achieve certain goals and objectives. The major objectives of this tasks are follows:

- To fix landuse activities and density of landuse
- To minimize number of trips
- To minimize trip length
- To make flow pattern predictable/ to have predictable traffic pattern
- To confine activities within the designated areas
- To make all part of the are more accessible
- To make balance in road hierarchy
- To provide good public transport facilities
- To provide parking and terminal facilities
- To make balance among land-use, transport policy and environment impact (Moniruzzaman, 2003).

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[4] Rahim A (2001)
[5] Moniruzzaman M. (2003)

2.9 FRINGE AREA DEVELOPMENT

While urban fringe areas act as a bridge to the wider countryside, the countryside around towns is also seen as providing land and resources for a combination of agricultural production, physical space and settings for residential use and recreation (Hodge. 200 I). For the majority of the population, the urban fringe is the first experience of countryside, and for the countryside itself, it is the leading edge of urbanization. With rapid social and economic changes, the countryside around towns is now under increasing threat, and as a consequence, appears more precious than ever before.

In terms of urban development patterns and trends, the urban fringe is a pressure point, residual element. and container for urban structures. Urban fringes are by their nature zones of rapid transition and change, where new landuses need to be accommodated while previous ones become dysfunctional[6].

2.10 TRANSPORTATION PLANNING

Transport planning is a science that seeks to study the problems that arise in providing transportation facilities in an urban, regional or national setting and to prepare a systematic basis for planning such facilities. Since the developed countries where this science has evolved are mainly urban-oriented the emphasis is more on urban transport planning. However, the principles of urban transport planning can be applied to regional or national transport planning as well with due changes wherever called for (Kadiyali 2007).

Transportation planning consists of three levels of planning: (1) policy planning, (2) systems planning, and (3) project or facility planning. Policy planning is concerned with the establishment of transportation policy and the development of goals and objectives. Systems planning is "a process under which transportation networks and corridors are defined starting from forecasts of population and economic growth and continuing through estimates of person and goods movement to a physical description of the systems required to meet those real or implied needs". roject or facility planning is concerned primarily with determining the scale and layout of individual facilities to accommodate the anticipated demand. Planning may be subdivided into three categories to account for differences in the planning period:

1. Long-range planning.
2. Intermediate-range planning.
3. Short-range planning.

Long range planning is typically conducted for a period of about 15 to 30 years into the future (3). The level of detail for such planning is generalized, and long-range plans should be periodically reappraised and changed to account for unexpected shifts in population, development, and so forth. Intermediate-range planning covers a period of about 5 to 15 years in the future. "In this planning, the facility characteristics and performance, as well as route location, would be more specific, with evaluation of alternative designs and route locations in terms of a performance analysis, including traditional benefit/cost analysis, as well as environmental impacts and developmental considerations" (3). Short-range planning is typically conducted for a period of about five years. In short-range plans, the physical features of transport facilities and the traffic and land developments that these facilities are expected to serve can be specified in considerable detail and with reasonable precision (Ahsan, 2003).

[6] Fatema R., 2003

2.11 LANDUSE FACTORS THAT AFFECT TRAVEL

There are several factors, which affect the travel pattern, travel behaviors as well as trip generation and distribution. Some of the factors are as follows:

- Density and Clustering
- Landuse Mix
- Roadway Design
- Site Design and Building Orientation
- Cumulative Impacts[7].

2.12 SYSTEMS APPROACH TO TRANSPORT PLANNING

In the recent past, a new activity known as Operations Research has taken shape and is finding interesting applications in diverse fields. Transport Planning is one field where this approach has already been tried and found extremely useful. Operations Research is mainly concerned with optimizing the performance of a "system". A "system" is defined as a complex whole, an organized whole, consisting of set of connected things or parts, whose components and interconnections are 'vital to the operation of the system[8]. The processes involved in the systems approach in transport planning can be represented by Figure 2.1

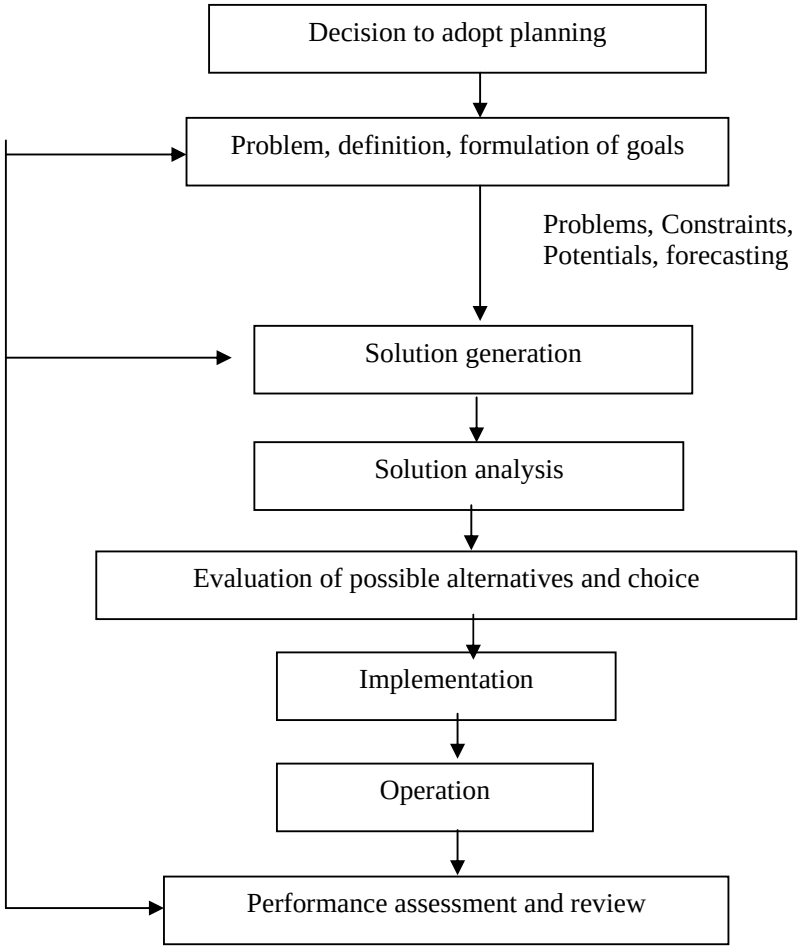


Figure 2.1: Systematic approach to transportation planning (Kadiyally 2007)

[7] Hossain A. M (2003)
[8] Kadiyally 2007

The transport planning process starts with the decision to adopt planning as a tool for achieving certain desired goals and objectives. After the goals and objectives are defined, solutions are generated, taking due cognizance of problems, constraints, potentials and forecasting. These solutions are evaluated after thorough analysis. The best amongst them is chosen for implementation. After implementation, the system is studied in operation and its performance assessed. Based on this assessment it may be necessary to go back to certain stages of planning and repeat the sequence (Kadiyali, 2007).

2.13 STAGES IN TRANSPORT PLANNING

The broad sequence of operations in the systems approach to transport planning has already been outlined. In this section it proposed to identify in greater detail the various stages in the transport planning process.

It will be seen that the transport planning process can be broken down to five important stages :

1. Survey and analysis of existing conditions
2. Forecast, analysis of future conditions and plan synthesis 3. Evaluation
3. Programme adoption and implementation
4. Continuing study[9].

2.14 ROAD LAYOUT PATTERN

The aim of a planned town is to seek the efficient road system to cope with the conditions of uncertainties and to enable traffic to enter or leave the town rapidly and safely, or to circulate freely within it. Thus an efficient road pattern should satisfy the following criteria:

i. flexibility and adaptability to growth;
ii. application to different sites according to size, topography etc;
iii. ease of design and construction
iv. efficiency of movement
v. required traffic capacities

Following are some of the street road layout patterns commonly used:

1. Orthogonal
2. Orthogonal with superimposed diagonal streets
3. Concentric streets
4. Radial streets
5. Radial and orthogonal combined
6. Irregular mediaeval streets system
7. Topographical street system
8. Combination 0: rectangular and irregular street systems[10]

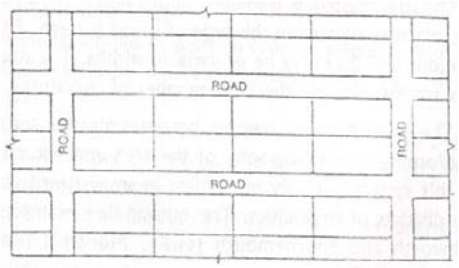


Figure 2.2: Orthogonal

2.14.1 Orthogonal

This is known as rectangular street system. In this pattern the streets are usually of equal width and they cross each other at right angles as shown in (Figure 2.2). This form is also known as grid-iron' pattern. It is easy to design the streets and also the various services. Dhaka, Dhanmondi is an outstanding example of this type of layout (Islam, 2001).

2.14.2 Orthogonal with Superimposed Diagonals

[9] Kadiyali, 2007
[10] Islam N. (2001)

This pattern allows more flexibility and accessibility to the traffic flow. The diagonal streets provide a direct link between the distant parts with the town centre (Figure2.3). But, at the same time diagonals form very typical and dangerous intersections with the grid-iron. Washington (U.S.A) is an example of this road pattern (Islam, 2001).

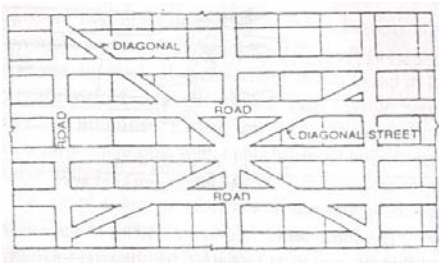


Figure 2.3: Orthogonal with Superimposed Diagonals

2.14.3 Concentric Street System

In this pattern concentric roads emerge out from the town centre and spread out to the town's circumference.

This concentric patterns is then connected by radial roads (Figure 2.4). This layout pattern is also called as Spider-Web pattern. Moscow, Paris and Frankfurt have this layout to a certain extent.

Figure 2.4: Concentric Street System

2.14.4 Radial Street System

A development of radiating roads from a city centre or a central civic centre like the spokes of a wheel (Figure 2.5) with urban accretions along the roads. Such a pattern enhances the significance of civic centre or any other important building from where the roads are radiating. The radial layout forms large blocks of trapezoidal shape. The example of this type of layout is Tripoli (Libya) (Islam, 2001).

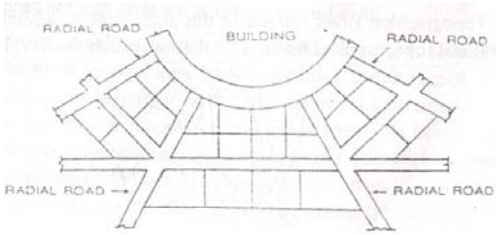


Figure 2.5: Radial Street System

2.14.5 Combination of Radial and Rectangular Street Systems

Radial street pattern if combined with rectangular street pattern often forms the basis of good planning (Figure 2.6). This combination can be of a great success where topographical features are favorable. Then it shall be possible to derive the advantages of both the patterns. The examples of this layout are London, New Delhi and Canberra

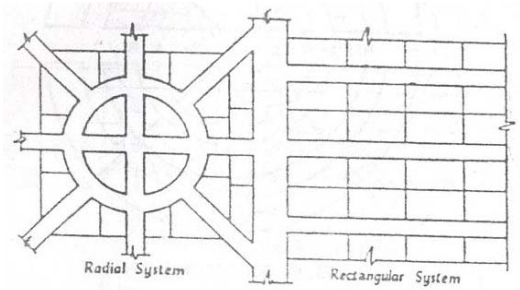


Figure 2.6: Combination of Radial and Rectangular Street Systems

2.14.6 Irregular Mediaeval Street System

Some of the old cities of middle ages, developed in an irregular way without any definite plan of the street system, possess this type of pattern. The growth of town or city is unmethodical and illogical. The mediaeval street pattern naturally does not efficiently serve the modern traffic and such towns are refereed to as irregular mediaeval towns. The towns of this category are Nuremberg (Germany), Nasik and Varanasi (India) (Islam, 2001).

2.14.7 Topographical Street System

In this arrangement, advantage is taken of the natural topographical features of the town such as river, lake, sea view hillock, etc. This system is also known as organic street pattern as it resembles the plan to a microscope slide showing the cell

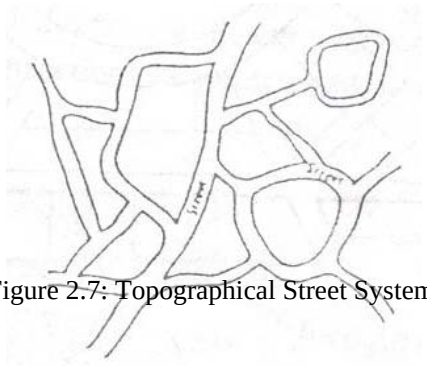


Figure 2.7: Topographical Street System

structure of vegetable or animal tissues. It is also sometimes referred to as studied irregularities.

The street system is absolutely unplanned as shown in Figure 2.7 and all sorts of irregularities are seen in this type of street pattern. The street may not be continuous and they may be of variable widths. The size and shape of open spaces are irregular and there are number of curvatures. The outstanding examples of this pattern are Letchworth and Bournemouth (U.K), Montreal (Canada), Amber and Vijaynagar (India) (Islam, 2001).

2.14.8 Combination of Rectangular and Irregular Street Systems

In this arrangement, a combination of rectangular pattern and irregular streets is made (Figure 2.8). The rectangular layout indicates the recent development and the irregular pattern Indicates earlier growth of town. When it is difficult or too costly to improve the existing irregular street system, a combination is formed. The outstanding example of this type of street system is Edinburgh (U.K.).

The above mentioned street systems of the existing towns and cities can suitably be applied and adjusted for the street pattern of a modern town. It will however be necessary to study and to analyze the present as well as the future traffic likely to use the streets of the modern town. The street pattern of moderns town should be designed in such a way that it effectively serves various parts of the town as desired and as conceived by the town planner (Islam, 2001).

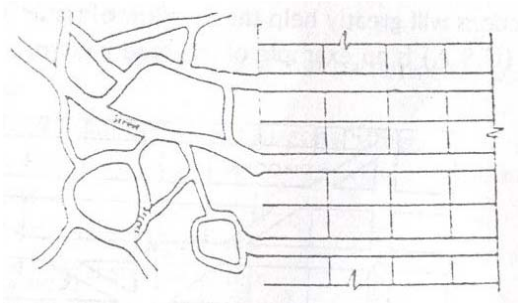


Figure 2.8: Combination of Rectangular and Irregular Street Systems

2.15 ROAD NETWORK CLASSIFICATION

The primary purpose and function of roads are to provide for the movement of traffic and to provide access to properties. While most roads provide some measure of each, the two functions are, in reality, competing rather then complementary. Roads with a high level of access to abutting properties do not function particularly well in terms of traffic movements. Roads that do function well in terms traffic movement, normally provide very limited access to abutting properties. In urban areas, both functions – traffic movement and property access – are important. One approach to meet this dual, but conflicting need is to have all roads serve both functions. However, experience has repeatedly shown that the result is normally a situation in which neither function – movement or access – works well. A generally accepted, better approach is one that establishes a hierarchy of roads wherein the primary purpose of one category of roads is the movement of traffic, the primary purpose of another category of roads is access to properties, and intermediate categories that have varying levels of emphasis of for the two functions - movement and access.

Therefore, roads are often classified according to the relative importance of the movement and access functions assigned. This permits the establishment and application of design and operational standards that reflect the particular function of a road in terms of the balance and trade off between movement and access. For example, roads designated primarily for movement of traffic are designed and operated in a manner that facilitates traffic movement and restricts access. Roads designated primarily for access to property are designed and operated in a manner that facilitates access to properties and not movement of traffic (Islam, 2001).

Figure 2.9 illustrates this general relationship between access and movement. The important concept here is the changing levels of emphasis between access function and movement function for different categories of roads, and not the particular names assigned to such categories (e.g. expressway, arterial, etc.)

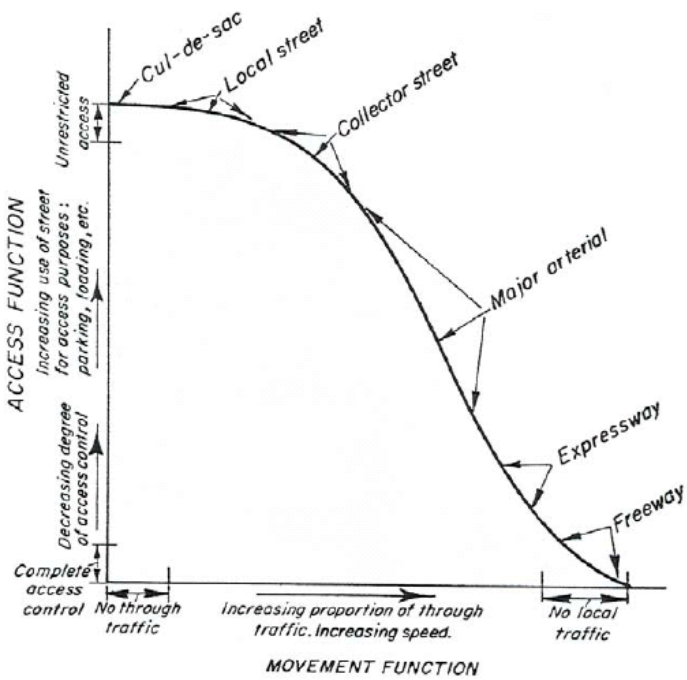


Figure 2.9: Relationship between Access Function and Movement Function (Kadiyali, 2007)

2.15.1 Benefits of Road Classifications

Roads should be designed to cater for a defined function. This typically reflects the distance of travel, level of traffic flow and desired speed of travel. Road networks in most countries will therefore reflect the development of a hierarchy of roads, with motorways at the highest level and local access roads at the lowest. In practice a basic hierarchy will occur naturally through the more heavily trafficked roads being engineered to higher standards. But it is important that the hierarchy is established to clear guidelines linking design to function, throughout the network. This is particularly necessary where different functional levels or different geographical areas are managed by different road authorities[11].

The major benefits of road classification are:

- To provide orderly grouping of streets and roads in a framework which governs the planning and implementation of construction and maintenance projects;
- To provide a sound basis for traffic route management, transport and landuse;
- To assist in the adoption of appropriate standards of construction of traffic routes and road traffic management;
- Capacities of designated routes can be reviewed and appropriate action taken to ensure function and operation accord.

Functional classification affects a number of other decisions which are made concerning the road, including:

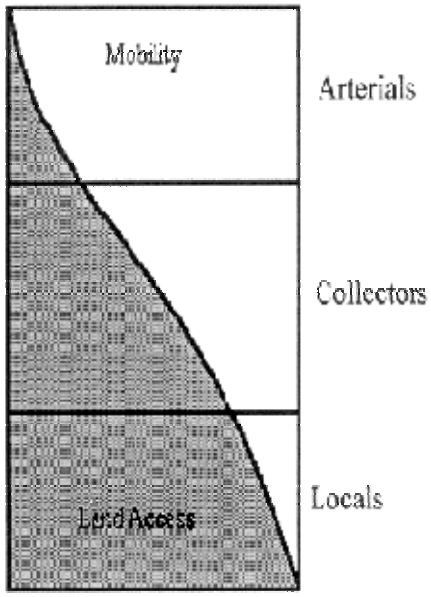
- The assignment of jurisdiction responsibility of the roadway
- The nature of access connections allowed to the roadway
- The amount of right-of-way needed for the road and related elements
- What types of uses are allowed in the right-of-way
- The types of traffic controls used at intersections
- Whether or not on-street parking is allowed
- The distance for building set-backs required when developing near the roadway right-of-way
- Design guidelines and standards which apply to any improvements

[11] Wikipedia, 2008

- The accrual of needs for state aid funding
- The eligibility of the road to use other available funding sources (Wikipedia, 2008)

2.15.2 Functional Classification

Functional Classification is the grouping of roads, streets, and highways in a hierarchy based on the type of highway service they provide. Streets and highways do not operate independently. They are part of an interconnected network, and each one performs a service in moving traffic throughout the system. Generally, streets and highways perform two types of service. They provide either traffic mobility or land access and can be ranked in terms of the proportion of service they perform as shown in this diagram[12].



At the top are Arterials. They include those classes of highways emphasizing a high level of mobility for the through movement of traffic. Land access is subordinate to this primary function. Generally, travel speeds and distances are greater on these facilities compared to the other classes. The highest classes of arterials, Interstates and freeways, are limited access to allow the free flow of traffic.

Between these extremes are the Collectors whose name describes their function. They collect traffic from the lower facilities and distribute it to the higher. Collectors provide both mobility and land access. Generally, trip lengths, speeds, and volumes are moderate.

At the bottom are Local streets and roads. Their primary function is to provide land access. Travel speeds, distances, and volumes are generally low, and through traffic is usually discouraged.

Figure 2.10: Mobility and Accessibility of Different Types of Road (Talvitie 1996)

2.15.3 Urban Functional Classification System

The urban functional classification system consists of all roads, streets, and highways located inside the urban/urbanized area boundary. There are four classes of highway in the urban system: urban principal arterials, urban minor arterials, collector streets, and local streets. Because of the greater concentration of population, more intense landuse, and higher traffic volumes in the urban area compared to rural, some characteristics of urban classes differ slightly from their rural counterparts, for example in the density and spacing of the urban network and in the volume and length of trips[13.]

Class	Characteristics
1. Urban Principal Arterial	a. Serve major activity centers, highest volume corridors, and longest trip demands; b. Carry high proportion of total urban travel on minimum of mileage;

[12] Talvitie A. (1996).
[13] Wikipedia

	c. Interconnect and provide continuity for major rural corridors to accommodate trips entering and leaving urban area and movements through the urban area; d. Serve demand for intra-area travel as between the central business district and outlying residential areas.

*The Urban Principal Arterial system is further divided into the following subclasses: (a) Urban Interstate consisting of principal arterials designated as part of the Interstate system; (b) Urban Other Freeways/Expressways consisting of non-Interstate principal arterials with controlled access; and (c) Urban Other Principal Arterials without controlled access (Islam, 2001).

2. Urban Minor Arterials	a. Interconnect with and augment the principal arterials; b. Serve trips of moderate length at a somewhat lower level of travel mobility than principal arterials; c. Distribute traffic to smaller geographic areas than those served by principal arterials; d. Provide more land access than principal arterials without penetrating identifiable neighborhoods; e. Provide urban connections for rural collectors.
3. Urban Collectors	a. Serve both land access and traffic circulation in residential, and commercial/industrial areas; b. Penetrate residential neighborhoods; c. Distribute and channel trips between local streets and arterials
4. Urban Locals	a. Provide direct access to adjacent land; b. Provide access to higher systems; c. Carry no through traffic movement.

2.15.4 Other Roads

2.15.4.1 Through and Bypass Roads

When a through road or a main road passes through the congested portion of the town, there is sharp reduction in the speeds of vehicles and the smooth flow of traffic on through roads is seriously obstructed. To maintain easy flow of traffic on through roads and to give convenience and comfort to the users of such roads, by-pass road are being constructed by circulating the peripheral area of the city area (Figure 2.11). These by-pass roads are also known as loop-roads and they enable the traffic on through roads to avoid the congested area of the town [14].

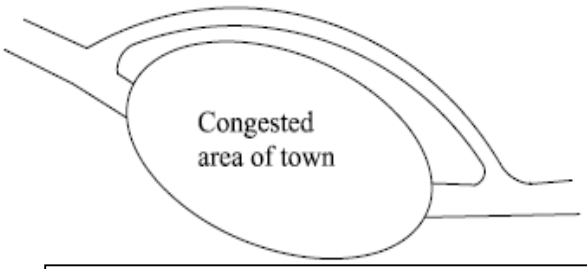


Figure 2.11: Example of Bypass Road

2.15.4.2 Outer or Inner Ring Roads

It is a type of by-pass road traffic approaching the town from all the directions. All classes of wheeled traffic will be admitted on the outer ring road and the pedestrians should be excluded. The outer ring road should be maintained clear of all existing development and it should be so designed as to compensate for a longer route by unbroken passage and high speed (Figure 2.12).

[14] Islam N. (2001)

The inner ring road is to divert from the town centre all local traffic and other traffic which have no business in the town centre. Such an arrangement will relive congestion of traffic in the town centre (Islam, 2001).

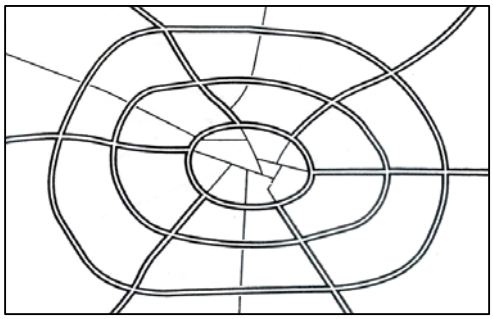


Figure 2.12: Typical Arrangement of Radial and Ring Road

2.15.4.3Expressway

A divided arterial highway for through traffic with full or partial control of access and, generally, with grade separated intersection. It is a high volume highway with high design speed providing no direct access to abutting landuses. The expressways do not form a part of the regular street system. But they are suitably joined and linked with the street pattern of the town (Islam, 2001).

2.15.4.4 Freeway

An expressway has full control of access. Freeways constitute a very small percentage of the total road system but carry high volumes of traffic. They are generally part of or connected to the interstate highway system; the freeway is the latest means to satisfying the demand or special routes which provide on express route for both the type of traffic, passenger as well as commercial (Islam, 2001).

2.16 REVIEW OF THE RECENT STUDIES ON ROAD CLASSIFICATION IN DHAKA CITY

Several studies have been undertaken for classification of road under DCC network. Recommendations for classification of roads as proposed in those studies are entailed below (DUTP 2001):

Dhaka Metropolitan Development Plan (DMDP)

- Main Roads
- Arterial Roads
- Connector Roads
- Access Roads

Dhaka Integrated Traffic Study (DITS)

- Primary Roads
- Secondary Roads
- Connector and Local Roads

Dhaka Urban Transport Study Project (DUTP)

- Primary Roads
- Secondary Roads
- Connector Roads
- Local Roads
- Non-Motorized Traffic (NMT) Roads

It has been observed that the aforesaid studies recommended for developing a road classification system for DCC road network on the basis of functional hierarchy with particular emphasis given on:

- To provide passage to vehicles (local and Inter-district)
- To provide passage to pedestrians and NMT
- To make provision for access to adjacent landuses

Road classification proposed in the report of DUTP, Phase 11 seems quite
realistic and responsive to the geometric features of the different categories of existing roads under DCC road network.[15]

2.16.1 Methodology and Approach for Proposed Road Classification

Dhaka is considered as one of the densely populated mega city of the world. Since the road network system of the city is not planned or built to cater to the needs of present days and future requirements, it becomes now difficult to upgrade roads with proper realigning or widening. Because, major portion of the roads now pass through densely populated area and numerous permanent residential and commercial multi storied buildings are constructed on both sides of the roads (DUTP, 2001).

Standard cross- sections of different categories of road have been developed on the basis of the following road classification. (slightly modifying the proposal of road classification appended in the final report of DUTP, Phase 11).

- Primary Roads
- Secondary Roads
- Connector Roads
- Local Roads
- Narrow Roads

The conflicting issues related to the geometric features of roads of old town and new town of the city were taken into account in developing a unified road classification system that have been focused on:

- Width of pavement, medians and footpath are not consistent in all primary roads and secondary roads irrespective of old town or new town of the city
- Pavement width of connector roads in old town of the city is not consistent and uniform with geometric criteria, whereas hardly there is such inconsistency with major portion of roads in new town of the city.
- Hard shoulder (brick paved) without footpath is provided in the connector roads of old town where as footpath without hard shoulder has been provided in major portion of roads in new town.
- Medians are not provided in the connector roads of old town where as it has been provided in major portion of roads of new town.
- Footpath is not provided to the local roads in old town where as it has been provided for some of the roads in new town.

Cross-sections of different categories of roads as per classification set forth are appended with this report. Road inventory survey has been undertaken to prepare a database of the network in accordance to classification criteria (DUTP, 2001).

[15] DUTP (2001)

- In future, all new roads will be designed as per the classification system
- The existing roads will be gradually upgraded as far as practicable in accordance with the road classification system.
- All major roads of DCC that are categorized as primary and secondary roads as per classification system would be administered by Traffic Engineering Division of DCC
- All minor road within zone categorized as Connector Roads, Local Roads
- Non-Motorized Traffic (NMT) Roads will be administered by Zonal Engineering unit

2.17 TRANSPORTATION SYSTEM MANAGEMENT

As the traffic on the existing road system in cities grows, congestion becomes a serious problem. Medium and long-term solution like widening roads, providing elevated fly-overs, constructing bypasses, and urban expressways are costly. Simple and inexpensive solutions can tide over the crisis for same time. Transportation System Management (TSM) is a package of short term measures to make the most productive and cost-effective use of existing transportation facilities, services and modes. TSM also embraces Travel Demand Management (TDM) and Traffic Supply Management (TSM)[16].

2.17.1 Travel Demand Management

TDM techniques are aimed at reducing the traffic flows, especially during the peak hour. Some of the techniques commonly adopted are:

1. Car pooling and other ride-sharing programmes
2. Peripheral parking schemes
3. Chartered buses (Institutional buses) to serve areas of trip origins to common work place
4. Staggering of office hours and flexible time of work
5. Internal shuttle service in the CBD
6. Parking restraint
7. Road pricing
8. Entry fee
9. Priority for buses in traffic.
10. Restrictions on entry of trucks during day-time.

2.17.2 Traffic Supply Management

The fundamental approach in traffic management measures is to retain as much as possible existing pattern of streets but to alter the pattern of traffic movement on these, so that the most efficient use is made of the system. Some of the well-known traffic management measures are:

- One-way streets
- Tidal-flow operations
- Restrictions on turning movements
- Reduction of Signal Phases
- Installation coordinated signals
- Restrictions on loading and waiting
- Exclusive Bus-lanes
- Closing side-streets (Kadiyali, 2007)

2.17.2.1One-way Streets

[16] Kadiyali,2007

Purpose
As the name itself imples, one-way streets are those where traffic movement is permitted in only one direction. As a traffic management measure intended to improve traffic flow, increase the capacity and reduce the delays, one-way streets are known to yield beneficial results. They afford the most immediate and the least expensive method of alleviating the traffic conditions in a busy area (Kadiyali, 2007).

Advantages of one-way streets
- A reduction in the points of conflict
- Increased capacity
- Increased speed
- Facilitating the operation of a progressive signal system
- Improvement in parking facilities
- Elimination of dazzle and head-on collision as well as reduce of accident severity.

Implementation Requirements:
- Must have suitable alternative roads (preferably grid-iron type or road network)
- Need to access the impact on
  - Transit operations
  - Freight movement
  - Road side business and major traffic generators

2.17.2.2 Tidal flow operation

One of the familiar characteristics of traffic flow on any street leading to the city centre is the imbalance in directional distribution of traffic during the peak hours. For instance, the morning peak results in a heavy preponderance of flow towards the city centre, whereas the evening peak brings in heavier flow away from the city centre. In either case, the street space provided for the opposing traffic will be found to be in excess. This phenomenon is commonly termed as "tidal flow"(Kadiyali, 2007).

Methods
The principle of tidal flow operation can be translated into practice in two ways:

(i) The first is to apportion a greater number of lanes in a multilane street to the in-bound traffic during the morning peak and similarly a great number of lanes to the out-bound traffic during the evening peak.

(ii) The second requires the existence of two separate streets parallel to each other and close to each other, so that the wider of the two can be set apart for the heavier traffic both during the morning peak and the evening peak. In this case, the two streets will operate as one-way streets.

Introduction Requirements
When considering the introduction of a proposed tidal-flow scheme it is important that the following conditions are met.
- Occurrences of flow imbalance should be periodic, distinct and predictable
- The difference between the flows in the two directions is substantial or at least sufficient to justify an extra lane in the direction of major flow
- For maximum efficiency of operation the number of traffic lanes allocated to each direction of travel should correspond as closely as possible to the ratio of the flows at the peak periods
- Route should be undivided

- There must be adequate capacity at the end points of the reversible lane system to ensure easy transition of vehicles between the normal and reversible lane conditions (Kadiyali, 2007).

2.17.2.3 Restrictions of Turning Movements

The problem posed by turning traffic

At a junction, the turning traffic includes left-turners and right-turners. Left-turning traffic does not usually obstruct traffic flows through the junctions, but right-turning traffic can cause serious loss of capacity. At times, right-turning traffic can lock the flow and bring the entire flow to a halt. One way of dealing with heavy right-turning traffic is to incorporate a separate right-turning phase in the signal scheme, or to introduce an early cut-off or late start arrangement. These schemes have their limitations and result in a long signal cycle. Another solution is to ban the turning movement altogether (Kadiyali, 2007).

Prohibited Right-Turning Movement: Prohibition of right-turning movement can be established only if the existing street system is capable of accommodating an alternative routing.

Prohibited Left Turning Movements: Left-turning movement is not obstructive to traffic and it is rare they are prohibited. However, such prohibition may be needed to provide a safe crossing for pedestrian traffic especially when the pedestrian traffic across the minor road is heavy.

Pre-requisite conditions for Prohibiting Turns

- Availability to suitable alternative diversion routes
- Need to examine to possible impact of traffic diversion
    - If the regulation, simply shift the problem to another junction
    - Extra travel must be investigated
    - Difficulties with the right turning mass transit
- The scheme should be coupled with continuous monitoring and enforcement (Kadiyali, 2007)

2.17.2.4Closing Side-streets/Access Control

A main street may have a number of side-streets where the traffic may be very light. In such situations, it may be possible to close some of these side-streets without affecting adversely the traffic, and yet reap a number of benefits.

Advantages

The following are some of the advantages of closing side-streets:

- Since interference from the traffic from side streets is eliminated, the speed increases and journey time reduces.
- For the same season as above, the accidents get reduced.
- If the side streets are too many and at close intervals, it is difficult to formulate a scheme for the progressive system of signals. A spacing of 275 m between signalized intersections is desirable and this necessitates the closure of all intermediate side streets.
- The side-streets which are closed can be utilized for parking of vehicles, if there is an acute shortage of parking space in the area.
- The side-streets, closed for traffic from the main streets, can he easily converted to a pedestrian precinct, thereby enhancing the safety, comfort and convenience of pedestrians (Kadiyali, 2007).

Prerequisites

- Before implementing this management scheme the relative advantages and disadvantages associated with closing side roads conditions are need to be studied
- It must be noted that displaced through traffic will reappear elsewhere on the network and care must be taken to ensure that the result of street closure is not simply to move the problems to other locations (Kadiyali, 2007).

2.17.2.5Exclusive Bus Lanes

A recent innovation in traffic management practice in some of the cities is to reserve a lane of the carriageway exclusively for but traffic. This is possibly only in situations where the carriageway is of adequate width and a lane can be easily spared for the buses. This implies that there should be at least 3 lanes in each direction. For reasons of convenience of alighting and embarking passengers at the curb, the exclusive lane has to be adjacent to the curb.

Exclusive bus lanes running against heavy one-way flow (Contra-flow lanes) are also very common. One experience suggests that such an arrangement nearly halves the journey time. A good measure of enforcement is needed if serious accidents have to be avoided in this system. To be successful, the bus-lanes should be created for a good length of the road instead of in small bits. An effective enforcement policy is a. prime requisite for safety. Satisfactory signing and marking of the lanes and adequate publicity are also needed. Recessed bus bays must be provided wherever reserved bus lanes are to be introduced (Kardiyali, 2007).

2.17.2.6Traffic Restraint Measures

Traffic restrain measures are becoming increasingly popular in many cities. The basic idea is to impose certain measures calculated to restrain the use of roads by traffic. The main Techniques that are available for this purpose are:

(i) Restrictions on parking

Parking facility is the basic requirement of motor vehicles. Any restriction on the place, duration and cost of parking has an immediate effect on traffic. Parking control is one of the most powerful of the direct and indirect techniques of restraining traffic from coming into the central business district. By a careful formulation of a parking policy, private car journeys to the major centres of activity in the peck period can be easily shifted to the public transport (Kadiyali, 2007).

Pre-requisites of Implementation Parking Policy
As parking policy influences directly and indirectly the travel pattern of the people and business dose not welcome the scheme, there is a need for

- Education
  - Public consultation
  - Intensive public motivation
  - Advertisement

- Engineering
  - Improving mass transit facilities
  - Improving walking facilities
  - Providing enough and safe bicycle parking spaces
  - Facilities interchanges between different mode of transport

- Enforcement – for effective enforcement of parking policies it
  - Should be coupled with proper legislative measures
  - Should be monitored continuous and enforced property by patrolling traffic wardens

- Should be self support

(ii) Fiscal measures such as road pricing and entry charges:

Road pricing is a method whereby vehicles pay for the use of the road space and this is achieved usually by some electronic device or otherwise. It has very great potentialities if developed and implemented after sound planning. A system of entry charges, such as licensing, tolls and admission charges is another fiscal measure that is possible (Kadiyali, 2007).

2.17.2.7 Promotion of Public Transport

The Context of Public Transport system [17] : To optimize the existing transportation infrastructure mobility needs must be met efficiently through a greater modal share of public transport. However, unless the quality of public transport services improves substantially, the increasing preference for personal vehicles will continue. Hence, it is extremely important that public transport services be restructured to match consumers' expectations through policy, planning, and regulatory functions (Hoque 2005).

Generalized Transport Modes and Public Transport: Transportation in an urban area consists of public transportation and private transportation. Trams, suburban railways, buses and paratransit or intermediate public transport modes such as taxis, rickshaws constitute the more common modes of public transport. The private transport consists of cars, motorcycles, bicycles, besides walking. These options include the following (Hoque 2005).

Walking on sidewalks or in the street: Walking is rarely used for regular journeys longer than about 5kms
Non-motorized transport (NMT): this appears as bicycles operating in the street, both personal cycling and rickshaw 'taxi-like' services.
Para transit: small vehicles, often one-man owned and operated. These either operate as small buses carrying 3-20 passengers as well as motor-cycle taxis. Para transit services typically develop in absence of formal bus operations or in response to bus service interruptions- often beginning with converted pickups and trucks.
Minibuses and Buses: typically carrying 20-35, and 60--100 passengers respectively
Suburban Rail: These services are physically part of a larger rail network, usually at-grade and fully-segregated by means of controlled level-crossings

MRT (Mass Rapid Transit): these are three generic forms of mass rapid transit

Busways: These are part of the road way, segregated between junctions for the exclusive use of buses, which have priority over the other traffic

Light Rail Transit (LRT): We have defined these to be at grade systems, usually built in the centre of a road

Metros: These are defined to be fully segregated rail systems that are usually built elevated or underground (Hoque, 2005).

2.17.2.8 Pedestrianisation

Complete banning of the motor vehicle from certain areas and declaring the same as pedestrian precincts has a salutary effect on the traffic situation. It increases the safety of the pedestrians. It gives them the freedom to move about and shop leisurely,. It frees the area from noise, fumes and smell. Contrary to the belief that it may affect adversely the shopping turn-over, it has led. to an increase in business. By and large, the motorists, the pedestrians and the commercial interests

[17] Hoque M. M.2005,

are all agreed about the beneficial results of pedestrianisation in selected locations (Kadiyali, 2007).

2.17.2.9 Staggering of Office Hours

Staggering of office hours is a simple and effective way to spread the duration of the peak hour and lessen the pressure on the road space. School hours can be very conveniently planned to be sufficiently away from the office hours. Even the office and industrial working hours can be staggered without detriment to the general efficiency of the activities concerned. While some modest staggering of hours is feasible and is in fact desirable, one cannot altogether avoid traffic concentrations in the peak hour, which must be accepted as a fact of life (Kadiyali, 2007)..

2.18 REVIEW OF RELEVANT STUDIES ON LANDUSE AND TRANSPORTATION SYSTEM

Different types of studies have been conduced in various level on landuse, transport panning, transport system etc. or different elements which directly or indirectly influence transport system of urban areas particularly Dhaka Metropolitan city by different educational institution, research institution, government and non-government organizations in individual as well as group basis. According to the thesis structure those literatures have been segregated in the following four groups:

- Landuse Planning.
- Transport Planning and Road Network in Urban Areas
- Traffic Management and Operations.
- Institutional or organizational functionality, setup, constraints and requirements etc.

The summary and research findings of the reviewed studies related to the different groups are provided below:

2.18.1 Landuse Planning

2.18.1.1 Development Plans for Dhaka

The Dhaka Master Plan, 1959:
This Master Plan was basically a development control document. The Town Improvement Act, 1953 provided regulatory powers to the DIT over a designated area. In practice, development control, based on the control of buildings on individual plots, can only be effective in specific development areas, which are planned and leased by the DIT. Development in the other parts of the city remains largely uncontrolled, and the lack of updating the plan leaves statutory service agencies in the city without a basis for coordinated action[18].

Dhaka Metropolitan Area Integrated Urban Development Plan (DMAIUP), 1981:
DMAIUP is the only comprehensive approach to planning and development in the Dhaka region since the 1958 Master plan. Many of the opportunities, constraints and issues it considered which are equally relevant now. It provides a comprehensive and widely used database and argues a coherent case for a particular landuse strategy. Many of its arguments are still valid. Some of its primary objectives are relevant till today, like-to prepare a long term strategy to guide and regulate the future growth of Dhaka metropolitan area and to develop local staff skill and effective institutions for implementation. Here, development has also been -predicted for DND area, Kamrangir Char etc. It evolved from the concern for storm water drainage and flood protection (Mitra, 2003).

[18] Mitra 2003

Dhaka Metropolitan Development Plan (DMDP), 1995

The Dhaka Metropolitan Development Plan was approved in 1995. The project's planning component is presented as a package of plan outputs which collectively address Dhaka's urban planning issues at three geographic levels; sub-regional, urban and sub-urban. The Dhaka Metropolitan Development Plan is therefore comprised of the three following components.

- Structure Pian
- Urban Area Plan
- Detailed Area Plans

Each component has a specialized function designed to address particular planning requirements. The contents of the components require to be combined to form the integrated Metropolitan Development Plan. Unfortunately, this plan is not yet completed (DMDP, 1995).

2.18.1.2Review of Urban Planning Related Legislations

Without any legal basis, enforcement of planning activities is not possible. There are a number of urban planning related legislations in Bangladesh which help to regulate and control urban development. The laws are usually of two types[19]:

- The statute, i.e. Act or Ordinance; and
- The Rules, By-laws and the Regulations that are framed by the Ministry under the provisions of different Acts and for Ordinances.

The available major legal frameworks for urban planning in Bangladesh are-

- The East Bengal Building Construction Act, 1952
- The Town Improvement Act, 1953
- The Chittagong Development Authority Ordinance 1959
- The Khulna Development Authority Ordinance 1961
- The Rajshahi Development Authority Ordinance 1976 and
- The Paurashava Ordinance, 1977
- The Natural Water body, Open space, Park, Play Ground protection Law, 2000 . The Private Land Development Housing Project Rules (PLDHPR), 2004

The available major legal frameworks related to Dhaka city are as follows

The East Bengal Building Construction Act, 1952

Just after independence of Pakistan in 1947, the big cities were growing rapidly in an unplanned manner. At that time there was no other building control regulation existed except the Bengal Municipal Act 1932. Recognizing the situation, Government promulgated the East Bengal Building Construction Ordinance 1951, which was later re-enacted as the East Bengal Building Construction Act, 1952.

The basic *shortcomings of this Act* are:

- The municipal authority was not given any power to prepare and implement master plan
- The authority had development control power, but did not have any authority to prepare and implement development scheme.

The Town Improvement Act, 1953

The Town Improvement Act, 1953 is the first statute that recognized the need for planning in the country, although planning was not mentioned in the preamble. The Town Improvement Act, 1953 provided the Trust with power of review and veto the building plans which had already been approved by the municipality; and over all planning of the city was not the aim of this Act

[19] Fatema R., 2003

initially. The main drawback of this Act was that it was just a copy of the Calcutta Improvement Trust Act of 1911, and could not consider many local important issues (Mitra, 2006).

The Town Improvement (Amendment) Ordinance, 1958

This amendment to the Act established the DIT as a planning, controlling and developing authority; Although, the Town Improvement (Amendment) Ordinance, 1958 is the first legal document which empowered the town development authority to prepare master plan but the highest power was vested to the Chairman of the organization who was appointed from non-planning cadre. As a result, the town planner can not exercise their professional practice and in many cases the proper development and planning activities were hampered (Mitra, 2006).

The Municipal Administration Ordinance, 1960

The Municipal Administration Ordinance, basically repealing the previous Bengal Municipal Act of 1932 was enacted in 1960 and was valid until the promulgation of Paurashava Ordinance, 1977.

The Paurashava Ordinance, 1977

The Paurashava ordinance, 1977 enabled the Paurashava authority to exercise similar power and functions which were given by the Municipal Administration Ordinance, 1960. Recently in 2006, the Paurashavas have been equipped with the Town Planners. Though the Paurashava ordinance empowered the Paurashava authority to prepare and implement the master plan, but the authority can not do the job, due to the lack of technical manpower and other logistic support (Mitra, 2003).

The Natural Water body, Open space, Park, Play Ground Protection Law, 2000

- The identified river, khal, bil, lake, natural water body, flood flow and sub- flood flow zones low lying in the master plan must be protected.
- These areas must be published under gazette notification.
- The character of the areas cannot be changed to project environment.

This landmark legal tool can protect environmentally sensitive areas of Dhaka but its application become difficult because the natural water bodies, the low lying and the retention area, *Khal* etc. within the DMDP are not earmarked on *mouza* map.

The Private Land Development Housing Project Rules (PLDHPR), 2004

- The PLDCs must submit project documents, layout plan indicating road, and infrastructure and service network.
- In the layout plan, certain lad should be preserved (as indicated in the PLDHPR) for schools, colleges, playgrounds, open space, lakes and other uses etc.
- The project documents should be checked by the authority and make field verification report according to PLDHPR.
- During the implementation the authority will supervise and monitor the projects as per of approval. Simultaneously, the company obtain completion certificate within the specific period.

The enforcement, management parts is not properly indicated, in PLDHPR and therefore whole process of the implementation delayed and cumbersome. There is no panel section in this rule, which can apply to protect the growing unauthorized housing estate. PLDHPR is supported by the clearance of other agencies. Those agencies are supported by acts and laws (Mitra, 2006).

2.18.1.3Review of the Policies:

- There is existence of number of legal provisions for urban planning and building control in Bangladesh. For proper planning and building control such provisions are inadequate

and weak to implement and guide the planning activities, particularly in the field level (ADB Report, 2005) due to poor supervision.

- Due to rapid urbanization, the big cities are overwhelmed by the presence of slums and squatter. But, there is no slums and squatters settlements improvement or upgrading clause in these planning laws. To tackle the existing situation there is need for formulation of appropriate legislation or amend the existing one.
- Sometimes similar powers have been provided to the different agencies in same urban area, which create problems to implement the planning and development program[20].

2.18.1.4Review of Landuse Related Studies

Several study focusing land ownership and landuse have been undertaken by some researchers in the country. Some of them are discussed below-

Alam, F., Kaiser, R., Amin, N., M., (2003-2004), in the study on an analysis of growth trend and development process of uttara model town described the introduction of satellite town Uttra to reduce housing need transportation problem, environmental pollution and such other problems in Dhaka city. This thesis was conducted to perform a qualitative and quantitative study to understand the development trend and characteristics of Uttara Model Town. In addition to that existing scenario of Uttara is compared with the proposed plan. An assessment of existing infrastructure and community facilities had also been done[21].

Bhuyan, M H, conduct a study on Transport Deficiencies at Kalabagan Area of Dhaka City in 2006. In this study, by the qualitative and quantitative analysis it was observed that there were total 20765 m^2 roadway in the area of Kalabagan which 39% local road, 32% secondary road and 28% primary road local road has a width of 8 ft of which 30% of the local road has a width 5ft that does not allow emergency vehicle as Ambulance. The authors state that unplanned, haphazard, and donation basis transportation system was developed by individuals initiative and so the existing transport system is a cause of unsafe, unreliable, inconvenient and uneconomical to the people of the area. Finally he recommended for the future landuse developments is given to clear out that transportation network planning is the first and tremendous need for an urban area[22].

Uday Sankar Das (May, 2001) studied on "Factors Influencing the Location and Distribution of Unauthorised Kutcha Bazars in Dhaka City" to find out the locational and distributional patterns of kutcha bazars in the city as well as the factors, which lead to the growth of unauthorized kutcha bazars in Dhaka City. He found in his studies that the distribution pattern of authorized kutcha bazar is not uniform, rather it is concentrated in a clustered pattern. In other cases, the locational pattern of unauthorized kutcha bazar in Dhaka City is random. He recommended that the unauthorized kutcha bazar should be shifted to proper location in order to balance the supply and demand of daily needs of city dwellers. Therefore, rehabilitation of unauthorized kutcha bazar should be the prime need rather than eviction[23].

Hashem M. (2001), in his study on trends of development in Dhanmondi residential area of Dhaka city make an investigation into the trend of pattern of development with respect to landuse, building height, intensity of land utilisation, land-sub division and also the causes of the changes. From that study he found that the non-residential uses were about 50% of the total; more than one fifth (21%) of the original one or two storey building in Dhanmondi had been rebuilt to six storey apartment structures; the intensity of land utilisation, in terms of building coverage increased from 28.3% in 1962 to 50% in the year 2000. He stated that these changes are mainly occurring due to outward expansion of Dhaka City and internal reorganization of city spatial structure. The non-

[20] Fatema R., 2003
[21] Alam, F., Kaiser, R., Amin, N., M., (2003-2004)
[22] Bhuyan, M H (2006)
[23] Das U. S. (2001)

residential uses have taken place uncontrolled, unregulated and haphazard manner to the detriment of the residential environment[24].

Akhtaruzzaman A. (2000) conducted a study of the integration of floating population in the urban system of Dhaka city to find out the reasons for their migration, their socio-economic and job pattern and to explore their integration process with the urban system of Dhaka city. He suggested that skill development training will help them get better jobs which ultimately will foster their integration process to the urban system which will help policy makers to target the resources properly and put forward some recommendations for more orderly and suitable integration of floating people in the urban system of Dhaka city[25].

Tariquzzaman S.M. (2000) in his study named process of squatter settlement of the embankment in Dhaka city investigated factors that influence the formation of the settlement on the embankment, the physical positive factors like free and available land, flood free condition of the area and socio-economic positive factors like cheap rent, more job opportunity, good communication etc. He identified the possible options to cope with the problem and recommended that in the short term the settlers should not be resettled in a distant place rather they should be replaced to the marginal khash land beside the embankment on stilt houses. In the long run he proposed that they should be resettled in another site beside an industrial belt like Savar[26].

Zahir S. (2000) performed a study on Potentials of Sites of Historical Monuments To Create Images Of A City Through Planning Integration to investigate into the possibility of using old monuments and sites of our cultural heritage to work as landmarks in the cityscape, create an image by the special character of each individual monument, impart a sense of identity of a locality and provide for the profound psychological need of permanence and continuity in our society. Finally the study concluded that architects and physical planners must respect for people's spiritual values, provide for their psychological and emotional needs, like the sense of joy and wonder and the feeling of permanence and continuity and establish a sense of continuity and identity in our built-up surroundings[27].

Rouf M. A. (1997) in his study "An Econometric Analysis of the Trends and Patterns of Urbanization In Bangladesh" have attempted to find out the answers of these questions through quantitative analyses and industrialization appeared as a factor that has the highest contribution towards urbanization. Share of urban land (i.e. are expansion) came in the second place in terms of contribution which was followed by initial level of urbanization and the much talked rural-urban migration[28].

Kalyan Hironi (1952), in his study named "Landuse Planning and Geomorphology", has identified and delineated land systems which form land units with the basis of landuse planning. This is a comprehensive in-depth study to improve the capacity and quality of land according to the basis of existing land forms in the area[29].

"Landuse Planning in Bangladesh" by A. K. M. K. Choudhury in 1985 is an in-depth study to identify the existing landuse pattern and find out the changing pattern of landuse and land ownership. It is revealed from the study that landuse pattern has been exchanged significantly in the rural areas in the last few decades. In the maximum cases, proper emphasis is not given to

[24] Hashem M. (2001)
[25] Akhtaruzzaman A. (2000)
[26] Tariquzzaman S. M. (2000)
[27] Zahir S. (2000).
[28] Rouf M. A. (1997)
[29] Hironi, Kalyan (1952)

landuse planning at both the micro and macro levels resulting in initialization and uneconomical use of land[30].

A. Alim, 1979, in his study "Land Reform in Bangladesh" has attempted to understand the land reform situation of Bangladesh. From the study it is seen that on most cases, the land reform legislation's been made operative, but in actual practice, there has not been any significant progress in the distribution of land to landless and tenants[31].

The study "Rural Settlement: Planning and Development" by Nard Lal in 1989 was carried out to identify the existing settlement development in India. It is seen from the study that the rapid population growth has increased the large scale use of cultivable land for homestead purposes. The rural settlement has hot been developed properly and economically resulting in initialization an uneconomical use of land[32].

A project taken by Dhaka Water and Sewerage Authority (DWASA), 2000 "Rehabilitation of Dholai Khal" described in its report that before 1947, storm water of Dhaka city drained out through different natural canals. But there after, the city developed spontaneously without any master plan causing depletion of natural drains. Henceforth water logging became a problem for the city. In 1964, Dholi khal was filled in for carrying out development works without taking any necessary steps to drain out the water of surrounding area and thus water logging turned out as a great problem[33].

A study named "Flood Management and Vulnerability of Dhaka City" done by Huq and Alam, 2003 described that after implementation of the flood control project in the Dhaka West, unplanned and uncontrolled expansion of urban area stretched rapidly towards the low-lying areas adjacent to the flood protection embankment. Land development through land filling processes in the low-lying areas is causing a drastic reduction in water storage areas. Construction of embankments through low-lying areas without providing adequate drainage facilities has caused internal flooding adversely affecting the residents in those areas[34].

Bari and Hasan, 2001 in their study "Effect of Urbanization on Storm Runoff Characteristics of Dhaka City" investigated the impact of landuse changes due to urbanization on storm runoff characteristics in the eastern part of Dhaka City. They found that the volume of peak rate runoff increases with growth in urbanization. Most of the low lying lands, which once acted as retarding basin, have been filled up. Computed results show that runoff volume is increasing with increase in built-up area in Dhaka city.

Chowdhury, J. U. et al. (July 1998) in their study, "Measurement and Analysis of Rainfall Runoff in Selected Catchments of Dhaka City" shown from the analysis of rainfall data that the spatial variability is quite large. Analysis of storm rainfall and runoff data indicates that the initial loss is much higher than those expected in cities in developing countries. There are domestic wastewater discharges in the storm sewers and the relative magnitude was highest in the unplanned high-density residential area. Deposition of solid materials and rubbish is larger in the surface drains than that in the underground sewers.

In the study "Dhaka City Storm Water Quality Assessment", Khan S.A. and Chowdhury, J.U. (1998), described that the ddeterioration of storm water quality in Dhaka has become a matter of concern in the recent years. Identified as one of the most densely populated cities in the world,

[30] Choudhury, A. K. M. Kamaluddin (1985)
[31] Alim (1979)
[32] Lal, Nand (1989),
[33] DWASA (2000)
[34] Alam, M., Huq. S. (2003)

Dhaka is unable to provide urban quality of living to its over 6 million inhabitants. Much of this inability has resulted from failure to maintain the required water environment of the city.

Tawhid K. G. (2004), in the study on "Causes and Effects of Water Logging in Dhaka City, Bangladesh" focused on the rainfall induced flooding that is caused by high intensity storm rainfall runoff in the city area that is inundated for several days mainly due to lack of proper drainage system and inefficient management. He highlighted that the unplanned spatial development activities and growth of habitation due to rapid population growth are causing encroachment on retention areas and natural drainage paths with little or no care of natural drainage system that creating obstacles to properly drained out the urban runoff. The authors argued, management of drainage system of Dhaka City is presently a challenge for the urban authorities because of rapid growth of population and unplanned development activities[35].

Chowdhury (1984) has identified several reasons for such unregulated landuses. First, most of the authorities and agencies have not prepared master plans or area plans, and therefore, cities grew in an unplanned way. Secondly, where plans have been prepared, these were not appropriately updated. For instance, Dhaka Master Plan was prepared in 1958. Despite several efforts, an updated or a second master plan is not yet available for use. Third, the responsible agencies find it difficult or useless to enforce many of the outdated regulations[36].

2.18.2 Transport Planning and Road Network

Strategic transport plan (STP) is the most recent and significant study on Dhaka Metropolitan transport planning. The study has been conducted by the Louis Berger Group, Inc, Bangladesh Consultants Ltd under Dhaka Transport Co-ordination Board (DTCB). By this study, develop a coherent long-term Strategic Transport Plan (2004-2024), following and updating the Dhaka Integrated Transport Study (DITS) and other transport related studies, to address projected transportation needs for future developments with special emphasis on integrating the planned landuse for the future growth of the city as presented in Dhaka Metropolitan Development Plan (1995-2015) with transport issues in Dhaka Metropolitan Area (DMA) over the next 20 year planning horizon in a phased program for the 20 year period. In this study also formulate an Urban Transport Policy document for governmental discussion and approval that would guide urban transport development, operations and management in DMA. The Strategic Transport Plan are finalized the scope and Terms of Reference for the priority multi-modal transportation improvement projects for the first five years. The final study reports comprise Strategic Transport Plan for Dhaka (Content of this report), Urban Transport Policy (Companion study report), Institutional Strengthening and Capacity Building (Companion study report)[37].

DITS Report (1992-1994). The one of the most important and significant study was the Greater Dhaka Metropolitan Area Integrated Transport Study (DITS) conducted with UNDP assistance between 1992 and 1994 under which all the activities of the DUTP Phase-1 and Phase-2 are undertaken. The study was undertaken by emerging awareness of planning commission about the improvement of transport services in greater Dhaka. DITS were conceived as a multidimensional and integrated study of transport services in greater Dhaka. It established a relatively sound database about the transportation infrastructure of greater Dhaka Metropolis. The study recommended realistic and affordable shot-term actions to improve the transport services in greater Dhaka. The study also developed a local capability to analyze and recommends long term policies and programs to respond to transport needs as urban areas grow and mature[38].

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[35] Tawhid K. G. (2004)
[36] Chowdhury, A.I (1984)
[37] STP (2004)
[38] DITS (1994)

Dhaka Bypass and/or Penetrator Road (1968). It is one of the earliest studies illustrated the engineering and economic feasibility study of the proposed Dhaka bypass road. Along with others, one of its recommendations was to control as well as phase out non-motorized vehicles, especially rickshaws, to reduce traffic congestion[39].

Shakland and Cox Partnership (1979). Till now this report may be considered as one of the most important document for the transport planners. It was a comprehensive study of transport development in metropolitan Dhaka, emphasized on the construction and management of road network. It also described physical characteristics such as capital cost, life of vehicles and capacity of different modes in the study area. Furthermore, it suggested the inclusion of special design considerations for rickshaws in road construction. In that study, the detail investigation was made on the slow moving vehicles. Also, attempts were made to find out the role of intermediate mode of transportation in Dhaka city. The role of rickshaws was analyzed in the context of city's demand and supply[40].

Hoque (1981) mainly dealt with different aspects of roadway safety. He identified several types of road accidents in Metropolitan Dhaka it was found that a total or 7767 vehicles were involved in 4514 accidents. In this investigation bus was placed in the third position (12.85%) according to its accident contribution, with cars and taxis being on the top (40.47%)[41].

Sarkar M. A. I, (January, 2003), in his study on the "Design, Construction and Use of Speed Breakers in Dhaka City" investigated the existing speed breakers within the road network of greater Dhaka to collect vehicular suspension and wheel base information of different vehicles and to conduct a brief users' perception study. He evaluated the existing problems associated with speed breakers and recommended guidelines to design and construct such devices considering local traffic conditions[42].

Yasmin F., Rahman A., Basu N., (2003-2004), in their study on "Mode Choice Behaviour of Public University Students -Case Study of University of Dhaka" developed a mode choice models of multi-nominal logit type and used LIMDEP, an application software for calibration of the model. In this regard, University of Dhaka, the largest of all the public universities in Dhaka city has been selected as the case study area. One of the most surprising and interesting findings was that there was no rationality between distance, in vehicle travel time and cost in Dhaka city[43].

2.18.3 Traffic Management and Operations

In Bangladesh, few studies have been undertaken on the traffic management and operations studies. However, the traffic operation studies in the urban area are richer than the traffic management. But these studies are not adequate to provide a comprehensive picture of the travel and transport inventory, traffic operation and safety problems, and physical characteristics of different modes. Very few are related to the role of mass transit in the life style of the urbanites from a view point of transportation planning. Some of the important studies finding are provided below:

Hossain M. A., (June 2005), in his study on "Deficiencies of Existing Mass Transit System in Metropolitan Dhaka and Remedy Measures to Improve the Situation" deals with the identification of deficiencies of existing mass transit system and remedy measures to improve the situation. In this study, in order to point out the deficiencies of existing mass transit system operation, data was is collected from published and unpublished papers relevant to transportation system, field works

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[39] Dhaka Bypass and/or Penetrator Road (1968)
40 Shakland and Cox Partnership (1979)
[41] Hoque M.M. (1981)
[42] Sarkar M. A. I, (2003)
[43] Yasmin F., Rahman A., Basu N., (2003-2004)

were done, and photographs were taken. The study suggested that to improve the situation of present mass transit system, must restrict the number of low occupancy vehicles (rickshaw, auto rickshaw, etc.) and increase the number of buses. Further studies for long range progress in urban passenger transportation, as in other fields are strongly recommended[44].

Debnath A. K. (June 2005) conduct a study on "Travel Pattern of Garments Industry Workers in Metropolitan Dhaka to identify the travel pattern of the workers as well as the behavior and problems related to them. He argued that the travel pattern of garments industries worker affects much the transportation system and decreases the safety level as its direction is in the perpendicular direction of the course of the arterials and mostly the garments industries (75 percent) are in the nearby areas along the course of the arterials. He also added that these are industries in name only; they do not comprise any characteristic of an industry building as most of them are at the multi-storied buildings near the arterials. Finally, he recommended for the garments industries are given to clear out these industries from the city and relocate in the outside districts of the country in a step by step manner[45].

Waresh, M.A. (2001) studied on "Effect of Pedestrian Underpasses on Traffic flow characteristics in Metropolitan Dhaka" with the aim to investigate the effectiveness of pedestrian underpasses at Karwan Bazar and at Gulistan Square in Metropolitan Dhaka. From his observation he seen that in general, expectedly pedestrians do not voluntarily use grade-separated facilities unless they are forced to do so either by median barrier or temporary barrier created by bumper-to-bumper jam condition. Moreover, relatively pedestrian's compliance of using footbridges is very poor especially where these facilities are constructed very near to the junction. In this study from the 'before and after' statistical analysis he shown that the underpass at Karwan Bazar site has improved all the measure of effectiveness (MOE) significantly but at Gulistan Square Underpass the underpass construction has failed to improve both traffic operation as well as pedestrian safety significantly[46].

Hoque S. A. M. A. (October, 1997) studied on "Modal Choice Behavior for Rickshaw in Dhaka City" to analyze the factors like travel cost, safety, time saving ability, accessibility of the mode, and comfort affecting the modal choice with Analytic Hierarchy Process (AHP) technique and also analyzed the behavioral pattern of the trip-makers and their attitudes towards choice of available modes. Among the five most important factors, cost was the strongest decisive factor in mode choice process. Safety came in the second most important factor. Time saving ability, accessibility, and comfort came next according to the importance of their weights. He also showed that personal variables like age, sex, income, family size and vehicle ownership were well correlated and of all these, income, family size, and vehicle ownership were well correlated and of all these, income had been the most prominent factor influencing the weights of AHP. By this study he proposed that the present existence of rickshaw along cannot make a transport system sustainable[47].

Das S. K. (October, 1998), in his study on "An Evaluation of Premium Bus Service in Dhaka City to identify characteristics of the passengers, determine acceptability of different service attributes, quality of service provided, and economic viability of operation, and to examine overall prospect of the service in Dhaka city. He found that the users were almost exclusively literate persons, most with private service, business, or commerce, as a profession, using predominantly auto-rickshaw as an alternative to the Premium Bus Service. On the basis of this findings he mentioned that the service levels against the PBs travel time and regularity of service involved much scope

[44] Hossain, M. A. (2005)
[45] Debnath A. K. (2005)
[46] Waresh, M.A. (2001)
[47] Shamsul Alam Mohammad Aminul Hoque (1997)

for improvement through some feasible improvement measures, like adopting bus priority options and proper rescheduling of the services[48].

Hossain, A.B. (1996) performed a study to determine the effects of non-motorized transport on the performance of road traffic in Metropolitan Dhaka. Analysis of lane divided major roads showed an average mobility of 15,000 person/hr without non-motorized transport (NMT) in the link traffic and about 9,000 person/hr with 45% NMTs in the link. Speed analysis showed an average speed of 21 mph without NMTs and 16 mph with 45% NMTs in the traffic of the links.

Hossain (1996) also developed some mobility and speed models using the data collected at different study sites. The mobility model showed that the mobility of a road section decrease with the increase of NMTs in the link traffic and increase with an increase in the effective road width. Accident analysis showed when facilities were considered, the share of NMTs especially rickshaws are much higher (26%) as compared to the motorized transport (bus 14%, tempo 14%, motor cycle 11%, truck 9% and auto rickshaw 9%)[49].

One of the effective attempts and a significant study of mass transit in Metropolitan Dhaka were undertaken by Ahsan in 1990. This research work investigated the overall passenger transport situation in Metropolitan Dhaka and examined the public transport system operations in Dhaka. The study revealed that public transportation in Metropolitan Dhaka serves about 15% to 20% of the passenger's trips. Further the study includes investigation of the system characteristics, usage and operation of mass transit system[50].

In 1996 DUTP prepared a report. The decision was taken to segregate NMT from MT on the main arteries and major intersections, out to arrange for level crossing for pedestrians and NMT away from the major intersections. These recommendations were supported by detailed designed proposals of NMT facilities. The report also identify some of the major factors that influencing the traffic situation in Dhaka city and provide some recommendation to improve the situation.

Gupta (1980) conducted a study regarding "Rickshaw Pullers, Rickshaw Owners and the Role of Rickshaws in Metropolitan Dhaka". It was found that the overwhelming majority of the pullers were rural migrants. They were illiterate, untrained and somewhat unskilled adult males. Gupta also pointed out a challenging issue that if the growth of rickshaws is allowed to continue at the present rate without any restrictions, an increase in number is likely. On the other hand if rickshaws are eliminated from the Metropolis, the situation will create serious pressure on other modes of transport which are grossly inadequate at present and will also have impact on the general living conditions of the public as the traveling costs in general is likely to elevate.

Ahsan, H.M. (1990) studied on Mass Transit in Metropolitan Dhaka. He observed that public transport plays a significant role in metropolitan's transport system. In developing countries, bus transit with combination of various vehicles sizes and services in playing an increasingly major role in urban passenger transportation. The study investigated the status of the public transport systems in metropolitan Dhaka. Particular attention has been given to examine the necessity of a functional and cost effective 'Mass Transit' system.

Rahman, M.M. (September 1999) studied on bus transport service in Dhaka city. He found that main cause of congestion is high volume of rickshaws, auto rickshaws, lack of rules and regulations. He also studied the relative cost benefit analysis and value of travel time of different modes of transport[51].

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[48] Das S.K. (1998)
[49] Hossain, A.B. (1996)
[50] Ahsan, H.M. (1990)
[51] Rahman, M.M. (1999), ".

Hoque, M.M. & Hossain, T. (2003), suggested to introduce Tramway in Dhaka. They emphasized on the agmentation of mass transit system is an necessity to ensure mobility need, road safety, and liable urban environment for Dhaka city in future. Rail based tramways, with description of its inherent cost and service characteristics have highlighted as a potential option for improvements of existing public transport system[52].

Karim, M.M. (1998) discussed about the Light Rail Transit (LRT) system as a mass transit option for Dhaka city. He said, "It is quite difficult to imagine that basic transport services can be provided for a metropolis with 10 million people without reliable mass transit system. To cope with the problems of increasing transportation demand, traffic congestion, deteriorating environmental quality, and inadequate traffic safety measures Light Rail Transit can be a probable solution."

Karim (1998) didn't specify the suitable location for the implementation of the LRT system. He also mentioned that although transport demand requires the development of rail mass transit system, financial restraints normally rejects the option and sometimes economic reason asks for better alternative solutions[53].

Bangladesh Transport Survey (1977). Particularly described the operational, financial and management aspects of most modes such as: water, rail, highway and air transport at national level. It aimed at providing a detailed program of transportation investment for first five-year plan.

Ahmed (1980). This report focused on the failure in traffic management and administration in Dhaka city. It concluded that existing transport modes are not adequate to meet the tyrave4l demand and mixed mode situation has resulted in traffic congestion and less safety. It also suggested for modifications of traffic management and policies.

Hoque (1981). It mainly dealt with different aspects of roadway safety. He identified several types of road accidents in metropolitan Dhaka. It was found that a total of 7767 vehicles were involved in 4514 accidents. In this investigation bus was placed in the third position (12.85%) according to its accident contribution, with cars and taxis being on the top (40.47%).

Ara (1983). He investigated the factors that are responsible for the selection of a Particular transport mode. In particular, it analyzed the travel behavior of a number of households from some particular localities in metropolitan Dhaka.

Chowdhury (1983). He studied about the improvement of traffic management in Old Dhaka and made out the plan for the recognition and positive management of rickshaw traffic. He emphasized on the positive roll of rickshaw in the city's informal economy and suggested control of rickshaws rather than eliminating the mode. He also stressed on the segregation of the slow and fast moving vehicles with particular reference to the Old city and central areas. The study concluded with some short-term Proposals form improving the existing traffic system.

Firdus (1984). In this paper a study was made on the problems of bus transport in Dhaka city entitled "A Study on the Problems of Bus Transport in Dhaka City". Here he paid a great importance to bus transport, as the economic status of the city dwellers is not in favor of private transport like cars. He studied some important but common transportation problems related to bus mode like long waiting period, delay, over loading and thus low level of services.

Amin S. M. A, Kabir M. H.(2004) a study has been conducted on "Evaluation of Bus Rapid

[52] Hoque, M.M. & Hossain T (2003),.
[53] Karim M. M.,

Transit as A Mass Transit Option for Dhaka City: Case Study of Route No.9 and 11". This study aims at introducing a mass rapid transit option of relatively low cost and fast implementation time, which would be able to cope with the physical and economic condition of Dhaka City. The study was undertaken to focus the comparison among various mass transit options and to identify a mass rapid transit option as well as to assess its physical and economic evaluation in the context of Dhaka City[54].

2.18.4 Institutional or Organizational Functionality, Setup, Constraints and Requirements

Very few studies has been found in different library and resource centre on the intuitional or organizational functionality, setup, constraints and requirements particularly related to the landuse and transportation system in Dhaka Metropolitan City. The key finding of some of the related studies are described below:

Banu M. (2000), in his study on "Solid Waste Management Through Community Based Organizations (Cbos) in Uttara, Kalabagan and Mohammadpur Areas Of Dhaka City evaluated the role of community based organizations (CBOs) for environmental improvement of the capital city of Dhaka. In that study he argued that there is an urgent need and scope to improve solid wast management system of Dhaka city and recommends both macro and micro level measures to improve it for eventual betterment of the environment. At last the concluded that improvement of solid waste management of the city can be achieved through joint involvement of the community and the DCC [55].

Hossain M. A. (1998), in his study on "Role of Community Participation in Developing Community Facilities at Kamrangir Char of Dhaka City" presented the existing condition of different community facilities on the basis of the people's level of satisfaction and revealed the effects, problems and limitations of community participation practice in the development process. The study suggested a community participation process through a community-based organization that will be helpful for involving people effectively in the development of community facilities in the absence of required governmental resources[56.]

Debnath K. K. (1998) made a Study on Slum Upgradation Through Community Based Organization In Dhaka City. At the inauguration of the thesis he expressed an overall common picture of the slum areas of Dhaka city. In that study it was concluded that the activity should be expanded for overcoming the present problems of the slum dwellers then only we could say the CBO based slum development could be achieved[57.]

Talukder S. H. and Newman P. studied on "Sustainable Governance and Development Management Setting for a Megacity and its Extended Metropolitan Region (EMR): The Case Study of Dhaka - Capital of Bangladeshy". This study examined one of the most complex and out of control Megacities- the city of Dhaka in Bangladesh in order to throw light on how such Megacities and its Extended Metropolitan Region (EMR) may be better governed. The identified the weaknesses include unclear strategies along with development policies and co-ordination, ineffective regulations and organizational structures. There are more than 42 bodies acting in an un-integrated way to manage Dhaka. Further, development planning as practiced in Bangladesh is done on a sector basis and hence it disregards the spatial dimensions of integrating the development and management of the city. The governance, development and management setting of EMR of Dhaka City are under a multiple organisational jurisdictions and responsibilities. Increasing concentration of national economic development and urban population in EMR of

[54] Amin S. M. A. & Kabir M. H.(2004),
[55] Banu M. (2000)
[56] Hossain (November, 1998)
[57] Debnath K. K. (1998)

Dhaka suggests that there may be a resurgence of interest in regional institutional structures[58].

2.19 OVERVIEW

The relevant literatures on landuse and transportation system from home and abroad that were studied are represented in this chapter. Efforts have been made to describe the different parameter of land and transportation planning, urban road network, traffic management and operations etc. From the above description, it is evaluated that there are enormous areas, field and branches related to the field and it is very difficult to conduct comprehensive study to identify the inherent weakness of the city comprising the every element or factor relating to the landuse and transportation planning of the city. It is also proved from the review of related studies where almost all of the previous research has been performed on the individual part of this problem like landuse scenario or road network problem or particular fringe area development or mass transit facility or particular route performance or transport operation and maintenance etc. But all this topics are interconnected with each other and one is directly affected by others.

Al most all of the study focused on a particular area or region like Dhanmondi, Kalabagan, or a particular user group like pedestrian, garments worker etc or particular operational, management issue like bust service, NMT, travel behavior etc. A comprehensive study is needed comprising all of the major issue like the aspects of landuse, transport planning, growth control and regulation, road network development, operational and management aspects as well as institutional issue to take a holistic approach.

[58] Talukder S. H., Newman P, (2003).

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CHAPTER 3

RESEARCH METHODOLOGY AND DATA COLLECTION

3.1 INTRODUCTION

Methodology outlines here the techniques for the collection of data and the procedures applied for the execution of the study. It expresses a systematic way through which any study can be done in a fruitful way. This chapter outlines the overall design of the study and research methodologies that have been followed to achieve the objectives setout in Chapter 1. It also describes data collection procedures at different stage of the research work. Data analysis procedures and techniques are also presented here. Finally, the difficulties or problems faced during the data collection process and the limitation of the study has been illustrated.

3.2 RESEARCH METHODOLOGY / EXPERIMENTAL DESIGN

3.2.1 Outline of the Research Methodology

Following processes/methods were applied for achieving the target which is setout as objective in the opening chapter.

- At the very outset of the research work, an extensive literature review has been carried out to know the conditions, types, nature, limitations, recommendations etc. of previous research, project reports conducted in home and abroad on landuse and transportation system, transport operation and maintenance, institutional setup etc. in Dhaka metropolitan city and to acquire knowledge for the basic understanding on that topics.

- Then objectives have been formulated related to the deficiencies of landuse-transport development from its planning, operation, maintenance and management and organizational context as well as the area itself which has been described in the Chapter one.

- Existing and historical landuse and transportation situations have been assessed by collecting geographical information and base map (digital, hard, satellite) from primary and secondary sources. In order to analyze the landuse and transport situation and to represent by visualizing the present and historical condition of the city, GIS base map has been collected, edited, manipulate and comprehensive GIS data base have been prepared.

- In order to evaluate the inherent weakness the Dhaka Metropolitan city particularly related to transportation system, four major sectors have been identified i.e. landuse, road network, maintenance and management, and institutional weakness. In this regard primary data have been collected by conducting comprehensive field survey like overall

observation of the city, landuse survey, road inventory survey, questionnaire survey, capturing photograph and discussion with the professionals and policy makers.

- Due to the nature of the study and extensive area concerned, a significant amount of landuse transport planning, institutional framework, management and maintenance practices relevant information and data have been collected from secondary sources like STPP, DCC, DUTP, SOB, RHD, DMP, BRTA, BRTC, JICA, WASA, previous research survey report and internet browsing. Besides this, in this study, a comprehensive database has been developed on landuse and transportation pattern, infrastructure, problems, requirements; transport operation, maintenance and management characteristics; local area development, needs, problems; institutional weakness, requirements etc. from the various published articles and media reports.

- Both primary and secondary data have been analyzed and manipulated with a view to achieve the objective which is set out in the introductory chapter.

- Sector and zone wise comprehensive data and system analysis has been carried out to evaluate and point out the deficiencies of landuse transportation system & potentialities of integrating landuse and transport planning as a capital city in micro and macro level.

- Finally, in line with research findings, the relevant guidelines, policies, regulations, have been proposed for realistic and affordable short and long term actions to improve the overall scenario in Dhaka Metropolitan city, which will fulfill the last objective of the study.

In birds eye view, it is seems that the study area and topics covered a wide range area and in-depth evaluation to fulfill the objectives in this topics is a complicated and difficult issue within the limited amount of manpower, resource, expertise and time in a M. Sc. Engineering research project. To overcome these difficulties, the study elaborated in breath but in depth it is shallow.

The methodology followed is outlined in the Figure 3.1 and described subsequently. A preliminary observation on geographic features and review on previous literature have been carried out before conducting detailed review and study to identify the relevant sectors and field. These also pointed out the required study area and from where data or information will have to be collected. The preliminary review also help to select the type and nature of data required for the study, to decide the source of data and to outlined the method of data collection and also to determine the appropriate person and time for data collection. Data or information has been verified by cross check with the other sources and secondary information and new data base has been prepared, manipulated and analyzed to identify deficiencies of Dhaka Metropolitan city in particular relation to the landuse-transport development of the city.

3.3 RELEVANT SECTORS AND FIELD SELECTION

To identify the deficiencies of landuse-transport development the following sectors or field have been selected:

- Profile of Dhaka Metropolitan city
- Landuse – macro and micro level
- Road network - quantity, quality, orientation/layout, functionality etc.
- Transport operation, management – facilities, conditions, limitations etc.
- Institutions – setup, functions, co-ordination etc.

3.4 TYPES AND SOURCES OF MAJOR DATA

As described earlier, in this study, different types of data has been collected from different sources applying different methods and techniques. Major types of data and sources are provided in below:

3.4.1 Primary Data

- Field Survey
    - Overall Observation
    - Road Inventory Survey
    - Landuse Survey
    - Questionnaire Survey in Different Levels and Sectors
    - O-D survey
    - Video Imaging Survey & Capturing Photograph

- Discussion with Professionals/Policy Makers of different relevant organizations

3.4.2 Secondary Data

- Published literature
    - Books and publications – transport planning, landuse, institutional framework of a megacity etc.
    - Research and Project Report – STPP, DMDP, DITS, Maser Plan (1959, 1995),
    - Seminar, conference presentations – Workshop, national and international conferences
    - Monthly/quarterly/yearly booklets, journal of different institutions or organizations

- Road Maintenance and Management Survey (RMMS) – Road quantity
- Survey of Bangladesh (SOB) – Landuse, road orientation and transport infrastructure
- Japan International Collaboration Association (JICA) – Utility and transport infrastructure, different survey reports and data
- Dhaka City Corporation – Landuse, road functionality, institutional setup,
- Rajdhani Unnayan Kartripakka (RAJUK) – Land development, institutional setup
- Water and Sewerage Authority (WASA) – Land classification, water management and maintenance, institutions
- Bangladesh Inland Water Transport Authority (BIWTA) – Waterway capacity and sharing, circular waterway, Institutional capacity and management
- Bangladesh Railway Authority (BRA) – Sharing of rail, commuter service, Institutional setup
- Bangladesh Road Transport Authority (BRTA) – Vehicle registration, route permit, institutional management
- Print and electronic Media Report- News Magazine; TV, Radio report
- Internet browsing – definition, good references/practices, examples

Detail procedure and aspects of the data collection has been described according to the flow chart 3.1 in the detailed methodology.

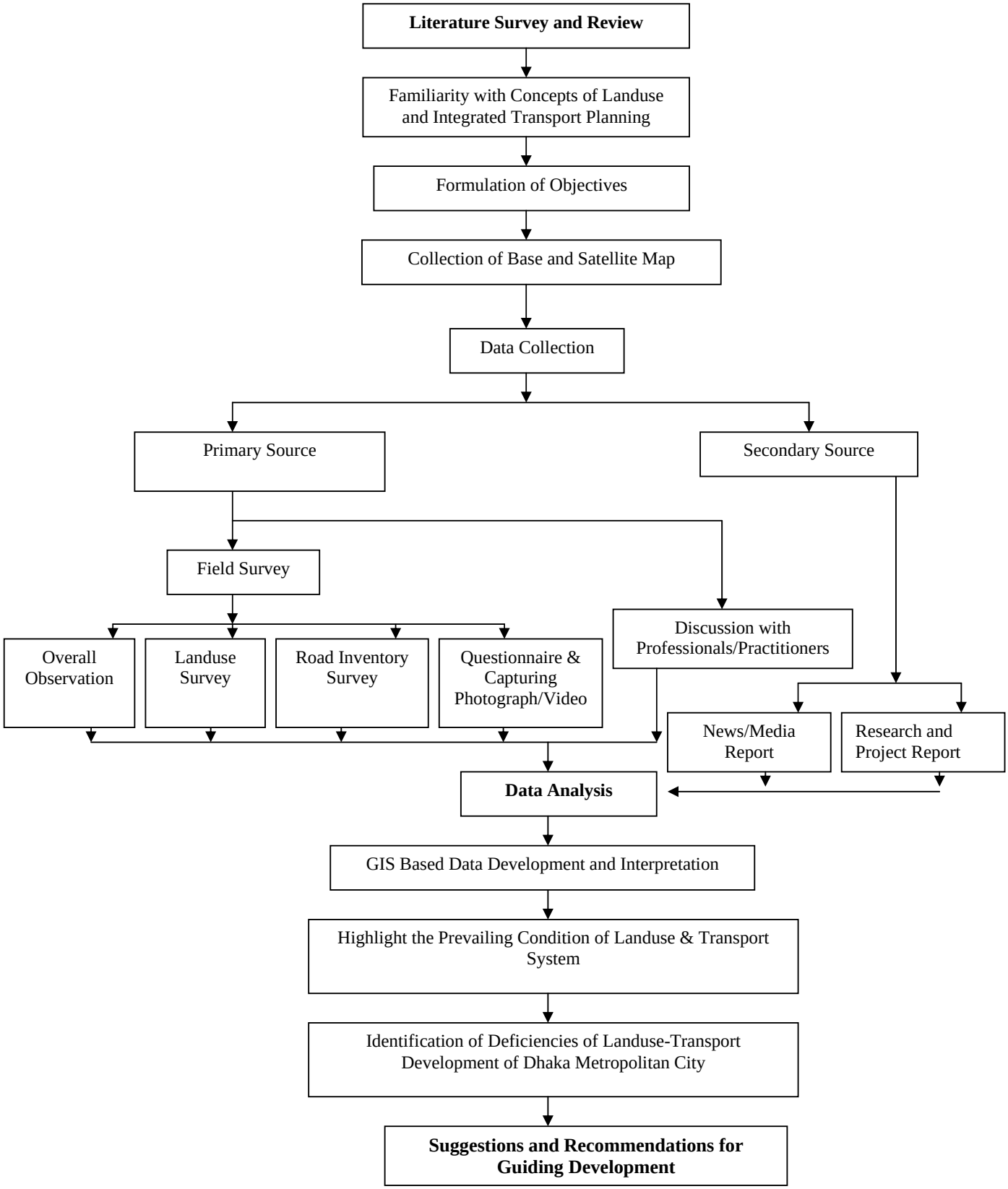


Figure 3.1: Flow chart of the study methodology

3.5 TIME OF DATA COLLECTION

For primary data collection, observations and survey were carried out during different days of month and different time of the day in different places within the couple of year to obtain more representative and authentic data and results. Data has been collected in different time of day to evaluate the operational and management problem like morning, noon and evening of the day, during the different period of week as well as month.

Special data has been collected in the special situation or conditions. For example, to show the conditions of transport operation problem after raining, data or photograph have been collected during the rainy day or to show the flood problem as well as landuse and transport problem due to flood, data have been collected at that particular period.

Data from media reports, news, views on Dhaka city or internet browsing have been collected continuously entire the study period, 2005-2009. Other secondary data like survey report, publications and presentations subsequently collected in different time.

3.6 DETAILED METHODOLOGY AND DATA COLLECTION OF THE STUDY

According to the flow chart of the methodological framework of this study, detailed methodology and procedure of data collection are discussed in this section. Sector wise data collection required to achieve the objectives of the research work as set out in the chapter one are highlighted. It also describes data collection procedures at different stage of the research work. Data analysis procedures and techniques are also presented here.

3.6.1 Literature Review and Information Capture

In order to get the basic understanding on the topic, in depth literature review was undertaken and information was collected from published and unpublished sources to broaden the knowledge in this respect. Different journals, thesis (published & unpublished), project reports, papers, booklets were studied for gathering knowledge and information. Different published articles and report were deeply observed to collect the news and views about the city landuse and transport planning, maintenance, management and operation, institutional and organizational constraints and requirements, and to point out the opinion of the professionals, policymaker, experts in different sectors of home and abroad. Various books on transportation engineering and landuse planning, social survey and urban planning were widely consulted throughout the study.

Comprising basic understanding on the landuse and transport planning, to know the further study requirements, limitations of the previous study and to collect secondary information literature survey has been conducted form the various institutions, centres, libraries. Some of the libraries and related survey literature are listed in Table 3.1.

Table 3.1: List of Libraries and Key Literature

S/N	Libraries	Key literature
1	BUET Central Library	Basic transportation planning and traffic engineering, Journal
2	Civil Departmental Library	Previous studies for M. Sc., and B. Sc. degree on landuse and transport system and different project reports on Dhaka city
3	Traffic Engineering Laboratory	DITS, STP, Recent studies and previous studies for M. Sc and B. Sc. degree on landuse and transport system etc.

4	Urban and Regional Planning (URP) Library	Basic landuse and transport planning, Concept of city planning, Dhaka Master Plan, GIS, thesis reports for MURP and BURP degree
5	Accident Research Institute (ARI) Library	Safety problem in Dhaka city, urban transport etc.
6	Center for Urban Studies Library	Studies on Dhaka city by this center
7	Public Library, Shahbag	Different historical articles and reports on Dhaka city, Different institutional and organizational research report, historic survey report

3.6.2 Familiarity with the Concepts of Landuse and Integrated Transport Planning

It is a fundamental theme to understand the ideal landuse and integrated transport planning for finding the deficiency and providing recommendation. For this purpose, thoroughly observe the geographical and satellite map of different countries, cities both developed and developing countries, gone through the different text books on landuse and transport planning, course material on the landuse planning etc. for familiar with the concept of landuse and integrated transport planning as well as overall city planning. Planning policy of different developed and underdeveloped countries are also observed by internet collection. Beside this, ideal network of different road infrastructure were also analyzed from other city ideal caption in scattered section and/or by internet browser from different research, map, picture and caption.

3.6.3 Formulation of Objectives

Objective is that which helps us to form a complete structure of the study with providing guidelines. So, at the first stage, objectives have been formulated. The objectives in the study are related to the deficiencies of landuse-transport development of Dhaka metropolitan City from its planning, operation, organizational context as well as the area itself. Study of exiting transport infrastructural and operational deficiencies and scope of development are also the main objectives of the study. Some objectives are also related to the proposals or recommendations that help to achieve the goals.

3.6.4 Collection of Map/Satellite Image

Maps are the graphical representation of some features of an area. In this study, collection of maps is an important step. The maps featuring past development trend, geographical extent, landuse, road pattern etc. of the area is very important for my study. At the outset of the study, the map featuring the geographical extent of City were collected from mappa, graphicsman, DCC, satellite map from the internet and GIS based map from SOB, DCC and the department of Urban and Regional Planning of BUET to represent and visualized the present and historical condition of the city and collecting geographical information of the city. With the collection of historical map, in order to explore the

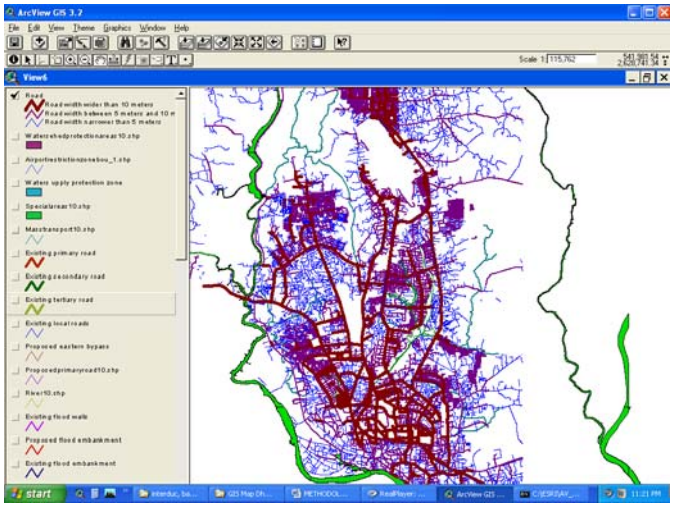


Figure 3.2: GIS Base City Map

past to present development pattern of the city, geographic data were collected from the previous survey report, planning proposal and master plan etc. These maps acts as a base map for the preparation of detail GIS map and recommended map.

Other maps related to historical growth trend and development of Dhaka City and the related studies were collected from Banglapedia and STP report and URP library resource respectively.

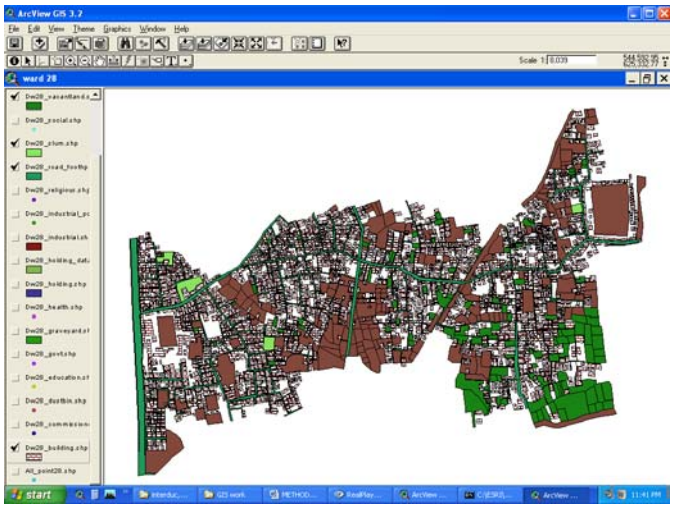


Figure 3.3: GIS base Individual Ward Map

3.6.5 Special Data Collection

Data has been collected from two sources:

- Primary source
- Secondary source

3.6.5.1 Primary Source:

This type data has been collected from two types of surveys:

- Field survey
- Questionnaire survey

- ***Field Survey:***

Under this survey work different types of survey has been conducted to find out the real picture and authentic data to achieve the ultimate goals of the study. Under the field survey, four types of survey has been conducted in macro and micro level of the city. That's were: (1) Overall observations of the city (2) Landuse survey (3) Road inventory survey and (4) Video Image or Photographic survey

Overall Observation: Overall city has been observed to find out an overall view of the study area within the whole study period both in a systematic and random nature. It also gives an outlook to the geographical extent of the city as well as landuse and transportation features of the area. An overall idea of the present development condition of the study area (CBD, industrial area, residential area, mixed area, fringe area) could also be found through this survey. Existing road network system and the general condition of the roads, organizational and transport integrity of the study area has also been revealed by this survey.

The condition of the existing mass transit and services such as operation, management, maintenance, parking, terminal, drainage system, garbage disposal system has also been found in the this survey. The conditions of side road, accessibility, road hierarchy, functionality were also enclosed in this survey of different zones of the city. This survey also helped to get an idea about the civic amenities such as educational and religious institutions, hospitals and health care centers, community centers and recreational facilities such as parks, playgrounds and open spaces.

Besides, this field survey also helped for the further study of the characteristics and existing services of the area. In addition, it also played an important role in the identification of the problems of the study area.

Landuse Survey: To find out the deficiencies of the landuse pattern of the metropolitan city, a comprehensive field survey has been conducted in the overall study area. Under this survey work, the overall distribution and condition of the residential, administrative, industrial and commercial buildings in the study area with overall landuse pattern was disclosed. Landuse and road network pattern, roadside development, distribution of tall building and their facilities were observed under this survey. Development pattern of wet land, marshy land, and fringe areas under private, government and individual initiative were observed and point out the present scenario, development and maintenance trends, faulty initiatives and requirement. Overall road network orientation with some preplanned and unplanned areas road network pattern, functional opportunity, accessibility, design and planning deficiencies were also point out by this survey work.

Road Inventory Survey: Some links, intersections, traffic generating points have been selected for general observation and detail field study to explore road side development, setback, type of development, apartment size and height, parking condition.

Construction, operation, management and maintenance hazards of the road network were listed in this survey. Parking facilities, access density, road width/lane, terminals deficiency, density of intersections, footpath, bus bay etc. were also evaluated in this study as those seem to be constitute most of the system characteristics of the overall city. Options of low cost system managements and improvement options by introducing integrated space efficient mode were also asses in this study. Vulnerable road users particularly pedestrian facilities has been briefly observed in this survey.

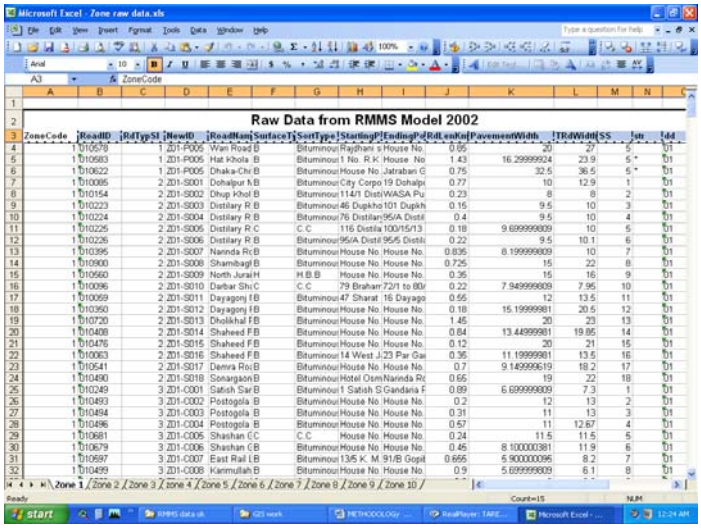


Figure 3.4: RMMS Database

Video Image Survey and Capturing Photograph: Video or Photograph is one of the most important tools for showing the real picture of any situation. For showing the real condition of Dhaka transport like landuse pattern, road side development, road maintenance, operation, management characteristics, road geometry, vehicle movement, foot path, parking, loading and unloading, side road, impact of road side development, accessibility, users facility etc. captions were taken from the different point of the city. Also for representing the landuse characteristic and development pattern of the city, photographs were captured from the fringe and core area of the city. To compare with the actual figure, few captions were taken from the some ideal places of the study area.

Huge numbers of photographs have been taken from different spots as the evidences of many events and as to present the real scenario of the system through out study period. Some places or areas could not capture in camera for not allowing taking photograph like cantonment, airport to show the separate space for NMV, passenger queue etc. Photograph from the rooftop of the Bangladesh Bank, Janata Bank etc. to show the peripheral development, CDB sky view etc. could not be taken because of the restriction imposed by the authority. Some could be convinced after making number of travel with strong evidence like photograph from rooftop of some apartment of Banashree, Dhanmondi.

- ***Questionnaire Survey***

Questionnaire Survey: In this study, several questionnaire survey was conducted to collect in-depth field information and opinion or observation of different users including professionals, policymakers etc. A questionnaire survey was made on the passenger of different modes like rail, road, and water in different intercity terminals and intra city terminals to observe the interchange facility and integration of different modes.

An attitudinal questionnaire survey was made in this study on the rickshaw puller of Dhaka city. The questionnaire has been designed into two parts. One was to evaluate the current status of rickshaw puller and other was to assess the knowledge and level of understanding on traffic rules and regulations and road signs and markings of rickshaw puller. In the person-to-person questionnaire survey, almost 14 questions with six sub-questions have been asked to the rickshaw puller. Through the location of the survey has been selected randomly in the city, higher number of sample have been collected from the old Dhaka as the intensity as well as dependency on rickshaw of the user of this area is much higher than any other areas of the city.

O-D Survey: Internal passenger origin and destination survey particularly terminal to destination or origin to terminal was made in different bus, rail and waterway terminals and landing stations to observe the interchange facilities, availability of transaction mode etc by using different methods or technique like direct question to the passenger, road side interview survey or making several trips or discussing with the service provider.

Discussion/Opinion Survey of Professional/Policy Maker: Discussion or opinion survey is a direct procedure for collection of data, which gives a clear idea of the respondent regarding the subject. As a result, it is an important procedure for the collection of data regarding the necessary socio economic condition, land development, services and facilities as well as about the land acquisition; development scenario; maintenance and management programs, progress, future plan; institutional framework, limitations, requirements.

To evaluate the intuitional framework, limitations/weakness; landuse transport problems; operation and management deficiencies discussion or opinion survey has been made with the professionals, practitioners, planners, media personnel etc. of different organizations and institutions.

Under this study, random surveys (face to face discussion) were conducted among respective professional (director, city planner, transport planner, data analyst etc.) of different institutions and organizations like BRTA, DTCB, DCC, RAJUK, DMP to get a clear view of institutional framework, objectives, constraints, requirements etc. Data regarding the organizational setup, manpower, activities, future program, co-ordination and integration system etc. were also collected.

Photograph 3.1: Discussion with the BRTA Officials

3.6.5.2 Collection of Data from Secondary Sources

Due to the nature of the study and extensive area concerned, a significant amount of transport relevant information and data have been collected from secondary sources. They include past records, previously carried out physical surveys, volume studies, origin-destination studies, landuse surveys and so on. Maps, drawings and figures used in the study are most important outcome of this step.

Published Articles/Media Reports: Print and electronic media reports and articles is one of the major sources of different information. In the variety of articles, news and views of the media publications, reports on various topics, research findings, opinion of the policymakers and general people, problems of local areas, deficiencies, requirements etc. being highlighted in a comprehensive manner. In this study, a comprehensive data base has been developed on landuse and transportation pattern, infrastructure, problems, requirements; transport operation, maintenance and management characteristics; local area development, needs, problems; institutional weakness, requirements etc. from the articles and reports of the newspaper and magazine. From this database, some impotent information has been used in this study after cross checking or verifying through direct contact or field observation. In addition, related published image/picture has been collected from that reports and publications.

Research and Project Reports: Due to the nature of the study and extensive area concerned, a significant amount of landuse transport planning, institutional framework, management and maintenance practices relevant information and data have been collected from secondary sources like DCC, RAJUK, RHD, DUTP, DMP, BRTA, BRTC, WASA, BIWTC, various consultancy firms. Besides this, details landuse, transport network; infrastructural data has been collected from the different survey agencies or organizational project reports or publications like RMMS, DMDP, SOB, STPP, DITS, master plan, text book on transport and landuse planning, management and maintenance, various training materials, journal and conference publications, previous research and survey reports. Transport **owner's association** and transport worker's association were good sources of information and data like number of vehicles in different route, owners etc. Besides these, different local and international landuse and transport planning related data has been collected from the internet services.

GIS Base Attributed Data: GIS base landuse and infrastructural survey data with geographical feature has been collected from Urban and Regional Planning (URP) and Survey of Bangladesh (SOB). Beside this, ward landuse and infrastructural data were also collected from Dhaka City Corporation (DCC).

3.6.6 Data Analysis

After the collection of data from various sources, all data have been analyzed by using spreadsheet & other software like Arc View, Arc GIS, Auto Cad etc.

3.6.7 Preparation of GIS Data Base and Interpretation

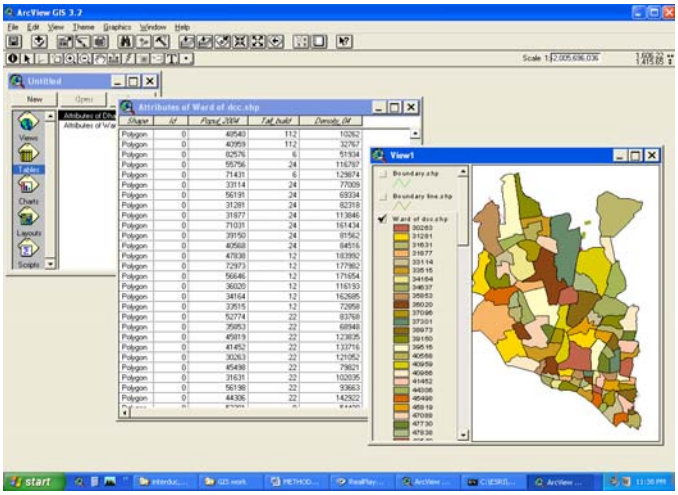


Figure 3.5: GIS Database and Interpretation

For any study's; map and chart are very important which give the guideline for the study. After analyzing data, GIS based DCC ward, zone, population density, bus route, tall building and others related infrastructural database and map has been readjusted or newly prepared. Amount and percent type of road in different zone, percent share of different mode, question relevant data chart etc. also prepared. Landuse, road network map with different attributes and features has manipulated and newly illustrated. Road side development maps are also isolated from the large scale landuse map to show the present city road condition. Attributed landuse and road network GIS based database of different ward of has been manipulated, ratified and analyzed and illustrated a serious of ward map showing the

existing landuse and road network pattern to evaluate the prevailing condition of different ward landuse and road network pattern as well as to identify the deficiencies. A series of maps have been prepared for clear identification of bus route, building position, road network and other infrastructures. Therefore, the map will help throughout the study to fulfill objects specially the second and third and forth one.

3.6.8 Evaluation of Inherent Weakness of Landuse and Transport System

After analyzing data collected from survey and secondary sources, existing condition of landuse and transportation pattern of the study area were identified.

Here all the aspects have been tried to cover such as landuse in micro and macro level, transport integrity, mode, road network, maintenance, management, operation etc. From this in-depth analysis, inherent weakness of the landuse and transportation system

Inherent weakness of institutional framework, integration, capacity, requirements, and constraint were also evaluated.

3.6.9 Identification of Potentialities of Integrating Landuse and Transport Planning

On the basis of the detail study the potentialities of public transport have been identified. It will be key tools for improving the lacking of the public transport services and also to provide a comprehensive basis for the overall transportation system, which has a greater influence over the overall economic pattern of the country.

3.6.10 Suggestions and Recommendations for Future Intervention:

Analyzing all the problems of the study and from the study of growth scenario of Dhaka City, make a sequence of our problem among the observation list to identify the real cause or root of problem for the present situation and preparing some suggestions and recommendations for realistic and affordable short and long term actions to improve transport service in Dhaka city, which will fulfill the last objective of the study.

3.7 LIMITATIONS OF THE DATA COLLECTION

A comprehensive and thorough study requires much time and resources. In this study, emphasis has been made on selected areas and parameters in selected field and concentrated on the selected factors related to the landuse and transportation system. As mentioned earlier that no significant research on this issues had been done so far, so it is often very much difficult to get the necessary reliable information about the present problems and issues.

Due to the limitation of time and necessary resources, a small sample survey has been conducted in each study areas. The study is mostly based on secondary data and information. Due to the large area concerned; it was not possible to carry out any comprehensive in-depth direct field study covering the whole area.

As there was variety of dimensions in the transportation system as well as associated problems, many of them could not be attended during the study period. Demand based analysis in different areas and routes were totally ignored due to the unavailability of data and resource constraint.

Finally, resources and time constraints were the most considerable limitation of the study. In spite of all these constraints, the study aims at identifying the deficiencies of landuse-transport development of such unplanned and haphazard development of the city and formulates a set of

recommendations which may contribute towards any effort for planned development of these areas.

3.8 PAIN AND SUFFERINGS OF DATA COLLECTION

It was a great challenge to find out any information, data from the reliable field, organizations as all of the sectors, stakeholder, professional or respective persons were not well wisher as well. At the time of data collection, various types of problems had faced from the various fields. Few example viz. to show the well planned service line, systematic and well designed bus bay, passenger shelter, well operated passenger alighting and boarding scenario, separate rickshaw lane as well as a good example of systematic operation and management of vehicles, passenger, pedestrian, the author tried to collect photograph from the cantonment. In spite of various types of documents regarding a research student, request letter from the supervisor for kind support, the authority not only prohibited to collect photograph but also preserved the camera and arrested him. Finally, the authority took him near to the enquiry shell and luckily release after one and half hours enquiry. Besides this, the author have to face many kind of problems, restriction etc. form different field at the time of data collection like careless or unsupportive behavior, lack of intention to support, lack of reliable data etc. Different types of questions, query have to face during the photographic survey from different persons, organizations etc. Some of the authorities didn't allow to capture photographs. Cantonment, Bangladesh Bank, Janata Bank, some of the multistoried building of Dhanmondi area could not allow to take photograph because of the restriction imposed by the authorities or owner.

At the time of questionnaire or interview survey, in most of the cases interviewee/officials were not in positive mood to disclose the information pertaining to the research work with a plea of security matter though the information were not sensitive to security matter. In most of the case, the authorities tried to avoid giving information or refer to other person, most of the case who were not concern. Even, many of the case they were provide simply answer that they have not any information or they did not conduct any study regarding this. Many of top officials as well as professionals directly refuse by coding simple word, "please, trim this part from your thesis, we could not provide any kind of information at present" particularly when asked about the institutional setup or institutional policy. In most of the case, more than one trip was required to have the appointment or interview, even to find the concern person or officials.

3.9 OVERVIEW

In this chapter, detail methodologies followed in the study are presented sequentially. Besides, possible methods of data collection and analysis for different parameters related to the objectives are discussed elaborately. The step by step procedure for achieving the objectives is discussed. Factors considered in data collection and analyses are also represented in this chapter. Different statistical and analytical analyses used to represent the real situation and to evaluate the deficiencies are highlighted. All these would form the basis of subsequent analysis conducted later. Collected data, statistics, information are presented and analyzed in the following chapters viz. Chapter 4 to Chapter 8.

CHAPTER 4

PROFILE OF DHAKA METROPOLITAN CITY

4.1 INTRODUCTION

Dhaka is the capital and the largest city of Bangladesh and enjoys distinct primacy in the national and regional hierarchy. The primacy of Dhaka is even stronger functionally than in terms of population. Administrative functions and civil employments, financial and banking service, international commerce and business services, except port functions, are all largely concentrated in Dhaka. Educational, cultural, and political activities are also over-concentrated in this city (Habib et al. 2005). In this chapter the historical background and existing landuse and transportation system in Dhaka Metropolitan city is described to understand the development pattern over the decades and prevailing landuse and transportation system. The evaluation is made by the both broad and detail surveys (as described in Chapter 3) which have been carried out to identify inherent weakness and deficiencies of the whole Dhaka City, particularly in landuse and transportation system. However, the purpose of this chapter is to provide a basic level of understanding and assessment of the present transport services and facilities in Dhaka and to show the prevailing characteristics of the landuse and transport operation and management system which will act as a background to achieve the objectives of the study as set in the Chapter 1.

4.2 HISTORY OF PHYSICAL AND DEMOGRAPHIC DEVELOPMENT OF DHAKA

Dhaka has grown from a small settlement within the confines of the river Buriganga and Dholai Khal to to-days mega city. The physical features, topography and demographic features of Dhaka City have always influenced its physical expansion. During the Mughal and British regime, political importance and trade played significant roles in the city's growth and expansion. This section briefly describes the growth and expansion of the city in the scale of time under five major periods: Pre-Mughal (before 1604), Mughal (1604-1764), British (1764-1947), Pakistan (1947-1971) and Bangladesh (after 1971).

4.2.1 Pre-Mughal Period (before 1604)

Growth and expansion of Dhaka city in the pre-Mughal period is obscure. 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. Some indications of human habitation of the area of the said period have been discovered which provide the evidence of existence of this town or settlement (Dani, 1962). It is around that time the name of Dhaka originated from the name of Dhakesshwari Temple, which was built by Raja Ballal Sen. Dhaka of that time was identified as Bengalla and was probably a small town (with fifty two bazars and fifty three lanes) lying between the river and what is now the Dulai Khal with its center near the present Bangla Bazar (Birt 1906 p. 94 and Rudduck 1964, p. 74).

Before Mughals reign, Dhaka was a small Hindu trading centre. After the Hindu rulers, Dhaka was successively under the Turks and Pathans for a long time (1299 to 1608) before the arrival of the Mughals. The Afghan Fort in Dhaka was located at the present Central Jail. After the Pathans, Dhaka went under the rulers of Sonargaon from whom the sovereignty of the area was acquired by the Mughals. The boundaries, size, and population of Dhaka city are relatively undocumented and unclear before 1604. It is evident from the various writings on Dhaka that the areas to the east, northeast and southeast of Babur Bazar up to the Dulai River on the left bank (northern bank) of the Buriganga formed the old town. The Dulai River possibly formed the northeastern boundary of the old city, though it is difficult to determine the western limit of the pre-Mughal 'old city'. Considering testimony to the existence of a mosque at that time, however, it can be assumed the city limits went beyond Babur Bazar on the western side. The town consisted of a few market centers like Lakshmi Bazar, Shankhari Bazar, Tanti Bazar, and a few localities of other craftsmen and businessmen like Patuatuli and Kumartuli, Bania Nagar and Goal Nagar[1].

It is quite likely that following the course of the Buriganga settlements grew on the southern, western and north-western parts of the city. These, of course, were sporadic growths with the riverbank determining the basis for settlements. The population size at that time of the Dhaka city is unknown (Islam, 1974).

4.2.2 Mughal Period (1604-1764)

According to documents and remnants of Muslim Mughal sculptures in the "old city", Mughal Dhaka incorporated the "old Dhaka" within its boundaries. In this period the expansion to the west and the north was significant; with the fort in the centre the expansion to the west followed the riverbank and the city spread northward to Phulbaria on the fringe of the Ramna area. In this growth of Mughal Dhaka the general characteristics of a Mughal city were noticeable. The areas to the south and southwest of the fort up to the riverbank grew mainly as commercial areas while to the north and northeast residential areas sprouted. The northern limit of the city extended to the gateway built by Mir Jumla (1660-63). Mir Jumla's name is also associated with the construction of two roads connecting Dhaka with a network of forts built for the defence of the capital city. A road headed north to a fort at Tongi-Jamalpur and another toward the east connecting Dhaka with Fatullah, where two other defensive forts were constructed. These two roads influenced the growth of the city in these directions. In the available early records of the East India Company (1786 and 1800 A.D.) the boundary of the city is mentioned as: Buriganga in the south, Tongi in the north, Jafarabad-Mirpur in the west and Postogola in the east. The expansion of the city in the Mughal period was dictated by nature, particularly highlands. As provincial capital, Dhaka enjoyed a golden era, serving as the commercial headquarters and chief emporium for products of Eastern Bengal. Dutch, Portuguese, French, English, and Armenians were among those who established trading houses in the 17thC. The physical size of Dhaka was about 50 square kilometres with a population of 0.9 million (Taylor, 1840).

Road Pattern: During Mughal days, there was no well-developed system of roads in Dhaka City. The city was divided into a number of mohallas (neighborhoods) which was a cluster of houses webbed with intricate narrow lanes. The mohallas were interconnected with dirt roads, which were paved with bricks in 1677-79 (Dani 1962, p. 75). There were two principal roads: one running parallel to the river from Victoria Park to the western fringe of the city and the other ran from the Park to Tejgaon. The roads had no name but the mohallas had names. The roads were named after the establishment of Dhaka Municipality in 1864.

During that period, there was very little of vehicular traffic in Dhaka City. This accounts for the absence of any well-developed road system. The traffic mainly consisted of pedestrians. Horses formed the chief means of conveyance. On festive and ceremonial occasions elephant-ride was preferred by the nobles. Sukhpals (palanquins) were also in vogue. Larakacha, a palanquin made

[1] http://www.bangladeshlive.net/1423980.html

of green bamboo, and carried by men on shoulders, was used mainly by the ladies (Mirza Nathan 1936, pp. 271-277).

The Burhiganga River and the Dulai Khal served as communication lines. Country boats used to ply on them with goods and passengers[2].

4.2.3 British Period (1764-1947)

After the East India Company, the British Colonial outfit, purchased Diwani in 1765, and the shift of the Bengal capital from Dhaka to Calcutta, Dhaka City suffered from lack of political and commercial importance. Gradually the administrative and commercial importance of the city dwindled and by 1828 the city was reduced to a mere district headquarters, though it retained its position as a provincial Circuit Court of Appeal. By 1840, this decline had reached its nadir and most of the former Mughal city had been deserted or had fallen victim to the encroaching jungle (Ahmed, S. U., 1986). The decline affected Dhaka seriously and during this period Dhaka also suffered physical shrinkage to such an extend that the physical boundaries actually shrunk from 50 km to 8 km (Islam, 1974) as did the population from 0.9 million to 0.2 million (Taylor, 1840).

Road Pattern: The gird pattern of road was introduced in Dhaka City for the first time in Wari and Gandaria. Roads in these areas were wider than those in the Mughal Dhaka but not as wide as those of the Ramna Civil Lines[3]. The layout of the Ramna area consists of two roughly concentric roads at the centre of which is the RaceCourse. To the south is a somewhat irregular road pattern which serves the main buildings while to the north-east are a number of well planned parallel residential streets. The tree planting and natural vegetation are excellent even by today's standard. The plan expresses the disregard for geometrical layout of roads, which is one of the main characteristics of contemporary town planning.

However, the second half of the nineteenth century marked the beginning of the physical renewal of the city. In 1857, India came under the direct rule of the British crown and saw some development of utility services. In 1905, Dhaka was made the capital of the new province of East Bengal and Assam, allowing further development of roads and proper drains, as well as fully planned residential areas like "Wari", an upper-middle class area considered "the sanatorium of Dacca." Thus the 'new Dhaka' of the present century had its birth at the hands of the British rulers. The impetus for growth created by the 1905 partition of Bengal was seriously jolted by the annulment of the partition in 1911 when Dhaka reverted back to the status of a district town. However, the establishment of the University of Dhaka in 1921 helped to retain a semblance of prominence until 1947 when Dhaka again attained the status of the provincial capital of East Bengal, later named East Pakistan (Islam, 1974).

4.2.4 Pakistan (1947-1971)

In 1947, India become independent of British rule and Pakistan was created. . Dhaka restarted its life as the capital of East Pakistan. Dhaka was thus suddenly called upon to shoulder many responsibilities. The problem since then has been to house the increasing number of government offices, firms, industrial establishments, government employees, Muslim migrants from India and people coming from other parts of the province. The influx of people caused the population to increase from 335,925 in 1951 to 556,712 in 1961 (Census of Pakistan 1961, Bulletin No. 2, p. 18) registering an increase of 65.7 percent. The needs of the officials engaged in administration, the business community and the residents grew out of the sudden onrush of people to Dhaka. This contributed to the growth of the city in its new role as the provincial capital. To accommodate the

[2] http://www.bangladeshlive.net/1423981.html
[3] http://www.bangladeshlive.net/1423982.html

rising population more houses were needed but the construction of new buildings takes time, while the incoming thousands had to be housed immediately. Thus growth of Dhaka City in the initial years after independence took place in the form of fission or division of existing houses and compounds mainly in the old city, and later expansion started in the open areas of the new city (Hafiz, 2002).

Functional Pattern:

Industries: After independence Dhaka has witnessed phenomenal growth in industries, which increased to over 100 in 1962. The industries are located mainly in three areas: Thjgaon, Postogola and Hazaribagh.

Business: Dhaka as a commercial centre handles both wholesale and retail trade. The wholesale area is located at Chauk, Mitford Road and Farashganj. The retail trade area extends from Islampur, Patuatuli, Bangla Bazar, and Nawabpur Road to Jinnah Avenue. A large cluster of commercial firms has developed in Motijheel. The retail trade centers along with Motijheel area forms the Central Business District of Dhaka City. Motijheel and Jinnah Avenue are the post independence extension of the CBD. A good shopping center has developed at New Market.

Administration: Being the provincial headquarters of East Pakistan and Subsidiary Capital of Pakistan, Dhaka City is an important administrative centre. The old administrative centre at Victoria Park still continues to be a nucleus of office buildings. The new centre of provincial and central administration is located in Ramna area. It has also penetrated into Purana Paltan and Segun Bagicha. More administrative buildings are under construction at Rajarbag and Tejgaon where the establishment of the second Federal Capital will ultimately wipe out the Tejgaon farm area.

Education: The present education zone is possessed by the two universities namely, Dhaka University and the University of Engineering and Technology. These two institutions occupy a large area west of the Secretariat up to the railway lines. Educational institutions also extend continuously from Bakshi Bazar up to Shahbagh, where the Government Institute of Art is situated. The educational centre of the early 19th century still continues to flourish near the Victoria Park.

Recreation: After 1947 the necessity of having more areas for recreation was felt. As a result, Ramna Park was laid out near the Race Course and a large stadium was built at Jinnah Avenue.

Low Class Residence*s:* The low class areas of the past period continued as before and more areas were included in the category during the last decade as population and density of houses increased. The major low class residential areas lie in old Dhaka. A slum area developed on either side of the railway line from Gandaria up to Tejgaon, with only small gaps at places. These areas are occupied by day laborers, cart pullers, rickshaw drivers and beggars. In the new Dhaka low class residences occupy the pottery area of Rayerbazar. In Karwan Bazar live many industrial workers with other low class people. The fringes of the city are occupied by low class dwellings where the laborers live (Hafiz, 2002).

Middle Class Residences: After 1947 only a few areas of the old city continues to remain as middle class residential neighborhoods. Bakshi Bazar was one such important locality, which retains its middle class standard until today. On the other hand some high-class areas have become middle class neighborhoods e.g. Gandaria, Wari and Purana Paltan. Some developing areas near Dhanmondi, which has mixture of modern buildings and mud houses, may be put in the category of middle class. To this category also belongs the Mohammadpur Housing Estate located north of Dhanmondi which was primarily developed to house the displaced persons from India.

High Class Residential Areas: Since 1947 Dhaka City is growing and changing rapidly. The residential areas (Except Ramna) classed as high in 1947, have lost their dignified status. Ramna

has expanded northward and eastward to include more areas in upper-grade category and a new high-class area has developed in Dhanmondi. The delimitation of different classes of residential areas are based upon rent and land values, population density, housing density, distribution of telephones, and private cars and water and electricity connection. The consideration of physical structure of houses, including architecture and open spaces was also made (Hafiz, 2002).

With the creation of the Dhaka Improvement Trust (DIT) in 1956 (transformed into the Rajdhani Unnayan Kartripakkha in 1987) greater interest and care was undertaken in road construction and city planning. The DIT developed the Gulshan Model Town in 1961, Banani in 1964, Uttara in 1965 and Baridhara in 1972 (though first conceived in 1962). The Dilkusha Gardens adjacent to Motijheel came to be engulfed by the ever-growing commercial needs. In the mid-1960s the main railway line was shifted and directed eastward. The Dhaka Railway Station was moved from Phulbaria to Kamalapur. This eliminated the landmark that had long stood between the 'old Dhaka' of the Mughals and the 'new Dhaka' of the English. The rapid growth and development of the area between the old railway track and Kawranbazar necessitated this change. In 1947, the area and population of Dhaka City was 12 sq. km (Islam, 1974) and 2.5 million (Census of Pakistan, 1951)[4].

4.2.5 Bangladesh (1971 onward)

Dhaka city became the capital of the independent state of Bangladesh in 1971. This additional factor as well as the initiatives of private sectors led to Dhaka's phenomenal growth since 1971.

The growth outward, following the pattern set by the Mughal founders has been limited by the waterways surrounding the city. With increased population pressure the highlands spreading northward were occupied and built up. The intervening ditches, swamps and marshes were filled in, not in any planned manner, but as exigencies arose and private initiatives dominated the process. Development under the aegis of the DIT dictated nature rather than allowed nature to direct planned growth. In selecting the sites for the Model Towns of Gulshan, Banani, Baridhara and Uttara, the method of selecting the highlands on the main Dhaka-Tongi axis road is clearly discernible. No serious effort at reclaiming land under a well-planned scheme to give the city a homogenous and cohesive growth is visible. Dhaka has grown on its own in a haphazard manner and the topography of the area dictated the terms and direction of the growth. Since Dhaka became the capital of an independent country the pressure on it has been enormous. The permanent inhabitants of the city have registered a steady growth. Along with it there was a very large floating population, the pressure of which has resulted in the growth of slums on any available vacant land. The recent phenomenon of high rise buildings, both in the commercial and residential sectors occupy the city's highlands and demonstrate ever-increasing pressure on Dhaka as it builds upwards, an inevitable and common phenomenon in all modern cities facing population growth. Since the 1990s, Dhaka has been on the verge of change in its urban character with vertical growth replacing horizontal expansion (Chowdhury and Faruqui, 1989). By 1981, the area of Dhaka SMA surpassed the Mughal Capital period by 12.4 sq. km at 155.4 sq. km (Census of Bangladesh, 1981). Population also had tripled to 3,440,147. The 2001 census recorded 9,912,908 inhabitants (Census of Bangladesh, 2001).

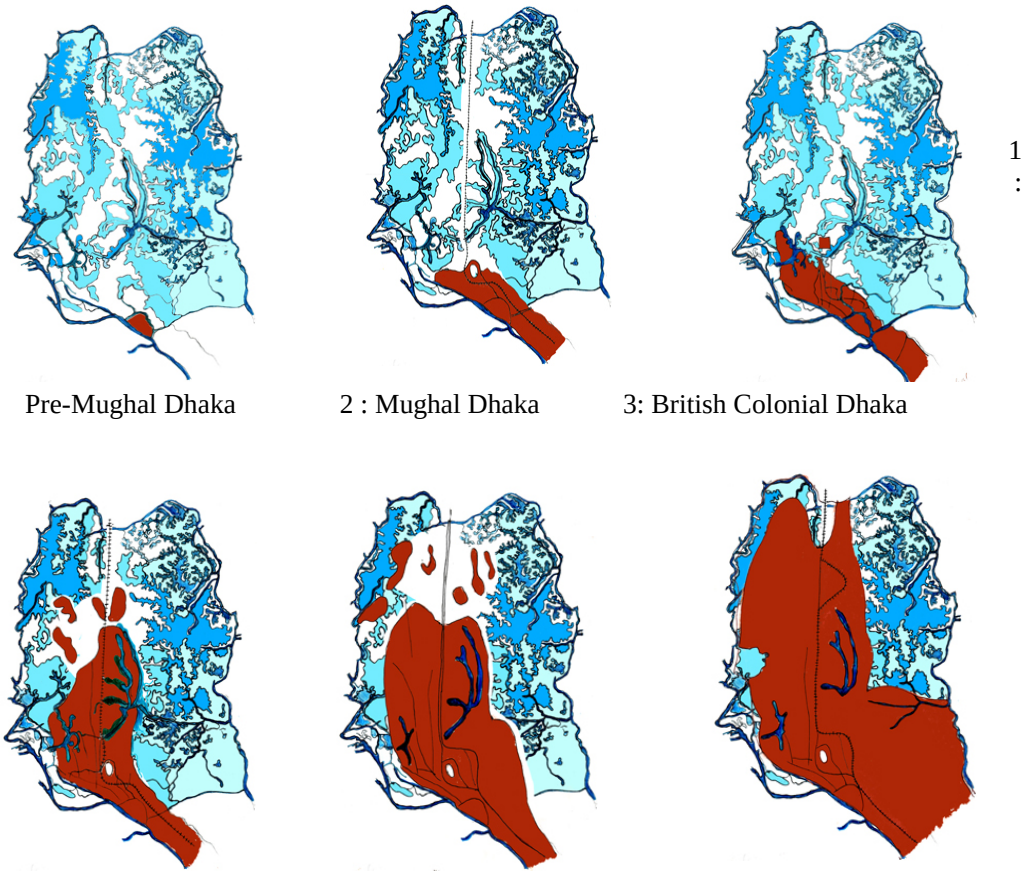
4.2.6 Physical Growth of Dhaka City (1850-2015)

The physical growth and expansion of the city is influenced by the topography and land characteristics of the city. Initial development of the city took place on the higher terraces elevation ranging from 10-12 AMSL. In the first phase of urban growth, until 1850 only the higher grounds, the natural levee and Madhupur clay units were brought under human settlement. After 1950, the city started to extend on high flood plains, low lying Madhupur Clay area. The city followed a faster pace of expansion after 1975 and encroached abandoned channels and

[4] http://www.bangladeshlive.net/1439111.html

depressions (ESCAP, 1999). The ever increasing population growth and urban activities and due to lack of proper regulatory and planning effort the city encroached large portion of the wetland, depression areas, canals and resulted in destruction of the natural drainage system significantly.

Sequential maps show urbanization as a static pattern that changes with each time period that is mapped. Map 4.1 shows the growth and expansion of Dhaka City in the scale of time under five major periods: pre-Mughal (before 1604), Mughal (1604-1764), British (1764-1947), Pakistan (1947-1971) and Bangladesh (after 1971).



Map 4.1: Growth and Expansion of Dhaka City (Hafiz, 2002)

4.3 DEVELOPMENT OF FRINGE AREA OF DHAKA CITY

The fringe in Dhaka, as it is in all cities, is continuously retreating. What was a fringe 40 years ago, is part of the inner city today, what was fringe 20 years back, is now part of the intermediate zone of the city (Islam, 1996). The present fringe surrounds the city in all directions although the spread of the fringe in the north and northeastern directions is very wide, while in other directions it is very narrow which is mainly due to the nature of the topography. It is clear that population of city has been increased and also the established urban areas have experienced heavy increase in population gradually. Moreover, the unused and under utilized lands are bring under urban use. The vacant small parcels of lands in the city areas are also being occupied intensively. In the course of time, the land value is going up at a fast pace. Therefore, middle income and lower

groups have very limited access to urban land. In this situation, urban fringe and surroundings are tremendously pressurized for urban development (Hoque, 2004).

The major development works in these areas are carried mostly by individual private landowners, formal private developers and partially by the public sector. But, all such attempts lack appropriate policies, strategies and sustainable planning proposals for the potential expansion of the city in this direction. The situation was worse since the inception of growth in the area and further augmented with the passage of time. Presently these areas are marked by haphazard and unregulated growth, environmentally substandard settlements, overcrowding, slum and squatter settlements, traffic congestion, unsanitary situation and chaotic uses of land.

4.3.1 Nature and Trends of Fringe Development during 1950's to 1970's

The land development in fringe areas during 1950's to 70's has been done mostly by the public sector agencies, and the individual initiatives. The formal private sectors played a very minor role. During this period urban land were developed and used for different purposes including residential, industrial, institutional and agricultural uses (Figure 4.1). Public sector was mainly responsible for land development and land conversion from rural to different urban uses during this period. The public sector has also made large scale conversion of agricultural land in the inner and outer fringe into residential area, for example, Tejgaon and Tongi in the 50's and Joydebpur in the60's. Some other examples of fringe area development by the public sector during 1950's to 1970's are as follows ((Islam et. al, 2003):

- Development of Mirpur into a large residential satellite in the 50s and 60s by the housing and settlement directorate (north-west periphery)
- Development of Gulshan as a high status residential 'area in the 60s by the RAJUK (in the north-east fringe).
- Development of Uttara as a large middle and upper middle income residential suburb beginning in the 60s by RAJUK.
- Conversion of the outer fringe into academic, military or other institutional uses were also initiated by the govt. in the 60s and early 70s, e.g. Jahangirnagar university campus at Savar in the 60s and the Cantonment at Savar in 70s.

4.3.2 Development through Private Initiatives

In 1950, the growth in the fringe areas was slowly continued by the initiative of individual owners. Growth opportunities were not available in the areas due to poor connectivity in terms of road, rail and others. During this period (1950s) there was an excellent channel canal network within the city and the eastern and western peripheral areas.

In 1960s the growth in fringe areas was continued by landowners to build houses through incremental land filling while the formal sectors played a minor role. Generally the fringe areas are low lying. Mostly growth has taken place in the peripheral place along the main roads on higher lands (Islam et. al, 2003).

Some other examples of fringe area development by the *public sector* during 1950's1970's are as follows:

- Development of Khigaon, Bashaboo, Madartek, Goran for middle and lower middle income residential suburb in the 60s (north-east fringe)
- Development of Rampura, Badda for middle and lower middle income residential area in the 70s (north-east periphery).

- The government decided to retain DND area as agricultural land in the late 50s and 60s. This large area has now been turned into a lower middle class residential area without official approval.
- Large tracts of fringe lands across the river Buriganga south of the city have been brought under mixed use of industries ware houses and lower income residence, by a combination of public and private efforts, but more predominantly by private initiatives.

It is evident from the above discussion and the map that transformation of fringe areas took place by both govt. and private initiatives both in a planned and unplanned way during 1950's to 1970's.

The conversion of the fringe lands into residential use was done by the individual initiatives to a large extent. The residential developments in the fringe lands have been made by the lower middle-income households. In general, the role of individual households in the residential development process is very significant because a major portion of the housing stock in the city has been provided through this process (Islam et al. 2003).

4.3.3 Nature and Trends of Fringe Development during 1980's and onwards

During 1980s, development took place in a spontaneous, but haphazard way, leaving little room either for an appropriate road network or for basic infrastructure facilities and services. The development of metropolitan fringe land has taken place in that period under all the agencies, which were operative in earlier decades. However, their roles have been gradually changing. Besides, land and residential development through squatting and slum growth is one of the current features in metropolitan fringe (Mitra, 2005).

Land is developed usually through *government agencies* in the inner as well as outer fringes. In Dhaka city, it is mainly RAJUK, which is responsible for land and housing development and to lease out land to private individuals, usually for a period of 99 years. Allocation of such plots are supposed to be made considering income, occupation, age , previous ownership of land in the city, income tax etc. Once again, the government agencies (public sector) are engaged in land and residential development process only in the northern and north eastern fringe areas of Dhaka city.

Land and residential development through *private sector* housing companies or housing societies cooperatives has become more active in the 80s in the fringe areas of Dhaka city. The Private Land Development Companies buy large tracks of land in the fringe areas, then make subdivision plan and get approval from the concerned authority. Usually they bought low lands and through earth filling land is developed. Fringe lands are lucrative sites for housing for following reasons:

- High demands for housing plots
- Large parcels of land are available
- Close to the city centre
- Low price of the land etc.

It has been alleged that commercial housing companies are motivated primarily in making high profits. The cooperative society supported housing developments are concentrated mostly in the outer northwest fringe and the inner northwest fringe. Some societies have also operated in the eastern fringe areas. At present time, private developing companies concentrated in the fringe areas with some lucrative proposals of planned satellite towns (Islam et. al 2003).

The private individual owners have always played the most significant role in housing development in Dhaka city. In the fringe area, the land development and supply process goes through a series of changes over time. Initially the conversion is from agricultural use to residential use when fairly large tracts of land are bought by individuals or small groups as an investment. It is a process of land speculation and the land purchasers are often accurate in estimating the future demand of land in these areas. Over time this land undergoes rapid

transformation by land fill and sub- division. The change in landuse depends on several external factors i.e.

- Improvement of road transports,
- Commercial, industrial or residential development of the area and
- Flood protection schemes.

Even, most of the areas in the central city have been grown in an unplanned way, like- Shantinagar, Sukrabad, Kanthalbagan etc by private individual owners. The determinants for the intensification of the city fabric are found mainly due to land and plot subdivision; initiated by landowners are:

- High concentration of economic activities
- Job opportunities
- Rising income levels encouraging real-estate investment and changes in the landuse with little or no control from the government [example- residential plots converted for commercialization. (Zaman and Lau, 2000)

It is interesting to note that this process goes on continuously without any control from RAJUK. As a result, the road pattern and building plots are often laid out in an unregulated manner, as is evident in the fringe areas of Dhaka city and pockets of low-lying areas. The land and residential development in Madartek, Meradia, Kalachandpur, Shewra, Uttar Khan, Dakhin Khan, Jatrabari, Jurain etc. through the individual household efforts is a good example of the 1980s fringe development. The housing characteristics were mixed with temporary or unapproved houses predominantly (Islam et. al, 2003)..

Table 4.1: Unplanned Housing in Dhaka

Year	Area (Sq. km)
1984	38.13
2004	88.75

Source: Mitra (2005)

The Map 4.1 depicts the rapid expansion of Dhaka city in the fringe areas in an unplanned manner. It has shown the rapid expansion of the unplanned housing situation in Dhaka city for a time period of last two decades from 1984 to 2004. This expansion increases 88.75 sq. km which almost two and half time higher than the earlier in 1984 (Table 4.1) (Mitra, 2005). This process goes very fast which might be alarming for the future as it does not follow any regulations and act as an element of constant pressure.

Table 4.2 Area of Landuse Shown in 1959 Master Plan on Dhaka City

Landuse Item	Percentage of Total Area
Housing and Ancillary Uses	20.1
Industries	3.4
Central Business	0.9
Commerce	1.3
Warehousing and Storage	1.5
Provincial Government Centre	0.4
Government Areas	1.7
Education and Institution Zone (including Hospital)	3.6
Main Roads	3.1
Railways and Railway Land	1.6
Steamer Station and Bus Station	0.1
Open Space	5.1
Cemeteries	0.4
Cantonments (part only)	3.7
Major Reclamation (part only)	14.4
Water Areas (rivers and land liable to flood)	38.7
Total	100

Source: Master Plan, 1959

4.4 LANDUSE SCENARIO OF DHAKA

The physical features, topography and demographic features of Dhaka City have always influenced its expansion. Amount

of landuse in the past three decades for different purposes in Dhaka City is shown in Table 4.2 and 4.3.

It is clear from the Table 4.2 that about 44% land was designed for the open space in and around the Dhaka City in 1959. Within the area, 5.1% was proposed as urban recreation area (park) and rest 38.7% area marked as buffer land for annual flood (Master Plan, 1959). More or less the city was designed to a garden city. Due to socio-political and socio-economic change, the 59's provincial town became the capital of Bangladesh. But, the 59's plan was not updated or revised for the capital of Dhaka. Therefore, unplanned and spontaneous urban growth is the common phenomenon in this city. Proposed 42% land was converted to different uses due to the demand of growing population. The existing urban area became over saturated.

From these two different landuse data sets, it is clearly identified that the significant change was occurred in the housing sector. Within the thirty years, planned residential areas increased from 22.5% to 25% but unplanned residential areas increased by 37%. Where as the urban green decreased by 1.5%. It is important to point out that the 59's plan was prepared for 1.5 million people but that plan was valid until the DMDP Structure Plan was approved.

Table 4.3 Landuse in Dhaka in 1995

Landuses	**Area in hectors**	**Percent**
Planned residential area	2976	25
Unplanned residential area	4444.64	37
Govt. Administrative area	440.8	4
Educational Institution area	236	2
Industrial area	636	5
Other Institutional area	395.2	3
Urban green area	425.6	4
New airport area	616	5
Old airport area	240	2
Cantonment area	1135.2	10
Central commercial area	84	1
Commercial area along road	270	2
Total	11899.44	100

Source : Unpublished Research by Taufique, 1995

The Master Plan in 1959 did not provide a map of the landuse of the Dhaka Statistical Metropolitan Area or the Dhaka Metropolitan Area (Islam, 1996). Surveys conducted in 1991 by the Japanese International Cooperation Agency (JICA) produced a landuse map of the 265-sq. kms of the Dhaka Metropolitan Area. The studies showed that only 19 percent of Dhaka City's land was used for residential purposes, 8 percent on commercial and industrial usage, 11 percent for roads and other categories, 4 percent for village settlements, 45 percent for agricultural usage and a further 14 percent of the capital is occupied by water (GOB, 1991); only 39 percent of the city's land was urbanized while the rest 61 percent was used for agricultural and non-urban rural usage (Taufique, 1995).

4.4.1 Housing Project

Figure 4.1 shows the increasing trend of housing project in last ten years. From this Figure it is revealed that the housing projects becomes double within the ten years period which reflects the popularity, demand of this projects as well as well benefit of this project.

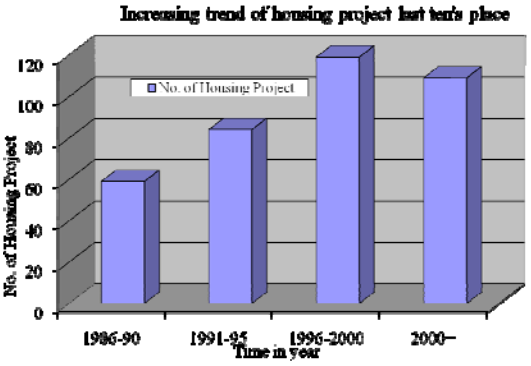


Figure 4.1: Housing project in the city area (Rehab, 2004)

From this study, it is observed that for the lack of controlled, legislation as

well as obligation increases the popularity of this business results mushrooming growth of this projects particularly in the fringe wet land areas. For the lack of controlled and obligation, the developer converting the wet land and water body as a residential areas as described in Article 4.3. Even in sometimes the project is developing by grabbing the restricted wet and other agricultural lands.

4.5 PREVAILING TRANSPORT AND TRAVELING SCENARIO IN DHAKA METROPOLITAN CITY

An assessment of the existing urban transport system of Dhaka revealed that it suffers from major constraints such as fragmentation of organizational responsibility; inefficient regulatory frameworks; insufficient financial resources; poor allocation of road space; presence of too many low capacity and slow vehicles on major roads; poor traffic control, management and enforcement; underdeveloped public transport system; absence of adequate pedestrian facilities; poor linkage between landuse planning and transport development and finally, lack of emphasis on environmentally sound and sustainable transport development.

Various surveys (STP 2004, DITS 1994, JBIC 2000 etc.) undertaken and their analysis revealed the following information about the city:

- The average household income in 2004 was Tk15,000 ($253) per month while 3½% of households was in the "high" income group exceeding Tk55,000 ($920) per month (STP 2004);
- The average number of persons per households in 2004 was 4.12 (STP 2004);
- Among households 7% either have or have access to a car, 4% owns motorcycle, 3% cycle rickshaw, 5% bicycle and 2% auto-rickshaw (STP 2004).
- Almost 84% of household do not have any sort of transport vehicles and depend on public transport and only 16% have some sort of vehicles (STP 2004).
- Among the important purposes (i) home-work 31%, (ii) home-education 25%, (iii) home-shopping and others 36%, and (iv) non-home based trips 8% (STP 2004).
- On average, each household undertook 8½ trips per day by all modes (STP 2004);
- At present, the number of trips that are generated per day is 21.98 million and after 20 years, the trip generation per day that is estimated is 159.63 million in 2024 (STP 2004).
- The average trip length was found to be 5.37 kilometers (STP 2004).
- Buses comprise a small proportion of vehicle numbers (11½%) but carry about 77% of people (STP 2004);
- Rickshaws comprise 28% of all vehicles moving in the city and forms primary travel mode for 34% of all person trips (STP 2004);
- Proportion of trips made by walking is substantial, though according to STP around 22%, DITS estimated that 62 percent; and
- Road space occupied by rickshaws is 73%, and by cars, buses and tempo is 19.7%, 4.4%, and 0.4% respectively (DITS, 1994).
- Among the modes, car occupies the highest space for carrying a person which is 75.8%. Rickshaw occupies 21.9%, Baby taxi 17.9%, bus 8.7% and tempo 5% (STP 2004).
- Autos are a low proportion of vehicles comprising less than 10% of travel;

4.6 EXISTING MODES OF TRAVEL IN DHAKA METROPOLITAN CITY

4.6.1 Vehicle Ownership

Among households 7% either have or have access to a car, 4% owns motorcycle, 3% cycle rickshaw, 5% bicycle and 2% auto-rickshaw. Auto-rickshaw and cycle rickshaw are for commercial uses. The results revealed that 84% of household do not have any sort of transport vehicles and depend on public transport and only 16% have some sort of vehicles. This explains the importance of and dependency on the public transport system (STP survey, 2004).

4.6.2 Purpose of Trips

Travel is made for different purposes. Among the important purposes (i) home-work 31%, (ii) home-education 25%, (iii) home-shopping and others 36%, and (iv) non-home based trips 8%. It shows that less than one-third of trips are made for work or business and rest are for non-work or other travels (STP survey, 2004).

4.6.3 Travel Modes Used

A variety of vehicle and travel modes including private, public and personalized vehicles and walking are used for different trips. For simplified analysis the modes are classified into 4 primary travel modes, walk, rickshaw, transit and non-transit. Transit mode is formal motorized public transport system comprised of bus, rail and waterway services. Non-transit is motorized modes including small motorized vehicles like car and light vehicles, personalized services like taxi and CNG auto-rickshaw and Para-transit like auto-tempo, maxi and human haulers. An STP (Strategic Transport Planning) survey showed that 22% trips are made by walking, 29% by rickshaw, 31% by transit and 18% by non-transit modes.

4.6.4 Variation of trip composition between STP and DITS

According to the results of the STP home interview survey it was found that in 2004 the daily travel made by an average household is 8.5 trips. According to this estimate 2.2 million city households are making approximately 18.7 million trips per day. Among the total trips, walk trips are 2.62 million indicating 14% of all trips, rickshaw and other NMT trips are 6.35 million representing 34%, transit trips are 8.23 million a day representing 44% and non-transit trips are 1.49 million representing 8% of the total trips.

As an interesting comparison, in DITS in 1994 the total trip per day was to the tune of 8.57 million a day, which is approximately 46% of the present trips. The walk trips were 5.15 million representing 60% of the trips while rickshaw trips were 1.48 million representing 17% and transit trips were only 0.38 million trips (2.4%). The average per household trip was 6.2 trips per day.

4.6.5 Growth of Transport Demand

According to the results of the STP home interview survey it was found that in 2004 the daily travel made by an average household is 9.01 trips. According to this estimate 2.2 million city households are making approximately 19.8 million trips per day. Due to rapid growth of population in Dhaka, the projected trip generation per day for the next 20 years period is 159.63 million which is about 8 times higher than the current trip generation per day. For such a large city and huge travel demand, mass transit is a prerequisite for its transportation system.

4.6.6 Growth of Travel Trips

Since DITS 1994 the growth of travel trips has occurred more than 11% per year considering all modes. The growth of trips by vehicular traffic modes was tremendous. The numbered NMT rickshaw trips have increased from1.48 million a day to 5.98 million a day, more than 4 times higher than DITS. The motorized transit mode has increased from a tiny 0.38 million a day to 6.13 million a day more than 16 times higher while the non-transit trips also increased from 0.9 million a day to 3.37 million a day representing approximately 4 times higher than previous study. The walk trips on contrary decline from 5.15 million a day to 4.3 million a day in STP, which is 82% of the earlier figure. The growth of vehicular trips needs special mention as it has increased from 2.76 million a day in DITS to 15.44 million a day in STP, an increase of about 6 times. The unauthorized growth of rickshaws has multiplied the traffic problems in Dhaka.

4.6.7 Growth of Vehicle Fleet

At present the city has approximately one million vehicles including NMT. If the rate of growth of the whole fleet is considered at random, then the city will have two million in 2010, three million in 2015 and five million in2020. Considering the present road space and usual low growth of the city network, this number cannot be accommodated.

4.6.8 Congestion Cost

The congestion is growing day by day in Dhaka like many other developing mega cities particularly in Asia. The situation here is being complicated due partly to the existence of an overwhelming number of non-motorized slow moving vehicles sharing the same road space. The economic loss due to congestion in Dhaka City was estimated at $ 140 million per annum in the major arterials and corridors only (Economic Loss Due to Traffic Congestion, DTCB, 2003). If the congestion in the whole city network is considered including narrow roads, NMT roads, lanes and bi-lanes the figure will go up enormously.

4.7 MODES OF PUBLIC TRANSPORT USED OTHER THAN MASS TRANSIT/BUS

4.7.1 Rickshaw

Rickshaws are three wheeled cycles called cycle rickshaws. It is manually operated giving door to door services to the passengers. The rickshaws normal carrying capacity is two passengers. Because of their size, rickshaws can easily operate on lanes and by-lanes of the city. Although it is slow moving vehicle, rickshaw journey is cheaper and comfortable.

One of the main causes of Dhaka’s traffic jam is the unrestricted playing of rickshaws particularly on the main transport corridor. Reliable estimates of the non-motorized vehicle fleet are difficult to obtain. DCC (Dhaka City Corporation) limits the number of license issued to rickshaw owners to some 79,000. However, unofficial estimate claimed that the number of rickshaw playing in Dhaka is about 500,000 (STP, 2004).

4.7.1.1 Profile of Rickshaw Puller

An attitudinal questionnaire survey was made in this study on the rickshaw puller of Dhaka city. The questionnaire has been designed into two parts. One was to evaluate the current status of rickshaw puller and other was to assess the knowledge and level of understanding on traffic rules and regulations and road signs and markings of rickshaw puller. In the person-to-person questionnaire survey, almost 14 questions with six sub-questions have been asked to the rickshaw puller. Through the location of the survey has been selected randomly in the city, higher number

of sample have been collected from the old Dhaka as the intensity as well as dependency on rickshaw of the user of this area is much higher than any other areas of the city.

In reply to a question on "location of home district" by the respondents, it is evaluated that rickshaw puller are not coming form some particular district or a particular region. Rickshaw puller are coming from almost all over the country. Among the respondents, 40 percent are come from the east Bengal like Kishorgon, Sunamgonj, Mowlavibazar district followed by south (22%) and north Bengal (22) like Potuakhali, Barishal, Sirajgonj, Dinajpur, Kurigram etc.

Almost all of the rickshaw puller lives in the fringe areas where socio-economic condition is very low compare to the other areas of the city. Among the respondent it is found that almost half of the puller live in Kamrangir char area followed by Lalbagh, Keranigon, Kafrul, Inrahimpu, Mirpur fringe area, Hazaribagh, Pagla, Islambagh etc.

From the questionnaire survey, it is also found that almost 90 percent of the rickshaw puller pull their rickshaw on hire basis. Among the respondent, 63 percent mentioned that they provide rent 80 TK for per full day and for half day, 40 to 50 Tk. From the discussion about hiring of the rickshaw, it is fond that the rent of the rickshaw varied on the originality of the number of rickshaw. If the number of rickshaw is original then its rent is around 100 and if they use duplicate number then the rent is 70 to 80. In the survey, it is found that only 14 percent pullers provide 100 TK rent per day. Almost 85 percent of the rickshaw puller, who pull personal rickshaw, bought second hand rickshaw because of in particular low cost. Among them, 43 percent bought their rickshaw by 5000TK only and 29 percent by 6000 TK and 14 percent by 4000 TK only. The price of a new rickshaw varied between ten to fifteen thousands taka. At the period of survey a large number of puller (8 %) mentioned that they pull rickshaw half of the day because of shortage of rickshaw.

In the survey, they were asked how many years they are pulling rickshaw. With this three connecting questions have been asked, have they participated any training program in this period, what did they do before this work and why did they involve in this job. Among the respondent it is found that almost 32 percent have involved in this profession within the last 1 to 5 years, followed by 28 percent 6 to 10 years, 27 percent 11 to 15 years, 10 percent 16 to 20 years and others 6 percent upto 20 years. Among the respondents, only 8 percent have participated in a formal training program and others 92 percent have not any formal training. They respondent who are participated in the training program have mentioned that they participated in the training program at the Earshad period. According to their opinion, after Earshad government, no formal training program has been organized for the rickshaw puller (Field Survey, 2009).

Almost 26 percent of the respondent was farmer before starting this work. Among the others, 20 percent was tempo driver, 18 was doing daily basis job in different sectors, 10 was daily worker, 10 percent was garments and other factories worker, 10 percent was businessman. Almost 26 percent replied that they come to this profession only for poverty. About 22 percent replied for more income, 18 percent replied that they did not find any other job and 12 percent mentioned that it is easy to do. A significant number of respondent come to this profession because of loosing every thing by river erosion (8%) and by accident (4%). About 8 percent puller mentioned that they are seasonal puller and involved this work for un-season of their main job. In this survey, they were asked about their daily income. Almost 32 percent replied that their daily income per day 251 to 300 TK, followed by 28 percent 201 to 250 TK, 28 percent 301 to 350 TK and 12 percent 100 to 200 TK (Field Survey, 2009).

In the questionnaire survey, it was tried to evaluate the percent of original number of the operating rickshaw. To find out this, in the discussion with the respondent they were tactfully asked about the number of rickshaw. Almost 62 percent agreed that the number of their rickshaw is duplicate. But if we consider the rent or hired value of the rickshaw, the percent of duplicate number rickshaw is more high and that would be nearly 80 percent. Even, in the cantonment area where

enforcement of legislation as well as traffic rules and regulation is very strict, almost 20 percent rickshaw puller among the respondent agreed that the number of their rickshaw is duplicate.

To assess the knowledge and level of understanding of traffic rules and regulations and road signs and markings of rickshaw puller, three questions with six sub-questions have been asked to the rickshaw puller in the second part of the questionnaire survey. In reply to the direct question on the level of understanding of the traffic rules and regulations and road signs and marking, almost 50 percent respondent mentioned that they know most of the rules and regulations, understand majority of the sings and markings, 18 percent replied that they fully understand the signs and markings and only 32 percent said that they do not understand signs and markings. To access their actual understanding on sings and marking they were asked six sub question showing demo picture coupled with real scenario about five signs (no parking, no stopping, pedestrian crossing, school ahead and stopping) and one marking (double solid). Surprisingly, there has not found any one who could provide correct answer of all the showing sings and markings, even there was not found any one who could provide 50 percent correct answer among the respondent. From this survey it is fond that none of the respondent understand that the real meaning of stop sign and double solid. About 22 percent of respondent understand the meaning of pedestrian crossing sign, 14 percent school ahead sing, 6 percent no parking sing and only 2 percent no stopping sing (Field Survey, 2009). From these results it is evaluated that almost 99 percent of the rickshaw puller do not understand most of the major road signs and markings. Even, they don't know that their conception or understanding on the road signs and markings is wrong and has not the realization that they need comprehensive training on this.

From this survey it is also evaluated that almost 50 percent of the rickshaw pullers have not any formal educational background i.e. illiterate. Around 34 percent of the respondent's educational level within class one to class three. Among the respondent, 6 percent were found who passed the primary level.

4.7.2 Auto Rickshaw

The auto rickshaws are three wheeled mechanically operated vehicles, whose body is generally manufactured locally but the chassis along with the engine is imported from foreign countries. The auto rickshaws carrying capacity is three persons at the back and the driver in the front. The auto rickshaws are mechanically operated and can run on long and short distance. They are operated like rickshaws, taking the passengers to their destination and not stopping to pick up other passengers on route. The charge of auto rickshaw is 6 Tk/km and a minimum flat rate of Tk 18 (BRTA, 2008).

4.7.3 Auto Tempo

The auto tempo is like the auto rickshaw based on three wheeled scooter chassis, but instead of three seats behind, it's seat arrangement is such that it can carry 10 persons at the back and two persons at the front, beside the driver. The auto tempo generally travels on specific routs. The style of operation of the auto tempo is similar to a bus rather than auto rickshaw. They play between defined points and on a defined route and pick up and drop passengers at those points or stoppage. Like the auto rickshaw the speed is same with the auto tempo as they both have the same engine (BRTA, 2008).

4.7.4 Taxi Cab

The taxicabs are like the passenger cars but are operated by a company or by an individual and available to all persons who meet the conditions of a contract for carriage (i.e. pay prescribed prices). There are mainly two types of taxicab, yellow and black taxicab. The carrying capacity of yellow cab is 4 persons and that of black cab is 3 persons. They run on metering system and fare

rate of AC taxi cab is 10 Tk/km and a minimum flat rate of 40 Tk and the fare rate of black cab are 8 Tk/km and a minimum flat rate of 30 Tk (BRTA, 2008).

4.7.5 Percent Modal Split

The latest surveys of persons movement in metropolitan Dhaka under the Dhaka Urban Transport Project showed walking as the predominant mode with a share of 62 percent of total person trips. This is followed by rickshaw (13.3%), bus (10.3%), auto rickshaw (5.8%), and car (4%). In considetation of person trips by vehicle, rickshaw takes the highest share, accounting for 35 percent followed by bus (21%), auto rickshaw (1.5%), and car (10.5%) (JBIC, 2000).

It has been observed that rickshaw and walk trips have declined in the form of percentage of person trips in recent years (Hossain, 2002). Trend in change of modal split is towards motorized auto rickshaw from non-motorized rickshaw and walking. Absence of efficient mass transit is responsible for high share of passenger trips taken, by auto rickshaw. It is causing congestion and deterioration of environment (Hoque, 2004)

4.8 EXISTING MASS TRANSIT SYSTEM OPERATION IN METROPOLITAN DHAKA

Existing mass transit system in metropolitan Dhaka is mainly characterized by large bus, mini bus and human hauler/auto-tempo. Bus and minibus routes tend to be concentrated along the limited number of arterial roads, in a generally north-south orientation. Human hauler routes are more dispersed, penetrating narrower roads, and include more east-west linkage.

4.8.1 Large Bus

Large buses are defined according to regulation as buses with more than 32 seats, but more generally large buses are considered to be ten (10) meters or more in length. The most significant recent change in the bus fleet composition is the increases in the number of large buses. This trend began with Sino Dipon in early 2003. They are now operating on four (4) routes with 105 buses. Green Express, which began operations in April 2004 with 20 buses, currently has 50 buses in operation on two (2) routes, and will shortly add 50 more buses. Beveco, commenced operation of 20 large buses on the Uttara to Motijheel route in August 2004. Dhaka Paribahan, a major mini bus operator in Dhaka, has recently improved 10 large CNG buses from China, which will likely be used to replace existing mini buses. All of these buses are running on CNG. The BRTC, which operates under immunity from regulation by licensing authorities, owns a total of 306 buses operating on 15 routes in Dhaka. Of these, 203 are double-decker buses (older Ashok Leyland and new Volvo) and the remainders are standard 12 meter single decker buses. BRTC does not actually operate the buses, but sub-contracts out the operations to private operators (STP, 2004).

4.8.2 Mini Buses

Mini buses are defined as buses with 15 to 30 seat capacity, excluding the driver. Most mini buses are around 8 meters in length, with locally manufactured bodies and Isuzu, Hino or Tata chassis and engines. The number of mini buses has increased rapidly since 2000. Current numbers are imprecise, but various estimates indicate that around 5,000 mini buses are in operation in Dhaka, around 2,000 of which are operating without permits or in contravention of allocated routes (STP, 2004).

Since April 2004, the Road Transport Committee (RTC) has resolved to limit the issuance and duration of new route permit of mini buses running on diesel fuel or under individual management. Although the permit system has only a limited relevance to the number of buses actually playing on the route, this change in policy approach appears to be having some effect, as

new operators are beginning to use large buses (STP, 2004). Table 4.4 shows that parametric comparison of different public transport modes in Metropolitan Dhaka

Table 4.4: Parametric Comparison of Public Transport Modes in Metropolitan Dhaka

Mode types	**Passengers boarding at peak hours (nos.)**	**Load factor**	**Avg. trip length (one way) km**	**No. of trips/ day/ vehicle**	**Passenger km per day per vehicle**	**Journey speed (km/hr)**	**Fare demand (Tk/km)**	**No. of conductor or helpers**
Rickshaw	2	1	4.8	35	252	9.3	2.7	Nil
Baby taxi	3	1	8	22	396	10.8	5.4	Nil
Mishuk	3	1	6	22	297	15.2	5.1	Nil
Auto tempo	12	1.2	6	18	927	21.9	0.47	1
Double Decker bus	102	1.4	14.5	12	8874	15.5	0.25	2 to 3
Single Decker bus	77	1.5	14.5	12	6700	15.5	0.25	2 to 3
Private bus	77	1.5	14.5	12	6700	15.5	0.25	2 to 3
Mini bus	42	1.2	16	14	4704	18.3	0.37	2

Source: STP 2004

4.8.3 Human Haulers/Auto-Tempo

Human haulers are 9 to 15 seated, generally in the form of a converted pickup truck with two benches added for passenger seating. Most have diesel engines, although some are petrol fueled and a small number have converted to CNG. A total of 1,609 route permits had been awarded to human haulers as of June 2004, operating on 45 routes (STP, 2004).

4.8.4 Use of Bus as Public Transit

An attitudinal questionnaire survey was made by STP in 2004 on public transport. In reply to a question on ‘reasons for using bus as usual travel mode’ respondents said they preferred bus journey because of various reasons. Almost 73% said it is cheaper, 69% said they don’t have any other alternatives, 31% said it is more or less reliable, 21% said it save time, 26% said it is convenient and comfortable too and 22% said it is comparatively safer. Only 10% said that they take bus because they cannot use their car to get to their work place due to the problem of parking (STP, 2004).

4.8.5 Average Trip Length, Travel Time, Speed and Carrying Capacity of Existing Mass Transit System

STP conducted a survey on Average trip length, travel time, speed and carrying capacity of existing mass transit system and got the following scenario (Table 4.5):

Table 4.5.: Average trip length, Travel time, Speed and Capacity of Existing Mass Transit system

Mode	Average route length	Average journey time (min)	Average travel speed (km/hr)	Average running speed (km/hr)	Average Boarding (Passenger)	Pass-load at max. point	Average Stops
Mini bus	20.12	65.0	17.14	23.19	79.27	39.1	16.56
Large bus	14.7	71.09	13.7	17.8	89.6	44.9	12.3
Double Decker	17.81	56.83	17.22	23.45	100.76	83.71	13.67
School/Staff bus	13.5	37.25	20.9	23.0	44.4	43.4	7.8
Auto-Tempo/Maxi	5.8	22.0	17.0	20.1	18.4	14.7	5.4
All mode	14.54	50.6	17.24	21.71	60.3	34.78	12.0

Source: STP Survey, 2004

4.8.6 Vehicles in Greater Dhaka

The vehicle fleet in Dhaka city comprises both motorized and traditional and modern non-motorized vehicles. Motorized vehicles although they have problems of accuracy they are registered with BRTA but non-motorized vehicles particularly the statistics for rickshaws and rickshaw vans are absent. Table 4.6 presents the position of cumulative registered vehicle fleet in Dhaka which is given in the next page.

Table 4.6: Registered Vehicle Fleet in Dhaka (Cumulative)

Vehicle type	Before 95	2006	Growth (%)
Motor Car	36998	105636	14.27
Jeep/Station Wagon/Microbus	17937	42356	10.47
Taxi	787	10672	96.62
Bus	269	5070	137.29
Minibus	2009	8021	23.02
Truck	9775	24363	11.48
Auto rickshaw/ Atutotempoo	8359	39829	28.96
Human Haller	**	829	
Coverd Van	*	527	
Motor Cycle	61478	156334	11.87
Others	2063	18903	62.79
Total	139675	412540	15.03

Source: BRTA, 2007

Among the fast growing vehicles percentage is the increase of large bus (137%) and mini bus (23%) surpassing growth of cars (14%).

DCC stopped registering the NMT in the city since 1989. The number of registered non-motorized vehicles mostly the cycle rickshaw and rickshaw van is 87,000 (1989). Stopping registration of rickshaw did not stop their growth. Rather it increased at an ever-faster rate than before. This is generally believed that Dhaka has at least 500,000 unregistered rickshaws most of which are operated illegally (STP, 2004).

4.9 OVERVIEW

The historical landuse pattern as described in the Article 4.2 revealed that the Dhaka city is not developed in a day. It has almost 400 years development history. But real thing is that the city is developing following such a which was at the initial stage. Some of the organized activities or initiatives are seen in the background considering some part of the city, but for the lack of controlled and legislation thatare not sustain for a longer period and so far the city is developed almost unplanned way which poses serious problems in different sectors of the city that's are described in the following chapters.

Prevailing transport scenarios are also highlighted in particular transport operational and management characteristics, public transport as well as mass transit system. Data has been collected from the different previous project and study reports couple with field and questionnaire survey. The prevailing characteristics which has been described in this chapter will act a background of the identification of the inherent weakness of the transport operation and management system in Dhaka city which is described in Chapter 7.

CHAPTER 5

DEFICIENCIES OF LANDUSE AND TRANSPORT PLANNING

5.1 INTRODUCTION

According to the description of the Article 2.3, the urban landuse and transport are inexorably inter-linked and the connection between transportation and landuse is a fundamental concept in transportation. Everything that happens to landuse has transportation implications and every transportation action affects landuse. Transportation developments are carried out to improve accessibility and mobility (Article 2.11-12). Accessibility and mobility is the fundamental of transportation planning. Accessibility can be measured by the number of travel opportunities or destinations within a particular travel radius, measured in terms of either travel time or distance. And mobility is a measure of the ability to move efficiently between origins and these destinations. Thus, mobility is directly influenced by the layout of the transportation network and the level of service it offers. Land development generates travel and travel generates the need for new facilities, which in turn increases accessibility and attracts further development (Hossain, 2003).

On the other hand, traffic is the function of activity. Concentration of activities gives rise to concentration of traffic. The spatial distribution of activities is called landuses. Hence landuses have large impact on transportation system. In effect, landuses are the generators of traffic. What type of traffic and how much traffic will be generated in a particular place simply depend on the type of landuses and distribution of landuses within the urban context. That is, the deficiencies of landuse are also treated as the deficiencies of transportation. However, evaluation of landuse deficiencies is highly required to identify the inherent weakness of transportation system. In this chapter, an attempt has been made to analyze transportation weakness due to landuse and associated planning deficiencies. To achieve this objective, data has been colleted particularly from the secondary source viz. previous study report, different organizations like JICA, JBIC, WASA etc. Besides, primary data has been collected field survey, road inventory and onsite investigation. A brief description of the identified weakness are provided in below:

5.2 GROWTH OF POPULATION

From the different literature and survey reports, it is revealed that the population of Dhaka increased from a modest figure of just over one million in 1971 to more than 10 million in 2001 in Dhaka Metropolitan city. Since independence in 1971, population of Dhaka began to increase rapidly. In 1974 (no census occurred in 1971 due to the Liberation War) the population was recorded about 1.77 lakh. With such rapid growth, the area of urbanization expanded beyond Dhaka District and Dhaka City Corporation limits. Figure 5.1 show the number of population in different years in the period of 1600 to 2001 and Figure 5.2 represents the fluctuation of growth in different times. From the Figure 5.2, it is revealed that the growth of population of the city was not smooth and homogeneous over the period. The trends of population growth perform a great high jump within the period of 1970 to 1985. The comparative advantage of size, its central

location and its administrative and other functional importance have caused a rapid and unpredictable growth of the city's population, particularly during the last 5 decades. During this time Bangladesh as a whole has experienced an extremely rapid growth of urban population. The city had only 0.33 million people in 1951, 0.55 million in 1961, 1.60 million in 1974, 3.44 million in 1981 while in 2001 the population rose to 10.7 million (Figure 5.1). Different UN bodies have already projected in their reports last year that Dhaka is going to be the second most populated city by 2015, next to Tokyo, with a growth rate of urban population at 3.1 percent per year. Few cities in recent history have experienced as rapid a population growth as Dhaka. Those amongst us here who have lived in this city from before or since 1951, has witnessed a phenomenal transformation of an urban system and of urbanism. From a small city of only 335,928 in 1951, it is now a mega city of over 10 million people, a thirty times increase in about 50 years. The average annual growth rate of Dhaka City's population during the last three decades has been over 7%, thus doubling its population every decade. A booming of population occurred at the early eighty with a growth rate around 13 percent per year. The rate of growth continues to be high even now, at nearly 6% annually. The accommodation and shelter facilities did not grow with the growth of population results haphazard and unplanned development of the different areas of the city to survive in the city area.

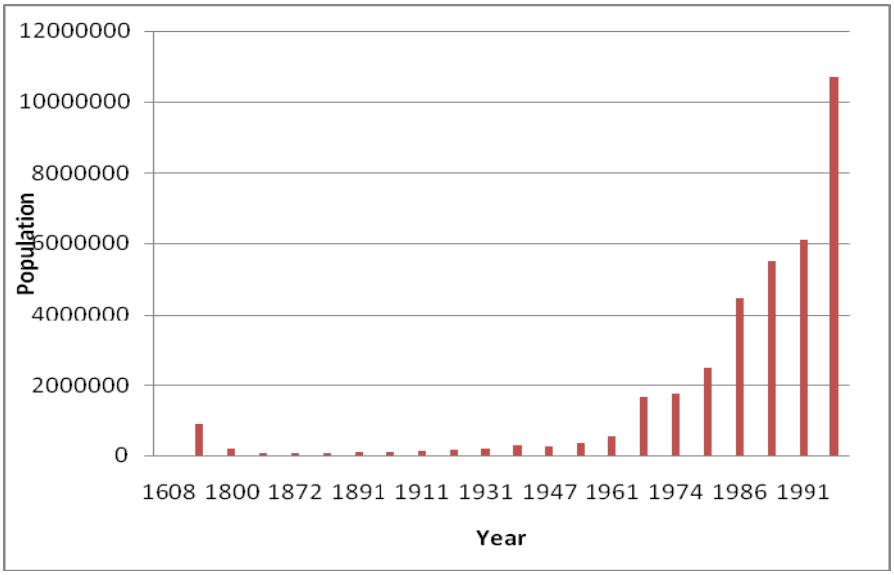


Figure 5.1: Population of Dhaka 1600-2001 (Neema, 2003)

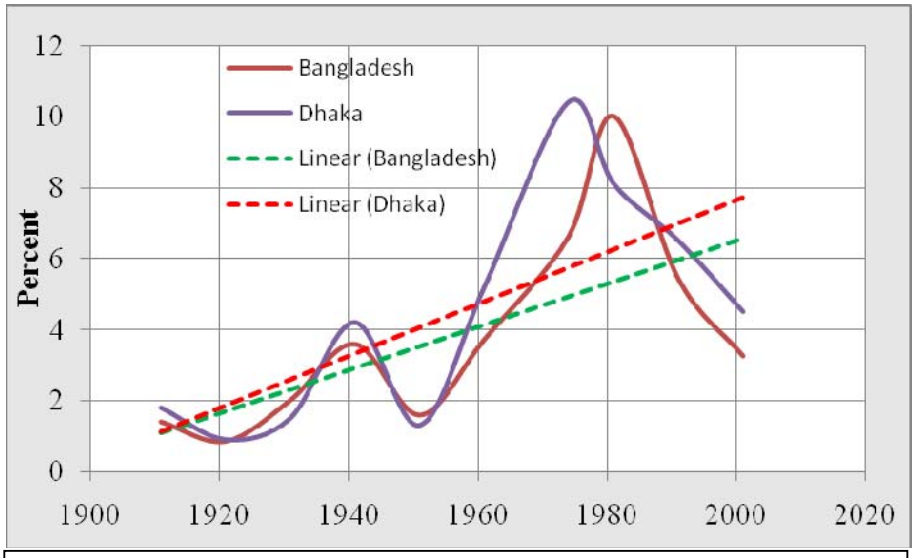


Figure 5.2: Annual Urban Population Growth Rate in Bangladesh and Dhaka (Source: BBS- 1997, BBS- 2001)

Meanwhile, of course, the a real limits of the city has also expanded from only 28 square miles (73 sq. kms) in 1951 to the present 590 square miles (or 1530 sq. kms). This extended metropolitan Area (or the metropolitan region) has been officially called the Megacity by BBS in the 1991 Census, as opposed to its previous identity as a Statistical Metropolitan Area. Megacity Dhaka, is an agglomeration of Dhaka City Corporation, four other municipalities such as Narayanganj, Tongi, Gazipur and Savar, several cantonments and a very large number of rural settlements, stretches of agricultural lands, wet lands, rivers, and even part of the Modhupur forest.

Dhaka too has grown very fast and the forefather of the city or city authority could not predicate that the population of the city will jump in this dramatic way. The great example of that is the master plan of 1959 which was developed assuming 1.75 percent of annual growth rate of population but actual growth rate of the city is almost three and half times higher than the assuming rate (1959 master plan) (Figure 5.1). So, city infrastructure was not planed for such huge number of population results the control of the planning of the city has been expired and the city has been developed in indiscriminant way. Bulk of employment opportunities attract people previous times and by the process diminish scope of further accommodation. But people have continued their migration and thereby seriously deteriorated many of the system components of the city. Transportation system has already reached at a crisis level due to this heavy influx of population.

However, the major factor that brought serious landuse and transportation problems in Dhaka City is the rapid unpredicted growth of population and associated indiscriminate landuse patterns. It is also revealed that main reasons for rapid growth of population are the centralization of development works, centralization of political & administrative power, high investment in already developed areas, potential employment opportunities, discrepancy of income level between the city and other regions of the country. This problem is one of the fundamental problems which are the source of many other problems in the city.

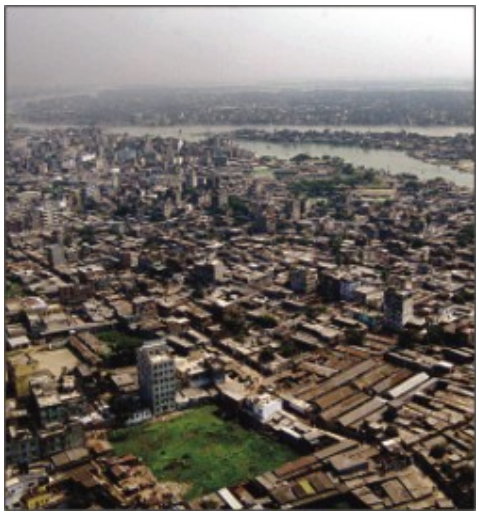
5.3 URBANIZATION IN DHAKA: LEGISLATION AND CONTROL

It is general phenomena that a city will be developed according to its master plan particularly detailed landuse plan. Master plan will dictate the future development pattern, expansion process of the city. It will also indentify and control unauthorized, unplanned development of the city. On the other hand Dhaka city is an uncontrolled and unplanned urban sprawl, totally chaotic, inefficient. Excepting a few main arteries of transportation and some small areas, the city is actually a vast unplanned growth, consisting of slum conditions, detrimental to the healthy growth of the society. As described in the literature review, 3 master plans and 7 construction acts and improvement act have been developed for the guidance and control of Dhaka city development since 1952 (Chapter 2, Article 2.19.1). Though several planning documents have been prepared to regulate and control development but in reality the application and execution of the proposed policies is not worth mentioning. This planning was just a guideline for the development of a city and RAJUK was supposed to get it done either by itself or through local consultants. They initiated the process at one point but nothing happened after that. Although, the prediction of the demand of the population was the initial fault of the city planner, the master plan which has been developed in different times had huge deficiencies and weakness.

Failure of government intervention to guide and control land development process is primarily responsible for uncontrolled conversion of wetland to urban use. Though urban landuse policy has been prepared where restrictions have been imposed on conversion of wetland or agricultural land but its application is almost absent. Failure of government in this regard can be summarized as follows: (a) Absence of proper landuse regulation and act; (b) Failure of application of existing regulation; (c) Absence of political will (d) Corruption; (e) Long time to complete the detail area

plan, the third component of DMDP Structure plan (1995-2015) and Detail Area Plan (DAP) for the city; (f) Lack of coordination with different organization involved with protection and management of lands (Ishrat, 2005).

Finally, a new 20-year plan, known as the Structure Plan/Master Plan, was approved in August 1997. The DMDP was initiated in 1992, completed in 1995 and officially gazetted in 1997. But it took around a decade for RAJUK to initiate framing of Detail Area Plan (DAP) in November 2004 and not yet completed. Whereas, DAP should have been completed by 1997 along with the Structural Plan and Urban Area Plan of the DMDP. DAP has to be details of the Structural Plan and Urban Area Plan but it has not been framed even after 12 years of preparing those two plans. It is argued that RAJUK'S delay in preparing the DAP facilitated the private land developers' bid to destroy city's topographic landscape and natural environment, wetlands, flood retention basins and open spaces within and in the periphery of the city. Geographical and topographical features of the city have been altered recklessly in absence of the DAP during the past decade (Nabi, 2006).



Photograph 5.1: In the Absence of a Detailed Area Plan Mushrooming Unplanned Buildings have Turned The City into a Concrete Jungle (Courtesy: The Daily Star).

The city is being extended outward more than planning. The authorities are neither prepared nor seriously concerned about preparations for future. The Rajdhani Unnayan Kartripakkha is still waiting to implement the master plan of 1995 which was also made under the guidelines of the 1959 master plan. The administration and management style is so outdated and corrupt that more than 80 percent of city buildings were constructed without appropriate planning (Islam et. al, 2003).

Very little, and if at all, effective effort went into the planned growth of the metropolis. No proper law exists for the planning and control of the development of the city. The Municipal Act and other regulations for control of buildings were more conspicuous by their violation than their implementation. Control mechanism is so ineffective that it is possible to put up buildings indiscriminately for the benefit of individuals at the expense of the community. These conditions have brought about the present chaotic state of the city.

Whenever there is no comprehensively planned development of a city and all the development is controlled by speculative motives, examples like Gulshan-Banani-Dhanmandi are bound to be created to cater the demands of a small minority who control the socio economic mechanism. It is obvious that the present lopsidedness of landuse reflects the inequality of the existing socio economic structures. These conditions are doubly highlighted when one see a vast number of city dwellers are living in slums and hovels, multistoried or otherwise, within the city limits. The other problem is that if a city does not grow according to a guideline, then the whole system gradually collapses. Political interference happens everywhere but here it has descended to the level of greed and this is the unfortunate reality in Dhaka city.

However, from the intensive literature review commensurate with the field observation, opinion survey and discussion with the professionals and policy makers it is evident that in spite of 11 acts, policies, action plan within 50 years, the city has been developed with immense lack of legislation and control. All the legislation was on the discussion and paper work. Indeed, there has not any plan, guidelines or act in the several decades particularly after the independence. Unfortunately, the population as well as infrastructural boom occurred in that period results

haphazard, unplanned development takes place at the formation as well as foundation level of the city. This uncontrolled and unlegislated growth leads to the many other problems of the city and this is one of the major inherent weakness of the city as overcome of this planning problem is almost impossible.

5.4 FRINGE AREA DEVELOPMENT

Urban fringe areas can accommodate large number of additional population and business activities if properly planned. It discussed that Dhaka is growing both in terms of population size and geographic areas. Like many other cities of Asia, Dhaka is also facing crucial challenges regarding the development in the peripheral area. In most of the cases, new development in the fringe areas are preferred than redevelopment of the inner city areas.

As discussed in Chapter 4, Article 4.3, almost 90 percent of these fringe areas are growing by private individual initiatives without following any plan and regulations (Map 5.6). In addition to planned satellite cities to accommodate growing population, encroachment of fringe areas for urban uses is a widespread occurrence especially by the Private Land Development Companies (PLDC). But the issue gets alarming when such growth become aggressive from environmental, transportation and socio-economic perspective. A close scrutiny of the city development reveals that most parts of Dhaka have developed in an unplanned manner particularly newly developed fringe areas whereas very few parts have been developed in a planned manner (Map 5.6). In this process private sector played the dominant role while public sector limited itself to infrastructure development and service provision.

To accommodate the additional population, DMDP has stated several spatial development strategies, such as- Optimizing Dhaka's Existing Urban Land Resources by i) consolidation, i.e. infill development within the existing urbanized area, and ii) accelerated development, i.e. adoption of policies which aim at accelerating and achieving more cost effective development process of recently converted areas for urban use and iii) Planned New Area Development

Photograph 5.2 Fringe Area Developments by Developer

Photograph 5.3 Fringe area Developments by Individual Owner

through promoting and developing affordable land delivery policies and mechanisms, in partnership with the private sector where necessary by infrastructure-led development initiatives (ILDls). All these strategies have already been started in the city but not in a planned way.

From the field observation, it is also evaluated that conversion of fringe land from agricultural use or wetland to urban use is a common phenomenon. Among the urban uses, residential use is most dominant. Though in recent years, private developers are playing an important role to transform fringe land to residential uses. But traditionally, individual owners of this fringe land acts as a significant force in this transformation process. The conversion of this fringe land into residential use area was done by the individual owners to a large extent.

On the other than, owners of rural land become the land developers and land sub-dividers in the fringe area. They subdivide their land themselves without any approval from the government authorities as a result the road patterns and building plots are often laid out in a haphazard manner. Since most land on fringes of Dhaka City is low and liable to annual flooding, the individual households generally develop it, by earth filling. This extensive earth filling in an unplanned manner would obviously result in environmental disaster.

After all, development by developer particularly big project like Banashree, Basundhara is quite better than the individual developer is. At least in these areas there is preplanned road fabric. Photograph 5.2 and 5.3 provide a sharp difference between the development of fringe areas by developer and individual owner. But, from the above discussion and the discussion is made in Chapter 4 Ariticle 4.3 it is revealed the overall development pattern of the fringe areas almost unplanned and uncontrolled as like occurred at the beginning of the Development in Dhaka city i.e. old Dhaka. Indeed, development pattern by individual owner is more haphazard and unplanned than the private initiatives and developer. This development phenomena of the fringe areas would be same problematic as like as old Dhaka. Therefore, what is the city achieving, where is the progress; same feature, same pattern, same landuse and transport development trends which was almost 100 years back.

5.5 DEVELOPMENT OF ROAD NETWORK

In this study, the development pattern of the city is analyzed through reviewing different reports, discussion with the experts to identify the weakness at the development level of the city road network. A brief summary of the pointed outcome are provided in below:

Before Independence:
By the end of the 19th century, The Dhaka City, was hemmed in between the Burhiganga River and the railway line. Dhaka was connected for the first time with Narayanganj by railways in 1885 and later in 1886 the railways extended up to Mymensingh. In 1905, Dhaka was made the capital of the new province of East Bengal and Assam, allowing further development of roads and proper drains, as well as fully planned residential areas like “Wari”, an upper-middle class area considered “the sanatorium of Dacca.” The gird pattern of road was introduced in Dhaka City for the first time in Wari and Gandaria. Roads in these areas were wider than those in the Mughal Dhaka but not as wide as those of the Ramna Civil Lines.

Prior to 1864 the roads of Dhaka had no names. Only mohallas had names, such as Kasaitoli, Patuatoli and Mughaltoli. It was only with the establishment of the Municipality in 1846 that the roads in this town began to be named. In 1961- 62, there was a total of 110 miles of municipal roads of which 44 miles were tarred or cemented, and 50 miles brick metalled, and 16 miles kutcha fair weather roads (DCC, 2004).

After the partition in 1947, Dhaka became the provincial capital of East Pakistan. Size and population of the city increased rapidly. The residential areas (Except Ramna) classed as high in 1947, have lost their dignified status. Ramna has expanded northward and eastward to include more areas in upper-grade category and a new high-class area has developed in Dhanmondi.

With the creation of the Dhaka Improvement Trust (DIT) in 1956 (transformed into the Rajdhani Unnayan Kartripakkha in 1987) greater interest and care was undertaken in road construction and city planning. The DIT developed the Gulshan Model Town in 1961, Banani in 1964, Uttara in 1965 and Baridhara in 1972 (though first conceived in 1962). The Dilkusha Gardens adjacent to Motijheel came to be engulfed by the ever-growing commercial needs. In the mid-1960s the main railway line was shifted and directed eastward. The Dhaka Railway Station was moved from

Fulbaria to Kamalapur but the vacant land haphazardly occupied by the construction of multi-storied buildings in front of the city authority, in sometimes with the auspicious of the city authority. This eliminated the landmark that had long stood between the 'old Dhaka' of the Mughals and the 'new Dhaka' of the English. The rapid growth and development of the area between the old railway track and Kawranbazar necessitated this change.

With the increasing of population and city size, a faster vehicle, rickshaws, was introduced. Through some motorcars were available at that time, they were few in numbers. "Privately owned bus system was introduced in the city in 1950. This was insignificant to meet the demand of the people. Thus the government introduced EPRTC (East Pakistan Road Transport Corporation) in 1961. The combined fleets of' EPRTC and private buses were operating in the following routes, Sadarghat-Rampura, Gulistari-Banani, Gulistan-Mirpur, Gulistan -Deinra, Gulistan-Mohammadpur. Later routes like Gulistan-Adamjee and Gulistan-Agargaun were introduced. (Firdous, 1984).

After Independence:

The war of Liberation in 1971 caused huge damage to the fleet. After the independence, city size and population grew in an unprecedented speed. Numbers of buses could not keep pace with the increased demand of the increased population. All types of vehicles increased very rapidly particularly public transport like bus. Transport system gradually turn on road based and demand on road network increases rapidly. But with the increasing demand, planed road network was not expanded to fulfill the requirement.

At this stage, the road network development takes place in an amalgam of actions and inactions that have evolved over a long time in distinct and often disparate ways that prevailed at such times. Such as: well planned, formal, residential areas (e.g. Dhanmondi), with well conceived, designed, and implemented road networks to serve low density residential development, now reeling under the adverse impacts that are the consequence of much higher density residential development coupled with the effects of excessive commercial activity. Unplanned, informal, residential areas (e.g. Badda, Kafrul, Goran, Malibagh, Rampura and Bahsaboo), where little or no planning for roads has occurred, and existing roads are a disorganized agglomeration of narrow, circuitous alleys and paths first established on an ad hoc basis when settlement first started and reinforced and informal development occurred, also on a seemingly ad hoc basis.

In the last three decades, most of the major roads of the city developed by executive order by army government particularly Ershad government where as a city road network should be developed by proper plan which may be longer term or shot term basis but not by executive order and local roads on the donated land by the local initiative results unplanned, inaccessible, non-functional road network (Map 5.1).

The list of projects during Ershad period provided below which have not been developed in according to long term master but executive order as a piecemeal solution.

- New road: English road, Rokeya Sharani, Progati Sharani,
- Missing link: Bijoy Sharani, Panthapath, Banglamotor, Tikatoli,
- Widening of roads
- Bus terminals establishment

Map 5.1: Major road developed during Ershad Government

- Rearrangement of Gulistan terminal area
- relocation golashaha mosque
- correction of road width at tejgaon by demolition of government staff quarter
- flood embankment project

Among the total primary road of Dhaka city, almost 25 percent (16 km) developed by this government. Besides, more than one kilometer secondary road has been constructed by the Ershad government. After the Ershad government, three elected government have been passed but unfortunately not a single functional primary or secondary road is constructed in this 15 years period in the city area. Even, the road which has been constructed by executive order, that roads are not properly functionally maintained like access controlled, side road entry restriction, road side development management etc for the lack of proper planning and weakness of related institution. Indeed, except two ramps in Mohakhali, and Khilgaon, no remarkable additional transport infrastructure has been developed after the Ershad government in the city. Ershad government developed western flood embankment project, eastern flood embankment project didn't developed within the past one and half decade. Ershad government relocate bus terminal from Fulbaria in three different entry place and that's existing in same place. That government did not establish track terminal, no track terminal is developed yet in the city area. Whereas, the space which has been opened by relocating the bus terminal from Fulbaria, that's are developed haphazardly without providing parking space, service road, bus layout, wide footpath, there are constructed multistoried market, office and residential building etc. Even existing footpath is occupied by vendors, hawker etc. DCC or Rajuk couldn't maintain it properly. All of the space sold for incoming money. Even road side series market is allowed in the Fulbari and Gulistan area results full block the single east-west continuous connecting road of the city. So, overall development of the city as well as the transport network progress in fully wrong way and at present the city come to extreme level form where undo is almost impossible.

5.6 TOPOGRAPHY OF THE CITY

The elevation of Greater Dhaka is 2 to 13 meters above the mean sea level (MSL) and most of the urbanized areas are at elevation of 6 to 8 meters above the MSL. The land area above 8 meters MSL covers about 20 square kilometers. The land ranging from 6 to 8 meters MSL covers 75 square kilometers (20% of DMA) while 170 square kilometers (29 %of Greater Dhaka Metropolitan area) of Greater Dhaka is below 6 meters (JICA, 1991 and SOB, 2004). Figure 5.3 shows the digital elevation of Dhaka City.

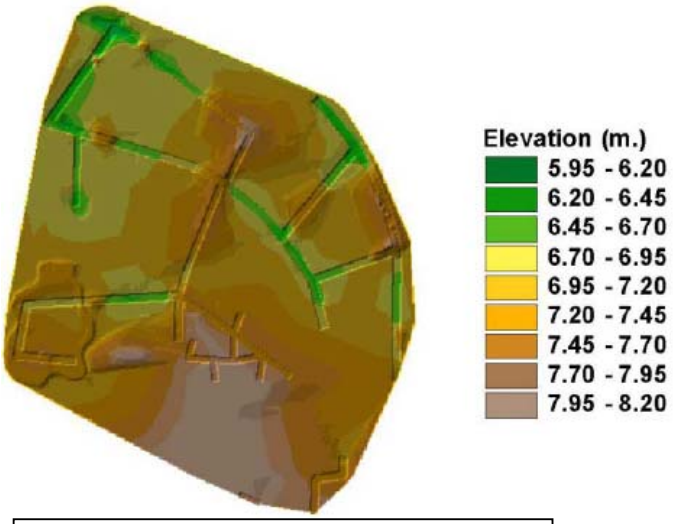


Figure 5.3 Digital Elevation Map of Dhaka City (Source: JICA, 1991)

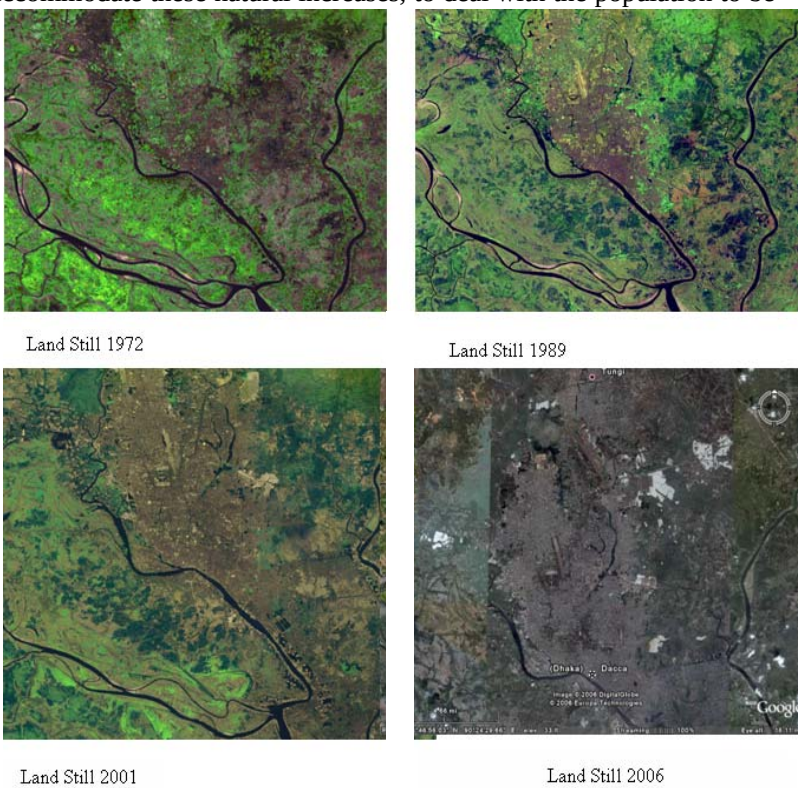
If one observe the feature of Dhaka city at the time of independent or near after that he will see that most of the place which are build area now was bill or drowned area like Pallabi, Hazaribagh, Badda, Rampura, Merun, Khilgaon,Uttar Khan, East side of Uttra, Madhubag, Begunbari in Mogh Bazer,Bashila,Kamrangir Char,

Nabinagar Housing in Mohammadpur, Nandarbag, Daibari, Bara Bazar Para in Gabtoli, Bhashantake, Rampura etc.

Due to such topographic condition, most of the land of the city are low land and the most of the area are below the natural water level where pre-planning of land and control of development for urbanization is really impossible. Besides, the rainwater cannot smoothly discharge to the lakes, khals, retention areas and surrounding rivers and the accumulated runoff remains stagnant in low laying areas inside the city and creates severe water logging problem as well as transport operation, management and maintenance problem. Some of the realistic effect, which is fully visible to the city for the low topography, is described in below**:**

5.6.1 Lack of Build able Land

For a sustainable, good communicable developed and modern city, sufficient and high quality land is first and foremost requirement. There should have sufficient build able highland for the expansion of the city in every direction. But for the case of Dhaka, first and foremost problem is the shortage of suitable located high land, free from annual flooding, on which to build; this applies to both Dhaka and Narayanganj which is argued in the first master plan of the city, master plan for Dacca 1959. The population of the city is expanding rapidly by natural increases and to a lesser extent by immigration, though the great tide of refuges which settled in the city after Partition has stopped. Large areas are needed for a wide variety of purposes, but principally for residential development to accommodate these natural increases, to deal with the population to be displaced from the old city by slum clearance and by specific planning proposals, and to relieve existing overcrowding generally throughout the city's area (master plan 1959). Map 5.2 show the land pattern in different chronological years. From this observation, it is revealed that almost three forth areas (in existing condition that's are around 120 sq.km out of 360 sq.km) of the Dhaka Metropolitan Areas are unbuildable marshy land.



Map 5.2: Land Still 1972 to 2006 (Source: Nasa & Google Earth)

From this image, overall observation and the description of the master plan, it can be concluded that buildable (only one - third of DMP area) land is one of the major problem in this city which promulgated the other problem of the city. So, it can be say that selection of this topography for a capital city was not fully appropriate decision particularly in considering the present condition.

5.6.2 Possibility of Pre-planning

As for the causes of low topography, most of the land of Dhaka city areas are marshy land. Mainly east-west side of the city most of the time of the year sustain under water. Besides, city development organization do not provide plan on the submersed land. So, the city is developing without any preplan of that area by filling of the low marshy land. With the increase of population, increase demand of land for their settlement. Once upon a time, one or two poor family makes shelter on the bill or drowned land by bamboo or others. By seeing them, neighbor come their. They makes bamboo pole for connectivity. On the other hand, land owner sells their unbuild land. The buyers fenced their land and after few years construct building on long column. Then and then land is developed through filling and construct residential building one after another occupying all most all of the space. At this stage, they demand for road, gas, electricity, sewer, water etc. Buildup a group and organize meeting, procession etc. Local political leaders comes in front of them. Call RAJUK, DCC, WASA, DESA. But at that time whole space is covered by the unplanned construction or by individual ownership. At last, road is constructed on the donated land (Figure 5.4). Donated land will be sufficient and proper place, it is unthinkable. As it is well known that beggar should not have any choice. So, narrow, zigzag road is the last solution. It cannot solve the proper demand of road, drainage facility, gas line, sewer line, as well as the necessity of the fire brigade and ambulance of a community. So problem is being ever lasting. An ideal city cannot buildup in this way. This is the one of the fundamental problem of this city and come out from this problem is very difficult at this moment.

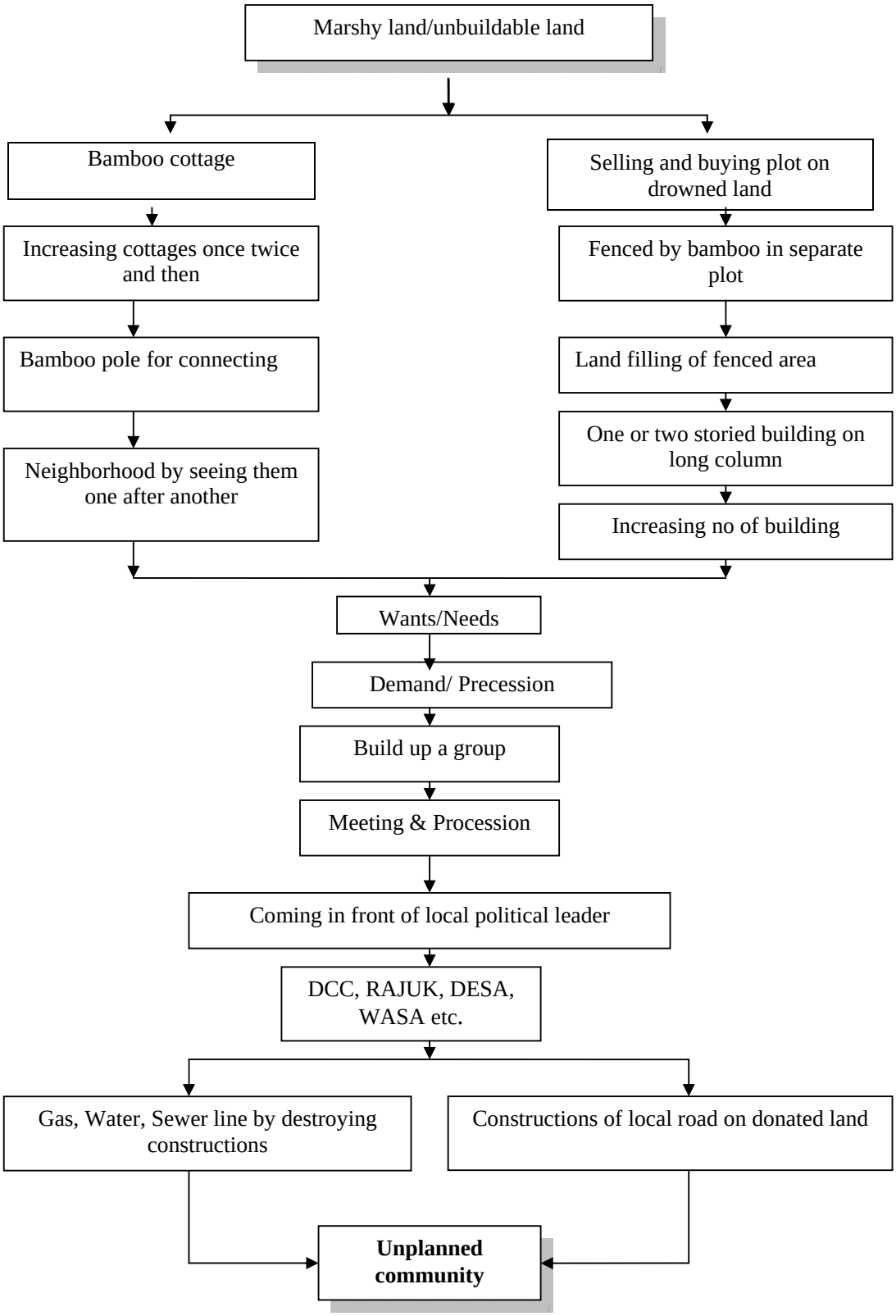


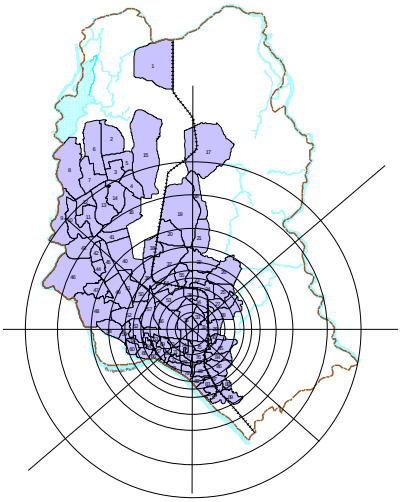
Figure 5.4: Flow Chart of General Development Process

5.6.3 Uneven City Size

Dhaka is like an island. All around of the city have rivers. So the growth of the city towards the Buriganga sort of ends as there was no bridges, not enough connections. On the other side too it's not growing. So for the lack of builable highland around city, the push is towards the north.

According to the description of 1959 master plan: Dhaka is hemmed in by a main river on the south, and on the east and west is restricted by wide tracts of low lying land which flood annually to a depth of as much as 10ft during monsoon season; only to the north is expansion possible.

At present the city is elongated in north south direction 18km and in east west direction 10 km i.e. nearly half of the north south direction. Most of the development are consented in the northern part of the city like Uttara 2nd, 3rd phase, satellite town etc. Many of the industry is also being developed in the Gazipur, Tongi, northern side of city. Map 5.3 clearly represents the uneven size of the city. For the causes of such uneven city size, transportation system are seriously affected like unnecessary longer trip, difficult to provide circular or ring roads, one directional flow etc.

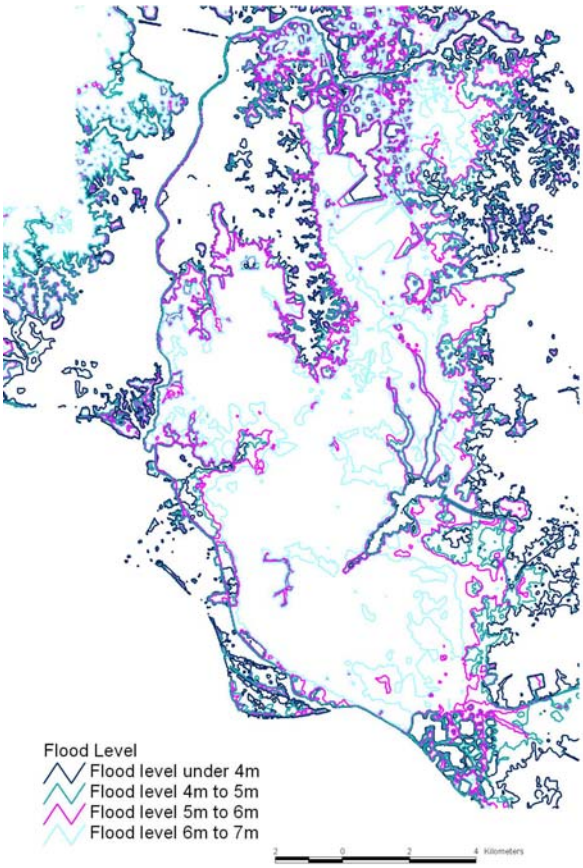


Map 5.3: Illustration of Circular Area from CBD

5.6.4 Excessive Flooding of the City

The city has been subjected to periodic flooding since its early days due to its river system and low topography. Further, water retention ponds/lakes that are naturally emerged with time are vanishing due to land filling for urbanization.

Major floods in the Dhaka city have occurred in 1954, 1955, 1970, 1974, 1980, 1987, 1988, 1998 and 2004 due to spill over from surrounding rivers. Among these, the 1988 and 1998 were catastrophic floods and most recent flood of 2004 also caused severe damage to city life. It is evident from recent floods that the poor discharge capacities of the existing drainage channel for unplanned and unrestrained development is responsible for longer duration of flood in built-up areas and aggravated the flood damage. Around 95 percent of the area of the city, the food level is within 5 to 7 meter (Map 5.4). In fringe area it is less than 4 meters. Every flood which is described, completely damage our transport infrastructure including major roads and



Map 5.4: Flood Level of the City (Source: SOB, illustrated by the author)

required huge amount of investment for the maintenance of transport network which is huge burden for our fizzle economy. This burden will be carry out as for low topography which cannot tolerate for a mega city.

5.6.5 Huge Water Logging of the City

Due to low topography and unplanned spatial development activities and growth of habitation for rapid population growth are causing encroachment on retention areas and natural drainage paths with little or no care of natural drainage system. Excessive rainfall, inadequate drainage sections, conventional drainage system with low capacity and gravity, natural siltation, absence of inlets and outlets, indefinite drainage outlets, lack of proper maintenance of existing drainage system, and over and above disposal of solid waste into the drains and drainage paths are accounted for the prime causes of blockage in drainage system and water logging. In addition, seasonal tidal effect and the topography of the city area also causing water logging. Even, storm drains and surface drains of both Wasa and DCC are also not maintained properly. Some of the adverse affect of water logging and flooding of the city area is pointed below:

- Disruption of Traffic Movement
- Disruption of Normal Life
- Damage of Road Infrastructure
- Damage of Structure
- Water Pollution through Strom Water
- Increase of Water Born Diseases
- Breeding Site of Mosquito
- Damage of Vegetation and Reduce Aquatic Habitats
- Loss of Income Potential
- **Increase of Construction and Maintenance Cost**

Urban drainage system is decreasing day by day due to uncontrolled rapid urbanization and water logging is the ultimate effect of not only the physical, social and environmental problem, it is an economic burden as well. As it is mentioned earlier that water logging reduces the life span and damage to roads (both pucca and katcha) and metalloid pipes of various underground utility services such as water, telephone, sewerage etc. It needs a huge cost to replace these facilities and increases the maintenance cost for the authority. The City authority had to spend about Taka 7 to 8 billions every year to replace and maintain infrastructures damaged by water logging. DCC, the city father estimated that they need 160 billion Taka need to repair the roads and intersections damaged by the recent flood and deadly rainfall in September 2004 (DCC, 2004). Damage to substructure, brick foundations, katcha houses in slums and low-income areas due to water logging means the huge economic losses for the inhabitants.

Photograph 5.4: Land Filling for the Construction

- **Huge Economic Losses Due to the Flood Protection and Removing Water Logging**

Due to the low topography, river floods and runoff from rainfall, acute drainage problem, unplanned development on flood flow zone, the city is facing serious flood problems leading to immense economic losses.

In 1954, 1956, 1988, 1998, 2004 devastating floods occurred submerging 70 percent or more of the country. Along with the country most of the Dhaka city except pockets of high spots went under various depths of water. In spite of huge investment over the years, particularly after 1988 floods when almost whole city of Dhaka went under water, the 1998 floods appeared most devastating.

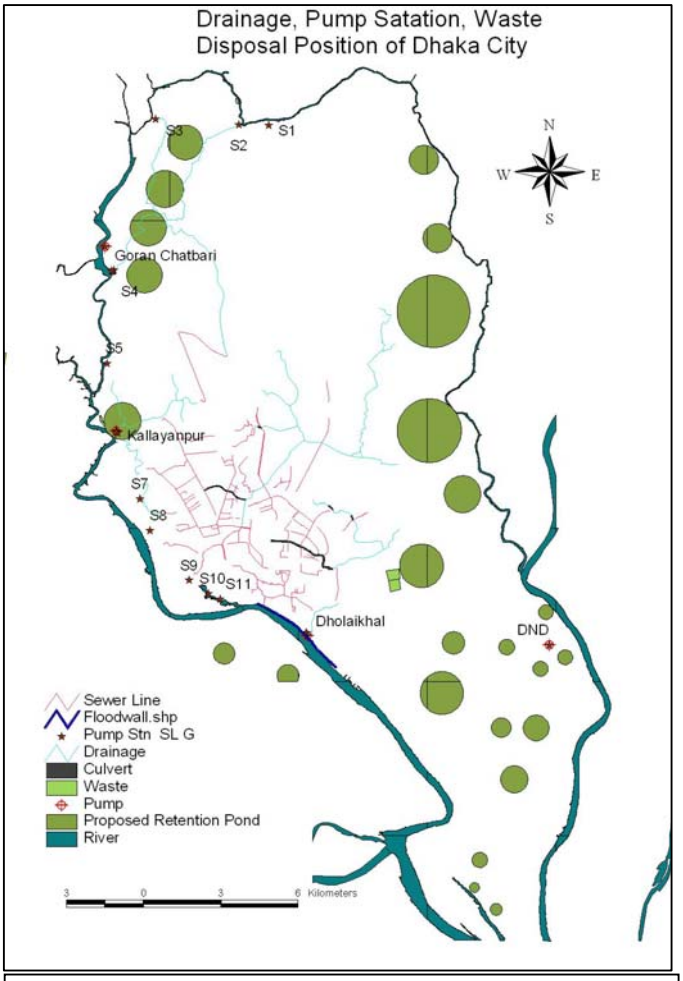
Table 5.1: WASA Coverage

Items	Amount
Service area	150 sq.km
Box culvert	12.0 km
Open channel	65.0 km
Pipe drain	250 km
Pump station	3 nos
Pump capacity	54 cumec
Sluice gate	11 no
Temporary Pumping Arrangement	a. 6 X 25 = 150 Cu sec)
	b.145X5 = 725 Cu sec

Source: WASA, 2006

To protect Dhaka from this devastation JICA prepared the Greater Dhaka Protection flood action plan (FAP) and the Greater Dhaka City area was divided into 12 drainage zones in 1991 (JICA, 1992). The division is on the basis of drainage channels and outfall to the surrounding rivers. The storm water drainage networks are shown in Map 5.5. The present storm water drainage network under Dhaka WASA covers an area of approximately 150 sq. km. Important components of drainage network are in Table 5.1

Recently DCC has constructed one storm-water pumping station, having capacity of 22 m3/s at the confluence of river Buriganga and Dholai khal. Dhaka WASA has taken over the operation and maintenance of the pumping station. Bangladesh Water Development Board (BWDB) has also constructed one pumping station (capacity 22 m3/s) at the northwestern part (Goran Chadbari at the outfall of the Degun khal into the Turag River) of the city. There are also 75 small pumps with individual capacities of 0.142 cumec, installed temporarily by Dhaka WASA to drain out storm water from various locations (Wasa, 2006).



Map 5.5: Sewer line, Pump Station, Sluice Gate and Retention Pond of Dhaka City (Illustrated by the author)

Moreover, DCC have constructed and maintains at least 130 km small diameter underground drains and approximately 1200 km surface drains, which carry storm water to the main sewer lines. RAJUK also constructs roadside underground drainage lines during the construction of new roads.

In addition, flood control embankment around the Dhaka south-west, Dhaka-Narayangonj-Demra (DND) and flood control embankment cum eastern

bypass has been constructed which required huge financial expenditure. However, for the construction, operation, maintenance and management of such intervention as well as for the flood protection, the city is loosening huge amount of financial resources every year and it will have to sustain everlasting the city.

There are altogether 133 pump in different place of the city. Among them Kallanpur and Dholaikhal are permanent pump station and other are temporary. Table 5.2 shows the capacity of the different pump station with yearly expenditure for operation and maintenance. From this Table, it is found that every year almost 810-lac taka is required for the operation and maintenance of these pump stations. This pump station act as a cathedra for survival of the city and it will have to continue for everlasting of the city.

Table 5.2: Yearly Expenditure for the Operation and Maintenance of the Pumping Station

Pump Station	Capacity (Cubic meter/Second)	No of Pump	Unite Expenditure per year (lac)	Total Expenditure (lac)
Kallanpur	20	5	6	30
Dholaikhal	22	3	40	120
Rampura	21.4	30	1	30
Janapath	8.6	20	1.25	25
Different places	10.7	75	8	600
Total		133		810

Source: WASA, 2009

Indeed, many of the area of the city face water logging in the area even after light rain and the stagnant water stands waist-deep after heavy shower. Even it seems many of the areas have to be stranded for about six months in a year and can only get relief in the dry season like west monipur area. To tackle this hazardous condition i.e. to sustain the city, various projects has been taken and under consideration by the WASA, which will drain huge amount of money. In addition almost 17 mega projects have been taken by Dhaka WASA allocating almost 40,229 million taka in 2006 for the survival of the city through protecting the city area from water logging. List of those projects with financial allocation are given below (Table 5.3):

Table 5.3: Projects Name and Financial Expenditure by WASA

Sl No	Projects	Amount (Million Taka)	Implementation time	Financing source
1.	Removal of Water Logging in Dhaka City	2,450	2005-09	GOB
2	Retrieval of Kalyanpur Ponding Area	880	2001-08	GOB
3	Development of Pumping Station at Kalyanpur (Phase II)	780	2007-09	JICA
4	DS-3: Dhaka Storm Water Drainage (Preparation of Master Plan ToR, Selection of contractor for 2 pumping stations along wit DD & BD for 7 canal improvement)	20	St. 2007	WB, GOB
5	DS-4: Resettlement Action Plan and SIA for Displacement of Squatters for Remaining Canals	2	St. 2007	WB, GOB
6	DS-5: Environmental Management Framework	1	St. 2007	WB, GOB
7	DS-8: Tracer Study	1	St.2007	WB, GOB
8	DS-9: Resettlement Action Plan and SIA for Displacement of Squatters	2	St. 2007	WB, GOB

Table 5.3 Continued

Sl No	Projects	Amount (Million Taka)	Implementation time	Financing source
9	DS-10: Detail design & preparation of BD for 14 canals	3	St. 2007	WB, GOB
10	Identification, Demarcation & Protection of Natural Drainage Channels	30	2007-10	GOB
11	Removing Encroachment from Drainage Channels, Regulating Ponds, Low-lands	10	2007-08	GOB
12	Rehabilitation Flood Proofing Structures & Regulators	50	2007-09	GOB
13	Rehabilitation & Expansion of Drainage System in Dhaka City	1000	2007-10	WB likely
14	Permanent Pump Station at Rampura & Maniknagar	3,000	2007-09	WB
15	Development of Drainage System in DND Area	5,000	2008-11	WB
16	Improvement of Drainage System in N. ganj	2,000	2008-11	WB
17	Development of Drainage Facilities of Eastern Dhaka after the Construction of Eastern Embankment	25,000	2010-15	WB

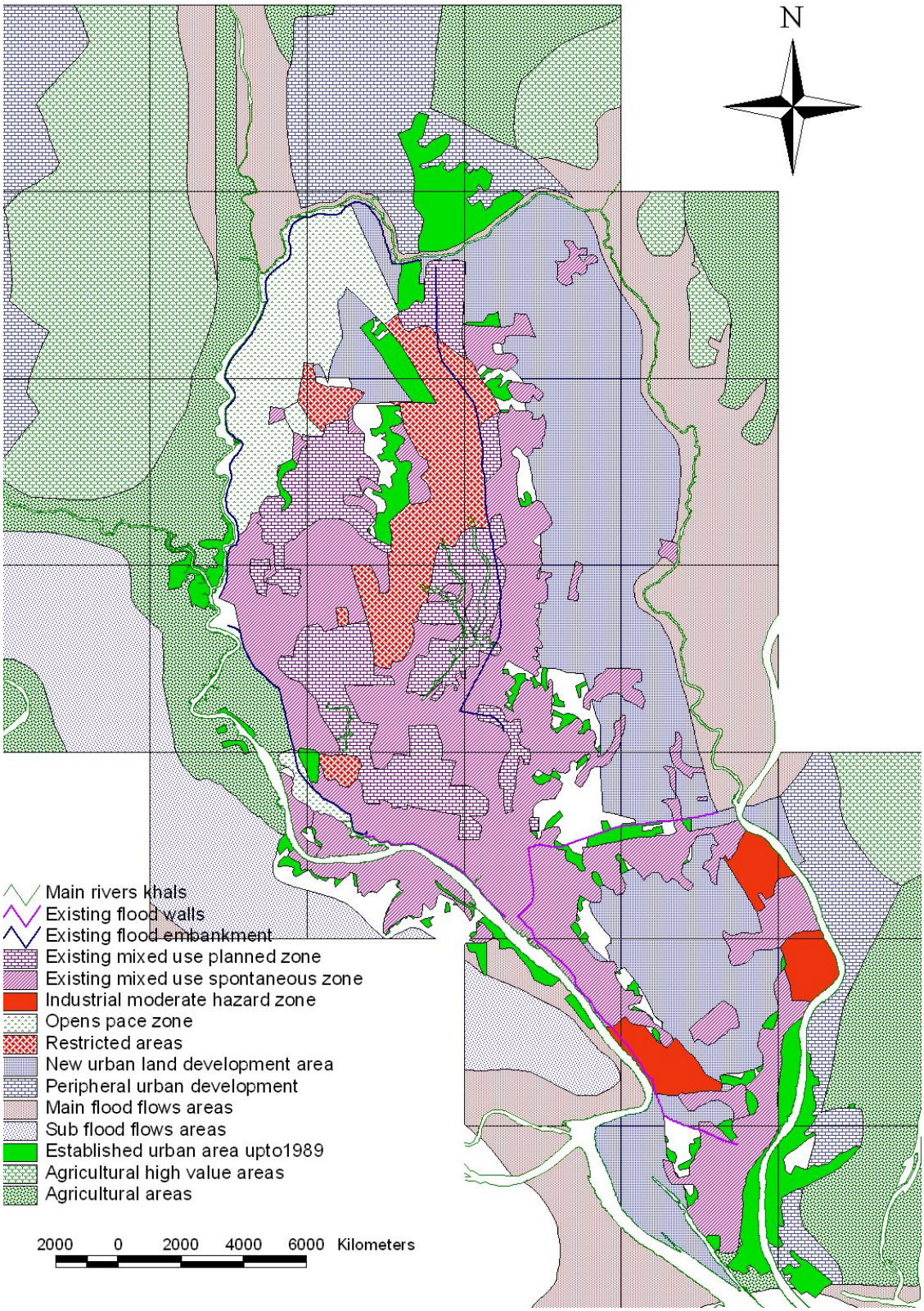
Source: WASA, 2006

Every year such huge amount of financial resources are loses due to survive the city and this type of resource drain will continue everlasting the city. That is, the city is a patient and at present condition it is seen that it is transferred to the coma and doctors (authorities) are trying to being alive the city providing continuous oxygen, saline and others many interventions. It is difficult to say, how many days it will stay alive if the present development condition continue.

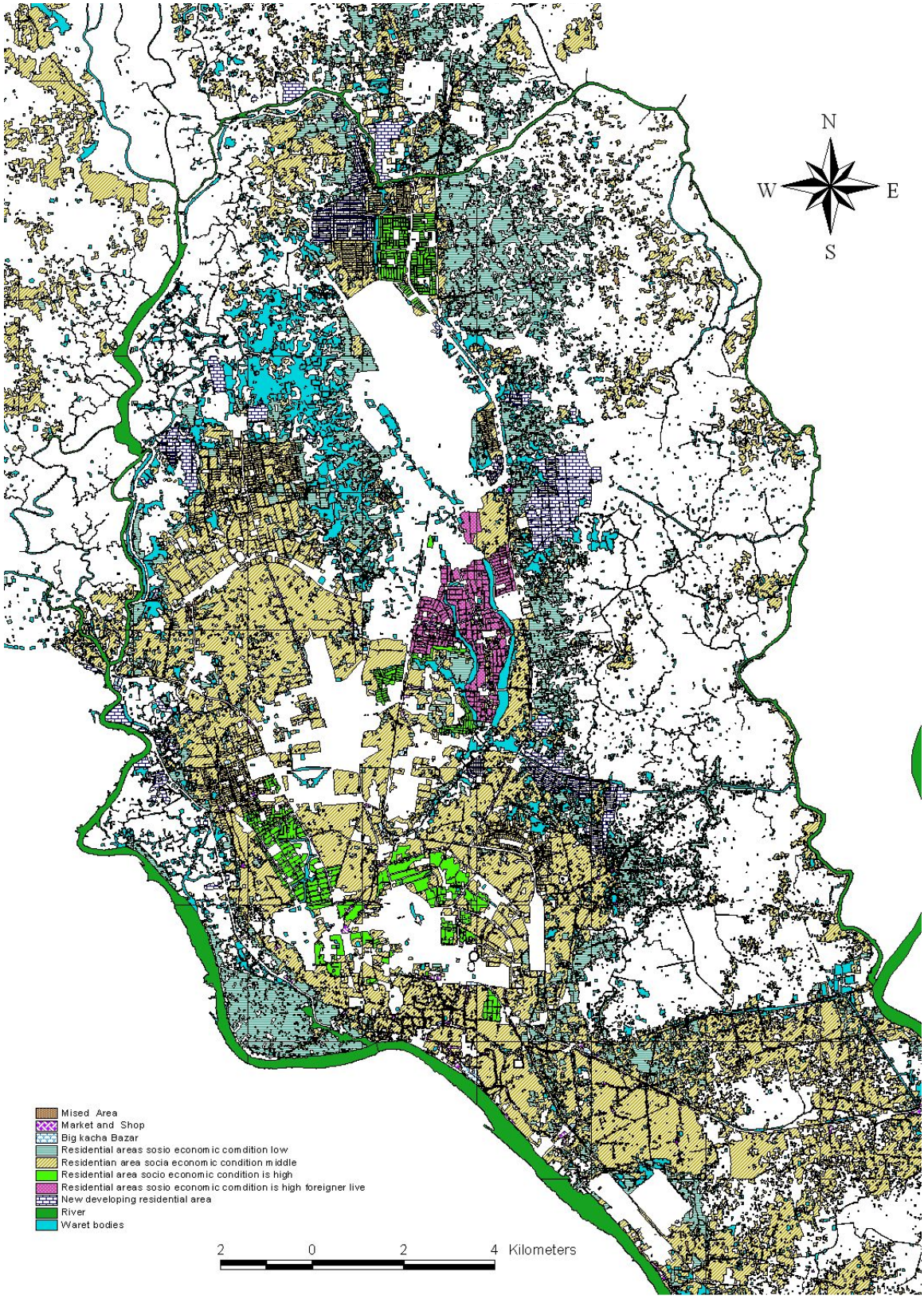
5.7 LANDUSE PATTERN OF THE CITY

As discussed in Chapter 4, Dhaka started to develop in a more planned way after 1947 when it gained regional and political importance (Chowdhury, 1998). Previously, commercial and residential areas were situated side by side, mostly concentrated beside the narrow roads, old Dhaka still presents this situation with a mixture commercial, residential and small industries. After preparation of the Master Plan of the city in 1958, the commercial centres of the city was moved to Motijheel and a high residential area was developed at Dhanmondi. Housing colonies for government employees, universities, parks, commercial and industrial zones, lakes and other public facilities were developed gradually to meet the demands of the expanding city.

With the development of the city, wide roads and other paved areas replaced the unpaved areas, natural depressions, and agricultural land. In many cases, natural drainage canals and open water bodies were filled up for development works. However the present status of Dhaka city demonstrates that the development of the city did not succeed to fully meet the requirements of a mega city. Absence of adequate parks, open water bodies, and drainage system has degraded the quality of living in the city in many ways. The present type of landuses of the greater Dhaka city include residential 32percent, commercial 4 percent, agricultural with new urban land development57%, water bodies 5percnet, and open fields 2 percent and in DCC area 62percent residential (25 percent planned and 37 percent unplanned), 8 percent commercial, 9 percent administrative, 4 percent open space including water bodies, 10 percent cantonment and 7 percent airport area (SOB, 2004 and Mitra, 2005). However, in the metropolitan city area, the percentage of the open space, water bodies as well as agricultural land is much lower.



Map 5.6: Landuse Map of the City (Source: Survey of Bangladesh, illustrated by the author)



Map 5.7: Landuse Map of the City with Economic Status of Inhabitant (Source: Survey of Bangladesh, illustrated by the author)

From the Map 5.6 and 5.7, it is found that most of the lands of the core area of the city are mixed landuse.

Almost 9 percent of the land of city area has been occupied by the restricted area like cantonment and BDR, 11.3 sq.km including old airport and 1 sq. km respectively in the prime area of the city which hindered the overall development of the city as well as transport network development and traffic performance of the city road network. Besides, almost 2 sq. km area has been occupied by the educational institute like Dhaka Univeristy, BUET and Dhaka Medical college which also restrict the public traffic movement and creates adverse impact on the traffic network which would be discussed in further section.

From the field observation coupled with various data and map data analysis it is found that among the 90 wards of the Dhaka city corporation area, only 15 wards are partially pre-planned. The total area of this planned wards are 36 kilometer which is about 27 percent of the total DCC area and only 10 percent of Dhaka Metropolitan area. Besides this, others areas are fully unplanned and developed fully uncontrolled haphazard way. The major effects for the causes of unplanned and uncontrolled growth are described in below:

5.7.1 Unplanned and Haphazard Road Network

The major roads in Dhaka include: Mirpur Road (north-westerly); Begum Rokeya Sharani (northwesterly); Airport Road and Pragati Sharani (northerly); Dhaka-Chittagong Road (easterly) and Sylhet Road (north-easterly); Dhaka-Narayanganj Road (south-easterly); and Mawa Road (southerly), all leading toward and/or into the main areas of the city centre where these and other roads take on various names that frequently change along their respective alignments. Within Dhaka City, the primary orientation of the major roads is in the north-south direction. The lack of sufficient east-west connections and capacity creates the need to travel longer distances, thereby overloading existing roads, unnecessarily. Now the city has a hazardous, expensive and slow transport system for the causes of unplanned landuse development. For example

Old Dhaka grew almost without any planning. This part was generally built before the introduction of automobiles in the city. Much of the “road system” in Old Dhaka follows the same footpaths established in the very early days when Dhaka was a small trading village. The road network is highly irregular with narrow (4-24 feet wide) and twisted, with a very rough east-west and north south orientation of roads. Thus, the existence of many narrow roads, poorly suited for motorized vehicles, as well as multitudinous alleyways, footpaths, and passageways, that function well for walk trips, but are so narrow as to prohibit passage of any motorized vehicle. Superimposed over this warren of historical pathways that have evolved over centuries, effectively interlinking all sectors of the Old City, are a few more conventional type roads (North South Road, English Road, Nawab Eusuf Road, etc.), that have been inserted into the mix at great effort in terms of physical destruction, social disruption and financial expense.

Well planned, formal, residential areas (e.g. Dhanmondi), with well conceived, designed, and implemented road networks to serve low density residential development, now reeling under the adverse impacts that are the consequence of much higher density residential development coupled with the effects of excessive commercial activity.

Unplanned, informal, residential areas (e.g. Badda, Kafrul, Goran, Malibagh, Rampura and Bahsaboo), where little or no planning for roads has occurred, and existing roads are a disorganized agglomeration of narrow, circuitous alleys and paths first established on an ad hoc basis when settlement first started and reinforced and informal development occurred, also on a seemingly ad hoc basis. Current developments (e.g. Bashundhara Housing and Uttara Model Town) that are built with extensive grid networks, the adequacy and suitability of which will only become evident when fully developed. In the case of Bashundhara Housing, while the internal road network is substantial, the only existing access linkage to/from Pragati Sharani is inadequate,

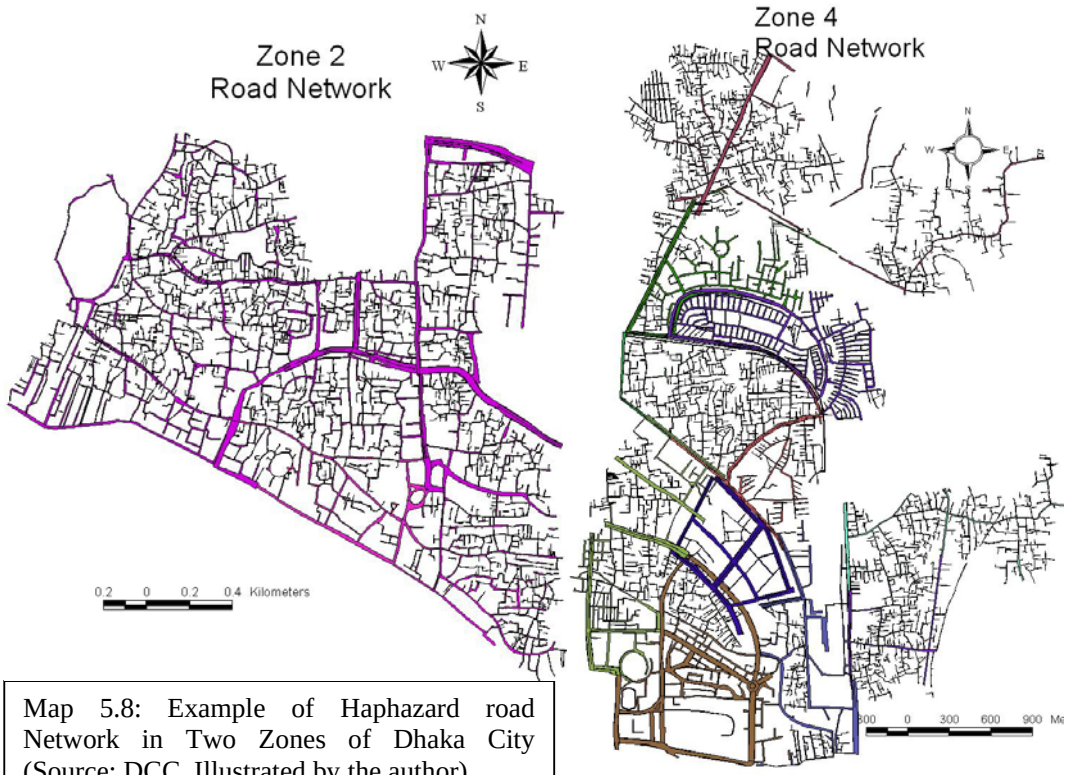
with improvement dependent upon construction of a major new road along the northern boundary of the housing area, at some time in the future.

Even there are so many blocks (almost 7 major blocks) have been developed of the city area which perimeters more or less 5 km has not any classical primary, secondary or tertiary road. Table 5.4 shows the name of some such areas with their perimeter, area, road should have and available roads. From this table it is found that almost all of that blocks have not 5 percent of road compare to the other preplanned grid-pattern zone.

Table 5.4: Different Blocks and their Available Accessible Road and Road should have

Name	Perimeter (km)	Area (sq.km)	Total number of grid should have	Road should have (km) (considering grid perimeter)	Available accessible Road (width more than 5 m)
Shawrapara, Monipuri, Paikpara	10.89	6.85	228	168	11.17
Ibrahimpur, section 14	8.69	2.38	79	58	3.30
Tejgaon, Nakhalpara	7.51	2.84	95	70	10.94
Modhubagh, Mahanagar Project (south-east of begunbari khal)	7.27	2.49	83	61	9.91
Wari, Narinda	4.98	1.37	46	34	7.32
Razabazar triangular area	5.88	1.49	50	37	4.22
Kamrangirchar	10.28	3.5	117	86	2.78

Source: Survey using Google map, 2008



Map 5.8: Example of Haphazard road Network in Two Zones of Dhaka City (Source: DCC, Illustrated by the author)

At present it is almost impossible to construct new road in these areas as most of the areas are highly densified and built in by small industry, hole sell market and residential development.

Indeed, the local and narrow roads which are developed in these areas are not well organized and the widths of those roads are not consistent in different place. Even there has very few interlink between the local roads and most of the roads are ended as a dead end without connecting to other road (Map 5.8). Therefore, local traffic like NMV even pedestrian can not move frequently.

For the causes of deficient landuse pattern, many big institution/infrastructure has been developed in the central part of the city and occupied a substantial area (around 12% of the city area) of the city like cantonment, old airport, BDR, Universities, Central Jail etc. These institutions seriously destroy the pattern of road network in local, secondary even primary level of road. The longitudinal cantonment divided the whole city into two parts and cut three major east-west link and changed the direction of one of the major north-south primary road i.e. airport road. The flow of traffic in Dhaka is severely restricted or disturbed by these special restricted zones. There are other functional areas which restrict common thoroughfare in the city. Even, five major road of the city have to close for the cause of education institute in the city which serious affect the overall transport and travel pattern of the city. Detailed of the road network deficiencies are described in the following chapter.

5.7.2 Conversion of Planned Residential area

Dhanmondi was once regarded as an excellent high class residential area. The one-bigha (1/3 acre) plots in this area offered good scope for suitable residences with enough space for gardens and trees. The total area of the site including water bodies, roads, etc. is about 472.62 acres and divided into 1000 plots. The plot sizes range between 15 decimal to 33 decimal.

This area was the first planned residential zone and developed in the early fifties by Public Works Department, Government of the east Pakistan, to provide residential accommodation for high income groups of population in Dhaka city. The area was located within five kilometers from CBD (Motijheel) of Dhaka City. Ministry of Housing and Public Works controls and regulates the developments within Dhanmondi area.

Even in the early '80s, Dhanmondi was a picture perfect residential area with independent homes, lakes, and only a few corner shops. All this has changed within a decade as schools, clinics, fast food shops, banks and commercialization has not only destroyed the residential character of the area, but has also resulted in unprecedented environmental degradation. With apartment blocks set up on many of the one-third acre plots in the area, each accommodating 20 or more families, Dhanmondi is set to become one of the most densely populated up-market residential areas in the country comprising 68 percent residential, 5 percent commercial, 12 percent institutional and 8 percent mixed use. Today, Dhanmondi has been surrounded by shopping malls, hospitals, clinics, restaurants and offices. For the lack of control and proper long planning now it is turn as a mixed area.

This conversion of Dhanmondi residential area is the results of initial planning deficiency. In the earlier stage Dhanmondi Residential Area was developed without the provision of any supporting facilities. It was planned keeping the concept of “Suburban Garden City” in mind. Considering the socio-technical aspects, New Market was chosen as a point for necessary services like (shopping, post-offices, banks, etc.). The whole area was divided into plots without keeping in mind the facilities that a community daily requires. So gradually out of necessity small scale commercial endeavors such as grocery shops, laundries, stationary shops, pharmacies etc were coming up in a haphazard manner within the neighborhood. Some influential bureaucratic also took advantage of the situation established larger scale shopping malls which were later legalized by the concerned authority in the face of pressure from high level. Necessary facilities such as shopping center, corner store, park, community center, and club have developed gradually in the last few years to meet the ever increasing daily demand.

According to a circular of January 1996, Ministry of Housing and Public Works, the authority legalized all the plots, on both sides of Mirpur road, Satmasjid road, Road-2 and Road-16 (old 27) for commercial use with 15% " Conversion Fee", By the circular the total plot (not partial) was permitted to be used for commercial purpose. Change in uses have been sanctioned without any in depth study of the site and service schemes as well as the requirements of the residents.

While the once homely Dhanmondi has gone fugitive, Banani in the recent years has been invaded by all kinds of establishments ranging from the mushrooming private universities, guesthouses and other commercial entities. The infiltration of commercial activities in the residential areas are changing the landuse pattern into mixed use zones.

Forty years ago, houses in Gulshan (meaning garden), Banani were at least half a mile apart. Thirty years ago, people used to go there to practice driving because a passing car could only be seen every five or six minutes. Today, even during hartals the roads are busy. Shops and clubs, schools and garment factories, banks, restaurants and high-rise buildings are what today's Gulshan is all about. Few independent houses remain, and even their owners are beginning to tire of the area. "Gulshan is not a residential area anymore," is the common complaint of its inhabitants. It's all shopping and banking and flats and restaurants.

5.7.3 The Death of Dhaka's Posh Spots

Every city has its posh residential areas. Once upon a time, Dhaka too could boast of elegant, quiet residential areas where cozy or majestic houses with fragrant flower gardens lined the tranquil lanes adorned with billowing trees. That certainly is a far cry from residential neighbourhoods of today's Dhaka. Its so-called "posh", "residential" areas have and continue to become anything but that. Dhanmondi, Gulshan, Banani, Baridhara -- places where half the city travels to every morning, to work in banks and restaurants, shops and garment factories.

The Gulshan-Banani-Baridhara lake, which once used to serve as an environmental relief to the local citizens, has also been gradually shrinking with influential people grabbing the land of the lake. Garbage and unauthorized structures and houses have besieged the lake on all sides. The lake, which stretched from Banani to the kalachanpur area has been reduced to a closed pool of polluted water. Most of the vacant land on both banks of the lake has now been taken over by the illegal occupants, some of whom have already raised multi-storied apartments, reclaiming the lake’s land. Slum-dwellers have built their makeshift shanties right inside the lake area. It is found that at least half of multistoried apartment building has been constructed on the land of the lake. Besides, other dwellings are being raised on land grabbed on both sides of the lake.

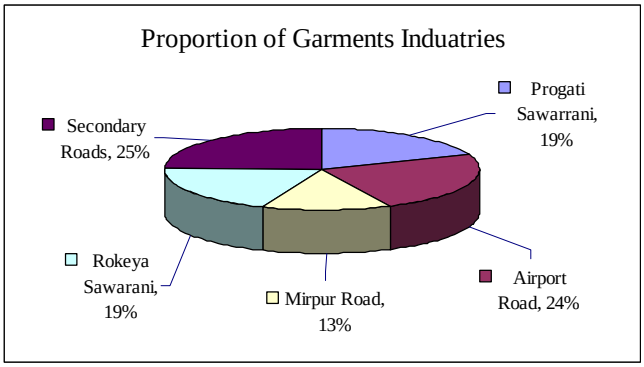
5.7.4 Indiscriminate and Unexpected Road Side Garments Industries

According to the BGMEA, 2005 there are around 4000 garments industry in the city area with over 1 millions workers, and the growth pattern of these industry as like as population growth i.e. 800 in 1980 and 4000 in 2005. Data of garments industry’s locations are analyzed on the basis of vicinity of the road types. Out of the analyzed garments industries, 75 percent is located along the primary roads and the rest are along the secondary roads. The proportion of workers employed in these industries is same as their numbers. The distribution of the garments industries and their employees in the city are shown in Figure 5.4. Table 5.5 represents the total number of garments industries and number of employees along the road types. The Table shows that Airport Road comprises 24% of the total, where as Progati Sawarani, Mirpur Road and Rokeya Sawarani comprises 19%, 13% and 19% respectively. The percentage of workers distribution is same as the percentage of industries distribution. But the only difference is 25% for Airport Road and 12% for Mirpur Road.

Table 5.5: Number of Garments Industries and Employees along Different Corridors

Corridor Name	No. of Garments Industries	Percentage	No. of Employee	Percentage
Progati Sawarrani	353	19.27	144029	18.75
Airport Road	432	23.58	195485	25.45
Mirpur Road	241	13.16	91967	11.97
Rokeya Sawarani	354	19.32	144973	18.87
Secondary Roads	452	24.67	191666	24.95
Total	**1832**	100.00	**768120**	100.00

Source: Hoque 2007



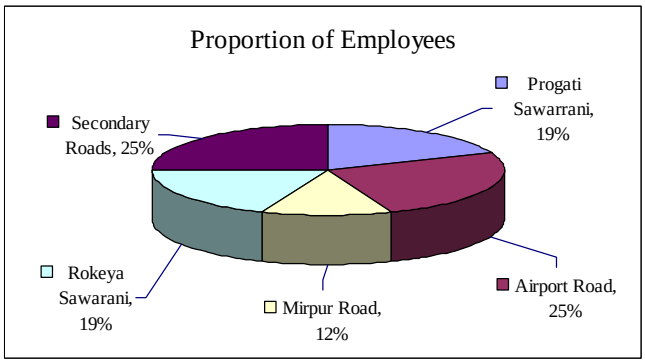


Figure 5.5: Proportion of Garments Industries and Employees along Various Corridors (Source: Hoque 2007)

There are a lot of secondary roads in the city which form network with the arterials. These roads are normally in the east-west direction of the city. 25% of the total analyzed garments industries are located in the vicinity of the roads. Figure 5.5 shows the distribution of the garments industries and their employees in these areas. It is found here that Motijheel area and Elephant Road have high concentration of garments industries.

From the field observation, it is found that in order to get access to work sites, almost 95 percent garments workers go on foot and walk almost 1 to 1.5 km per trip. Every day they make at least two home to work planceand work place to home trips particularly at the morning and evening rush. A significant amount of worker make extra two trip at the lunch period i.e. every day at least 2-millions walk trips are generating in this small city by the garments worker. Their movements are in the perpendicular direction to the course of arterials and cross the primary roads in-group at lest in 23 places of the city. Besides, they are walking and crossing the road individually in frequently and haphazardly almost all over the city. These huge numbers of frequent, haphazard and unguided, indiscriminate trips greatly influences the traffic flow parameters in the arterials. This also imposes serious safety hazards for the workers as it increases the possibility of pedestrian-vehicular conflicts.

It is also revealed that at the time of crossing the arterials, generally the workers do not voluntarily use the grade-separated or other pedestrian facilities like pavement crossing marking or pedestrian signal. As they have to reach the garments industries timely, they remain busy at the time of walking. This influences them to make shortcuts to cross the roads using the gaps in median barriers.

Due to obstructions at footpath workers are forced to walk on the roadways. This also reduces the level of traffic flow condition reducing the effective width of the roadways. It may also increases

the fatality rate as the workers walk along with the motor vehicles in the same direction. It is hard for them to observe the condition of traffic flow behind them during walking. These are poses a serious problem in the Capital city Dhaka not only for traffic or transport management perspective but also landuse management, food and shelter supply, environmental management etc.. These problems are also induced from the planning problem.

5.7.5 Loss of Open Space, Greeneries in City Areas

Urban Plans should provide for adequate open space, greenery and water bodies (rivers, canals, lakes, ponds and tanks). Dhaka resembling a concrete jungle with each passing day, the suffocated residents of this populated city are frequently on the lookout for places to go and enjoy some breath of fresh air.

In the first master plan 1959, there were 1338 Acreage (5%) open space comprising around 20 notable open park, lake and recreational space. But at present, there are only 853 acre of land for open space comprising only 13 notable park and lake in all over the city (Table 5.6). According to the PDB, 2008, within the thirty years, open space areas decreases from 5% to 3.09%. Also the urban green decreases by 1.5%. As of now, there are 46 parks in Dhaka and about 17 lakes among which Dhanmondi Lake, Crescent Lake and Gulshan Lake are notable (b).

Table 5.6 Few Notable Parks and Lakes within Dhaka Municipal Area

Managing Organizations	**Park/Lake**	**Area (acre)**	**Scope for Use**
Arboury Culture	Ramna Park & Nursery	63	Universal
Public Works	Osmany Uddyan & Auditorium.	85	“
Department	Suhrawardy Uddyan.	80	“
	Jatiya Sansad Bhaban yard (north & south plaza).	58	Protected
	Zia Uddyan (Chandrima Uddyan)	77	Universal
	Dhanmondi Lake (including Ministers res.)	15	Protected
Dhaka City	Ramna Shishu (children’s) Park	12	Universal
Corporation	National Shishu (children’s) Park	16	“
	Bahadur Shah Park	0.2872	“
	Gulshan Park and Lake	8.9700	“
Forest Department	National Botanical Garden	205	Universal
	Baldha Garden	3	“
Livestock Directorate	1. Zoological Garden (Zoo)	230	Universal

Source: a. Public Works Department.
b. State Department, Dhaka City Corporation.

As described earlier, two-thirds of the population increase over the past decade has been accommodated at higher densities in established urban areas, and only a third through new land development. However, a rapid population growth has seen the demise of such parks due to space constraint. space around Dhaka and this can have a negative effect on the population of the city as well. Most of the vacant land on both banks of the lake has now been taken over by the illegal occupants, some of whom have already raised multi-storied apartments, reclaiming the lake’s land. Slum-dwellers have built their makeshift shanties right inside the lake area. Many unsocial activities or incidences often take place in the garden encircled by a large number and species of trees and plants. Instance of irregularities and corruption of in the Zoo is abundantly reflected from the famine beaten faces of the animals there and their deaths in succession. Immediately after sunset the locale around the many open area or park presents the scene of a literal fair as a result many people assembling there.

5.7.6 Loses of Wet Land of the City and Encroachment of Drainage Channels and Retention Ponds

At the beginning of urbanization, wetlands of urban area were treated as a part of landscape. In addition to its ecological and drainage functions, most of the wetlands of urban area were intelligently used for agriculture, fisheries and transportation function. But with increasing demand of land and habitat people started to destroy these natural resources by polluting and dumping waste and later encroachment and conversion of wetland become a common phenomenon (Ishrat et al. 2005). Figure 5.6 shows the coverage of wetland in DMDP area during the years 1989, 1999 and 2003. It can be easily understood the gradual shrinkage wetland over the period 1989-1990-2003. Table 5.7 provides information on coverage of wetlands of Dhaka during the year 1989, 1999 and 2003.

Table 5.7: Coverage of Wetland (in acre) in DMDP Area 1989-1999-2003

Land cover Type	1989 (Nov)		1999 (Nov)		2003 (Nov)	
Permanent Water Bodies	12363	**3.5%**	12363	**3.5%**	12363	**3.5%**
Temporary Water Bodies	100,733	**28.5%**	88,314	**25.0%**	68,269	**19.3%**
Others	240,612	**68.0%**	253,031	**71.5%**	273,076	**77.2%**
Total Area	**353,708**	**100%**	**353,708**	**100%**	**353,708**	**100%**

Source: Analysis of Landsat TM/ETM Image of year 1989, 1999 and 2003

It is found that if the current rate of loss of wetland continues, by the year, 2037 all temporary wetlands of Dhaka will be disappeared (Figure 5.5). It is alarming to find that yearly rate of loss of wetland during 1999-2003 period is 5.67 percent where as during 1989-1999 period; yearly rate of loss was 1.23 percent. The land filling activity of developers became irresistible during the later half of 90's. Even after the enactment of the water body conservation act 2000, the city has lost a huge amount of wetland.

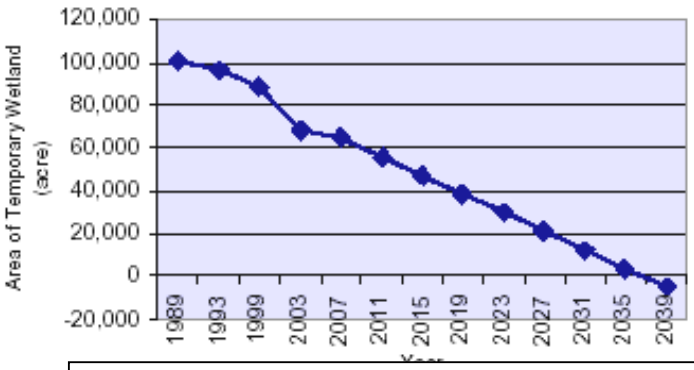
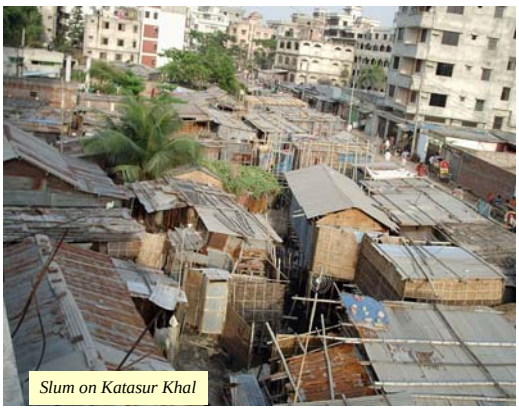


Figure 5.6: Declining Trends of Wetland of Dhaka (DMDP Area)
Source: Analysis of Lansat TM/ETM Image of the Years 1989, 1999 and 2003
(Ishrat,I. Kanegae, H. Takao, K. 2005)

Though it is seen in the previous study (Table 5.7) that the permanent water body are remain same, from this study, it is found that almost 0.096 sq km (23.7 acre)of designated permanent water body are reduced after 2000 in Dhaka city. Most frightening that almost all of that water bodies are destroyed intentionally by the city developer particularly by constructing box culvert on the open channel. Box culverts, which were constructed on different canals or water bodies, also remain clogged for lack of cleaning, contributing to the problem. Dholai Khal, a canal in the southern part of the city which used to be more than 30 metres wide was turned into a 2.5 metres wide box culvert. Besides, significant amounts of permanent water bodies are lost due to the encroachment of the surrounding rivers, Tongi Khal on the North, the Turag and the Buriganga rivers on the West-South and as the Balu River on the East bank by the gravers.


Land filling in the vicinity of Ramchandrapur Khal


Ranchandrapur khal being encroached

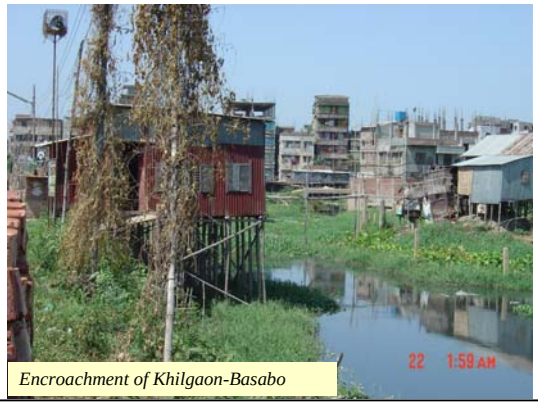

Slum on Katasur Khal


30 ft Ramchandrapur khal constricted by a 3 ft


Encroachment of Jirani Khal by road on khal


Encroachment of Jirani


Encroachment of Khilgaon-basabo Khal:


Encroachment of Khilgaon-Basabo

Photograph 5.5: Encroachment of Drainage Channels (Courtesy: WASA, 2007)

Indeed, most of the natural drainages of Dhaka City disappeared or are in way to lose their existence due to illegal encroachment. A good number of Khals criss-crossing the city, have some of their out falls in these rivers and are playing a very significant role in the drainage of the city area. During 60s, there were around 50 khals in Dhaka City and their length was 256 km. But due to the encroachment, presently there are only 26 and their length is 125 km. Photograph 5.16 shows some glimpses of the encroachment of natural channels.

Due to rapid urbanization with unplanned construction, most of these khals have been encroached, filled up, diverted and caused obstruction to the smooth flow of water to the out fall rivers. The Bangladesh Inland Water Transport Authority (BIWTA) identified in May 2001, 204 illegal structures built on both banks of the river. In July 2001, BIWTA prepared a new list of 309 illegal establishments. According to wasa, they demolished 657 illegal structures on 17 encroached upon canals till March 31, 2007 (WASA, 2007).

Encroachment of drainage channels and retention ponds are causing water logging in many parts. A list of filling up water bodies and consequent impact in different areas is provided in Table 5.8:

Table 5.8: Encroachment of Canal or Lake and Affected area for Logging

Canal or Lake	Affected Water Logging Area
Katasur canal	Rayer Bazar and Mohammadpur areas
Ramchandpur canal	Islambagh, Nawabganj and Hajaribagh areas
Narrowing of the Dholai khal	Bangladesh University of Engineering and Technology (BUET), Bakshibazar, Husaini Dalan, Nimtoli, Nazimuddin Road, Bangshal, Aga Sadek Road, Gandaria, Postagola and Faridabad
Filling up of 5 to 6 jheels (swamps)	Bashabo, Khilgaon and Mugda areas
Jirani canal	Motijheel and Kamalapur
Segunbagicha canal at Maniknagar and Manda	Shantinagar, Inner Circular Road, Arambagh, Fakirerpool, Motijheel, Dilkusha and Sayedabad areas
Jirani canal and Shahjahanpur canal	Malibagh, Mouchak and Shantinagar areas
Shahjadpur canal	Kuril, Progoti Sarani and adjacent areas
Some parts of Begunbari canal	Gulshan 1, Tejgaon and Mohakhali areas
Mohakhali canal	Nakhalpara, Arjatpara, Rasulbagh and Shahinbagh areas
Five branches of Kallanpur canal	Taltala, Agargaon, Kazipara, Shewrapara, Barabagh, Mirpur 1 and adjacent areas
Diyabari canal	Eastern Housing Project in Pallabi and its adjacent areas
Pipeline for draining out water set clogged	Cantonment, DOHS, Kala Chandpur, and a section of Baridhara
Ibarahimpur canal	Uttara and Banani areas

Source: WASA, 2008

DCC remove around 3000 tons of solid waste everyday and carry those to its dumping grounds. Unfortunately, these dumping grounds are located in open spaces, low-lands and river banks creating encroachment to the rivers and drainage systems contributing to air and water pollution in the areas in the immediate vicinity of Dhaka city.

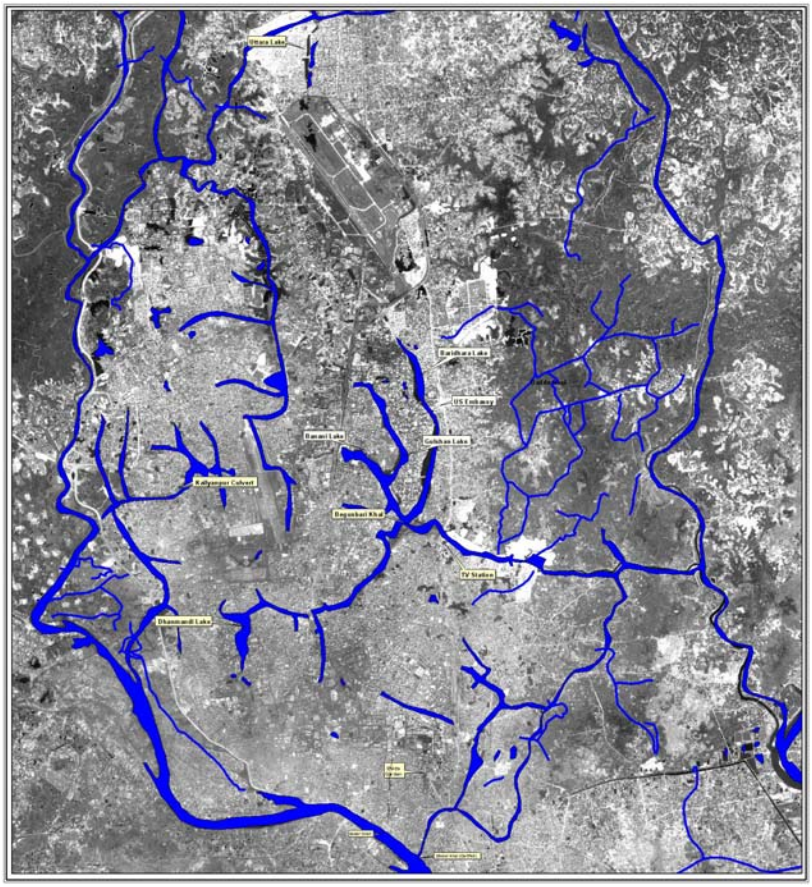
On the other hand, land developer filling-up of vast areas in Ashulia, Banashree, Aftabnagar, Meradia, Baunia, Badda, Amin Bazar and Hatirjheel, known as water catchments, increased the hazards of water logging that swamped much of the city. The Dhaka Master Plan has clearly marked these areas for flood retention and the Wetland Conservation Act, 2000 bars land

development in water bodies. According to the Conservation Act, no one has the right to develop wetlands, flood flow zones or catchments. But the developers and land owners have occupied and filled the areas (Map 5.14).

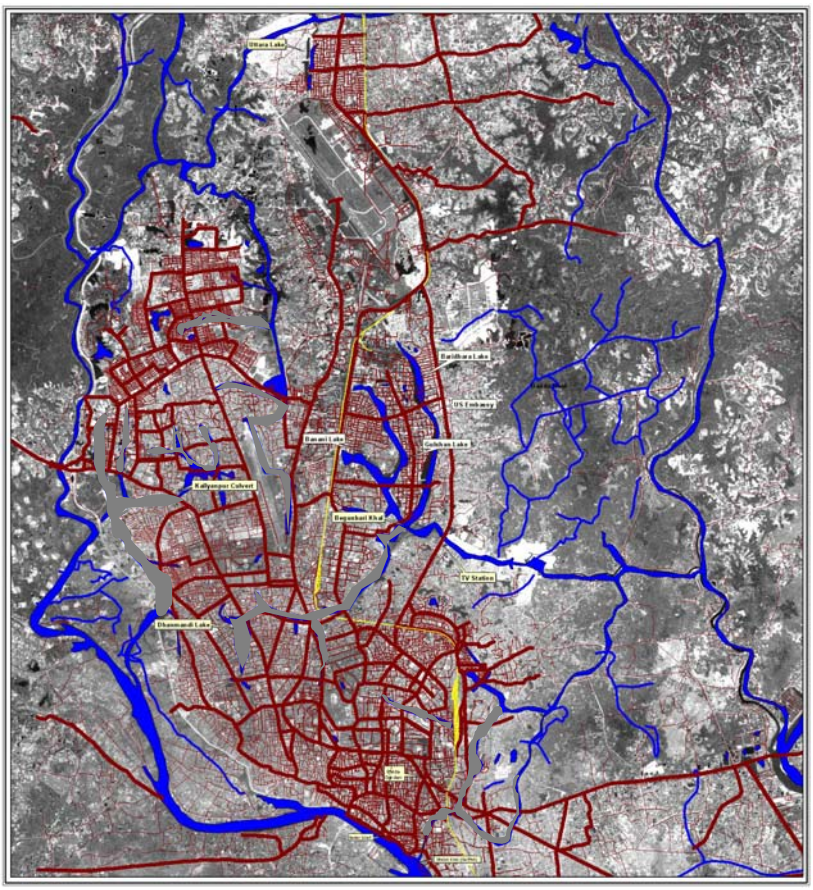
5.7.7 Disappearance of Natural Drainage System

A proper drainage system does not only mean having a few sewerage lines and drains, it means building up a network that connects the drains and sewerage lines with natural water bodies such as ponds, lakes, and canals. As discussed in the previous article, although, Dhaka had hundreds of ponds, natural canals and lakes rapid population growth and unplanned development, unplanned land filling to develop new residential areas, uncontrolled and haphazard disposal of solid wastes and garbage into the existing drainage system, and encroachment on lakes, khals/canals and rivers with unauthorized construction are the summarized general man made physical and social activities related to the disappearance of natural drainage system which is the prime causes of flood and water logging in Dhaka City.

In 50 years back, Dhaka city city has altogether 43 canals. Among them 26 canals are under Dhaka WASA. Other 17 canals are almost out of the map for converting as box culvert or grabbing for construction.



Map 5.9: Natural Drains-50 Years Back



Map 5.10 Natural Drains Intervened

Even the 26 canal which are under WASA, that's are not properly functioned for the causes of encroachment or grabbing. Dholaikhal, Shegunbagicha khal, Ibrahimpur khal, Pantho path canal,

Table 5.9 DWASA Production

Items		**Production**
Total Actual Production		1576.7 mld
Total Production Capacity		1707.2 mld
Surface Water Treatment Capacity	Sayedabad	225 mld
	Chadnighat	39 mld
	Narayanganj (Godnail & Sonakanda)	46 mld
Actual Surface Water Prod.		255.5 mld
Groundwater	Operational DTW	454
Actual Ground Water Prod.		1321.2 mld

Source: WASA, 2008

Poribagh canal, Mokhali canal and Kadamtoli and khilgaon canal are converted as box culvert. Kallanpur canal, Motijheel canal or Jheel are filled by land graver. From the opinion of many of the experts of different organization particularly in WASA, it is evaluated that filling up of eighty percent low lying areas and water bodies in the capital by encroachers is the main reason for water logging in the city, since those used to be the major channels for draining out rain water. The drainage channels in the western Dhaka underwent major intervention due to unplanned development.

5.7.8 Decrease of Ground Water Recharge Area and Ground Water Level

According to a study conducted by SWMC (2000), 95% of water supplied for Dhaka is extracted from underground. The average annual decline of ground water within the city area during 1995 to 1999 varied from 1.02m to 2.46 m but in the periphery this decline is less than 0.5 m after the 1988 and 1998 flood. This loss of ground water is an alarming issue for the city (SWMC, 2000).

According to the source of WASA the groundwater depletion occurring at alarming rate: 2-3m/year at most places in Dhaka Metropolitan City. The surface water has been polluted severely; quality of air in and around the city is already in a bad shape. Every year groundwater level is receding fast due to over extraction. Demand for water, electricity, and gas is increasing every day. From this Figure 5.5 it is clear that the city is facing huge water supply problem and the problem will increase day by day ever lasting the city.

5.7.9 Pollution of Water

Water and air pollution has already become a very serious concern. Continuous media reports and pressures from the environmentalists forced the authorities to take some measures, which are not enough. From the various research, it is revealed that rivers around the city including the Buriganga, Turag, Balu and Tongi Khal are

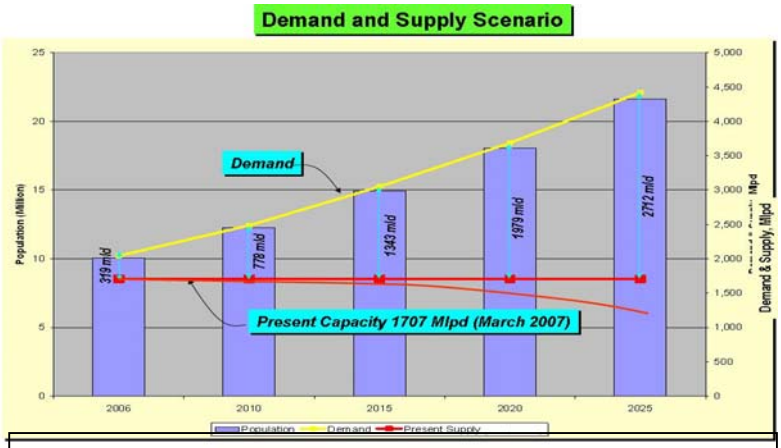


Figure 5.7: Present and Projected Demand and Supply of Water

so polluted that no fish or other aquatic species can survive in their waters. Indiscriminate discharging of industry waste, human excreta and household garbage led those rivers, canals, lakes and other water sources to severe pollution.

Right now there are more than five lakh buildings in the city, half of these buildings are under the water supply network. According to the authorities, they have so far linked water connections to about 2.48 lakh buildings (Wasa counts single connection for an apartment building, while city corporation counts each apartment for their connection). But they have sewerage connections to only 59,310 buildings in the capital. The house owners have to pay as much as water bills to the government if they want to take sewage management service. Therefore, the house owners connect the sewage line to the storm sewerage drainage to save the money. Besides, due to uncontrolled development and lack of proper monitoring, a large number of house owners in Dhaka resort to linking their sewage discharge connection directly to the storm water drainage instead of sewage management networks to evade government service charges. This results in severe pollution to the rivers, canals and lakes in and around the capital.

Every day the city dwellers generate around 3.6 lakh cubic metres of excreta, of which a major portion directly gets mixed with the waters of rivers, lakes and canals due to the ill practice of the house owners. Pagla sewerage treatment plant has a capacity of treating 120,000 cubic metres of excreta every day, nearly one-third of total human waste generated by the city people. But the authorities say they are getting maximum 50,000 CM of excreta every day to treat, and sometimes it comes down to 30,000 CM. The rest of the excreta is being directly discharged to the water bodies through storm sewerage network, as almost the entire city has that network (Wasa, 2007).

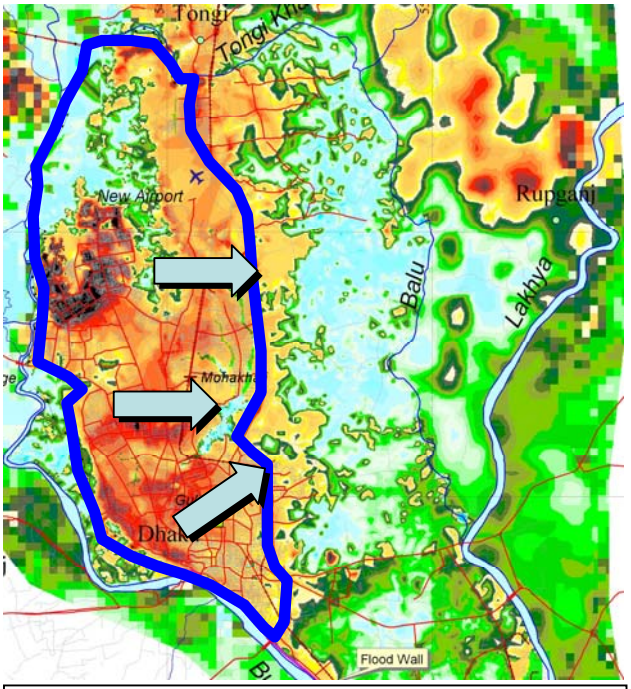
The authorities say their sewage management service covers different city areas including Dhanmondi, Shyamoli, Tejgaon, Basabo, Dhaka University, Azimpur, Mohammadpur and Old Dhaka. Right now Wasa has a 2,533.73 kilometres of underground water pipeline network against 881 kilometres of sewage pipeline. The buildings in Mirpur, Uttara, Kafrul, Baridhara, Kallanpur, Amin Bazar, Gulshan, Mohakhali, Banani, Badda and other adjoining areas discharge sewage into the water bodies, as there is no sewage network in these areas.

When the city groundwater level is depleting several metres a year and Wasa has to put extra chemicals to treat supply water, the government does not have any effective steps to manage excreta or stop discharging excreta into the water bodies. Even, industrial waste, clinical wastes are directly disposed to the storm water drainage and it is going to the canal, river without any treatment. Therefore, surrounding rivers act as the receivers of storm water, municipal, and industrial wastewater from Dhaka City. Many of the experts argued that the water quality situation would further deteriorate if no pollution control measures in Dhaka watershed is undertaken.

5.7.10 Losses of Water Runoff Area

About 50 km2 of western Dhaka's rain water drains into eastern Dhaka. Any encroachment of drainage khals and low lying areas in eastern Dhaka may cause major problem in the western part.

Due to unplanned development by property developer, most of the runoff



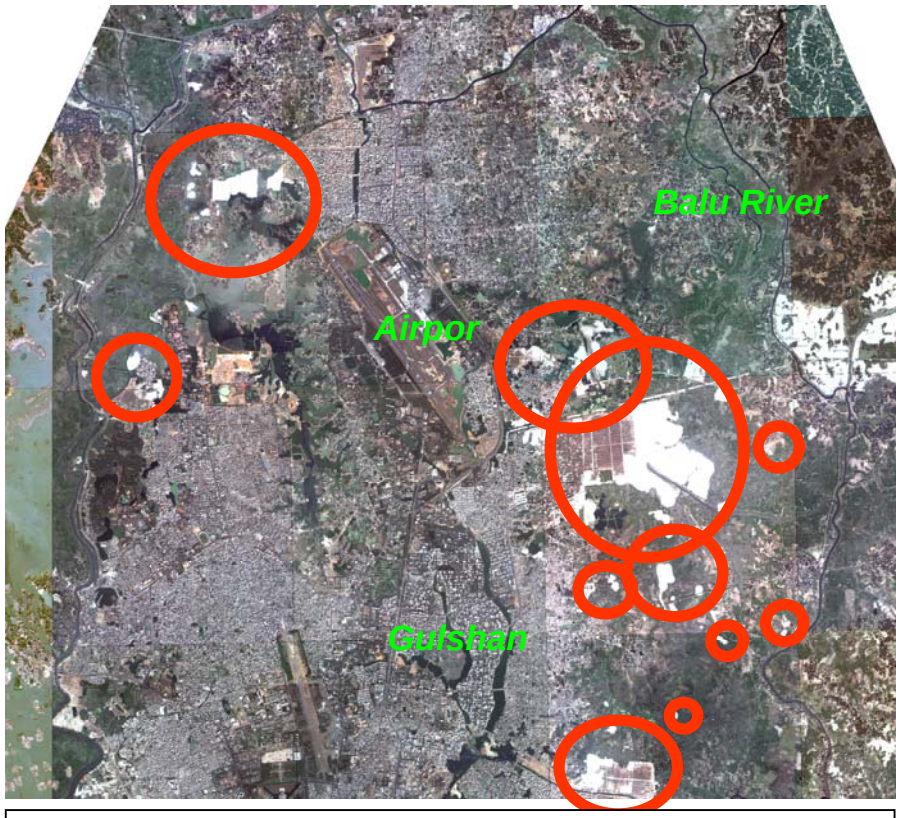
Map 5.11: Western Dhaka's Rain Water Drains into Eastern Dhaka

areas are filled by the land developer for housing development. Large scale unplanned land filling by land developers in eastern Dhaka is creating havoc (Map 5.13).

5.7.11 Shrinking of Retention Pond

To preserve the excessive rain water at the heavy rainfall, JICA in FAP8A 12% of total land area as retention ponds of total embankment area of Dhaka in 1992 for protect the city area from water logging problem as shown map 5.5. RAJUK in DMDP also proposed retention areas in 1998.

In 2006, Bangladesh Water Development Board, has conducted another study on "Updating/Upgrading the Feasibility Study of Dhaka Integrated Flood Control Embankment cum Eastern Bypass Road multipurpose Project" and proposed only 5.05% of total embankment area of Dhaka as retention ponds (Halcrow, 2006). Halcrow study 2006 also revealed that ultimately only the areas near the Balu river would be available if nothing is done to conserve the retention areas.



Map 5.12: Unplanned land filling by land developers in eastern Dhaka

From the field observation it is unfortunately evaluated, for the causes of ill maintenance and unplanned development, this small amount of proposed "retention ponds" in some locations have already been filled up by the land developers as shown in Photograph 5.19. Land grabbers under the name of land development filled almost of those areas. In the city area, major retention pond of Hatirjheel, Rampura, Kallanpur pumping station, filled by developer. Immediate action required to conserve these areas. Otherwise, this will also create an environmental as well as economic burden for the society.

5.8 ROAD SIDE DEVELOPMENT

5.8.1 Uncontrolled Access

In Dhaka metropolitan city, there has not any rule or regulation to control the direct access in the different classes of road. People are frequently connected their buildings/ abating properties with the main road by access road even with the principal arterial road

.

Photograph 5.6: Uncontrolled Access with Main Road

Table 5.10: Number Of Direct Connection With The Main Road In Some Major Road Segments

Road Segment	**Side**	**Distance**	**Connection with Abating Properties**	**Direct Access**	**Total Access**
Moghbazar to Banglamoter	North		44	8	52
Motijheel to Baitul Mukaram Mosque	North		122	10	132
Baitul Mukaram Mosque to Press club	North		47	7	54
Nilkhet to Elephent road	East	0.71	93	9	102
Indrira road to Rasel Square	East	1.25	112	13	125

Source: Field survey, 2009

Photograph 5.10 shows some glimpses of the directing connection form the abating property with the road. Table 5.10 presents the number of direct connection of abating property with the main road in some major road segment. From this table it is revealed that there are almost 100 connecting access per kilometer road of the selected roadway segments.

Photograph 5.7: Direct Connection from Abating Property

Almost, all of the accesses are directly connect with the main road. Besides this access road, there are huge opening on the main road by which adjacent abating properties are connected frequently. Even, most of the case, there has not any service or parallel road. These huge numbers of uncontrolled access directly conflict with the present transit operation and obviously conflict with the mass transit system and the quality and

productivity is farther deteriorated.. The statistics and associated problems regarding uncontrolled access are discussed in detailed in the chapter 7.

5.8.2 Set Back Problem

Photograph 5.8: Ideal Setback with Circulated Traffic Lane

Rear and Side yard set-backs are intended to provide a minimum space between buildings to reduce the potential spread of fire, to ensure access to light and air, and on site access to building sides for maintenance (Table 5.11). For the approval from RAJUK for the construction beside the set-back rules, there are some provisions for access road. They consider having minimum width of 3.75 metres road, whereas now suggested for 4.75 metres road for the dead end and 6 metres for the normal access road.

Table 5.11: Rear and Side Yard Set-Backs

Category of use	'plot size	Rear(m)	Side(m)
Residential- (other than *row housing, semi- detached or minimal housing* schemes)	less than 135sq.m	1.25	1.0-
	135 to 200 sq.m	1.50	1.25
	201 to 265 sq.m	1.75	1.25
	266 to 330 sq.m	2.50	1.25
	331 to 660 sq.m	3.00	1.25
	over 600 sq.m	4.00	1.25

Source: Mitra 2006

In the British and Pakistan period, even early in the independence, most of the multistoried building has been constructed providing sufficient setback with circular traffic movement facilities like DCC building, Police Headquarter, Bangladesh Bank, National Museum etc.

Photograph 5.9: Construction of Multi-Stored Building without Minimum Set-Back

(Photograph 5. 11). But, after that period, even until today, most of the multi stored building are erected violating the set back rules. Buildings are constructing just adjacent to the roadside boundary leaving no space and indeed in many case parts of the building are extended over the streets in 90 percent cases (Photograph 5.12). Even, so many multi-stored commercial building is buildup without frontage road, proving sufficient setback for walking, parking etc. like Rapa plaza, Eastern plaza, Motaleb plaza, Concord plaza. In some cases, parking spaces are designed just overlapping the carriageway, which is also serious problem itself for traffic movement.

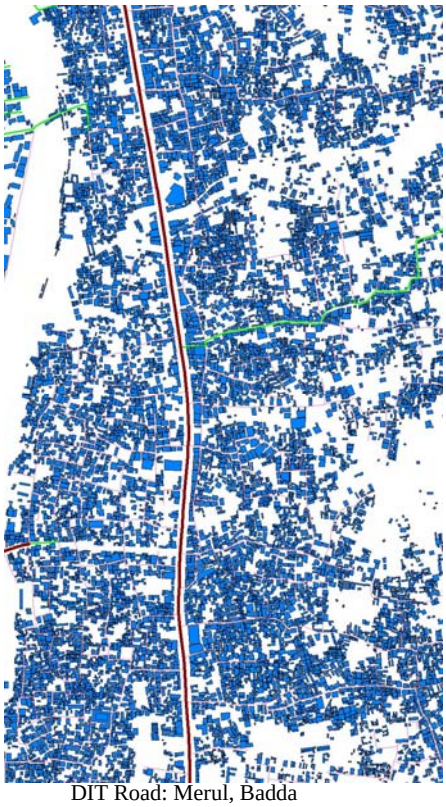
In the study of on urban fringe area of Dhaka city by Mitra 2006 was shown that in badda, matoil and gabtoli areas respectively 36%, 23%and 32% landowners have the approval from RAJUK . In this study also shown that only 30%, 33% and 28% of the owner has maintained the set-back rules in that area respectively and 51%, 40% and 47% of the landowners have the knowledge about the building rules and regulations and the approval procedures (Mitra, 2006).

5.8.3 Frontage Development (road side base development)

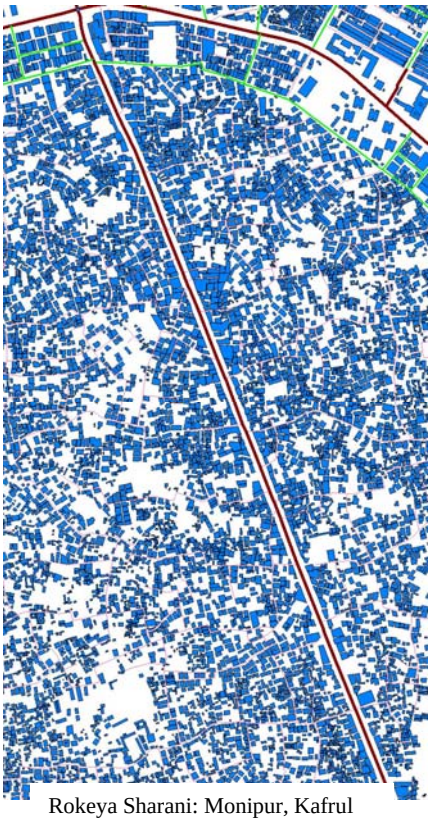
Random residential, commercial and other socio-economic developments like super markets, high-rise buildings or apartment complexes, garments factories at various parts of the city without appropriate consideration to planning principle, standard and existing or future provisions of abutting roads resulting only road side base development of the city. The mushroom growth of uncontrolled multistoried building, shopping centers, private institutions and organizations on the side of main road even primary road without any frontage space causing enormous bad impact on the road network as well as transportation system of the city.

5.8.4 Rear Side Accessibility

Most of the development is progressed only on road side base in the city. Road side plot are well organized and developed without providing sufficient space for rear side accessibility. As there has not any regulation of access of road, most of the plots (almost 95 percent of the plots in Pragati Sharani and Rokeya Sharani) adjacent to the road are highly developed without considering any access facility for rear side properties. However, most of the area of the city, unplanned, haphazard, inaccessible road has been developed on the donated land in



DIT Road: Merul, Badda



Rokeya Sharani: Monipur, Kafrul

Map 5.13: Rear side development of two Major Road in Dhaka City (Source: SOB, GIS map illustrated by the authors

the rear side of the main road of the city and becomes a concrete jangle in the period last of 400 years. Map 5.13 illustrated the road side development and rear side accessibility of two main road of Dhaka city.

5.8.5 Road Side Multi Stored Series Building

In Dhaka city, it is observed that there have been built so many multi-stored building, markets and shopping centers at the very near to roadside and without considering the resulting impact on through traffic movements (almost 100 percent in New Elephant road, Topkhana road, New Eskaton road, 95 percent in Mirpur road, Kakrail road, Rokeye Sharani etc.). Here high rise building are allowed based on road width, not the functional classification of road and super market are allowed considering only single entry based basement parking – not open parking lot. However, fundamental problem is the policy problem in this regard. Construction of the multi-storied building should be allowed on the basis of functional classification of the road, not only the road width and market are should be allowed considering open parking lot.

Photograph 5.10: Road Side Multi Stored Series Building

5.8.6 Road Side Series Market

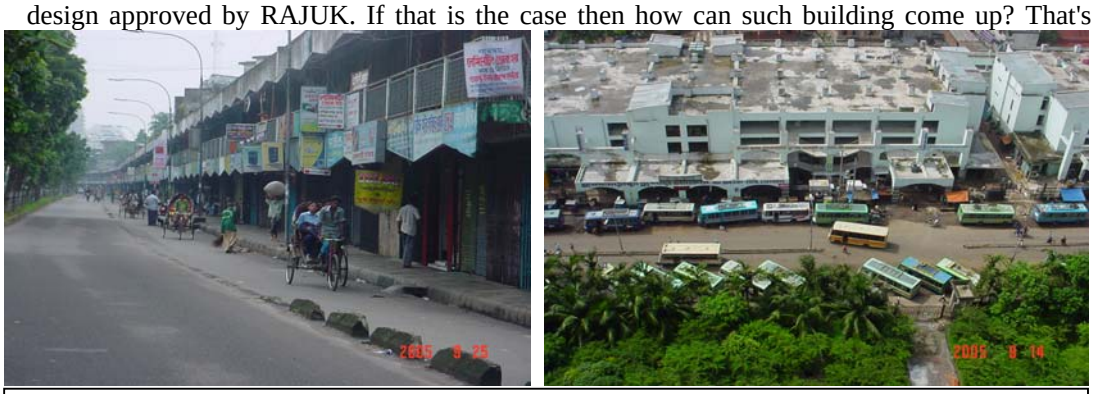
A series of multistoried shopping malls have been constructed along the major street network of the entire city. A similar situation is seen in every busy street in the sprawling capital city of more than 10 million people. Multistoried shopping malls are coming up almost every month, turning the city into a huge bazaar.

Most of these malls are located along the otherwise overcrowded and busy streets with little space for car parking. The lack of space for parking cars and vehicles of the shoppers is one of the main reasons why traffic jams are increasing in the areas dotted by shopping malls.

Photograph 5.11: Road Side Market with Ideal Parking Lot

Rajuk and PWD rules require builders to keep for parking space at least 23 square metres for each 200 square metres of a commercial building. In case of shopping complexes, at least 23 square metres of every 100 square metre must be kept for parking lots. Visits to many of the city's shopping complexes reveal large-scale violation of the rules. Many wonder how such violation can occur. No one can construct a building in the city without its

design approved by RAJUK. If that is the case then how can such building come up? That's a



Photograph 5.12: Road Side Series Market without Proper Parking Facilities

million-dollar question, which deserves an answer from the officials and engineers who have approved these buildings. However, there have been cases against some of those who violated the rules. Authorities say about 4,500 such cases are pending with the High Court after the defenders went to the higher court seeking stay orders. From the field survey it is found that there are 64 multi-storied markets are developed around the DCC head office area i.e. Gulistnan and Fubaria along the road side. Almost all of the market has not any parking space. Indeed, some of the space which has been designated for the parking in between two markets or inside of a rectangular or circular market, there is now developing larger market by the approval of DCC. Most unfortunate is that the city only one east-west continuous road which are just back side of DCC building are fully occupied by the series of DCC market.

5.8.7 Junction Corner Point Development

Junction corner point which is most complicated but lucrative zone of the road network. From the field observation it is clearly evident that all most all of the major junctions like Banglamotor, Shahabagh, Doinik Bangla, Polton, Gulistan, Fulbaria, Mirpur 1 &10, Moghbazar, Malibagh, Mouchack, Katabone etc. corner point (excluding very few notable exception) is developed without considering sufficient turning space as well without considering future development possibilities for improving capacity like extra lane, left merging lane, grade separation etc.. On the other hand it attracts huge number of vehicles at that complicated point, encourage stopping of public transport as it is generating passenger as well. Even those, many roads are ended or change direction for the construction of multi-stored building ahead of its alignment. Photograph 5.15

Photograph 5.13: Junction Conner Point Development

presents some example of such bad practice. Further detailed in the Chapter 7

In light of these there should be a specific suggestion regarding future roadside development projects particularly those would be initiated by DCC and RAJUK with their own finance to adopt EIA and TIA studies before undertaking the project. Most importantly, in consideration of scarcity of road adjacent empty space as well as acute shortage of different transport facilities within the built-up areas, in the first place DCC and RAJUK should be discouraged to construct any road adjacent commercial project on the government land before ensuring road widening works, providing adequate on-street parking facilities, bus-lays, para-transit waiting place etc.

5.8.8 Unacceptable Railway Level Crossings

There are altogether 51 (Fifty one) railway level crossing from Shyampur high school to Abdullahpur, 37 authorized and 14 unauthorized. Among the 51 level crossing, 13 are in Kamalapur-Narayagonj corridor and others 38 are in Kamalapur-Tongi corridor. From the field observations it is observed that among the 51 level crossing, in 12 point cross the bus operating major route, 5 are in Kamalapur-Narayagonj corridor and others 8 are in Kamalapur- Tongi corridor like Khilgaong, Malibagh, Moghbazar, FDC gate, Mohakhali, Kakoli, Banani and Bishaw road. Everyday 98 outgoing and incoming trains pass through the level crossing in the city. Among them 78 trains move through Kamalapur-Tongi corridor and other 20 moves Kamalapur-Narayagonj corridor (Appendix D). Out of 78 trains in the Kamalapur to Tongi corridor, 54 (67%) operate between 8.30 am to 10.30 pm. One an average a period of 3.5 minutes from Kamalapur to Mohakhali and 3.0 minutes from Bonani to Tongi is required to give a train its passage at each level crossing. In addition, 1.5 and 1 minutes times are required to come into normal condition of traffic flow at peck period and at off peck period respectively. However train creating interruption during passage of train on both sides of rail gates for an average of 5 to 6.0 hours in each day in each level crossing (Table 5.11).

Table 5.11: Delay per Day in Some Selected Level Crossing

Name of Level Crossing		Normalization Time		Total Delay per Signal		Queue length (m)		Delay (h)		**Total Delay (h)**
	Signal time	Peck hour	Off peck	Peck hour	Off peck	Peck hour	Off peck	Peck hour	Off peck	
F. D. C Level Crossing	3	1	0.5	4	3.5	75	40	3.40	1.58	**4.98**
Moghbazar	3.5	1	0.5	4.5	4	100	70	3.83	1.80	**5.63**
Banani Level Crossing	3.25	1.25	0.75	4.5	4	200	100	3.83	1.80	**5.63**

Source: Field Survey, 2010

From the in-depth field survey on Moghbazar level crossing, it is found that around 5.92 hours interrupting traffic flow every day in Mogh bazaar level crossing. Losses of man hour per day around 150,000 and loses of fuel for that interruption around 300 liter. Economic lose due to man-hour loss and fuel loss around 50,000 TK. per day. On the other hand, 238 employee are engaged for the controlling of the authorized level crossing and excluding other expenditure per month around 7.5 lac taka is losing only for their salary purpose (Appendix D).

On the other hand, every day average 212 trucks or covered is required for the loading and unloading of the freights in Kamalapur ICD. Among them around 150 trucks or covered van distributed around the city as well as out side of the city with full loading of imported freight and around 60 loaded trucks or covered vans enter into the ICD with exported freight. More than 400 large trucks or covered vans trips are creating every day on Dhaka road by the ICD. Whereas from the analysis of the origin and destination of that trips, it is fond that almost 70 percent of that

Photograph 5.14: Railway Level Crossing in the Main Road of the City

trips (Savar or DEPZ 30%, Gazipur 27 %, Tongi 10%) destination or origin are outside of Dhaka city (Figure 5.8). Only 30 percent freight movement occur in Dhaka city. However, the city transport system is adversely affected for the ICD by generating huge number of large trucks trips. On the other hand, freight train impact on level crossing is almost double than the passenger train for the causes of low speed but longer size. So, the city transport system is suffering in two ways which essentially suggest that Kamalapur ICD should be relocated in Tongi or Gazipur or new ICD should be developed in that area.

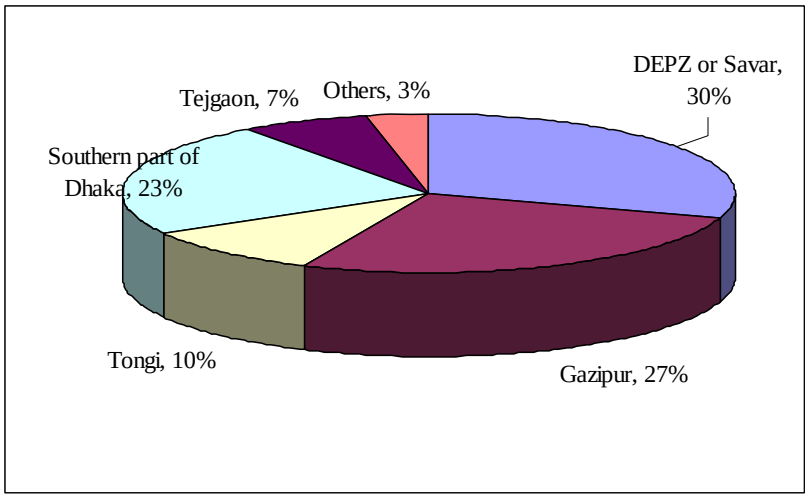


Figure 5.8: Distribution of the Trucks from Kalamlpur ICD

So, the road and rail is not supporting but interrupting each other. If railway facility increases then the road will deprive and vise versa. Whereas, it should be integrated, coordinated and supportive to each other. At present rail and road network condition, it is very difficult to integrate and make supportive to each other. Grade separation by raising the railway tract was one of the possible solution to overcome this problems but after the construction of Mohakhali ramp and Khilgaon interchange, the possibility of the grade separation by elevating the present railway track is become almost impossible. Construction of underground railway track is also become difficult for the deep foundation of the mega structure. So, this interrupting situation would be continued until the construction of flyover or ramp in every level crossing and that would be not only economically less feasible in the existing railway track but also very difficult in the present haphazard and unplanned road network.

5.9 LACK OF FUNCTIONAL EFFICIENCY

An efficient city is one in which people can work and perform their tasks easily, conveniently, and economically. That is the performance of tasks requires less effort, less time, and less cost.

On the other hand, when the city is inefficient, performance of tasks require more effort, more time, and more cost. The functional efficiency of a town primarily depends on-

- The provision of appropriate facilities according to requirement
- The organization of landuses or activity areas according to their hierarchy
- The grouping of the facilities according to their relationship and compatibility
- The linkage between the activity areas and the ease of movement
- The overall compactness of the development

From the above description it is established that Dhaka city is developed without any proper guidance and control. Facilities has developed on the basis of need as per as available location. So, facilities have little been developed according to the requirement. There has no landuse even transport hierarchy and it is very difficult to find out any relationship and compatibility among the facilities and user group like 17 universities adjacent to the satmasjid road of Dhanmondi. Most of the development of the city took place by sprawling and scattered way and there has very little linkage between the activity areas and the ease of movement. However, most of the case the city dwellers requires more effort, more time as well as more cost to perform in the city area. That way, it is evident that, the city is not functionally efficient.

5.10 OVERVIEW

In this chapter, an overview of landuse deficiencies in Dhaka Metropolitan City have tried to highlighted with a broader perspective. There is enormous scope to in-depth investigation and analysis on every perspective which is recommended for further study. From this broader evaluation it can be summarized that the city has the huge scarcity of build able land for the cause of low topography which is not suitable for such a mega city with this the city available resources of city have been utilized without any proper legislation and controlled results unplanned, environmentally unhealthy, inconvenient and unsafe as well as economically deprived and unsustainable city. The mobility and the accessibility of the city are not swift, convenient, safe and easy for the traffic (pedestrian, passenger and goods) which makes the city ecologically unbalanced and aesthetically unpleasant as well as functionally inefficient. That's, there is no planning principle of the city has fulfill and very unfortunate is that there has a very few scope to renew of these inherent deficiencies.

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CHAPTER 6

DEFICIENCIES OF ROAD NETWORK

6.1 INTRODUCTION

Road network plays an important role in the smooth functioning of a city. It is an integral facet of urban life. As the city grows, demand for the vehicles and new roadway facilities and new routes also arise. Dhaka being the capital city of Bangladesh plays a vital role on overall transportation network in the country. Dhaka's transport system is predominantly road based. But the road quantity, orientation, quality and condition of Dhaka city is quite far from the satisfactory level. As a result, the city is affected by a lot of problems regarding transportation as well as road transport system. For the causes of unplanned and ad-hoc base development in the city, so many irrecoverable inherent deficiencies take places in entire road network overall the city and the situation is further deteriorating with the passing of time. In this study an attempt has been made to identify and highlight the inherent weakness of the road network of the city with the evaluation and present the existing condition and situation for justification of future improvement options of the entire road network of the city. To achieve the goals, two parameters have been considered in this study like quantity, alignment/orientation. In this study to present the quantity as well as quality of road network of the city, a comprehensive analysis has been conducted of the row road survey database conducted under the project of Road Maintenance and Management System (RMMS) by DCC. To highlight the road orientation or alignment problems, data has been collected from the field investigation, field survey and in house survey using Google map and GIS data base.

6.2 EVALUATION AND JUSTIFICATION OF ROAD QUANTITY OF THE CITY

For the causes of unplanned and ad-hoc base development in the city, so many deficiencies take places in entire road network overall the city. To present the deficiencies of road network of the city, the deficiencies are categorized in two parts like quantity and alignment/orientation pattern in this chapter, are described below in brief:

6.2.1 Total Road Network of the City

Table 6.1 presents the length, pavement area, road area, percent of road area, percent of pavement area, percent of pavement area and road area of total land area of the Dhaka City Corporation area different types of road. In general, it is also said that a city should have 25% roads of its total area. But it is not the universal truth that 25% road is adequate for a city for sustainable and comfortable transport. Various factors must be included with this because surface space is limited and almost fixed but density of population, number of vehicles, number of trips etc. increases day by day which creates enormous pressure on land, road, environment as well as landuse and transport system, where's Dhaka city is the most densely and overpopulated city in the world according to the description of article 4.3. Excluding that factor, if it is considered that 25% road is enough for this city, but the existing city road space is far apart from that requirement in Dhaka

City Corporation Area. From the in-depth data analysis, it is found that here is only 9 percent of the total area are road space where's pavement space only 6 percent in the DCC area.

Table 6.1: Different Types of Road Length, Pavement Area and Road Area of DCC

Classes of road	Length (km)	Percent	Pavement area (sq. km)	Percent	Percent of total land area	Road area (sq. km)	Percent	Percent of total land area
Primary	61.45	4.78	1.46	16.47	**1.08**	1.89	15.67	**1.41**
Secondary	108.20	8.41	1.86	21.05	**1.39**	2.41	19.94	**1.80**
Connector	221.35	17.21	1.68	19.04	**1.25**	2.47	20.42	**1.84**
Local	573.75	44.61	2.93	33.17	**2.18**	4.25	35.19	**3.17**
Narrow	321.27	24.98	0.91	10.28	**0.68**	1.06	8.78	**0.79**
Total	1286.02	100.00	8.84	100.00	**6.59**	12.09	100.00	**9.01**

Source: RMMS, 2004 (Analyzed by the Author)

From the Table 6.1 it is also evaluated that the total road length of the DCC area is 1286 km, among them the lengths of primary, secondary, connector, local and narrow roads are 61.348 km, 116.40 km, 219.54 km, 569.87km, and 318.27 km respectively. The road length of a city should have an cumulative increasing trend according to its classification to form a pyramid of road hierarchy in which primary road will be at the apex, then secondary, then connector, the local and at last narrow. Here, primary to local road formed an unsymmetrical pyramid but it should have a symmetrical pyramid of the enter city road according to classification as well as priority demand.

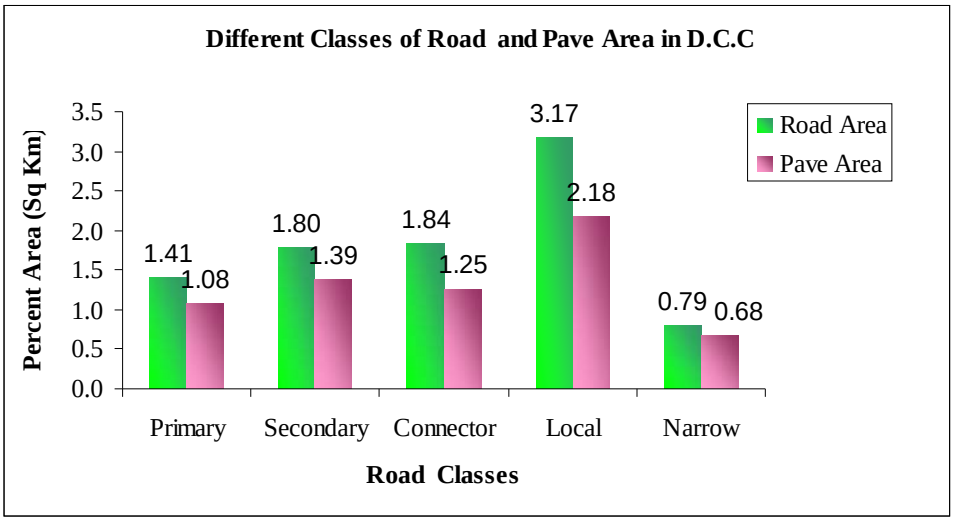


Figure 6.1: Different Classes' Road and Pave Area in sq km among the Total Area of the City

In the Figure 6.1, it is shown that according to the classification, there is only 1.08 sq kilometer of primary road pavement area available in the total land area of the city area which contain 1.41 sq. kilometer of road area. Pavement areas of the other roads secondary, connector, local and narrow road are 1.39, 1.25, 2.18, 0.68 sq. kilometer containing road area 1.80, 1.84, 3.17 and 0.79 sq. kilometer respectively. The total road area of these five types of road in the city area is 12.09 sq. kilometer with the 8.84 sq. kilometer of pavement area. The percent of these road and pavement areas of the total areas of the city are respectively 9.01 percent and 6.59 percent. Among the 12.09 sq. kilometer of road area, 9 percent of narrow road and 35 percent are local road (Table 6.1).

The percent of narrow roads and primary roads are 25 percent and 5 percent in length and 10 percent and 16 percent in pavement area respectively (Table 6.1). Among the total pave area, 10

percent are narrow road. In both case, local road are the highest in percent within all other road, accounted for 45 percent of total length and 34 percent of total area. These figures indicate high inconsistency in planning of road network system of Dhaka City Corporation.

Besides the scarcity of the quantity of road, the entire road network splits into two sections as does the city itself, which is the Old Dhaka and the remainder. The road standards vary widely in both the sections. In Old Dhaka, which dates back 400 years, many of the principal links are narrow lanes, except the North-South Road and the English Road, street width (building to building) varies from 3m to 7m with the average being around 5m, In the newer areas, the major roads are wide but there is an absence of a well oriented continuous secondary and local network.

Many of the urban transport experts have argued that Dhaka City has enough road space for its functioning. But the thing is only true for two factors. Firstly, level of motorization in Dhaka is very low which does not represent actual demand of trips made by the city dwellers avoiding non-motorized vehicles. Secondly, travel demand is not evenly distributed through the city rather has heavy pressure on certain few links of the network. The situation has sharp changed. Increasing rate of demand is very high at present. A principal reason of such a rapid growth is over concentration of maximum activities and development works in the city and little improvements in other cities, towns and villages in terms of infrastructure development and economic activities. Improved road communication in the country further made it easy to converge on the capital for searching employment and better quality of life.

From the above discussion and facts, it is found that the existing road in the entire city road network is not quite enough and is the one-forth of the minimum requirement of a modern city. Even, the existing roads are not well oriented according to the functional hierarchy. Still, there have huge road network planning, layout, pattern problem which is discussed in the following sections. Therefore, there is highly needed to increase the high potential road network as well as to increase road and pavement area. But, it is the real fact that, there has minimum option to construct new road or widening the road area. This is also one of our major planning problems that the authority could not allocate sufficient space for future expansion. Now, most of the area of Dhaka city is build up with road side multi-stored building and/series market etc. Most of the areas are highly densified with more than 0.1 million people per sq. kilometer like Lalbagh thana. There is a very few provision to increase the roadway area of the city without destroying the road side development. That is very difficult and would be huge burden of our fragile economy. So, this scarcity of the road length or area would be sustaining until the city remain. That’s this is one of the fundamental inherent weakness of the city of Dhaka for their yield landuse and transport panning.

6.2.2 Road in Different Zones

It is described in earlier that administrative areas of Dhaka city has been divided in 90 wards and 10 zones. Table 6.3 shows the areas of each zones, total roads length, pavement areas, road areas and density of roads per sq. km of each zone. Total road length in zone 1 is 171 km, is the highest amount of road in length and lowest amount of road in length in zone 10 (63 km).

The difference between the road and pave area is the highest in the zone 10, more than double which represent that there has significant amount of road side space for foot path, utility service, green space, future expansion options etc. On the other hand, the other zone mainly zone 1, 2, 3 and 7, the road area and pave area are nearly equal which represents that the road side is highly buildup without sufficient road side space for footpath, utility line, drain, as well as a very few of future expansion option (Table 6.2).

Table 6.2: Roads in Different Zones of Dhaka City

Zone	Area sq.km	Total Road			Percent of Area		Density km per sq.km
		Length (km)	Pavt. Area (Sq. km)	Road Area (Sq. km)	Pav. Area	Road Area	
1	9.02	170.990	0.827	0.974	9.164	10.796	18.96
2	4.39	100.866	0.525	0.559	11.964	12.739	22.98
3	7.10	98.149	0.500	0.592	7.039	8.339	13.82
4	16.59	166.263	1.227	1.534	7.396	9.248	10.02
5	15.73	125.089	1.535	1.893	9.761	12.037	7.95
6	13.38	120.102	0.833	1.212	6.228	9.058	8.98
7	14.73	135.627	0.976	1.111	6.627	7.540	9.21
8	28.79	159.046	0.908	1.331	3.153	4.624	5.52
9	20.38	147.350	1.184	2.078	5.808	10.194	7.23
10	4.15	62.541	0.330	0.807	7.944	19.442	15.07
Total	**134.26**	**1286.023**	**8.844**	**12.091**	**6.587**	**9.006**	**9.58**

Different types of road in different zones are presented in the Table 6.2. Among the total primary roads (61.45 km), highest amount of primary roads are available in zone 5 (14.72 km), followed by zone 7 (11.1 km), zone 9 (11.06 km). Though, highest amount of roads are in zone 1 (170.99 km), primary roads are only 3.03 km, and most of the roads in this zone are local roads (100.9 km). Highest quantity of narrow roads are in zone 8 (57.55 km), and followed by zone 4 and zone 7, 54 and 51 km respectively (Table 6.3).

Table 6.3 Different Types of Road in Different Zones

Zone	Road Length (km) under Diff. Types					Total Rd Under Zone
	Primary	Secondary	Connector	Local	Narrow	
1	3.03 (2)	8.92 (5)	15.00 (9)	100.90 (59)	43.14 (25)	170.99 (100)
2	0.48 (0)	9.25 (9)	7.53 (7)	56.71 (56)	26.90 (27)	100.87 (100)
3	3.68 (4)	14.90 (15)	19.97 (20)	19.04 (19)	40.56 (41)	98.15 (100)
4	10.10 (6)	18.33 (11)	17.75 (11)	66.57 (40)	53.51 (32)	166.26 (100)
5	14.72 (12)	22.36 (18)	30.87 (25)	38.92 (31)	18.22 (15)	125.09 (100)
6	4.78 (4)	7.10 (6)	38.40 (13)	48.94 (41)	20.89 (17)	120.10 (100)
7	11.10 (8)	8.80 (6)	16.65 (12)	44.92 (33)	54.16 (40)	135.63 (100)
8	2.50 (2)	7.81 (5)	21.34 (13)	69.84 (44)	57.55 (36)	159.05 (100)
9	11.06 (8)	10.75 (7)	48.69 (33)	70.52 (48)	6.34 (4)	147.35 (100)
10	0.00 (0)	0.00 (0)	5.16 (8)	57.38 (92)	0.00 (0)	62.54 (100)
Total	**61.45 (5)**	**108.20 (8)**	**221.35 (17)**	**573.75 (45)**	**321.27 (25)**	**1286.02** (100)

*Note: Figure in bracket shows the percent of different types of road

Source: RMMS, Analyzed by the author

More than 100 km of roads in zone 1 is local road. Zone 3 and zone 7 (Lalbagh, Monipur and Kafrul), narrow road is disproportionately higher than any other road types which indicate that the most of the road of this areas is respectively narrow and unplanned development take place (Article 4.8). From the Table 6.3, it is shown that nearly 50 percent of the roads are local road and 25 percent are narrow road and only rest 25 percent are primary, secondary and connector road of the different zones. Table 6.3 also represent that in the zone 1, 2, 8 and 10 percent of primary road is far lower than the average percent of primary road which is 2, 0, 2, and 0 percent respectively. Table 6.3 also shows that the percent of narrow road in the zone number 3, 7, 8 are very high accounting for about 41 percent, 40 percent and 36 percent respectively where as average percent

of narrow road is about 25 percent. It is more frightening that these zones are more built-up and crowed areas which indicate that there have very few scopes of improving the existing converting the narrow to local road or local to connector road through widening the road width. For the lack of preplanning of development or uncontrolled growth of the permanent structure, the city will have to survive with such narrow and thin vein.

Table 6.3 also shows that there are only 0.009, 0.011, 011 sq. km of pave area is available in zone 3, 2 and 8 respectively and according to Table 6.4 it is found that the average pave and road area per 10,000 population in all over the DCC area is only 0.015 and 0.020 sq. km respectively. In further analysis, it is found that there are only 2.15 km of road is available for 10,000 of population and pavement space available only 0.015 sq. km. The availability of major roads in terms of either km per thousand populations or km per square kilometer of area is too low as compared to the other cities of developing countries. According to the world bank statistics in the report on road per capita in 9 cities of developing countries and 26 cities of developed countries is 0.5 and 4.5 meter respectively (Ingram and Liu, 1998). Whereas, in Dhaka City Corporation area, per capita road only 0.0213 meters is available. This scarcity of the road length or area will be sustaining until the city remain. That's this is one of the fundamental inherent weakness of the city of Dhaka results from the unplanned haphazard landuse and transport panning.

Table 6.4: Road per 10,000 Populations in Different Zones

Zone	Area sq. km	Pop.2004	Density	Road per 10,000 Population		
				Road Len.	Pave. Area	Road Area
1	9.02	671,416	74,436	2.55	0.012	0.015
2	4.39	489,409	111,483	2.06	0.011	0.011
3	7.10	528,828	74,483	1.86	0.009	0.011
4	16.59	933,531	56,271	1.78	0.013	0.016
5	15.73	621,792	39,529	2.01	0.025	0.030
6	13.38	462,468	34,564	2.60	0.018	0.026
7	14.73	777,679	52,796	1.74	0.013	0.014
8	28.79	845,172	29,356	1.88	0.011	0.016
9	20.38	623,620	30,600	2.36	0.019	0.033
10	4.15	74,789	18,021	8.36	0.044	0.108
Total	**134.26**	**6,028,704**	**44,903**	**2.13**	**0.015**	**0.020**

6.2.3 Road in Different Widths

There are only 107 kilometers road which width more than 24 meters (Table 6.5) in all over the city of Dhaka among the total 1286 km road. Indeed, there are only 45 km of road which pavement width more than 24 meter (Table 6.5, Table 6.6). Among them airport road and Mirpur road is continuous road in on one direction and others road like Rokeya Sharani, DIT road is not continuous so far. From the different width base analysis which are represent in Table 6.6 and 6.7, it is seen that there are very few road which pavement width even road width is more than or equal to 24.5 meter that's more than 6 lane. So, it is highly difficult to provide separate lane for rapid mass transit like BRT. In the zone number 2 and 3, there has not even 1km of road which width are more than 24 meters (0.31 and 0.59 km according to road area, 0.31 and 0.00 km according to pavement area respectively) (Table 6.6). In these table, the road which width is equal or grater than 4.75 meters i.e. emergency service like ambulance, fire service can be enter freely is denoted as accessible road. More than 50 percent of roads are narrow road in the zone 1, 2, 3, 7 whereas in zone 10, narrow road is negligible which indicate that most of the roads are sufficient width as well as planned development with sufficient setback of road side.

Table 6.5: Length of Different Width of Roads of Different Zones in DCC

Zone	Road Length (km) Under Diff. Width of Road					Total Rd Under Zone	Accessible Rd (w>=4.75)	% of Acc. Road	% of Narrow Road
	>24.5	>18<=24.5	>8.25<=18	>4.75<=8.25	<4.75m				
1	1.60	6.10	17.23	49.89	96.18	170.99	74.81	43.75	56.25
2	0.31	2.38	13.37	27.79	57.03	100.87	43.84	43.46	56.54
3	0.59	2.55	21.42	23.60	50.00	98.15	48.15	49.06	50.94
4	21.43	5.90	25.33	47.13	66.47	166.26	99.79	60.02	39.98
5	25.57	18.82	34.64	18.20	27.87	125.09	97.22	77.72	22.28
6	9.27	5.97	34.61	46.26	23.98	120.10	96.12	80.03	19.97
7	15.10	4.80	4.21	32.57	78.96	135.63	56.67	41.78	58.22
8	9.17	3.14	25.33	67.67	53.74	159.05	105.31	66.21	33.79
9	20.53	10.42	70.94	35.37	10.09	147.35	137.26	93.15	6.85
10	3.60	5.94	51.32	1.58	0.10	62.54	62.44	99.84	0.16
Total (km)	**107.17**	**66.00**	**298.38**	**350.06**	**464.41**	**1286.02**	**821.61**	**63.89**	**36.11**
% of Len.	**8.33**	**5.13**	**23.20**	**27.22**	**36.11**	**100.00**	**63.89**		

*****Note: Width has been selected according to the width base functional classification of DCC for maintenance work.

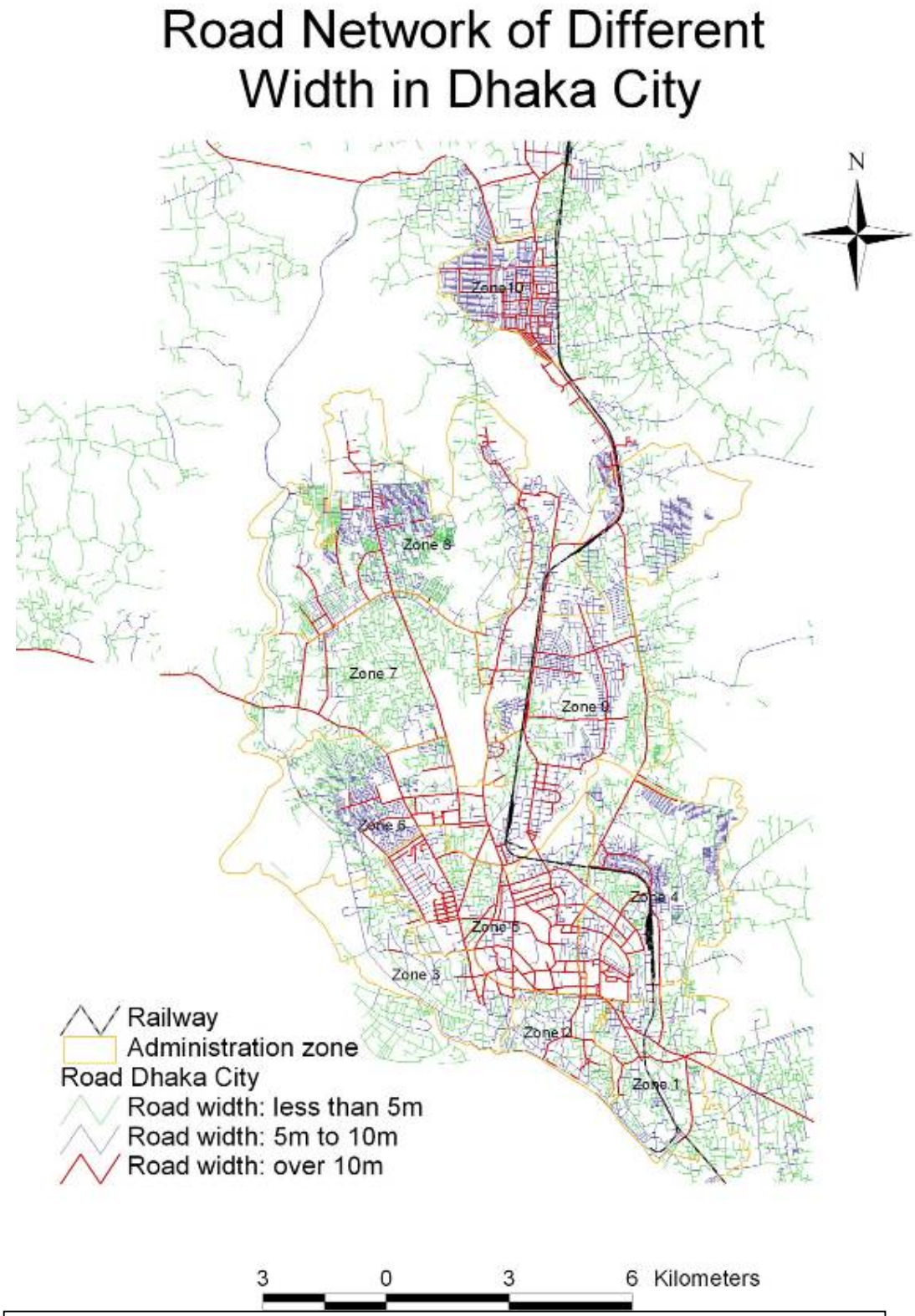
Table 6.6: Length of Different Width of Pavement of Different Zones in DCC

Zone	Road Length (km) Under Diff. Width of Pavement					Total Rd Under Zone	Accessible Rd (w>=4.75)	% of Acc. Road	% of Narrow Road
	>24.5	>18<=24.5	>8.25<=18	>4.75<=8.25	<4.75m				
1	0.75	3.07	12.33	43.38	111.46	170.99	59.53	34.81	65.19
2	0.31	1.33	13.94	24.13	61.16	100.87	39.71	39.37	60.63
3	0.00	1.70	9.91	34.34	52.20	98.15	45.95	46.81	53.19
4	6.75	15.76	12.66	45.75	85.35	166.26	80.91	48.67	51.33
5	16.49	17.65	37.80	23.99	29.16	125.09	95.93	76.69	23.31
6	3.62	5.90	10.88	49.36	50.35	120.10	69.75	58.07	41.93
7	8.10	8.26	4.57	30.25	84.46	135.63	51.17	37.73	62.27
8	2.20	3.75	12.01	40.06	101.03	159.05	58.02	36.48	63.52
9	6.87	11.97	12.37	66.51	49.64	147.35	97.71	66.31	33.69
10	0.00	0.70	4.87	14.39	42.58	62.54	19.96	31.91	68.09
Total (km)	**45.08**	**70.08**	**131.32**	**372.15**	**667.39**	**1286.02**	**618.64**	**48.10**	**51.90**
% of Len.	**3.51**	**5.45**	**10.21**	**28.94**	**51.90**	**100.00**	**48.10**		

From the Table 6.6, there are only 48 percent of roads pavement with is more or equal to 4.75 m which could be term as accessible) i.e. more than 50 percent of road not accessible indeed for emergency vehicle. From this Table, it is also evaluated that zone 9 has the highest amount accessible pavement followed by zone 5, zone 4. But the highest percent of accessible road is in zone 5 (77%), followed by zone 9 (58%) and zone 6 (66%) (Table 6.6).

According to road width, almost 100 percent of road width is more than 4.75 meter but only 70 percent pavement width is less than 4.75 meter i.e. only 30 percent of roads pavement with is more than 4.75 meter in the zone 10 named, Uttara planned residential area. In zone 6, almost 80 percent road width is more than that accessible width but pavement only 58 percent. More than 60 percent of road and pavement width is less than 4.75 in zone 1, 2, and 7 (Table 6.6, 6.7).

Among the total road of the Dhaka City Corporation area, 821.61 (64%) km road width is more or equal to 4.75 meter but according to pavement width, that's are only 618.14 (48%) km. So, although 203 (16%) km road width is more or equal to 4.75 meter but their pavement width is less than 4.75 meter, i.e. emergency vehicle could not be entered that pavement width road. So, this 203 km road could be made accessible by increasing the width of pavement of the road. But, other 464 (36%) road pavement width could not be increased without demolishing existing road side development as road entire road width is less than that the desired level of accessibility (Table 6.6). So, these roads will be remaining inaccessible and a city could not sustain with a huge amount of so thin vein which is totally blocked or plugged or out of use. As this problem is started from very beginning of the planning of the city and both side roads is highly buildup by multi-storied building, the only solution is the redevelopment of the city by demolishing the entire side development. But, this are not only the extremely difficult but also almost impossible. In these circumstances, only solution is the abandon of the city.



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Map 6.1: Road Network in Different Width

6.2.4 Road Area of Different width of Road in Different Zone

Table 6.7 and 6.8 shows the road pavement areas of different widths of roads and widths of pavements in different zones. Among the total pavement areas, only 28 percent of pavement areas are of the roads which road width more than 24.5 meter.

Table 6.7: Pavement Area of Different Width Roads of Different Zones in DCC

Zone	Road Pave Area (sq. km) of Different Width of Road					Total Pav. Area of Diff. Zone	Accessible Rd (w>=4.75)	% of Accessible Rd
	>24.5	>18<=24.5	>8.25<=18	>4.75<=8.25	<4.75m			
1	0.04	0.10	0.15	0.26	0.28	0.83	0.55	66.50
2	0.01	0.05	0.15	0.16	0.16	0.53	0.37	69.55
3	0.01	0.04	0.17	0.14	0.14	0.50	0.36	72.45
4	0.49	0.10	0.19	0.24	0.21	1.23	1.02	83.27
5	0.65	0.33	0.35	0.11	0.10	1.54	1.43	93.36
6	0.24	0.08	0.22	0.22	0.07	0.83	0.76	91.68
7	0.41	0.08	0.03	0.17	0.29	0.98	0.69	70.54
8	0.19	0.04	0.17	0.32	0.19	0.91	0.72	78.94
9	0.45	0.11	0.44	0.16	0.03	1.18	1.15	97.35
10	0.05	0.04	0.24	0.01	0.00	0.33	0.33	99.91
Total (sq. km)	**2.538**	**0.963**	**2.101**	**1.781**	**1.461**	**8.844**	**7.383**	83.48
% of Diff. Area	**28.69**	**10.89**	**23.76**	**20.14**	**16.52**	**100.00**	**83.48**	
% of Total Area	**1.89**	**0.72**	**1.56**	**1.33**	**1.09**	**6.59**	**5.50**	

Table 6.8: Road Area of Different Width of Roads of Different Zones in DCC

Zone	Road Area (sq. km) of Different Width of Road					Total Rd Ar. Under Zone	Accessible Rd (sq. km) (w>=4.75)	% of Accessible Rd
	>24.5	>18<=24.5	>8.25<=18	>4.75<=8.25	<4.75m			
1	0.050	0.133	0.183	0.303	0.304	0.974	0.67	68.81
2	0.008	0.049	0.160	0.170	0.172	0.559	0.39	69.17
3	0.016	0.054	0.225	0.146	0.152	0.592	0.44	74.29
4	0.603	0.129	0.276	0.306	0.221	1.534	1.31	85.63
5	0.808	0.407	0.465	0.112	0.102	1.893	1.79	94.63
6	0.324	0.125	0.375	0.299	0.088	1.212	1.12	92.74
7	0.486	0.103	0.047	0.185	0.290	1.111	0.82	73.89
8	0.342	0.068	0.290	0.426	0.206	1.331	1.13	84.56
9	0.686	0.219	0.907	0.227	0.038	2.078	2.04	98.18
10	0.112	0.113	0.570	0.011	0.000	0.807	0.81	99.96
Total (sq. km)	**3.434**	**1.400**	**3.499**	**2.186**	**1.572**	**12.091**	**10.519**	87.00
% of Diff. Width	**28.40**	**11.58**	**28.94**	**18.08**	**13.00**	**100.00**	**87.00**	
% of Total Area	**2.56**	**1.04**	**2.61**	**1.63**	**1.17**	**9.01**	**7.83**	

From the Table 6.9 it is found that though pavement area of the city is 8.85 sq.km. the pavement area of that road which pavement width more than 24.5 meters is only 1.27 sq.km which is only 14 percent of total pavement width and less than 1 percent (0.95) of total city area. Most of the zone of Dhaka Metropolitan city has not less than 0.10 sq.km of pavement area which pavement width is more than 24.5 meter.

Table 6.9: Pavement Area of Different Width Pavement of Different Zones in DCC

Zone	Pave Area (sq. km) of Different Width of Pavement					All Pav. Area	Accessible Pave (w>=4.75)	% of Accessible Pave
	>24.5	>18<=24.5	>8.25<=18	>4.75<=8.25	<4.75m			
1	0.02	0.06	0.14	0.26	0.34	0.83	0.49	58.89
2	0.01	0.03	0.16	0.15	0.18	0.53	0.35	66.19
3	0.00	0.06	0.09	0.21	0.15	0.50	0.35	70.46
4	0.18	0.33	0.16	0.27	0.28	1.23	0.94	77.02
5	0.46	0.36	0.45	0.16	0.11	1.54	1.43	93.02
6	0.12	0.13	0.12	0.29	0.17	0.83	0.66	79.12
7	0.24	0.19	0.07	0.16	0.31	0.98	0.67	68.15
8	0.06	0.08	0.16	0.23	0.37	0.91	0.53	58.82
9	0.18	0.27	0.13	0.41	0.19	1.18	0.99	83.81
10	0.00	0.01	0.05	0.08	0.18	0.33	0.15	44.85
Total (sq. km)	**1.271**	**1.525**	**1.548**	**2.215**	**2.286**	**8.844**	**6.558**	74.15
% of Diff. Area	**14.37**	**17.24**	**17.50**	**25.04**	**25.85**	**100.00**	**74.15**	
% of Total Area	**0.95**	**1.14**	**1.15**	**1.65**	**1.70**	**6.59**	**4.88**	

In the present landuse condition, according to the description of Chapter 5, there is very little opportunity to widening of the existing roads for the causes of unplanned road side development without any allocation or restriction for future improvement. So, improvement of capacity of the existing road is almost impossible by geometric improvement as well as road side conflict management. It is the reality that the demand of the road will be increasing and the capacity of the road network required to be increased for the proper functioning of the city. One of the most effective ways to increase the capacity of the road network is the geometric improvement of the road. But, there are very few prospects to increase the capacity by the geometrically improvement of the existing roads. For the lack of sufficient width road of the existing road network, there are also very few possibility to introduce high occupancy vehicle (HOV) for enormous forthcoming demand management. This are also result from the planning fault and would have to be contained until the city alive.

6.2.5 Lack of Accessible Road:

The road in which at least one motorized vehicle can easily move may be term as accessible road. In Dhaka city, about half of the road is not sufficient width from where a motorized vehicle can move among the existing road. As described earlier, among the 1286 kilometers of road in Dhaka city, only 821 kilometer (64%) road are accessible in accordance with road width and 618 kilometer (48%) roads in terms of pavement width and in terms of area, that's are 10.5 and 7.38 sq. km respectively. In the zone 1, 2, 3 and 7 more than 50 percent road width is less than 4.75m. Table 6.10 shows the accessible road length, pave area and road area of the total road in different zone.

Table 6.10: Road Length and Area of Accessible Road on Road Width in Different Zones in DCC

Zone	Total Accessible Road			Percent of Road Area		Density km per sq.km
	Length (km)	Pavt. Area (Sq. km)	Road Area (Sq. km)	Pav. Area	Road Area	
1	74.81	0.550	0.670	6.094	7.429	8.29
2	43.84	0.365	0.387	8.321	8.812	9.99
3	48.15	0.362	0.440	5.100	6.196	6.78
4	99.79	1.022	1.314	6.159	7.918	6.02
5	97.22	1.433	1.792	9.113	11.390	6.18

6	96.12	0.764	1.124	5.710	8.400	7.18
7	56.67	0.689	0.821	4.674	5.571	3.85
8	105.31	0.716	1.126	2.489	3.910	3.66
9	137.26	1.152	2.040	5.654	10.009	6.74
10	62.44	0.329	0.807	7.937	19.434	15.05
Total	**821.61**	**7.38**	**10.52**	**5.50**	**7.84**	**6.12**

Table 6.11: : Road Length and Area of Accessible Road on Pavement Width in Different Zones in DCC

Zone	**Total Accessible Road**			**% of Road Under Area**		**Density km per sq.km**
	Length (km)	**Pavt. Area (Sq. km)**	**Road Area (Sq. km)**	**Pav. Area**	**Road Area**	
1	59.53	0.487	0.583	5.396	6.468	6.60
2	39.71	0.348	0.366	7.919	8.340	9.05
3	45.95	0.352	0.429	4.959	6.040	6.47
4	80.91	0.945	1.177	5.696	7.093	4.88
5	95.93	1.428	1.600	9.080	10.172	6.10
6	69.75	0.659	0.953	4.927	7.120	5.21
7	51.17	0.665	0.600	4.516	4.073	3.47
8	58.02	0.534	0.428	1.854	1.488	2.02
9	97.71	0.992	0.849	4.868	4.168	4.79
10	19.96	0.148	0.152	3.563	3.656	4.81
Total	**618.64**	**6.56**	**7.137**	**4.89**	**5.32**	**4.61**

Table 6.10 represents that there are only 10.51 sq.km road area or 7.3 sq.km pave areas of roads which road width the more than 4.75 m or can be treated as accessible road. But according to the pavement width, there are only 7.1 sq.km road area or 6.6 sq.km pave areas of roads which pavement width the more than 4.75 m or can be treated as accessible road. Percent of accessible road area and pavement area of the city of the total area of the city are 7.83 and 5.49 percent respectively. Though, the total pavement area of the city is 6.59 percent, but the functional pavement area of the city only 5.49 percent. Indeed, according to the pavement width base analysis, there are only 4.9 percent of road which pavement width is more than 4.75 m. (Table 6.11).

Considering the pavement width of road, it is shown that the accessible pavement area is only 4.88 percent (Table 6.12). Obviously, it is very very lower than the minimum standard of a modern city. Unfortunately, there has not any option to convert a narrow road to an accessible road by widening the road as both sides are highly buildup without any setback. So, this inaccessibility will be sustained of the city as a patient who has not any medicine for treatment and going to certain death.

Table 6.12: Accessible Pavement Area of Different Zones in DCC

Zone	Area sq.km	Total Accessible Pavement		% of	Density km per sq.km
		Length (km)	Pavt. Area (Sq. km)	Pav. Area	
1	9.02	59.526	0.487	5.396	6.60
2	4.39	39.710	0.348	7.919	9.05
3	7.10	45.945	0.352	4.959	6.47
4	16.59	80.913	0.945	5.696	4.88
5	15.73	95.934	1.428	9.080	6.10
6	13.38	69.748	0.659	4.927	5.21
7	14.73	51.170	0.665	4.516	3.47
8	28.79	58.016	0.534	1.854	2.02
9	20.38	97.714	0.992	4.868	4.79
10	4.15	19.959	0.148	3.563	4.81
Total	**134.26**	**618.64**	**6.56**	**4.88**	**4.61**

From this table (Table 6.12) it can say that in the city there are statistically only 4.8 percent of road which is fit for vehicle operation.

6.2.6 High Quantity of Unproductive Narrow Road

According to RMMS classical classification there are 321.27 km of narrow road which is 25 percent of total road in the city. But, according to width base analysis, the length of narrow road (width less than 4.75 m) is 464.4 km (36.1%) which is very high with regard to other roads (Table 6.5). Highest Narrow road is in the zone 7, about 79 kilometers (58%) among the 136 kilometers road. After this, zone 1 and 2 narrow roads are 56 and 57 percent respectively (Figure 6.2). Any four wheeler vehicle cannot access in the narrow roads even ambulance and fire bridge vehicles. Indeed, most of the narrow roads are not sufficient width in which three wheeler non-motorized vehicles like rickshaw can enter and it is almost impossible to widen and extended of that roads as most of the areas are highly buildup. Even the alignment of the road is not sufficient straight and sight distance in most of the case is very short. There are many narrow roads where indeed sunlight can not fall and remain dark and marshy in all time. For the cause of high construction on both side of that road, the improvement of the condition of that roads are almost impossible and this weakness will have to sustain everlasting of the city. A city cannot livable as well as functionally efficient with these huge amounts of damaged or useless vain. The flow of the city is blocked in every type land area in different parts and becoming blue/pale face as a part of a human body whose blood circulation has been blocked and sensitivity has been lost and once upon a time it is affected the entire body. So, the city is becoming such a patient who will eventually die for the lack of blood circulation. Therefore, the only solution is the abandon of the city.

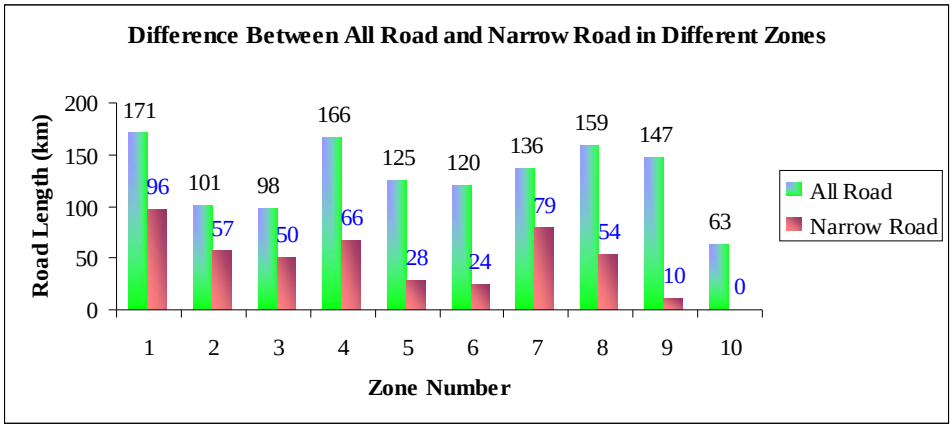


Figure 6.2: Narrow Road Length in Compare to all Roads of Different Zones

Photograph 6.1: Some narrow or Inaccessible Road in Dhaka City

6.3 ROAD AFTER IMPLEMENTATION OF STP:

STP study area was 7440 sq. km including surrounding five districts like Gazipur, Narshindi, Narayanganj, Munshiganj, Manikganj. There are 74 road projects in three different phases of varying lengths and widths (Exhibit 10-1, STP report). Primarily they form the basic access needs for the study area and complete a number of east-west routes thereby forming a basic grid of strategic roads. Among them 36 roads or link road are proposed in the DCC area or started from the DCC area.

Table 6.13: Roads after Implementation of Proposed STP Road

Items	Road Length (km)	Pave area (sq. km)	Road Area (sq. km)
STP	127.65	2.23	3.20
Total	1413.67	11.07	15.29
% of DCC	-	8.25	11.39

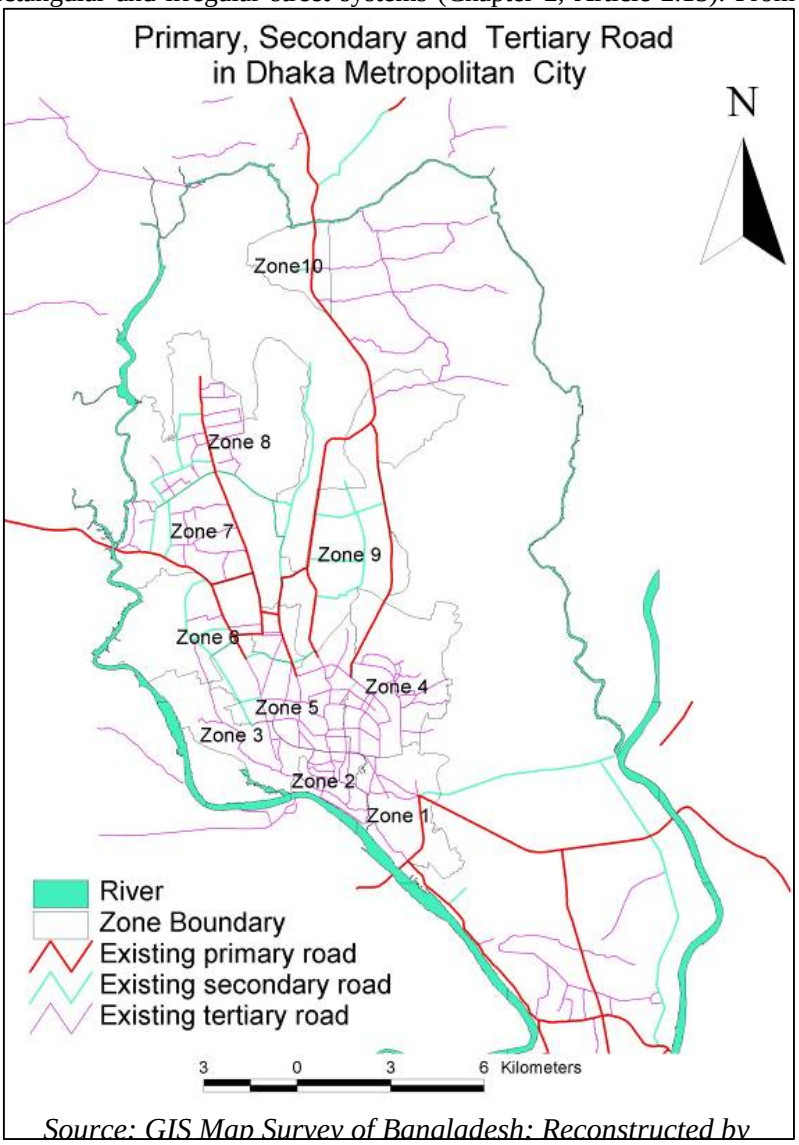
From the above discussion and facts, it is found that the existing road in the entire city road network is not quite enough and is the one-forth of the minimum requirement of a modern city. Even, after the implementation of STP, total road network would be around 1413.67 km and road and pavement area would be 15 (11%) and 11 (8%) sq.km respectively (Table 6.13). Besides this, the roads which are existing are not proper functioned and are not fully operation with full capacity for the causes of huge alignment, layout or orientation problems of the entire road network. Some of the major alignment, layout or orientation problems which are hindered the optimum capacity of the road network as well as the entire transport operational system and their adverse impact on the functionality, accessibility and mobility of the road are described below.

6.4 ROAD ALIGNMENT/LAYOUT IN THE CITY

In order to identify the road alignment or patter deficiencies, observation study has been made in broader perspective as well as in particular sector and area basis. GIS based map has been illustrated and attributed data has been analyzed to present the network patter and to provide quantitative figure respectively. A brief overview of the observed deficiencies is provided in below:

6.4.1 Alignment or Pattern of the City Road Network

The aim of a planned town is to seek the efficient road system to cope with conditions of uncertainties and to enable traffic to enter or leave the town rapidly and safely or to circulate freely within it. Thus an efficient road pattern should satisfy the criteria like flexibility and adaptability, application to different sites according to size, topography etc., ease of design and construction, efficiency of movement and required traffic capacities. For this regard, the pattern may be as: orthogonal, orthogonal with superimposed diagonal streets, concentric streets, radial streets, radial and orthogonal combination, irregular medieval streets system, topographical street system, combination of rectangular and irregular street systems (Chapter 2, Article 2.15). From the overall observation of the layout of the city road network combined with GIS based analysis (Map 6.2), it can be undoubtedly said that there is no systematic pattern/orientation overall the city except few local areas. The layout of major roads e.g. primary, secondary and tertiary are neither straight nor diagonal, neither grid nor orthogonal. Indeed, the primary, secondary even tertiary roads are scattered and haphazard without well-linked and functional connectivity with each other. Primary roads are separated from each other and ended by creating either a T-junction or staggered junction with tertiary road which are creating permanent bottleneck on the enter city road network. Even, no east-west, north-south straight or circular or diagonal continuous road is available in the city. Indeed, the city



Source: GIS Map Survey of Bangladesh; Reconstructed by

Map 6.2: Major Road Layout Map in DCC Area

road network was developed without any well-defined pre-plan. Even, until today, the city is expanding without any long-term vision, following any detailed road network master plan. Most of the roads are developed by executive order to recover the public demand as a piecemeal solution and aligned on the availability of land acquisition results unplanned, haphazard and unsystematic road network entire the city area. At present condition, there is no possibility to re-adjust the road alignment to make it a systematic pattern. So, the orientation of major road network is one of the major built in problem itself and weakened the city transports system as well as city structure inherently.

From the example of various well planned city, it is found that, city center should be thoroughly connected by radial arterial road from the surrounding area of the country like the spoke of a tire (example: city of London) (Figure 6.3). But, for the city of Dhaka, there is not a single road which is thoroughly connected with the CBD like Motijheel or Kawranbazar. All the primary roads or arterials of the city are ended at the outside of the major city areas. There are no through or direct connectivity with the CDB and gateways.

Figure 6.3: Radial Arterial Road System

From the Map 6.3, it is also evaluated that there is not any functional primary road in the core area including CBD according to the definition of JICA and the survey report of Survey of Bangladesh (SOB), whereas there should have at least three or two Principal arterial/Freeways/Expressways consisting of Interstate/non-Interstate principal arterials with controlled access. It is argued that primary road at core area or Principle arterial/Freeways/Expressways is as like as a main artery or vein of the human body. Without main artery or with a defected artery as a human body cannot sustain, similarly a city cannot sustain without a functional Principal arterial/Freeways/Expressways. In the present haphazard densified build up condition (Chapter 5), it is almost impossible to construct or provide new arterial facility to the existing city road network. Indeed, sufficient space and facility is not available to upgrade the so called existing primary road to a functional arterial. So, obviously, it can be concluded that the city now is suffering like a chronic heart attack patient and will eventually die.

6.4.2 Road Orientation at Micro/Local level

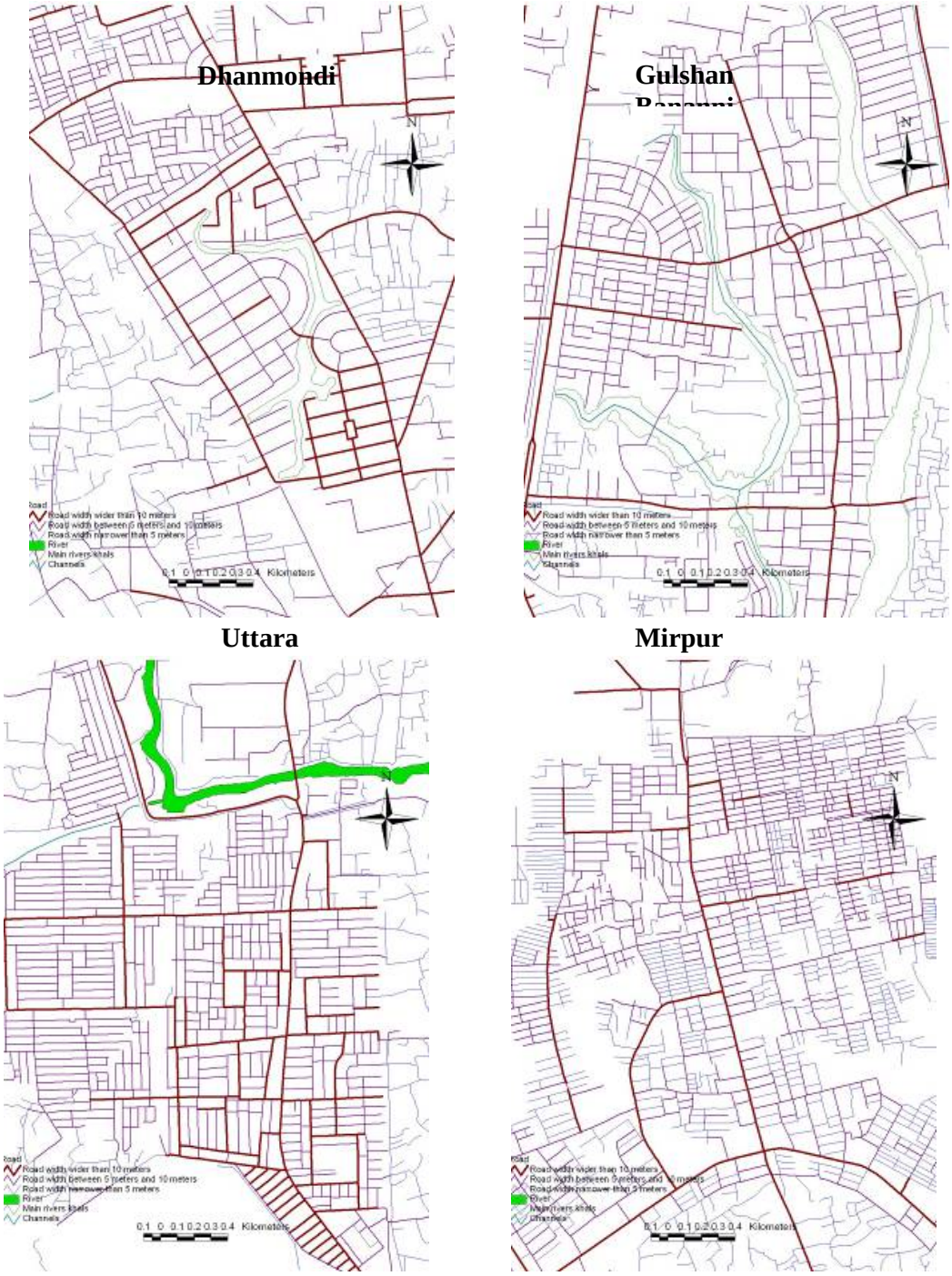
In Dhaka Metropolitan city, there are two types of road network in micro level or local level, one is pre-planed and other unplanned.

Pre-preplanned Areas

In the preplanned area, all of the road networks are in Grid-iron pattern and consists of straight lines and rectangular co-ordinates. The Figures shown below are the various examples of pre-planned road network. The areas, which are shown in the Map 6.4, are planed as residential area. In the residential area, road network should be planed considering the local vehicle which could not move with high speed. Through vehicle should be discouraged by planning of road network and speed will be control by network design. In the grid pattern road network, through vehicles can enter easily in the local area with high speed, as it get straight and continuous. If the high speedy through vehicle could not be controlled which should be built in design, the area will be converted to as commercial and/or industrial area today or tomorrow. This statement is again proved for the case of Dhaka city. Dhanmondi, Uttara, Banani, Gulshan are planned as residential area, but at present it is converted as commercial and industrial area (Chapter 5, article 5.7.2). It is a burning issue for the inhabitants even policy makers, city authorities that how to control this conversion. But, in reality, this problem was built-in the planning of this areas. A residential area, traffic should move with slow speed. It is difficult to maintain this speed limit by police enforcement. It will be maintained by the planning of road infrastructure as well as road orientation. That's, road network will be such a pattern where vehicle operator will not able to

thoroughly move with high speed. It is also proven that providing opportunity of vehicle operator to move thoroughly with high speed welcome commercial and residential activities. So, road network orientation in the planned area itself says that it will be converted once upon a time. If the road network of this area would discontinuous pattern (Map 6.3) instated of continuous grid pattern, the area would remain residential area everlasting. Therefore, this is the one of the inherent problem of the preplanned residential area of Dhaka city, which is built in from the planning stage of the city by the city planner or authorities.

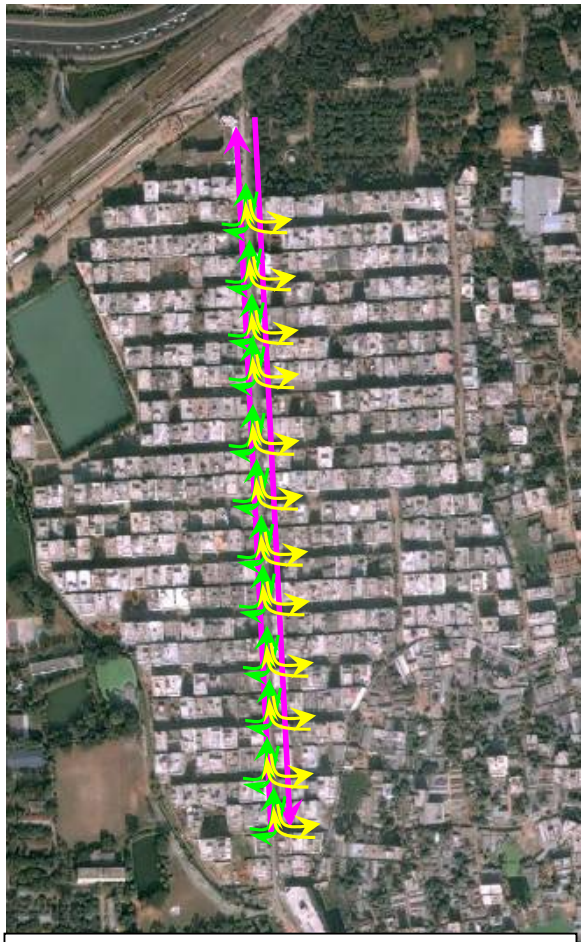
Another major inherent weakness of the road network in the pre planned areas of the Dhaka city is that most of the East-West roads are directly connected with the primary arterial road like Mirpur



Map 6.3: Road Network of Preplanned Residential Area of Dhaka City
Source: SOB, 2004 Illustrated by the author

road, Airport road, Rokeya sharani etc. Each of the connecting roads formed a direct access creating T-junction with the primary road, which should have minimum access and high mobility for through vehicles mainly in Mirpur Road and Rokey Sharani in Dhanmondi and Mirpur area. Even, there has not any provision for providing service road facility to reduce the access density. This is also an inherent problem of the road network of the preplanned area of the city, which is built in from the faulty planning by the planner/authority. This access road directly conflict with the through traffic of the primary arterial road and reduces its capacity, loses productivity. So, the minimum primary road which is available in the city area, that's are not fully productive. Indeed, the impact of this problem will be increases day by day with the increasing of the density, vehicle ownership of the local residents. Consequently, the productivity, capacity, potentiality of the primary arterial road will be decreasing day by day. That's, which the city has, that's are losing gradually.

From the Map 6.3, it is also shown that most of the major east-west roads directly connected with the so called primary forming T-junction or staggered junction. Whereas, T-junction on major road indicate that there has certainly a missing link and create two right turn on the major road results continuity of traffic flow discard and operation become more complicated. Staggered junction formed two subsequent junctions and two separate phases for the same vehicle i. e. 50 percent of the road capacity reduced. Indeed, such staggered junction is preferred in residential area to act as a self speed reduction device like roundabout to reduce speed in the local roads of the residential area. Where as such type of junction is formed at the major road of the city where most of the through traffic move. These are the shier ignorance of the city planned which permanently destroyed the city infrastructure as well as transportation system.



Map 6.4: Conflicting Point of Major Road in New DOSH (Source: Google Earth, 2008)

From the field observation it is also observed that the major junction of the pre-planned areas are not developed well planned way like Gushan 1, Gulshan 2 at Gulshan area, Mirpur 10 at Mirpur areas, Abdullahpur at Uttara area. All these intersections cross intersection connecting two major roads and the demand of these intersections are very high. Today or tomorrow, grade separation would be required for sustain and efficient movement of traffic particularly Abdullahpur, Mirpur 10 intersection. But, unfortunately there has very little possibility to construct grade separated infrastructure for the lack of sufficient open space around the intersection. This is also one of major inherent weakness of this areas like many other intersections of the city which evolved by the corner point development of the intersection resulted from the unplanned development of the city as well as ignorance of the city planner the relevant authorities.

Map 6.4 represents a recently developed preplanned residential area named new DOSH. Entire local road network cross transversely a single road as branch of a tree results all the vehicle diverted in a single road which are also directly connected with the main road and create at least four conflict at every crossing. Besides, for the causes of grid pattern both local and secondary road, any vehicle can move easily with high speed which should not expected at the purely residential area. So, there is also a built in possibility to convert the area residential to mixed area like Gulshan, Dhanmondi. This indicates the enormous incompetence of the city planner. They have not such a minimum capacity that they will realize their problem from the earlier mistake and would be changed for the future. A capital city could not run with such incompetence authorities and person who are gradually bumping off the city.

Unplanned Area

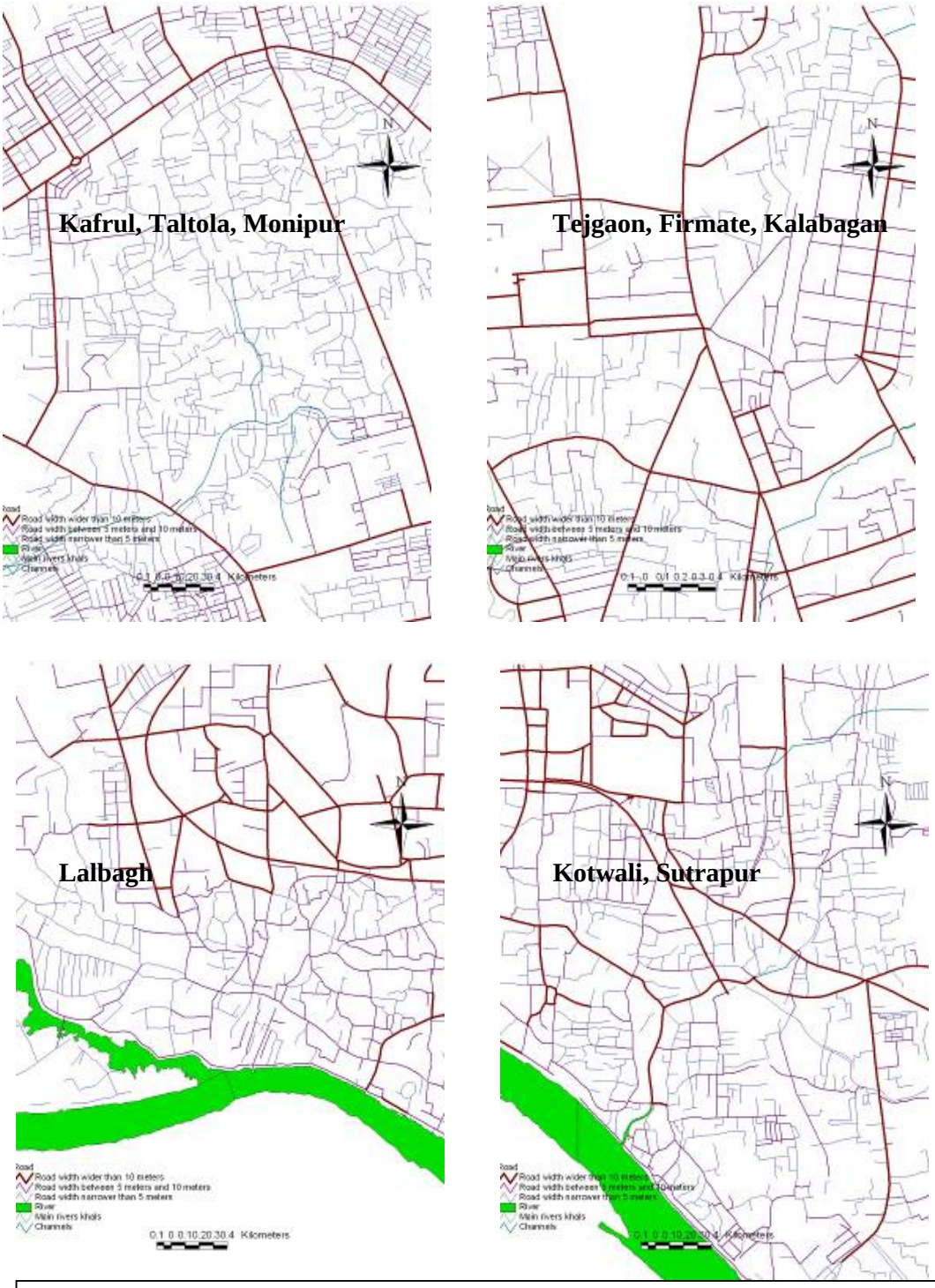
A road network consists of a number of links, nodes and associated special arrangements for the efficient performance of the entire system. The areas in which have not any system of that arrangement and developed without any systematic planning with a long-term vision is termed as unplanned area. Except some planned area which are described in the previous article, all of the area in the Dhaka city are unplanned area. Map 6.5 shows the road network pattern of some of the unplanned areas.

The inherent problems in these areas regarding landuse transportation planning are enormous. Those unplanned areas are haphazardly evolved and highly built up without any control, guidance. Almost all the areas are developed by private individual initiative. The owner of the land sell as building plot or construct building occupying almost all of the plot areas without considering minimum setback for road space. After densification, road has been developed on the donated land. Most of the side roads are developed by getting lands from road adjacent property**.** It is well known that beggar should not have any choice. So, first weakness is that there are huge lacks of sufficient road, even many of the areas where have not any accessible path which can be defined as a road. Secondly, the post planning superimposed roads which are available that's fully scattered, un-patterned, narrow, zigzag as well as inaccessible, non-functional. Most of the roads are so narrow that is not fit for motorized vehicle. Even, there are lots of apartments which has not any roadway facilities to go to even by a rickshaw.

Under this areas, not only all of the old Dhaka (southern part of the Dhaka) but also most of the new Dhaka like kalabagan, kafurl, Tejgaon even Rajabazar, which is just in front of National Assembly of Bangladesh. Though some of secondary road viz. English road, dar-us-salam road, midford road, ring road etc. are available in these areas, the entire roadway network also losses its functional property for the existing of so many 90 degree turn, staggered junction, width inconsistency in the secondary roadway alignment of the this areas. Most frightening is that, there has not any general solution to overcome these problems as most of the areas are highly developed. It is also impossible to renew these areas for providing accessibility for at least emergency vehicle of all the apartments by changing geometric configuration like widening or other infrastructure of existing road without demolishing massive existing multi-storied construction. Construction of underground road network by connecting all of the areas is also so difficult for such a lower developed country. So, these areas are remaining as a cell of the city where has not any blood circulation facility i.e. act as a dead cell and finally it will spoil.

6.4.3 Un-Organization and Non-Integration of Road Network

Dhaka mainly depends on road-based transportation network system. Road bias has been evolved due to topography of the city, technical advantage, past network development trend, availability of foreign aid etc. Continuous focus on road based network system has weakened potentials of other types of transportation system like rail or water transportation system. Hence there is no such inter-linked and mutually dependent multi-network system for Dhaka Mega City. As a result, no other alternative for the movement of people and goods can be found to meet increasing and



Map 6.5: Haphazardly Evolved Road Network System in the Unplanned Areas of Dhaka city
Source: SOB, 2004 Illustrated by the author

diversified demand of the urban community. The situation becomes worst in case of any disruption of road network, particularly the major links of the City.

During last twenty to thirty years, significant road development has been taken place to cope with sudden transformation of the city from provincial town to the capital of a sovereign country. But most of the transport developments have been driven by ad hoc considerations having no explicit

focus on analysis of existing demand or future requirements. As a result, the road network of the city is not organized and integrated in terms of connectivity. Many strategic links are missing in the network and many areas have inadequate accessibility to it.

Large amounts of residential and commercial development both by public authority and private agencies have taken place after the independence. In most parts of the city, the road network has emerged with relatively wide primary and secondary roads (termed mostly on the basis of road width only) built by public agencies, but narrow tertiary and access roads due to lack of planning and building controls. Consequently, with the exception of a few planned residential areas, in most of the areas the road network is too narrow and alignment is poor to accommodate motorized vehicles, especially the public transport modes (Article 6.2). This also poses a serious problem to provide other network infrastructures for utility services. Development in the absence of a strong planning framework results many discontinuities in the network. Beside these short missing links, absence of east-west connection has become the major problem for the entire road network of Dhaka. Presently, such requirements are met by relatively narrow and poorly aligned roads, which are far beyond to meet the existing demand in terms of capacity, speed and level of service. East-west connections have suffered because of fragmented responsibilities for road planning and construction (e.g. between RAJUK, DCC and private sector actors) and the many barriers e.g. the large cantonment area (including the former airport site), in addition to the large tracts of low lying, flood prone land.

6.4.4 No Through and By-Pass Road

According to the articles 2.16.2, the provision of a by-pass road results in the reduction in traffic through the congested area of town and thus the chances of accidents are minimized. The land along the by-pass route appreciates in value and unless proper precautionary measures are taken, there are chances for ribbon development to take place along the by-pass. It is also necessary to plan ahead the development of likely area to be developed surrounding the by-pass. A low-level Bypass Road has been proposed between Trimukh and Amulia along with flood embankment. In the mean time, RHD is constructing a Bypass Road along approximately Route 4 that was proposed in the Halcrow Fox study. This bypass, which is near to complete, connects with the Dhaka – Chittagong Highway in the south and the Dhaka – Tangail Highway in the north. With the expected completion of the Route 4 bypass this has for the present reduced the strategic importance of the originally proposed bypass associated with the eastern flood embankment. Besides, it is a burning issue arises that the provision of a low-level bypass would increase the overall costs of the Dhaka Integrated Bypass cum Flood Embankment Project as for the high embankment in low laying land. Problem of rainwater disposal is also a grater issue in the overall project (Article 5.7) Besides, inadequate space to accommodate and embankment at many locations like Demra; Faidabad, Tongi; due to industrial areas, local housing lying and agricultural land causes a great problem to construct the flood embankment cum road. Based on these considerations, BWDB requested the Consultant to undertake a supplementary analysis for an alternative scheme that excludes the low level bypass between Trimukh and Amulia but instead includes a road on the Flood Embankment (at the top) similar to the existing western embankment. Where as, the flood embankment cum road will provide an important function in facilitating connections, via link roads, into the Eastern part of Dhaka City. It will also serve as a secondary local access need for traffic traveling from north to south alongside the Balu River. As an integral part of the strategic road network to the east of Dhaka, the flood embankment cum road would also connect with the Route 4 Bypass. This will cater for longer distance traffic entering or leaving the Dhaka urban area

Finally, the whole flood embankment alignment with 10m width at the top alongside the Tongi Khal at the north and the Balu River at the east, a two lane single carriageway road of 7.3m wide along its crest were proposed. This standard and specifications are the same as the road alignment along the Western embankment. At its southern end near Amulia the road alignment will move away from the flood embankment and join up with the local road presently being upgraded

towards the Demra/DND area road. This approximately 600m connector road will be newly constructed through agricultural land and the road level will be the same as the level of the existing local road being developed. This is necessary as the flood embankment in this area will be replaced by a flood wall due to existing industrial areas and communities lying close to the Balu River. Along the Tongi khal approaches Tongi Town at Faidabad, the road alignment will connect with the local pucca road passing into Tongi town. Due to this reason a flood wall will be provided over the final 1.3km of flood protection up to the railway bridge (BWDB 2006). These arrangements obviously reduce the functionality of the entire by-pass road and increases extra cost of construction and maintenance

Here, Tongi Ahsulia may be an example by which the vehicle come from Khulna, Barishal and Rajshahi division can divert from Dhaka-Aricha to Tongi-Airport road and as for as North Bengal without interrupting the city centre. Not only this, if another such kind of road or proposed eastern bypass would available then the through vehicles from Dhaka Aricha highway could move to Dhaka Chittagong Highway without affecting city road and vise versa. By which direct connection would be established with eastern part of the country to western part without interrupting the capital central city congested road network, fright vehicle would be able to move easily by which entry restriction losses could be reduce.

On the other hand, the RHD bypass road connects three major national highways of the city, N1, N2, N3 as a part of another national highway N4. Besides it also crosses two rail line and two other national roads (tongi-Narsingdi, Dhaka- Monshigonj) with so many regional and local roads. All the major and minor intersections are at grade intersection. It is unexpected that two major national highway intersect each other without any grade separated facilities. Even there have very few provisions to provide grade separated interchange in future for uninterrupted traffic flow for the lack of sufficient space. Because, RDH constructed road without allocated space for grade separation at least at the major intersection and at present multi-storied commercial complex are being constructed at the corner point of the intersection. This road is one of the newly constructed roads and there should have preplan and allocation of required space to provide interchange facilities at the two major national highway crossing point to cater future demand of the major national highway. Unfortunately, they could construct 54 km of road and could not allocate space for the intersection capacity build up. This is not the cause of unavailability of space but the sheer ignorance of the authorities. This is also a permanent bottleneck of these major three national highways and gradually this bottleneck will increases with the increasing of the traffic flow.

6.4.5 No Ring or Distributor Road

The object of an inner ring road is to divert from the town centre all local traffic and other traffic which have no business in the town centre. Such an arrangement will relive congestion of traffic in the town centre. The inner ring road should have minimum junctions and it should afford a faster passage than on a direct road through the town centre.

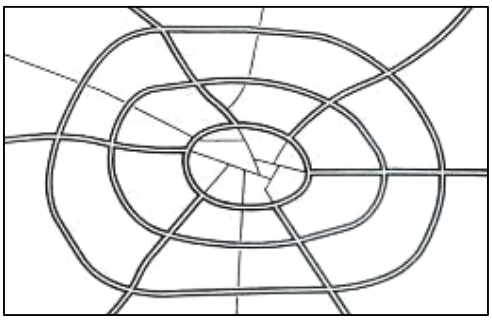


Figure 6.4: Typical Arrangement of Radial and Ring Road

For the absence of such outer ring road in the Dhaka city, the user who wants to go the opposite side or right angle side from his incoming direction, he doesn't find any alternative to reach there destination avoiding CBD. As a result, increase travel time, trip demand and extra burden on CBD and causes congestion around the CBD and other part of the city.

To overcome this serious problem by reducing the travel demand, flood embankment around the city could be converted as an embankment cum road which may be act as suitable outer ring road. It is not a proposal, already some part of the embankment (Babubazar to Gabtoli) converted as

embankment cum road but unfortunately it is a only one lane road and most of the time occupied by the loading and unloading goods, materials of ship, launch cargo vessel which come from the south Bangle by river way. At, present it is highly difficult to expand the width the embankment road for the one side river bank protection wall and other side commercial and residential development. That's, for the lack of development control and vision, city lost such a better opportunity to construct a peripheral circular road like many other cities (viz. New Delhi).

New Circular Road, Outer Circular Road, New Eskaton Road, Kataban Road, Zahir Raihan Sharani, S. Kamruzzaman Sharani might turn as a inner circular road around the CBD. But for the lack of planning with functional classification, it is separated from each other by some missing link or unacceptable bend. Now these roads act separately for which loses its functionality. At the present condition, it is almost impossible to connect each other and city is permanently hampered from the ring or distributor road facility.

6.4.6 No through Principle Arterial for Inter District through Traffic

With the required specification, there is not a single road in Dhaka metropolitan city. The three main arterial roads which are available in the city, all the roads have frequent access and there is no possibility to control the direct access road as there has not any service road (except few areas in airport road), even there ha not any legislation or policy to control of direct access or limitation of access in a certain length of road. Indeed, there has not any possibility to provide service road in both side of the arterial road as most of the road sides are occupied by multi-stored commercial, industrial or residential apartment. In addition, the arterial roads are mixed with through and local traffic, three-wheeler with four-wheeler, even motorized and non-motorized. Parking on the road, loading and unloading on road are the common practices on that road. Even almost very few designated bus bay for load and unloading passenger is only in airport road after mohakhali. At present condition, it is almost impossible to provide parking space by the side of this road or construct new bus bay for loading and unloading even providing separate space for ticket counter and passenger space. Therefore, ticket counter and waiting passenger become bound to share the road space of this arterial road, which should solely used for vehicles operation.

No service road along these inter district principle arterial road except some portion of Uttara road (2.26 km which is planned before independence). Even there has not any access controlled measure or policy and frequently connecting access both side of the road resulting decreasing existing capacity gradually. Even, for the cause of uncontrolled access, there are forming staggered junctions on these arterial like abdullahpur. Road side space as well as intersection corner point are developing without any regulation (Chapter 5). As a result, future improvement options like grade separation are decreases. So, with the increasing demand of traffic, the performances as well as capacity of the road will be decreasing (like jatrabari intersection) and eventually it will create intolerable and irreparable bottleneck. So, the neck of the city will be clogged and eventually the city will die.

6.4.7 No Alternative Corridor to Connect the Other Parts of the City

The spacing of urban principal arterials is closely related to the trip-end density characteristics of particular portions of the urban areas. Although no firm spacing rule applies in all or even in most circumstances, the spacing between principal arterials (in larger urban area) may vary from less than 1 mile in the highly developed central business areas to 5 miles or more in the sparsely developed urban fringes (AASHTO). In Dhaka metropolitan city, there are only three principles arterial (only denoted not functional) which are segregated in three directions. Therefore, there has not any homogeneous spacing of the arterial road in the city and there has not any alternative to connect the other part of the city.

That's are the three main highways, which are also the main radial roads, are

a) Connecting to the north: Airport road
b) Connecting to the south via Chittagong highway: Hatkhola, Fuibaria and other roads
c) Connecting west and north-west via Dhaka Aricha Highway: Mirpur road.

These three main arterial roads/thoroughfares are the only alternative to collect traffic from outside the city and to distribute them throughout the city, and at the same time these are criss-crossed by hundreds of roads of varying right-of-ways (ROW).

It is a pathetic and intolerable real fact that, if incase these particular corridor could not surve properly for the cause of and incident like accident or physical damage, or any other cause, for the lack of alternative road, the road connectivity would disconnected from that particular region with the capital city. Not only this, for the lack of alternative transport facility like railway mainly for Khulna and Barishal division and waterway for Sylhet and Rajshahi, the city would be almost disconnected from that particular region of the country, and this is a general phenomenon once or twice in every month. For which suffer general people, damage property, badly affect local business, export and import etc.

The main radial road which is only for through traffic and it will be thoroughly connected with the city centre without any level crossing. But in this city, there has not any particular road which is only for through traffic, all of the radial corridor local traffic and through traffic mixed up among them local minibus, taxi, three wheeler even non motorized vehicle like rickshaw. For the causes mixed traffic operation and presence of level crossing, colossal traffic congestion even grid lock is a general scenario of all the mouth of the city, particularly in Dhaka- Chittagong corridor. If a vehicle need 1 to 1.5 hours for 70 kilometers from Comilla to Jatrabary, after that it will required 1 to 2 hours or even more for 7 kilometers from Jatrabary to Mothjheel. So, increases travel time, loses time, loses wealth, loses property as well huge economic lose. To overcome this problem, a 7 kilometers length flyover is proposed in Dhaka Chittagong corridor. But it is very expansive and at present unplanned and chaotic situation, it seems to be an extra burden for our underdeveloped economy. Indeed, it is also impossible to construct new road parallel to the existing so called arterial road with a certain distance.

6.4.8 Lack of Functional Gateway of the City

In Bangladesh, there are eight major national highways (N1 to N8) connected all over the country with the capital city. As for requirements, there should have minimum eight gate ways of the city for eight national highways i.e. every highway should enter the city with a separate gateway. Whereas there are only three corridors or gateway to connect the other part of the city with the capital city. Two or more national highway meets each other in each gateway. National highway number N1 and N2 meet with the jatrabari gateway, N3, N4 meet with the airport road gateway, and N5, N7 and N8 meet with the Mirpur road gateway. Two or three road merge in a road that is vehicle from two/three roads concede in one road like water from two or three river fall in a single river results overflow of the off stream. Like this stream overflow, traffic is overflowed demand extra functional and operational capacity of the gateway. But for the lack extra facility to recover combined for of two stream results immense traffic congestions that is wastage of time, resource, fuel, money etc. This problem is built in by faulty planning. There is only solutions is the separate gateway for separate highways. In the present condition, construction of separate gateway for individual highway is the ultimate solution and besides this, any investment will not fully fruitful to solve this problem. But unfortunately, providing separate gateway is almost impossible.

Another but not ultimate options could be grade separated interchange of the intersecting point of the two national highways like Kanchpur, Abdullahpur, Nabinagar intersection. These intersections create chronic congestion particularly at the different occasional period for the cause of huge demand and low capacity of at grade intersection. There is urgent need and planning requirement of the grade separation of that intersection of efficient movement of the two major roads vehicle. But, for the causes of yield planning and lack of allocation of required land at the

corner point of the junction for the construction of ramp by the Roads and Highways Department (RHD) and for the present development of most of the corner point of the junction, it is highly difficult to provide grade separation facility of the intersections. With the time, these difficulties are increases for the side development but the authority is not fully concern about the matter. So, these will also a permanent bottleneck and the connectivity of the city with the other part of the country will be catastrophically collapsed.

Another major weakness of the gateway of the city i.e. the major arterial of the city road network is the lack of service road. Only some portion of the Uttara road (Nikonjo to Uttara 9 no sector) has service road which are particularly planned in Pakistan period. Befor Nikonjo and after Uttara 9 no sector, has not any service facilities which are almost developed after independence. The city authority after independence did not provide any service road, even which were exist, could not continued. Indeed, others two gateways have not any functional service road and at present condition, there has not any provision or option to construct service road along the gateway for the causes of not allocation of land and huge densification. This could be an everlasting weakness of the city causes by the sheer ignorance or the hypocrisy of the local city authority and eventually almost murdered the city.

6.4.9 Only North-South Directional Connectivity

Road network of the city should be homogeneously distributed to connect thoroughly every part of a city in every direction. It is mentioned earlier that there are only four major main roads in the city viz. Mirpur road, Begum Rokeya Sharani, Airport road, DIT road. All of the roads are north south direction. Among them, Begum Rokeya Sharani is ended in the mirpur cantonment and DIT road join with the Airport road. Therefore, major main connecting road are only two and that are north-south direction (Map 6.3). Indeed, this north south road is not thoroughly passes the city from south to north of city. It just starts form the indoors of the city and promulgated to north direction. So, it is unfortunately truth that there has not a single road in the city which is thoroughly passes the city from one direction to other direction. Because of north-south connectivity, the city is elongated north-south 18 km and maximum width 10 km. In both old and newer areas there are so many roads (may not sufficient) but road connectivity is very poor and mainly north-south oriented. In particular there is a lack of east-west links and alternative access roads to the Motijheel business center and to Old Dhaka.

6.4.10 No East-West Continuous Road

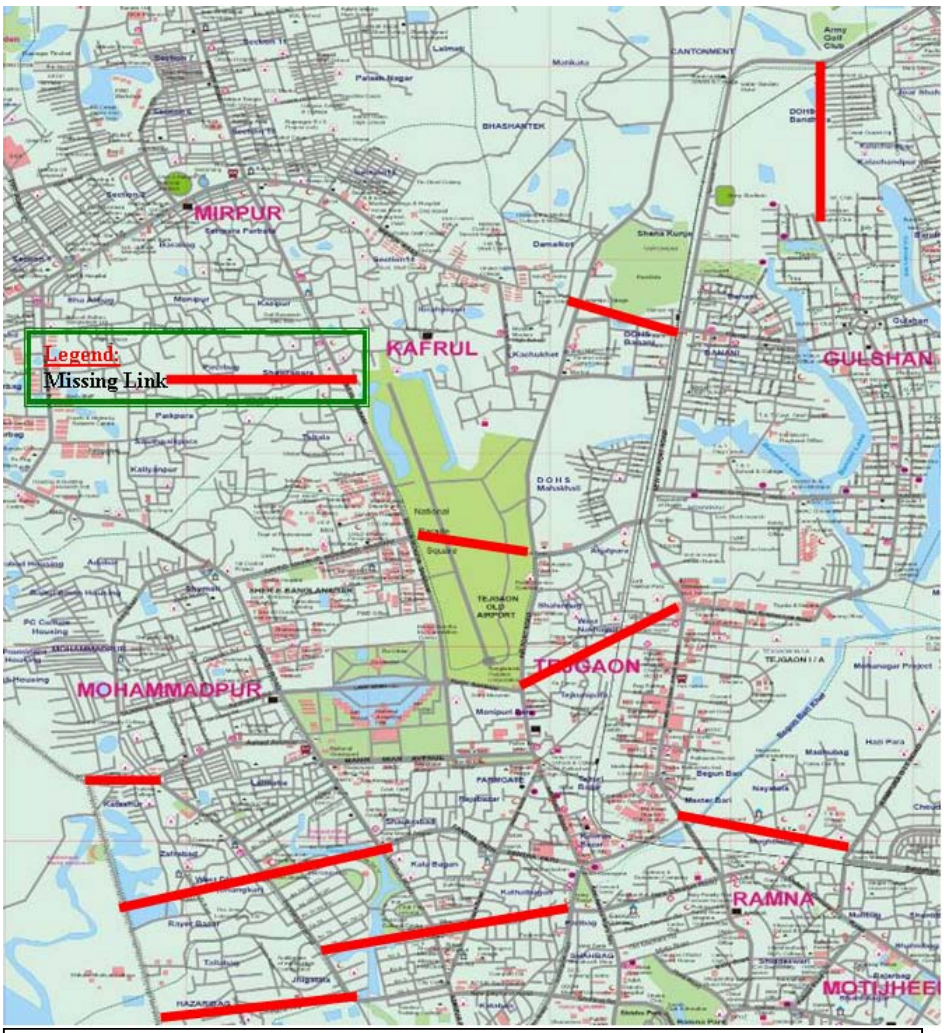
As discussed earlier, in Dhaka City, the primary orientation of the major roads is in the north-south direction. The lack of sufficient east-west connections and capacity creates the need to travel longer distances, thereby overloading existing roads, unnecessarily.

Longitudinal directional cantonment and old air port are situated in the central area is one of the prime causes of discontinuity of east-west connecting road. At least four major east-west roads cut by these two structures. Indeed, cantonment divided the whole city into two parts. Because of this discontinuity, every vehicles require to travel around 2 to 3 km extra distance. Vehicles from three major links are merged in one road i.e. Airport road and crating chronic congestion in front of the Prime Minister office. Recently, to overcome this problem, a link road has been constructed between the Agargoan and Airport road circulating the old airport runway area. From the field observation, it is found that 5 routed buses are diverge from this link road which previously used Bijoy sharani. From the observation of road network pattern, it is revealed that in all over the city, there has not a single continuous main road in east-west direction. The road which are existing in this direction all are formed as a connecting road or link road. For the causes of discontinuity of the road, huge number of T and Staggered junction develop on the layout of the city. So vehicle cannot move thoroughly in that direction.

6.4.11 Link Missing

Development in the absence of a strong planning framework results many discontinuities in the entire road network of the city. For this discontinuous between two ling creates so many link missing like (Map 6.6). In Dhaka city, there are around 9 major missing links in the bus operating routes. The lists of that major link are in below:

- Agargoan Road to Mohakhali Gulshan Road,
- Dar-Us Salam Road to Kamal Atarturk Avenue,
- Bijoy Sharani to Gulshan Avenue,
- Embankment road to Sat masjid Road to Pantha Path and Pantha Path to DIT Road,
- New Eskaton Road to Mirpur Road to Sat masjid Road,
- Gulhan Avenue to New Airport road,
- Embankment to Road No. 16 (old 27),
- Asad Avenue to Embankment road,
- Road No. 2 to Embankment road.



Map 6.6: Major Missing Links in Dhaka City

At present, most of the space between two links is highly buildup. So, construction of connecting road between two link is very difficult and costly. For the construction of connecting road there will be damage many buildings, high rise apartment, property except under ground road. But the

construction of underground road is very intricate for our under developed country. Like, at the time of construction of Pantha Path, at least 6 numbers of buildings was destroyed which was more than 5 stories. Present condition is more devastating than that.

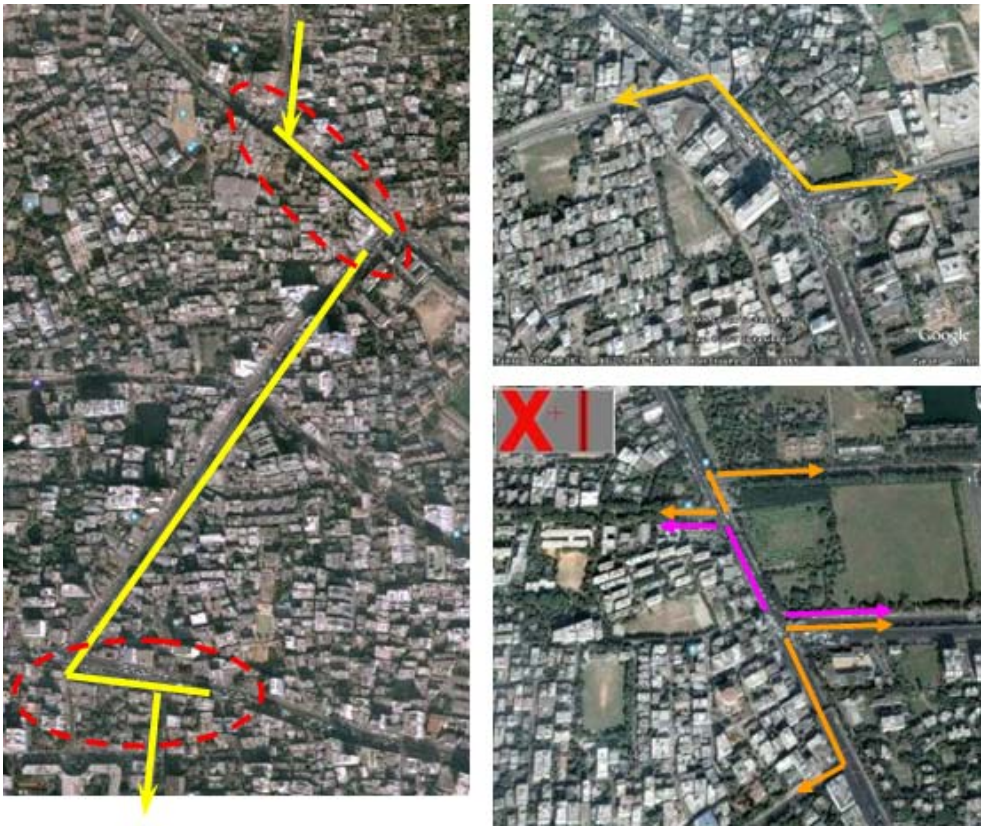
6.4.12 Huge Number of T- Junction

For the unplanned and piecemeal development of road network, there are so many T- junctions formed in the main road network in the city where as T-junction of the main road network should not considered of an ideal road network of the city. As, every T-junction means that there are a missing link or discontinuity. Functionally this T-junction is very weak as in a T-junction two right turn obviously provide for its operation but that is the most complicated and capacity reducing tool in operational point of view. For the case of Dhaka city, all of the major T-junction in the main primary road allowed right turn except only ressel square. Where as, if T-junction is being formed in the main road it should be right turn restricted by design but in this city for the lack of alternative road, this simple measure for improvement capacity of the main road could not introduced. In below listed such type of few junction names.

Table 6.14: Major T-junction of the Main Road in the City

Major Road	**Major Intersections**	**Major Road**	**Major Intersections**
Mirpur Road	Elephant Road	Kakrail Road	Santinagar
	City college (Rd No 2)		Kakrail
	Relesl Squire		Malibagh
	Manik Mia		
	Asad Gate	Phoenix Road	College road
	Agargaon Road		DIT Avenue
	Ring Road		Progati Sharani and Madani Avenue
	Technical More		Khilgaon Rail Crossing
	Beribadh Road		Hatkhola Road and Autish Dipankar Road
DIT Road	Mouchack Intersection		Hatkhola road and Fazle Rabbi Road
	Saidabad DIT Road Int.		English Road and North South Road etc
	Natun Bazar Int.		
	Bashundhara Junction	S. C. M. Ali and S. Tazuddin Road	Central Charch
Airport Road	Sheraton		Baily Road
	Rangs Bijoy sharani		Old Elephant Road
	Jahangir Gate int.		New Eskaton Road
	Mohakahli Gulshan Road		Pantha Path
	Kamal Ataturk Avenue		Gulshan Avenue
	Kuril Bishaw road int.		Mohakhali

Therefore for the causes of huge number of T-junction, traffic operation makes highly complicated, creating bottleneck to the entire road network. In this highly density condition of the city, reducing this bottleneck is very expansive even impossible in some case for the causes of lack of sufficient space to provide grade separated intervention like ramp, clover leaf etc. To minimize the problem creating by the T-junction, huge resource has been already drained viz. Kuril Bishaw road T- junction results proposed grade separated interchange, Bijoy sharani T-junction results Rangs building demolish and proposed extended road with a huge investment (127 crore only 1.1 km of road), Panthpath T-junction results proposed Hatirjheel project, Mohakhali T-junction results mohakhali flyover, Khilgaon T-junction results Khilgaon flyover.



Map 6.7: Example of Some Major Staggered Junctions
Source: Google Earth, 2008

But most of the case that are being act as a bottleneck for the lack of proper design, plan again or unavailability of sufficient space or other facilities like high-rise building at the mouth, rail line, utility line etc.. Besides this, most of the T-junction has not minimum space/facilities to treat this in the front or side of the junction. So, it is being also a built in problem cases by the faulty planning of road network as well as the landuse pattern of the city.

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6.4.13 Staggered Junction

There are six staggered junctions within the 5.19 kilometer of Mipur Road (new market to shyamoli) (Table 6.15). That is, more than one staggered junction within one kilometer of road in this section of mirpur road. From the field survey it is fond that there are almost 21 major staggered junction in the bus operating route of the city. Among them 6 are in Mirpur road, 5 in DIT road, 3 in Aripor road and 2 in Kakrain road (Table 6.15). Where as staggered junction is not tolerable in such a primary road. It is one of the planning principle that staggered junction could be allowable for the local road in residential area to control the speed of vehicle, not for primary or secondary road. Every staggered junction decreases the capacity of the junction nearly 50 percent as within a short segment a vehicle takes two times turn with a right turn. Unacceptable number of such type of complicated junction is formed overall the city road network.

Table 6.15: Major Staggered Junctions

Road Name	Major Staggered Intersections
Mirpur Road	Elephant Road & Road No 2
	Relesl Squire & Road No 11 (old 32)
	Road No 16 (Old 27) & Manik Mia Avenue
	Manik Mia & Asad Avenue
	Asad Gate & Lake Road
	Agargaon Road & Lake Road
Kakrail Road	Outer Circular & Kakrail VIP road
	Kakrail VIP Road & New Circular Road
Airport Road	Airport Road & Bijoy Sharani
	Airport Road & Mohakhali Gulshan Road
	Shaheed Yausuf Road & Kamal Atatuk Road
DIT Road	S. S. Nazrul Islam Sharani & kakrail Road (Kakrail)
	Kakrail Road & DIT Road (Malibagh)
	New Circular Road & Sayedabad Road
	P O Road & Mohakhali Gulshan Road
	Bashundhara Road & Airport Road
Others	Road 2 and Hazaribagh Road
	Hatkhola Road & Toyenbee Circular Road (Tikatuli)
	Folder Street and DIT Avenue (Banga Bhaban)
	Autish Dipankar Road & Dhaka Narayanganj Road
	S. S. Nazrul Islam Sharani & B. B. Avenue

Source: Field Survey, 2007

This occurred for the lack of planning of road network, post planning development to provide peace meal solution. If there is X-junction instead of staggered junction, the productivity/capacity of the junction approach as well as network increased two times. That is, congestion doesn't come itself. Planer invite congestion by our design, planning. At present, there is no option to reduce the staggered junction for increasing the capacity of road by converting it an X-junction or any other way. So, this is also a built in problem. There is no permanent solution or option to reduce this staggered junction.

6.4.14 Right Angle Bends on Main Road or L-Turn

It's not a common type of junction. But it is one of the most complicated and distinctive point in the road network and causes hindered in the normal flow of traffic. There altogether 5 right angle bend of L-turn in the major road of the city.

- B.B. Avenue in front of Baitul Mukarram
- Toyenbee Circular Road and R,K. Mission road , near Ittefaq Bhavan
- Road No 2 and Sat Masjid Road, Rifle Square
- Begum Rokeya Sharani and Indira road,
- English Road and North South Road etc

Every right angle bend reflects that no continuity of the road and forced to take bend creating L shaped. Every right angle bends cerates one right and one left tern which reduce the speed of the vehicle as well as capacity of the road.

6.4.15 Discontinuity of Main Road

In Dhaka metropolitan city, There are at least 15 main roads (bus operating) are ended in inappropriate location. For which is loses its functionality, causes T-junction as well as continuity.

Like: Rokeya Sharani: it is a north south directional functionally primary road which is four lanes divided by median and nearly straight. But the road is not preceded continuously. Started from the city centre in khamarari creating a T-junction and ended mirpur cantonment as a dead end. As a primary road it should be proceed in south direction to the old Dhaka and in north direction to the Tongi-Ashulia Road.

Map 6.8: Dead End at Roakeya Sharani

Pantho Path: it's a east-west connecting road which connect three main arterial in the city of north south direction. But the road is ended creating T-junction in both side with the Mirpur road and Shaheed Tazuddin Road. It can proceed in both directions; to the DIT road and further in east direction and to the Sat Masjid Road and further until Buriganga. But it becomes so difficult for the causes of not providing space for future extension

Bijoy Sharani: Bijoy sharani-lake road also a connecting road which connect Mirpur road, Rokeya Sharani and Airport Road. But the road is closed in this area by creating T-junction in both sides. It may be proceeds in both directions, Turag River to DIT road and then will acts as east west continuous road. But it becomes so difficult for the causes high built up front space of that alignment.

Dar-Us-Salam Road: Dar-Us-Salam road is one of the major secondary roads, started creating a T-junction with mirpur road and ended by a right angle bend in mirpur-14. Its may an east-west continuous road by connecting with the Kamal Ataturk Avenue but only for the miss planning here shaped a missing link. In technical more section it may proceed to the embankment road which creates a suitable access for the inhabitant of the Ramchandrapur and Nobinagar housing and easily comes under the mass transit facility.

DIT Road: It a north-south directional primary road serves a major demand of the city but the road is fully discontinuous. Started creating a staggered junction with Kakrail road and ended in the Bishaw road with airport road by not only a T-junction but also rail crossing. In south direction it may directly connect with Syed Nazrul Islam Sharani and then propagate to the Buriganga bridge 2. On the other hand in north direction it may continue to the north-east direction and meet with Tongi-Kaliganj road. By which may connect the eastern part of the country Sylhet and reduce the demand of Jatrabari road.

Map 6.9: Dead End at DIT Road

Sat Masjid Road: Sat Masjid Road is one of the major secondary roads also connecting with the mirpur road and ring road as a continuous road comparatively narrow, providing mass transit facility to the Hazaribag and Mohammadpur residents. It may acts as a parallel road to the mirpur road by proceeding to the north-south direction. But both side of the road meet with the mirpur road by a right angle bend and T-junction in mirpur road. Besides this there are 3 main steam roads which are discontinuous like Manik Mia Avenue, Cantonment Road, DIT Avenue, etc.

6.5 OVERVIEW

Two major parts of transport system i.e. quantity of road network and quality of that road are described in this chapter. From the analysis of total road network it is evaluated that the total road length of the DCC area is 1286 km comprising 61.35 km, 116.40 km, 219.54 km, 569.87 km, and 318.27 km of primary, secondary, connector, local and narrow roads respectively. The total area of these five types of road area is only 12.09 sq. kilometer among them 8.84 sq. kilometer is pavement area which are respectively 9.01 percent and 6.59 percent of the total land area of the city. Of this road network, only 48 percent are accessible for motorized four wheelers which is comprises only 4.88 of the total land area of the city. Though, it is almost impossible, if it is constructed three layers of road; underground, existing ground and elevated of all roads of the city as construction of new at grade road is highly difficult in this enormous haphazard densified areas, the total road network will be around 20 percent, which is far below the desire level of a modern city. So, it is very unfortunate that, the city will have to alive with this significant shortage of road network.

From this chapter it is also evaluated that these few amount roads has not any systematic pattern or proper orientation. Even there has not any through and by-pass road, ring or distributor road, through principle arterial for inter district through traffic, alternative corridor to connect the other parts of the city, proper gateway of the city, direct east-west continuous road etc. Besides, huge number of missing link, T and staggered junction, right angle bends on main road, lack of no classical road hierarchy and discontinuity of main road functionally weakened the entire road network system as well as transport system of the city. As a human body cannot sustain without proper and fully functional nerve system, it is difficult sustain the city with this unsystematic discontinuous and poor functional road network. It is also so alarming and reality that, as the capacity of the nerve decreases by sedimenting cholesterol and creates heart attack, the capacity of the entire road network even so called major primary roads are decreases with the development of the city day by day and once upon a time the heart will be stopped i.e. the circulation of traffic will be collapsed and eventually the city could die.

CHAPTER 7

FUNCTIONAL AND OPERATIONAL DEFICIENCIES

7.1 INTRODUCTION

This chapter deals with functional and operational inherent weakness of landuse and transportation system of Dhaka Metropolitan city which is widely recognized one of the major deficiencies of transportation system by experts, policy makers, professionals as well as general people. The chapter also includes management, maintenance and behavioral weaknesses associated with transportation system of Dhaka Metropolitan City.

7.2 FUNCTIONAL DEFICIENCIES OF THE CITY ROAD NETWORK

7.2.1 Functional Roadway Classification

A city road network should be functionally defined and its geometric design, vehicle operation, maintenance, road side landuse, connectivity with other roads should be as per as specification (Article 2.22.2). In this study, a comparative observation has been made with the desirable feature selected by the DITS in 1993 for the functional classification of road and present functional condition of the city road to evaluate the functional hierarchy of the city road. From this observation, it is seen that there are a wide lack of Classical as well as functional Road Hierarchy in the Dhaka city.

Map7.1: Example of Functional Roadway Classification in Beijing City *(Source: Google Earth, 2008)*

DITS and RMMS classically divided the road of the city in five categories and definitions of each classification also provide by DITS according to

some selected geometric specification (Article 2.16) not by functional or operational configuration, and that's are indeed only in papers. In real sense, in terms of mobility, accessibility, geometric configuration and operational condition, there are extensive lack of classical as well as functional classification of road. In the present landuse and roadway condition which is described in Chapter 5 and 6, it is almost impossible to divide the road network of the city functionally with its geometric, operational, functional, maintenance and management configuration particularly for principle arterial, arterial, primary or connector road. This inherent weakness of the city road network will be containing until the city will exist in this location without major demolishing or shifting.

Fundamentally mobility and accessibility are the prime considerations of road classification which is describe in Chapter 2. Considering this facts, for developing a functional road classification for the network of roads of Dhaka City 20 desirable features are depicted. But, unfortunately, from the in-depth onsite field observation coupled with discussion with the experts and local users it is revealed that hierarchical road classification made by DITS could not satisfy almost 90 percent of the desirable features, classification criteria and assessment factors particularly for the so called primary and secondary road. In particular, traffic composition, parking, pedestrian, road spacing is not coinciding with the desirable features not only for primary road but also for secondary and connector road. As a result, in reality the road network remain without any functional hierarchical order and function serving the city with discontinuous and fragmented links, which is the major system deficiency of transportation system of Dhaka. There is no possible way to overcome this deficiency and this inherent weakness of the city road network will be containing until the city will exist in this location without major demolishing or shifting particularly in the Metropolitan Area.

7.2.2 Non Integrated Transport System

From literature review, field observation as well as discussion with the professionals and academician, it is revealed that the existing modes and sub-modes (bus-water-rail-NMT) are acting independently of each other. In this study a significant investigation comprising onsite field investigation, questionnaire survey, discussion with the professionals and users has made to integration between different mode of transport of the city. Particular focus has made on the interchange facility of interface between inter city modes, intra city modes and inter and intra city bus service which is described below:

Interchange Facility or Interface between Inter City Modes: Table 7.1 shows that the different facilities and flow of inter city passenger from the different stations of Dhaka city. From the Table it is revealed that the share of intercity passenger by different modes bus, train and launch are 76, 9 and 15 percent respectively. Interchange or interface facility between the three modes are very poor. Total bus passengers are served by the five bus terminal viz. Gabtoli (23%), Mohakahli (6%), Gulistan (7%), Fulbari (15%) and Saidabad (25%) bus terminal. There has not any well functional direct connectivity between these five terminals. Gabtoli to Gulistan and Gabtoli to Saidabad has separate singe bus connecting service but the connecting route is fully circumlocutory comprising several links, right turn, left turn, local road, tertiary road etc. and passes through the commercial, residential, educational as well as CBD. There has not also any connecting service with the Saidabad and Mohakhali bus terminal and Gabtoli to Mokhali terminals. At present condition it is almost difficult to provide direct connecting route for interchange of the passenger terminal to terminal.

Table 7.1: Different Facilities and Flow of Inter City Passenger from the Different Stations of Dhaka City

Terminal	Bus/Launch/ Train schedule	Passenger (thousands)	Visitors (Thousa nds)	Parking Capacit y	Total Area (Sq.m)	Built up area (Sq.m.)	Percent of Passenge r
Gabtoli Bus Terminal	2000	80-95	10---12	1000	56800	11500	23%
Mohakhali Bus Terminal	450	20-25	1—2	400	20000	4000	6%
Gulistan Bus Terminal	450	25-30	na	125	6000	1000	7%
Fulbaria Bus Terminal	500	50-60	na	no	no	no	15%
Saidabad Bus Terminal	2000	80-100	10---12	1000	61000	12500	25%
Kamalapur Railway Station	78	20-25	4—5	8	-	-	6%
Tejgaon Railway Station	26	5—6	-	-	-	-	1%
Airport Railway Station	-	5—7	-	-	-	-	2%
Sadarghat Launch Terminal	300	50-60	10—12	-	-	-	15%
Total							100%

Source: STP, 2004 and Field survey, 2009

Railway passengers are served by the three railway station, viz. Kamalapur (6%), Tegaon (1%), Airport (2%) railway station. Kamalapur railway station is eastern side of the city and only 0.5 kilometer away from the CBD. Though there has a radial connecting road between CBD and Kamalapur railway station, almost 90 percent of the people go or come to the station to CBD by rickshaw through circular road for the poor maintenance of the road and for the lack of user friendly footpath. Only option for the people is to use rickshaw. To serve the 20-25 thousands incoming and outgoing passengers every day making it an important busy place. Though there are four connecting bus route with the different part of the city, there has not also any connecting service with the Gabtoli and Mohakhali and Sadarghat terminals. For the lack of well connecting mass transit network, almost 60 percent of the passengers' pre and post travel mode is rickshaw, followed by minibus (16%), Auto rickshaw (9%) (Appendix C). Though, there are three intra city (midway, myline and no 6) and one semi-intracity connecting bus service from the front road of the city station, three has not any either bus terminal or bus parking space. A significant amount of passenger (8%) pre or post travel from old Dhaka, but there has not any connecting bus service. There has well designed parking space for rickshaw and auto rickshaw, but there has not a bus loading unloading bay. On the other hand, no connecting bus route is started or ended from the station premises. The station is the via of all of the four bus routes. There are three bus counter and all of them are on the footpath. From the field survey it is observed that all of the buses reached the station counter with full loading condition by other station passenger. As a result, passenger of the railway station are not interested to go by bus and bound to use rickshaw or auto rickshaw.

The airport station is a newly established station in between Tongi and Cantonment stations to serve passengers from northern areas of the metro-city. By introducing operation and stoppage for intercity trains the station has become popular. The reasons for this popularity are quick transportation during pre and post travel short journey, connecting NMT free VIP road at doorstep and ready availability of fast moving motorized taxi and other services at all hours to go to almost all around the city. On the other hand, for the lack of such facility i.e. for the lack well connecting road, the Tegaon station is becoming unfamiliar gradually.

Almost all of the waterway passengers are served by the Sadarghat launch terminal. The nearest bus stoppage is almost 1 km away from the Sadarghat launch terminal. The only one 4 lane undivided main road serving the terminal is extremely congested at all times. From the field

observation it is observed that almost 2 lanes of that are occupied by the hawkers and protruded part of the both side commercial activities. Indeed, the intensity of commercial activity on the road is so desnsified that it is difficult to realize the there has or has not any footpath. Unfortunately, the widening of that road is almost impossible at present because of both side high-rise multi-storied commercial building. The accessibility of this important and busy terminal is hindered for ever by allowing construction of such gigantic multi-storied commercial building along the side of the road. At this condition passenger are bound to use smaller vehicles like rickshaw or auto rickshaw for pre and post travel. From the questionnaire survey it is found that almost 55 percent of passenger use rickshaw and CNG in pre and post travel; rickshaw 40% and CNG (15%) (Appendix C). Only 16 percent of people use minibus service and 15 percent use tempo and human haulers after walking almost 1 km from Launch ghat to Victoria Park. There are only three routed buses available in the Park terminal. Among the respondent, almost 33 percent of the passenger's origin/destination is Jatrabai (13%), Firmgate (8%), Kamalapur, Motijheel (6%), Moghbazar & Tejgaon (5%) but there has not any connecting bus route. There is a human haulers service from Victoria park to Jatrabai (Appendix C).. The main railway station Kamlapur is 4 km away from the terminal but does not have any good access or interface. There has not also any connecting bus route with Mohakhali and Saidabad bus terminal. As discussed, in the present condition it is very difficult to develop any well design interchange infrastructure or interface facility around the Sadarghat launch terminal.

Interchange Facility or Interface between Intra City Modes: According to the estimation by STP, there are approximately 18.7 million trips per day. From the field observation it is revealed that the share of intra city passenger by commuter train and launch are 5000 and 2000 passenger per day respectively. Others all of the trips are road based either by walk, or by bus, rickshaws or other motorized or non-motorized vehicles. The interchange facility between these three intra city modes road, rail and water is also very poor. Actually, for the lack of interchange facility or well interface between intra city road-rail transport and road-water transport are one of the major causes of the very less share of other modes.

There are two intra city commuter train routes one is Kamalapur to Tongi via Tejgaon, Airport and other is Kamalapur to Narayangong via Gandaria. Every day 26 incoming and outgoing (13 incoming and 13 out going) mail train are operating in the Kamalapur to Tongi route and flow of passenger per day in this route around 2000 to 2500. The fare of this route per passenger is 6 TK only which is one fifth compare to bus fare. In Dhaka Narayangong route, 20 trains (10 incoming and 10 out going) are operating per day except holiday (in holiday 4 incoming and 4 out going) (Appendix D) and the flow passenger per day one an average 2500 to 3000. Fare of per passenger in Kamalapur to Gandaria is 5 TK and Kamalapur to Narayangong is 6 TK which is also around 5 times lower compare to the bus fare. Even this, the flow of passenger in this route by train is much lower than the by bus route. From the field survey couple with discussion with the users it is revealed that lack of interchange facility as well as connecting facility with final destination to railway station is the major cause of less demand of the commuter train service. Delay of train or improper maintain of the train schedule is also one of the major issues are found for this less popularity. For example, a special commuter train Kamalapur to Gazipur was scheduled for the office passenger in Gazipur after demanding by the office passenger. But after few days that train becomes unpopular for the delay and other operation problems. Illegal negotiation between the railway authority and bus operators are found one of the factors of such operational problems and this could be for two distinct services provider; one is private and other is public or governmental.

Shawrighat to Khlomor is the only one intra city waterway passenger flow route carrying around 1500 to 2000 passenger par day. For freight transport there are some other extended route along the circular waterway. In addition, there are almost 30 passenger crossing station in the both side circular waterway and every day thousands of passenger cross the river using that stations. Almost 60 percent of the stations have not any functional road connectivity. For the lack of connecting road or interchange facility people are bound to go their final destination either by rickshaw or by foot and their share in some selected stations is 50 to 60 percent and 30 to 40

percent respectively. And in present condition, it is almost impossible to develop well connecting facility with most of landing station in present condition.

Interchange Facility between Intercity and Intra City Bus Service: There are five intercity bus terminal in Dhaka city i.e. Gabtoli (23%), Mohakahli (6%), Gulistan (7%), Fulbari (15%) and Saidabad (25%) bus terminal. But, unfortunately there has not any designated intra city bus terminal. The interface facility between inter city and intra city passenger is very poor. The major bus terminal, Gabtoli and Saidabad bus terminal are outside of the city serve almost 50 percent of the total inter city passenger. But there has not any facility for intra city bus parking or loading and unloading.

In Gabtoli bus terminal, there are only two connecting intra city bus route is available, one in number 7 (Gabtoli to Shadarghat) and another is number 8 (Gabtoli to Jatrabari) serve almost 65 percent of the passengers. From the O-D survey it is found that in Gabtoli terminal, a significant amount of passenger's origin and destination is Mirpur and Mohakhali area, 23 percent passenger's (Mirpur 14% and Mohakhali 9%) origin towards Gabtoli and 35 percent passenger's destination (Mirpur 19% and Mohakhali 16%) from Gabtoli. But, there has not any direct bus service for Mirpur and Mohakhali which should be provided urgently (Appendix C). All the intra city vehicles including buses, tempo, and human hauler parked on road. Every three to four minutes a number 7 or number 8 buses is leaving the terminal. Besides there has some semi intra city bus, but there have not any loading and unloading facility too. All of buses stand on road, parking on road and loading and unloading from the road. Indeed, there has not well turning facility for both types of vehicles. Right turn and U-turn are taking place on the main road in same place by the both types of intra city and intercity vehicles often creating conflict between them. At present condition, it is almost impossible to provide designated place for intra city buses because of lack of empty space around the terminal.

In Saidabad bus terminal, there are around 12 intra city connecting bus routes but almost 75 percent of the passenger make pre and post trip by other than bus (rickshaw 45%, walk 17% and auto-rickshaw 10%) particularly for the operational deficiency of the bus service. There are very few (20 parking space occupied by Balaka paribahan) designated intra city bus parking space for intra city buses. From the O-D survey it is found that around 15 percent of passenger pre and post travel origin and destination is Sadarghat and Basabo (Sadarghat 9%, Basabo 6%), but there has not any connecting bus service facility from this terminal (Appendix C).. On the other hand, terminal is the via of the entire commuter bus route except Balaka paribahan route and reached to the station almost in fully loading condition which also discourage passenger to use this service. Like Gabtoli terminal, all of buses are standing on road, parking on road and loading and unloading from the road and interrupting the through and local traffic each other. However, in spite of 12 connecting bus services with the Saidabad bus terminal from the different part of the city, very few passengers (27 %) are use this facility for the lack of interchange facility as well as huge operational deficiency.

Mokhali bus terminal is almost middle in the city connect the northern part of the country and serve every day almost 20-25 passenger. There are about 9 intra city or semi intra city via bus route along this terminal but and almost all of them are ticket system company based bus except 6 and 3 B. But, the nearest ticket counter is almost 500 m away from the terminal. Though there has well design circulating area for local traffic, there has not any intra city bus bay or loading unloading area. The loading condition of the intra city bus also discourage inter city passenger to go to by bus. Almost 11 percent pre and post travel destination is Badda area, but there has not any direct bus service from the terminal. For the lack of intra city bus service facility, almost 75 percent passenger use other mode of transport in their pre and post travel.

There have developed some intra city bus terminal around the city. Among them Abdullahpur, Mirpur, Azimpur are dominant and these terminals are the origin of the around 15, 21, and 7 routes respectively. But unfortunately, there has not any designated bus parking space. There has

not also any facility for the drivers', helper and other worker. Even there has not any designated ticket counter. All of the buses are parked on road and ticket counter of that buses are on footpath.

Interchange Facility Between Inland Circular Waterway and Road: There altogether 19 landing stations in the circular water way in Dhaka city, phase 1 (Ashulia to Shewari Ghat) 10 stations and phase 2 (Tongi to Kanchpur) 9 stations but only 8 stations have well road connectivity with the city area. In addition, there are 13 crossing station or ghat use for the crossing the river by country boat. Table 7.2 shows a brief summary of the two phases water circular way. Appendix E presents the passenger and freight in different landing stations of the circular waterway.

Table 7. 2: Length, Expenditure, Income and Landing Station of Circular Waterway

Phase	Area	Length (km)	Expenditure (crore)	Expenditure of land acquisition (crore)	Yearly estimated income (Crore)	Landing station	Well road connecting station
1 st phase	Ashulia to Shewari Ghat	30 km	35.9	10	3.5	10	5
2 Phase	Tongi to Kanchpur	40 km	65.9	15	3.5	9	3

Source: BIWTA, January 2010

In the first phase of the circular water way in Dhaka city, Ashulia to Shewari Ghat, there are all together ten landing stations. Among them Rayer bazaar are only staircase used only for rainy season and Nawaber Bap ghat only for the crossing facility. Others 8 stations have permanent landing station for both passenger and freight. But from the field investigation it is found that Only one launch connecting route between two ghat, Shewari Ghat to Kholamora are operating now and this route carry only 1500 to 2000 passenger per day by single deck launch. The passenger which has been shown in feasibility study, almost all of that passenger are only thoroughly crossing passenger using the ghat by country boat, not distributed or circulated through the circular route. In this study, it is found that only 11 percent of the total passenger of the Shewari Ghat use the circular route and other 89 percent only cross the river. However, the number of passenger which have been shown in the feasibility study in both phase I and II, (Appendix E) is confusing because from the field study coupled with review of previous study, it is observed that almost 90 percent of the passenger use these stations only for crossing the river not for circulating from one station to another station. So, the demand which has been shown in the feasibility study could be verified which required further in-depth study. They are bound to cross the river for the absence of any alternative like bridge. From the field observation, it is observed that almost 5 landing stations have not sufficient connecting road to go to the destination. In Shadarghat to Rayer bazaar there are altogether 17 stations including 3 circular waterway landing station and every year around 200 lac passenger use this stations but there has not any well connecting interchanging route except embankment road. Although, only one bus route is available on the embankment road, Amin Bazaar to Babu Bazaar, the performance of that route is very poor. The two-lane road is almost occupied by the freight or parking vehicles or vendors and for the lack of radial road; passenger could not circulate throughout the city area. In some of the stations like Shewari Ghat, Waisghat, Kholomora, Raer bazaar have 12-15 feet wide connecting road with the old Dhaka. These connecting roads are also made uncontrolled T-junction with the embankment road and reduce the operational capacity of that road. These roads are not quite straight and continuous. In addition, disposal waste or parking rickshaws or tempos occupy almost one-third spaces of those roads. Some of the stations which have major connecting road but there have not any mass transit route. As a result, it is observed that, almost 80 percent passengers are bound to go to their destination either by foot or by rickshaw. From the O-D

survey in some selected landing stations, it is found that almost 30 percent passengers go to new Dhaka like Rampura, Badda, Motijheel from Shewari Ghat, Waisghat, Kholomora or Matbar bazaar by rickshaw expending around 50-90 TK per trip for the lack of alternative cheaper mode like bus. This high fare obviously a great burden for the user that discourages them to use this route second time. Some of the passenger use tempo through the embankment. From the questionnaire survey couple with the discussion with the local authority, it is revealed that for the lack of well connectivity with the landing station to different parts of the city as well as lack of interface or interchange facility is one of the major causes for unpopularity of these investments. In present condition, most of the spaces are occupied by haphazardly developed multi-storied residential and commercial building and it is almost impossible to develop connecting road or provide well facilitate interchange facility with the city center.

In Second phase, there are nine landing stations point, among them only three corner points have well connecting national and regional highway route, Tongi, Kanchpur and Demra. Among the other 6 stations, 3 stations have local road connectivity with the Dhaka city and others have not any connection. That could be used only for the some compact local residents. There will have to face same problem as like as phase one i.e. lack of spike or radial connectivity by waterway as well as roadway. As shown earlier, most of the areas of eastern part of the city are the flood runoff area, it almost difficult to construct well connecting road with the landing stations. After all, there have a well connecting radial canal named Rampur canal, which could be potentially use as a mid point connecting facility with the city area. In the first phase, there have also some connecting radial canal like Dholaikal (connecting with the CBD), Rayer bazaar Canal (connecting with the Mohammadpur and Shamoli), but that's are not only history, no geological features are exist in realty as present for the conversion as box culvert and residential area filling by graver for unplanned development. Therefore, the potentiality which have for the well performance of the water circular way are lost for the lack of vision, lack of planning of the city authority.

Finally, it is to be mentioned here that the peak hour commuter movement of Dhaka city is mainly road based and other alternative travel systems viz. rail and water has inherent weakness, as they are not aligned with the inner city commuter movement paths. Rail is eccentrically located in the Eastern side of the city and towards N-S directions and not capable of providing service to the other parts of Dhaka city. In its present from, the rail system is neither a competitor nor a suitable alternative of the road based travel modes particularly in case of inner city commuter movements. Rather, to some extent, a large number of at-grate railroad crossing (51) are acting as a great hindrance for efficient operation of road based travel system. On the other hand, since the proposed circular waterways are located at the periphery of the built-up areas, it is also not a viable alternative particularly at the fringe areas. Indeed, there has not well connecting road network between the waterway landing area and city area. In consideration of these, it is obvious that for certain areas of Dhaka city, physically as well as functional integration of different modes of public transport would be a very challenging job and feasibility of which needs a very comprehensive study.

7.2.3 Geometry Delay due to Faulty Road Alignment

Not operational delay it is the geometric delay because of road geometry and alignment. In order to evaluate the geometric delay which has been resulted from the road geometric condition, landuse and road network plan and road patter/alignment, extra travel distance has been measured through comparing between travel, straight and grid distance using Google Earth. Table 7.5 shows the road distance or travel distance and straight distance or geographic distance in the different area of the city.

From the Table 7.3, it is found that Gulistan to Rampura only 5 km distance but travel distance nearly 5.5 km, that 10% more distance would be required. With this there are about 6 junctions among them 3 are T-junction, 4 right turn within this short distance for the faulty transport landuse as well as road alignment. Gulistan to Aminbazar Bridge actual straight distance 10.2 km

but distance would be travel (via Firmgate) about 12.7 km that 2.5 km more distance required to travel for the faulty geometric condition of the road network. Sadarghat to Mirpur Zoo satellite distance is only 13 km but minimum distance required to travel more than 16 km i.e. 3 km (23%) more distance require to travel. This extra distance is the result of faulty unplanned road alignment. This is a built in problem. It cannot minimize because of high built up of land along the both side of the road. This problem arises from the wrong development of the city. This alignment denote that there was not followed any master plan to develop the city with a long vision. That is the city is developing in ad hoc manner. The solution is provided for the city is piecemeal. A city cannot develop in this way and this problem has not any cost-effective and sustainable solution.

Table 7.3: Road Distance and Straight Distance in Different Area of the City

From	To	Via	Road Distance (M)	Straight Distance (M)	Grid Distance (M)	Extra Distance Travel (M)
Gulistan	Rampura Bridge	Kakrail	5691.66	5142.42	6246.9	549.24
Gulistan	Aminbazar Bridge	Firmgate	12746.58	10245.98	14432.85	2500.6
Saidabad B. T.	Gabtoli B. T.	Firmgate	13538.78	11371.25	16071.21	2167.53
Saidabad B. T.	Mirpur 10	Firmgate	13606.84	11782.68	16053.11	1824.16
Sadarghat	Mirpur Zoo	Mirpur 10	16463.82	13097.42	17905.64	3366.4
Motijheel	Firmgate	Shahbag	5595.08	4772.49	6761.57	822.59
Azimpur	Rampura Bridge	Shahbag	8588.15	5879.87	8306.7	2708.28
Azimpur	Tongi Bridge	Firmgate	21174.17	17208.04	8622.47	3966.13
Azimpur	Firmgate	Kalabagan	5280.92	3581.69	3910.76	1699.23
Manik Mia West int	Mirpur 10	Rokeya Sharani	6571.42	5448.69	5989.8	1122.73
Manik Mia West int	Mirpur 10	Technical More	7438.43	5448.69	5989.8	1989.74

Source: Survey Using Google Earth, 2007

In this study, travel time data at peck and off peck period has been collected from the field survey using random trip selection method in different routes of the city. Distance and free flow speed has also been counted of that routes. Geometric and operation delay has been calculated using the average value of three sample trips. Table 7.4 shows the geometric and operational delay at different routes in Dhaka city.

Table 7.4: Geometric and Operational Delay at Different Route in Dhaka City

Route	Distance (km)	Free Flow Speed (Km/hr)	Time Required at Off-peak period (m)	Time Required at Peak Period (m)	Time should required (m)	Geometric Delay (m)	Operational Delay (m)
Azimpur to Kakoli	9.79	38	35	62	15	20	27
Shabagh to Mirpur 10	8.65	41.5	40	90	13	27	50
Azimpur to Shymoli to Mirpur 10	11.16	35	45	120	19	26	75
Gulistan to Bishaw Road	11.5	28	55	130	25	30	75
Gulistan to Chittagong Road	11.4	36	30	75	19	11	45
Azimpur to Matsha Bhaban	3.3	42	12	24	5	7	12
Azimpur to Manik Mia	3.71	35	15	24	6	9	9
Sonargaon to Rasel Square	1.6	30	11	25	3	8	14
Shabagh to Workshop	5.6	41.5	21	46	8	13	25
Shabagh to Kakoli	6.95	41	28	47	10	18	19

Source: Field Survey, 2007

From the Table 7.3, it is found that the route which length in between 8 to 11 km. almost 20 to 30 minutes geometric and 50 to 75 minutes operational delay occur in Dhaka city area. The geometric delay results from the default road network plan, turning of vehicles for the default road alignment and staggered link i.e. results from the planning problem. However, it will have to continue and minimization is almost impossible.

7.2.4 Transportation System Management: Assessment of Implementation of General Tools

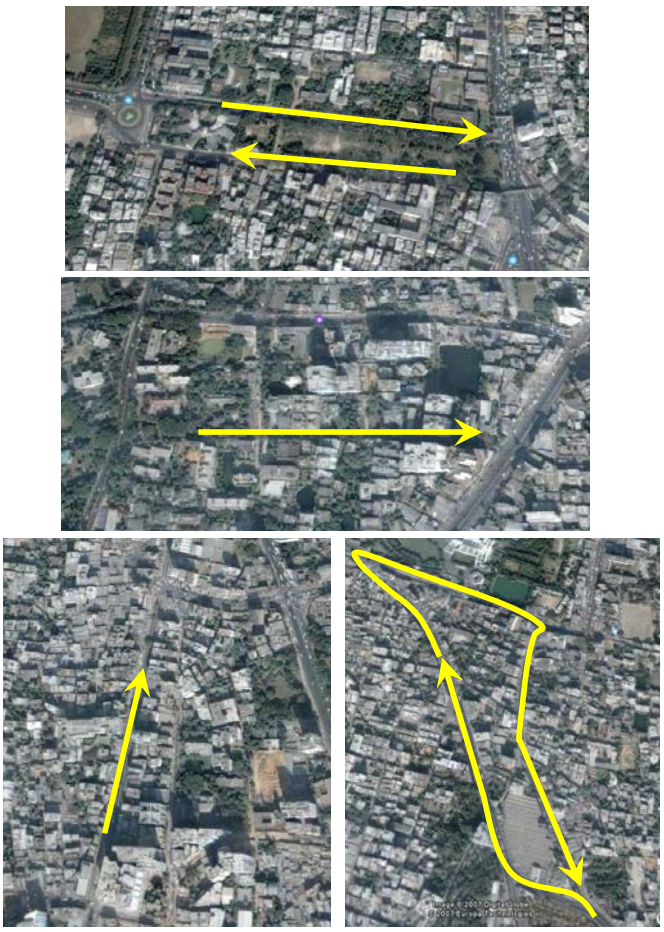
From the literature review, it is narrated (Chapter 2, Article 2.18) that Transportation System Management (TSM) is a package of short term measures to make the most productive and cost-effective use of existing transportation facilities, services and modes. Some of the well-known low cost traffic management measures are:

i) One-way streets
ii) Tidal-flow operations
iii) Restrictions on turning movements
iv) Reduction of Signal Phases
v) Installation coordinated signals
vi) Restrictions on loading and waiting
vii) Exclusive Bus-lane
viii) Closing side-streets

For the possibility assessment of the implementation of well recognized, cost effective above mentioned general transportation system management tool, effectiveness and pre-requisite of the implementation has been gathered from the literature review which has been described in Chapter 2. Correspondingly data has been collected from the field observation, road inventory and landuse survey and tried to justified with the prerequisite for the implementation of the tools. The observations are described in below:

7.2.4.1 One-Way Operation

One way operation is one of major and cost effective tool of traffic system management which is widely use in so many developed as well as in developing countries to improve the operational and management hazards of traffic. One way operation provide enormous advantages viz. reduce points of conflict, increased capacity, increased speed, facilitate the operation of a progressive signal system, improve in parking facilities, eliminate of dazzle and head-on collision. By converting a road two ways to one way, at least two times capacity of that road can be improved (Literature Review, Article 2. 18).



Map 7.2: Major One-way Operational Road in Dhaka Metropolitan City

Even, this tool can by apply in a particular period of a road in accordance with its peak hour to reduce the peak time hazards and huge benefit can be achieved by improving capacity of the road etc. In Dhaka city, there are only about 4 km one way road which is only 0.31 percent of total road network of DCC. Now question is, is there any option to introduce one way operational tool to other roads. According to the literature review (Article 2.18.2.1), for the implementation of one way operation of a city, first and foremost requirement is alternative or/and analogous couple/twin road for opposite directional vehicle. That is road network pattern should be developed in such a way that parallel and twin road must available for both directional vehicles. From the overall observation of Dhaka city road network, there are a very few parallel alternative or identical twin road where one way operational can be implemented. Indeed, the city road network is not developed considering this idea for future implementation of such tool to manage the demand of traffic. Even, the roads where one way operation is now being implemented, most of them are super imposed on road by executive force, not by traditional manner. Only, farmgate Indira and Kharmarbari road is parallel road which is fit for traditional one way operation (Map 7.2). Besides this, Tikatoli hatkhola road form as loop and Sonargaon road in front of Eastern plaza is a only single road which is fully unfit for one way operation (Map 7.2). Now, if such question arise, is there any further option to introduce one way operation in the present road network of Dhaka city, obviously the answer is quite impossible, because of the pattern of road network not is support the criteria of one way operation. If it is observed the Mirpur road, there is no matching road to go to Gabtoli from Azimpur. Similarly, there is no similar alternative to move to Uttara from Shahabag except New Airport Road. The picture is also same fashion for the case of the Rokeya Sharani and DIT road. From the observation it is also found that, there is no twin or couple road any of the east-west connecting major road like Fazli Rabbi Road, Topkhana Road, Inner Circular Road, Outer circular Road, Elephant Road, Pantha Path etc. which is fit for reverse directional vehicle. So, it is concluded that there is very few option to introduce the one way operation of the entire city road network of the mega city Dhaka and also there is not any cost effective solution to make possible for introducing such tool. This is a built in problem for the mega city of Dhaka and the city is detriment such a cost effective modern traffic management tool everlasting.

7.2.4.2 Introduction of Tidal Flow Operation

As described in the Chapter 2, tidal flow operation is one of the most potential and cost effective tools to increase the capacity of a road as well as to reduce the congestion but there has some pre-requisite to introduce this tools. Generally, tidal flow operation is justified where 65 per cent or more of traffic moves in one direction during peak periods. It is also necessary that the remaining lanes for the lighter flow are adequate for that traffic. With a three-lane street, two lanes can be reserved for heavier flow and one lane for the smaller flow. In most of the modern city, a large proportion of inbound traffic inter into the city in morning and vise versa in evening. To found this pattern of traffic flow, residential area and office area, industrial area, market area i.e. residential place and work place must be fully separated. People come to their work place from the peripheral residential area in morning and return to the resident in evening. It is described earlier in Chapter 5 that in Dhaka Metropolitan city; most of the lands are mixed use. There has not any pure residential area, pure industrial area, even pure commercial area. It is also described that the planned residential area, commercial are has been converted to also mixed area like Dhankondi, Banani, Gulshan (Chapter 5, Article 5.8). Dhanmondi area was planned as a residential area and developed in such way. But, at present, for the lack of controlled, huge number of mixed used (8%), institution (5%), commercial market and industry (7%), is developed and turn as a fully mixed up area (Map 7.3). Motijeel CBD area is developed as fully commercial area. But present situation is that commercial building is lower than the residential building, which is accounted for 38 percent and 40 percent respectively (Table 7.5). Therefore, most of the developed land of this city (pre-planned, post planned, unplanned) are mixed landuse, there is no possibility to grow inbound and outbound peak flow in opposite direction in different times. That is, no possibility to introduce tidal flow operation in this road network of the Dhaka city too.

Table 7.5: Number of Building by Different Types of Use in Dhanmondi (Ward 49) and Motijheel (Ward 32)

Area	**Ward no 49 Dhanmondi**		**Ward no 32 Motijheel CBD**	
Building use type	Number	Percent	Number	Percent
Commercial/ Industry	156	7%	585	38%
Residential	1523	68%	619	40%
Education	123	5%	12	1%
Mixed	191	8%	238	15%
Medical /Health	53	2%	0	0%
Govt. Organization /Social Centre	85	4%	51	3%
Religious	13	1%	11	1%
Unknown/Under Construction	95	4%	25	2%
Club	7	0%	5	0%
Open Area	6	0%		0%
Total	2252	100%	1546	100%

Source: DCC, 2006

Map 7.3: Landuse Map of Dhanmondi and Motijheel

7.2.4.3 Restriction of Turning Movements

According to the description of the Chapter 2, it is also a very cost effective and efficient tool for traffic management, but prerequisite of prohibition of right-turning movement is availability to suitable alternative diversion routes and the existing street system is capable of accommodating an alternative routing.

From the field observation and the project report on the intersection improvement, in Dhaka city, there are only two intersections viz. Banglamotor and Resel square intersection where's' exclusively right turning has been banded. In Newmarket, Kawranbazar intersections, right turn is being partially banded in several times. Besides this, for the lack of well orientation of road

network as well as for the lack of alternative road, there have very few options to restrict right turn of an intersection by accommodating the vehicle in alternative road in Dhaka city. Very few options which was available that's are being unusable for the restriction of the road use by Dhaka University, BUET etc. Prohibition of right-turning movement is known to increase the saturation flow and the capacity of the junction but the city is deprived of this effective and efficient management system.

Left-turning movement prohibition is needed to provide a safe crossing for pedestrian traffic especially when the pedestrian traffic across the minor road is heavy. In Dhaka metropolitan city, around 60 percent of all trips are pedestrian (DITS) and pedestrian are the most vulnerable road users groups. Among the total road fatalities, 86 percent are pedestrian (ARI, 2008). So, for safe pedestrian crossing, banning of left turn would be very effective for the Dhaka city, but for the lack of alternative road and lack of continuous monitoring and enforcement, there has very few options to introduce this tool.

7.2.4.4 Reduction of Signal Phases

Intersection is the most complicated and complex part of the entire road network. The productivity/ capacity of a road is proportionally depends on the productivity of the approach of intersections of that road. Therefore, intersection dictates the overall performance of the road network. The road network or approach road will be more productive when its intersection signal phase will be minimum. To observe the possibility of the reduction of signal phase, number of intersection phase and corner widening data has been collected from the field survey. The survey results are shown in Table 7.6.

Table 7.6: Major Intersection, Phase, Operational Type and Corner Widening in Dhaka City

Road	Major Intersections	Type	Phase	Operational Type	Corner Widening
Mirpur Road	Azimpur Intersection	X-junction	4	Signalized	nil
	New market	X-junction	4	Signalized	3
	Elephant Road	T-junction	2	Signalized	2
	City college (Rd No 2)	T-junction	2	Non-signalized	nil
	Relesl Squire	T-junction	2	Signalized	
	Manik Mia	T-junction	3	Signalized	2
	Asad Gate	T-junction	3	Non-signalized	1
	Lake Road	X-junction	4	Non-signalized	
	Agargaon Road	T-junction	3	Non-signalized	2
	Technical More	T-junction	3	Signalized	
	Beribadh Road	T-junction	3	Non-signalized	nil
Pragati Sharani	Mouchack Intersection	T-Junction	3	Signalized	2
	Saidabad DIT Road Int.	T-Junction	3		1
	Natun Bazar Int.	T-Junction	3	Signalized Non-signalized	2
	Bashundhara Junction	T-Junction	3	Non-signalized	0
Airport Road	Shabagh Int.	X-junction	4	Signalized	4
	Sheraton	T-juncton	3	Signalized	2
	Banglamotor	X-junction	2	Signalized	2
	Kawranbazar	X-junction	4	Signalized	RA
	Rangs Bijoy sharani	T-juncton	3	Signalized	2
	Jahangir Gate int.	T-junction	3	Signalized	0
	Kuril Bishaw road int.	T-juncton	3	Signalized	2
S. C. M. Ali	MatshaBhaban	X-junction	4	Signalized	2

Table 7.6 Continued

and S. Tazuddin Road	Kakrail Mosque	Y-junction	3	Signalized	3
	Maghbazar	X-junction	4	Signalized	0
	Pantha Path	T-juncton	3	Signalized	2
	Mohakhali	Y-juncton	3	Signalized	1
Kakrail Road	Santinagar	T-juncton	3	Signalized	2
	Kakrail	X-juncton	4	Signalized	2
	Malibagh	T-juncton	3	Signalized	2
	Polashi	X-junction	5	Signalized	0
	Paltan	X-junction	4	Signalized	2
	Dainik Bangla	X-junction	4	Signalized	2
	Katabone	X-junction	4	Signalized	0

Source: Field Survey, 2008

From this Table7.6, it is seen that about 86 percent of X-junction are 4 phases and about 90 percent of T-junction are 3 phases. Only the Banglamotor X-intersection and New elephant road to Mirpur road T- intersections' 2 and 1 phases respectively could be reduced for the supportive road of Panthopath road and Sonargaon road. Besides this, some intersections like Shahabag intersection phase can be reduce, but the alternative Nilkhet road is closed for public transport for the causes of Dhaka University area.

In recent year, new traffic signal has been installed in 59 major intersections in Dhaka city by the DTCB. Among the newly signalized intersection, 31 intersections are X-intersection, 26 are T-intersection and 2 intersections are multi-leg intersection. Among the 31 intersections are X-intersection, 22 (71 %) are 4 phases and 8 (26%) are 3 phases and only one intersection are 2 phases. On the other hand, among the 26 T-intersections, 23 intersections are 3 phases and other 3 are 2 phases. Both the multi-leg intersections are 5 phases. However, among the total 59 intersections, 47 (80%) intersections phases are equal to its approaches. Indeed, for the causes of 4 phases every X-junctions and 3 phases T-junctions, the each approach road loses their capacity ¾ times and 2/3 times respectively. For the lack of alternative road, or link road or for the lack of east-west connectivity as well as for the lack of proportionality between north-south and east-west connective road, there is very few opportunity of reducing signal phases of the major busy intersections. Therefore, this lose will continue until the alternative road is constructed to diverse right turn traffic into other road. However, it is not only very difficult but also almost impossible for such an over populated unplanned built-up city. So, most of the cases, for the lack of alternative road even secondary road, there is not possible to reduce the signal phase by diverting the traffic into other roads. Indeed, the city is not built considering such opportunity and there has not provided any option to fulfill the requirements by developing new infrastructure or road in the city areas. So, these unproductive intersections would be sustained until the city life.

7.2.4.5 Installation of Coordinated Signal

For uninterrupted movement of traffic or to pass the maximum amount traffic without enforced halts or to have minimum overall delay to traffic streams both in main and side road and to prevent the queue of vehicles at one intersection from extending and reaching the next intersection, coordination between the signal is one of the fundamental tools which is widely used in various cities in the world.

For the causes of uncoordinated signal design, a significant time of delay has been occurred in different intersection of different route in the city. To show the operational impact of uncoordinated signal, delay time at peck period has been counted in the major intersection in different routes of the city. Table 7.7 presents average delay at peck period in the major intersection in different routes of Dhaka city.

Table 7.7: Avg. Delay at Peak Hour in the Major Intersection in Different Route

Route	Major Intersection	Avg. Delay (M)
Shahbag to Pallabi via Rokeya Sharani	Shahbagh	10
	Sheraton	9
	Banglamotor	7
	Sonargaon	11
	Firmgate	6
	Bijoy sharani (west)	5.5
	Bijoy sharani (east)	4
	Agargoan	4.5
	Mirpur 10	6
Azimpur to Mirpur 10 via Mirpur Road	New market	8
	Science Lab	9.3
	Green road	4.5
	Dhanmondi 6	6.5
	Road No 8	7
	Kalabagan	7
	Panthopath	2
	Road No 16	4
	Manik Mia Avenue	2.5
	Asad Gate	4
	Lake Road	4.5
	Agargao Road	5
	Shamoli intersection	6
	Ring Road	2.5
	Technical More	8
	Mirpur 1	6.5
	Mirpur 10	6
Gulistan to Chittagong Road via Saidabad	Saidabad Rail crossing	13
	Jatrabari	10
	Narayangong Link road	12.5
Azimpur to Matshaya Bhaban	Azimpur	3
	Polashi	6
	Nilkhet	1
	Katabon	5
	Shahbagh	3
	Matshaya bhaban	1.5
Gulistan to Bishaw Road via Pragati Sharani	Ziro Point	3
	Paltan	4
	Kakrail more	4
	Malibagh more	8.5
	Mouchack more	10
	Malibagh rail crossing	3
	Banashree road	1.5
	Gulshan 1 con. Rd.	2.5
	Natun Bazar	3
	Bashundhara road	3

Source: Field Survey, 2008

As discussed earlier, this delay could be minimized by co-ordinated signal system. But, for the interdiction of co-ordinated signal system, there must fulfill some prerequisite condition as discussed in Chapter 2. Most of the system operates efficiency where the blocks are of equal length and traffic motion is free and smooth in the link road between the two intersections (Kadiyali, 2007). To evaluate the possibility of the installation of coordinated signal under considering this requirement, intersection to intersection data has been collected using Google map and field survey. As the road network in the city is not any particular pattern and the difference between the two major roads is not chronological, the distance between the two intersections is varying on after another. So, it is difficult to provide coordinated signal in the intersection of the city. Figure 7.1 presents the intersection to intersection distance in major road in Dhaka metropolitan city.

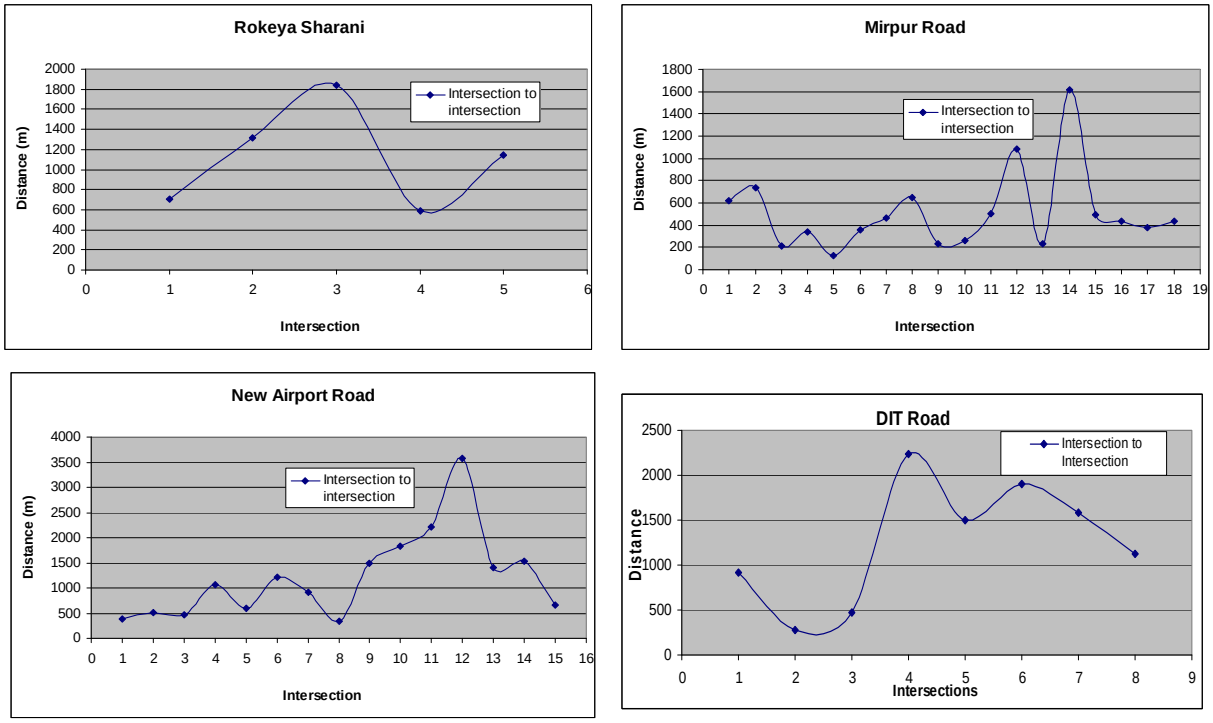


Figure 7.1: Distance between Intersection to Intersection in Different Road *(Source: Field Survey, 2008)*

Smooth discipline traffic flow is also one of the fundamental requirements for signal co-ordination. But, unfortunately for the causes of huge pedestrian flow on main road, random crossing, frequent access, mix traffic particularly rickshaw with the main stream flow interrupt the traffic in all of the sections of the main road. However, if the geometric configuration allows implementing coordinated signal, it will impossible to operate properly for the causes of such miasmas indiscipline traffic operational characteristics.

7.2.4.6 Closing Side Streets/Access control

In Dhaka city, there are huge numbers (around 10 side road per km in the main road) of side streets in the main road (Article 2.18.2.4). For reducing the interruption of traffic flow or eliminating the interference from the traffic from side streets, closing of side road is a very effective and demandable solution. Various types of advantages are provided in the Article 2.18.2.4. Closing some of these side-streets without affecting adversely the traffic requires interconnection between two side roads or service road facilities for diverging the vehicles. But, from the field observation it is observed that in Dhaka city, the side access road has not sufficient interconnection by which vehicle can diverge from one road to another road and finally come to the main road from a particular point. Besides this, there has not sufficient service road by the

side of main road. Most of the case, side roads are perpendicularly connected with the main road and closes as a dead end.

Even there has not sufficient space in the side of main road by which two accesses can merge in a single road and will act as an access road. The root of this problem is the lack of planning and guidance of development. At the time of planning road, there has not provide the layout of access road or even did not locate the access merging point of the main street. So, frequent accesses are joined with the main road from different directions, angles and the adjacent spaces are highly developed. So, it is almost impossible to close side streets as it is form from the very beginning of the planning.

7.2.4.7 Restrictions on Loading and Waiting

Restriction on loading and waiting from the main stream requires sufficient bus-bays. Properly designed bus-bays recessed into the curb facilitate loading and unloading of passengers without the vehicles blocking the stream of traffic on the carriageway. But, it is real to fact that in Dhaka city, there has not single bus bay in the core area. Only few bays are available in the cantonment road and airport road after Mohakhali. Even, few passenger shelter which are constructed by DCC, (most of them are occupied by hawker) all of the passenger shelter just on footpath without any bus waiting or stopping facilities. Therefore, all of the passenger vehicles even trucks are loading or unloading standing on the main carriageway, which reducing almost one lane of the road way capacity. Even, all the ticket counters of the newly introducing non-stop modern bus service of Dhaka's road are on the footpath and alighting and boarding of passenger done standing on the main road. Real fact is that, at present condition, it is nearly impossible to construct bus bay on road side, as most of the side of the road are fully buildup without sufficient setback.

Another fact is that, most of the stoppages of the vehicle are on the intersection or just approach of the intersection. Where as the stoppage should not be located too close to the intersections. A minimum distance of 75 m from the intersections in desirable for urban situation and for rural locations a distance of 300 m is desirable (Kadiyali, 2007). But, it is open to all of us that most of the bus stoppage are just on the junction clear way, even in many case the than within the junction influencing area. At present haphazard densified condition which is described in Chapter 5, there has not any scope without major demolishing to provide well designed loading and unloading facility and ensure of proper use of that facility without massive strict enforcement. However, this problem is also a built in problem, which loses about one third of the capacity of the main road of Dhaka City.

7.2.4.8 Exclusive Bus Lanes

Bus priority measures are a cheap and easy way to provide some aid to bus services. The journey time can be considerably reduced and bus journey can be made more attractive. Regularity of the buses can be improved. Viewed in the present context of traffic dilemma caused by the increase in car ownership and the need to patronize public transport, this is a welcome strategy. To be successful, the bus-lanes should be created for a good length of the road instead of in small portion of the route. An effective enforcement policy is a prime requisite for safety. Satisfactory signing and marking of the lanes and adequate publicity are also needed. Recessed bus bays must be provided wherever reserved bus lanes are to be introduced.

In some of the advanced countries, as a further measure of patronage of the buses, traffic signals have been installed with special bus detectors at street intersections. Thereby it is possible to give preferential treatment for buses at traffic signals, minimizing delays (Kadiyali, 07.) But, unfortunately, from the road network data analysis coupled with road inventory survey as well as field observation it is revealed that in Dhaka metropolitan city, there is a minimum scope to provide exclusive bus lane in present road network. Further details have been discussed in mass transit part of this Chapter.

7.2.5 Minimum Scope to Provide Expensive Management Measures

As described earlier, the traffic on the existing road system in cities grows, accessibility, mobility becomes a serious problem in all over the city. Medium and long-term measures like road widening, construction of fly-over or underpass, constructing bypasses or urban expressways, introduction of underground or elevated metro etc. are inevitable for the survival of the city. But, in the present situation it is also very difficult to develop effective and well design such facility for the causes of following challenges:

- Highly haphazard densification and unplanned development
- Lack of space in roadside as well as in intersection
- Conflict between other utility line and road infrastructure
- Conflict between different existing and proposed road project

Technological measures such as intelligent/automated highway/vehicles, advanced traffic information system, adaptive traffic signal control, active marking and headlight, auto-surveillance/incident detection/enforcement measures requires discipline traffic operation. It is reality which is also revealed again in this study that the traffic operation is this city is very indiscipline and make almost impossible to implement such measures in the present huge unplanned densified landuse and haphazard transport condition of the city.

From the above discussion, it could be concluded that the road network that is available in the city is not fully productive as well as functional as it is not a candidate to support the modern low cost, efficient and effective traffic management tools. And there has also minimum scope to provide expensive management measures as well as to provide technological measures. However, though the city has very small amount of road, only 6 percent of total area, is not functionally productive and efficient as almost one-third less productivity compare to the well pattern planned road network due to difficulties of the implementation of such tools and their consequent impact. Indeed, the city will have to sustain with this immense deficiencies as the city was not developed considering the possibility of the future implementation of that traffic management tools.

7.2.6 Lack of Access Control

One of the major problems of Dhaka city roads are the uncontrolled access which reduce the mobility of the road as well as entire capacity of the road is that too much access roads which are directly connected with the major road. No service road has been provided either side of the road except some part of Uttara. So the access or connector roads get direct access to the road and reduce the desired mobility of the city road.

RAJUK provide the alignment of road but the layout of access or position of access is not identified. It is well known that the city authority has not sufficient fund for construction of access or local community road. But RAJUK could identify the fixed position for access and provide an act that besides this any extra or unplaced access is not permissible.

Table 7.8: Access Density of Major Roads in Dhaka City

DIT Road						
From	**To**	**Length (M)**	**Access Road**		**Access per KM**	
			East side	**West Side**	**East side**	**West Side**
Mouchack	Rampura Bridge	2739	26	20	9.49	7.30
Rampur Bridge	Natun Bazar	3362	36	33	10.71	9.82
Natun Bazar int.	Kuril Bisaw Road int.	2719	27	19	9.93	6.99
Mouchack	**Rampura Bridge**	**8819**	**89**	**72**	**10.09**	**8.16**

Airport Road

From	To	Length (M)	Access Road		Access per KM	
			East side	West Side	East side	West Side
Shabagh	Firmgate	2340	12	16	5.13	6.84
Firmagate	Mohakhali	2817	18	17	6.39	6.03
Mohakhali	Kakoli int.	1812	7	2	3.86	1.10
Kakoli int.	Kuril Bishaw Road Int	4041	14	9	3.46	2.23
Kuril Bishaw Road Int	Airport int.	3574	7	9	1.96	2.52
Airport int.	Abdullahpur	3628	13	14	3.58	3.86
Shabagh	**Abdullahpur**	**18212**	**71.00**	**67.00**	**3.90**	**3.68**

Mirpur road

From	To	Length (M)	Access Road		Access per KM	
			East side	West Side	East side	West Side
Newmarket	Kalabagan Over bridge	1879	17	18	9.05	9.58
Kalabagan Over bridge	Manik mia Avenue	1230	10	9	8.13	7.32
Manik mia Avenue	Shamoli Over bridge	2025	13	17	6.42	8.40
Shamoli Over bridge	Technical More	1655	13	12	7.85	7.25
Technical More	Mirpur Bridge	1719	14	14	8.14	8.14
Newmarket	**Mirpur Bridge**	8508	67.00	70.00	7.87	8.23

Rokeya sharani

From	To	Length (M)	Access Road		Access per KM	
			East side	West Side	East side	West Side
Agargaon road	Mirpur 10 RA	3579	20	17	5.59	4.75
Kathal bagan	Agargaon road	2060	8	8	3.88	3.88
Kathal bagan	**Mirpur 10 RA**	5639	28	25	4.97	4.43

Source: Field Survey, 2006-2008

From the Table 7.8, it is found that in DIT, Mirpur road and Rokeya sharan almost one access road per 100 meter in each direction and in Airport road difference between two access roads is 200 meter. All of the access are directly connect with the main road directly. Besides this access road there are huge opening on the main road by which adjacent abating property are connected frequently.

For the lack of proper pre- positioning of access, the owner who has road adjacent plot on the side of road, constructs building without considering the condition of the communities which are behind that. At this condition, for the accessibility of the community people who are generally behind the road adjacent plot, made connection with the main road haphazardly particularly with zigzag pattern on the donated land. So, access becomes multi directional, thin and less productive. As for example Pantha Path whish is constructed few years ago. If at the time of provide alignment of that road also show the position and total number of access then road side building position would be planned and proper place, Access would be straight, sufficient width and more productive, excessive access could be controlled. Then planned community could be buildup. So at the time of providing of alignment of a main road, total number of access will be fixed, their position will be identified and additional access besides this must be controlled properly.

7.2.7 Less Productive Intersections

As described earlier, around 90 percent major intersections phases are equal to its approaches in Dhaka city and for the causes of various phases at intersection, the approach road capacity is drastically reduced as well as reduce the intersection productivity for the loses of operational time i.e. the each approach road loses their capacity ¾ times and 2/3 times in an 4 phases every X-

junctions and 3 phases T-junctions respectively. Besides, this also always reduces intersection productivity. Again, there is no practice to provide junction clearways that severely inhibits the performance of the intersections. From the field observation as well as practical experience, the performance of intersections are also gradually deteriorating and becoming worse due to various reasons like high influx of non-motorized vehicles, especially rickshaws, minimum turning provisions, indiscriminate pedestrian crossing, inefficient signal control, absence of appropriate channelization devices, roadside landuse pattern, frequent stopping or parking of public transport, especially buses, tempos and rickshaws, Taxi/Tempo/Rickshaw etc stand on the junction clearway, poor enforcement of law etc. It is also observed that, traffic signal pole are often placed too far back from the intersection, forcing the traffic to move beyond the poles to access traffic on the intersection. Due to acute lack of enforcement on illegal stopping and parking at and around intersections, a complete break down of lane discipline and overall traffic flow situation occurs, mostly out of control of the traffic police men on duty. Besides, inappropriate road sides landuse activities, corner point development not only further decreasing the capacity of the intersection but also deteriorating the future improvement options.

7.2.8 Low Space on Road for Vehicles

According to daily star report Bangladesh Road Transport Authority (BRTA) say the total number of motorized vehicles in the city now stands at a staggering 1.05 million (29-7-08). From the vehicle register database of BRTA it is found that in Dhaka city there are 4,12,540 registered vehicles excluding rickshaw in 2006. There is no exact statistics in DCC about the number of rickshaw. One says that the registered rickshaw is about 80 thousands but it is argued that almost 0.4 million rickshaws are operating in Dhaka Metropolitan city.

The length of roads, pavement areas and road areas in considering all roads and accessible roads separately are available in the city for the case of entire, 70 percent and 50 percent registered motorized vehicles on road are provided in the Table 7.9.

From this Table, it is found that there are only 5.33 meters of road is available if all the registered motorized vehicles are coming on road at a time and if at least 50 percent of vehicles come into the road then they will get only 10.66 meters of road. In the case of accessible road, these length only 4.86 and 9.72 meters respectively and this are exactly operational. In terms of pavement space, the available areas are 17.9 sq. m, 25.57 sq.m and 35.8 sq. m. for the case of all, 70 percent and 50 percent on road registered motorized vehicles. That is, if it is consider that 50 percent of registered vehicles are non-operational or out of Dhaka or off street parking and other 50 percent of vehicles on road, then they will get only 9.72 meter road length and 35.8 sq.m pavement area on the city road network (Table 7.9). Where as only for resting situation at least one an average 6 to 7 meter road length and 12-18 sq. m. roads space is required (Kadiyali, 07) and for free flow condition there will required more length and space. In this situation, congestion is must and which is a real fact in the on the road of city.

Table 7.9: The Length of Roads, Pavement Areas and Road Areas are Available for on Road Motorized Vehicles

All Road				Accessible Road			
Vehicle	**Length per veh (m)**	**Pavement Area per vehicle (sq. m)**	**Road area Per Veh (sq. m.)**	**Vehicle**	**Length per veh (m)**	**Pavement Area per vehicle (sq. m)**	**Road area Per Veh (sq. m.)**
AL Vehcie	5.33	21.44	29.31	All Vehicle	4.86	17.90	25.50
30% less Vehicle	7.62	30.63	41.87	30% less Vehicle	6.95	25.57	36.43
50% less Vehicle	10.67	42.88	58.62	50% less Vehicle	9.72	35.79	51.00

Source: RMMS, BRTA, 2008

On the other hand, every month around 3,000 new vehicles hit the road contributing to increasing burden on road and severe traffic congestion. This is also badly hampering the average speed as well as traffic operational condition of the vehicles.

7.2.9 Inconsistency of Road Width

The roadway capacity of the major roads of Dhaka city is further deteriorating for the inconsistency of road width. The width of the road suddenly reduced in many segment of the road of the major road. Indeed, there are so many straight segment of the road where land number or width of roads is not uniform for the causes of road side development like, Sobhanbag, Mirpur road; Nabisco to Mohakhali bus terminal, Shahid Tajuddin Ahmed Sharani etc. As discussed earlier in Chapter 5 as well as Chapter 6, the road side is highly built up and there has not minimum space to wide the road as well as to develop wider walkway without major demolishing. Therefore, it can also treated as a sustain deficiency in the present condition of road network of Dhaka city.

7.2.10 Further Deterioration of Roadway Productivity Due to

- Allowing development at junction corner
- Road side market development by DCC and Rajuk – which could be used for widening of road by providing frontage road, parking, bus lay-by wide footpath, landscaping etc.
- Allowing mixed landuse at Dhanmondi R/A and Commercial development along arterial road
- Changing functional definition of road from link road to access road (Panthapath)
- Construction of Mohakhali Flyover

7.3 OPERATIONAL DEFICIENCIES OF THE CITY ROAD

As described in methodology in Chapter 3, in this study to observe the operational deficiencies data has been collected from the field survey, questionnaire survey, road inventory survey, observational study and previous study reports. Finally, data has been analyzed considering different issues viz. non-motorized issue, pedestrian issue, mass transit issue, BRT issue etc. Short descriptions on the findings of these analyses are provided in below:

7.3.1 Mixed Operation in Major Roads

Road network of Dhaka city is characterized by mix traffic system. All types of vehicles, both motorized and non-motorized vehicles are in operation on each and every road, except some NMT restricted routes. Where, all types of vehicles are played on the road, majority of road spaces occupied by rickshaw as described in Article 4.6. Because of the presence of non-motorized vehicles, travel speed is significantly reduced for motorized vehicles and a huge congestion occurred. To realize the facts comparative picture with and without NMT of Azimpur to Technical route (Mirpur Road) are shown below.

Photograph 7.1: New Market Road with Rickshaw and without Rickshaw

Even where non-motorized vehicles are restricted, the majority of road space is occupied by three wheeler vehicles for the lack of alternative whereas alternative is the fundamental pre-requisite to remove or ban any facility. Without any alternative, it could not be sustainable. Rickshaw was the dominant mode in the Mirpur road but it is banned without any alternative results opening space is occupied by motorized three wheeler.

On the other hand, a capital city contains two types of traffic: local and through and they will be segregated in separate routes. But in Dhaka city, both the traffic moves in same way sharing the inter city road. There are no alternative routes for through traffic. In the strategies transport study, a plan has been provided on the name of NMT free arterial network- phased implementation plan and in the revised plan there has targets times for specific route. But, unfortunately more than two years have passed from the last target time (time was 31-07-06 and specific route North-south, English road and Chittagong AV.) but all are in paper until now except Mirpur road.

The Old Dhaka roads are normally suitable for cycle rickshaws, pushcarts, cycle vans, auto-rickshaws, small pick-up vans, small and light trucks, and mini or micro buses. Only a few roads can take large trucks and buses. Almost no road in old Dhaka has any footpath. There is no modal restriction by street; the only restriction is enforced by road width. Streets offer an extremely mixed modal pattern of transport. Except in the narrowest lanes, where no motorized vehicle can enter, pedestrians have least honored right of way in spite of their high concentration on the streets. At present, rickshaws poses dominate mode of the roads which one of the major weakness of the entire transport operational system particularly for the through arterial road. This problem is now become a major concern issue and becomes an irreversible problem for the causes of uninhibited landuse and transport planning and uncontrolled development.

7.3.2 Excessive Dependency on Non-Motorized Transport

The majority of transport in Dhaka city is non-motorized. It accounts for over half of all vehicle trips within Dhaka city. Dhaka Urban Transport Project showed walking as the predominant mode with a share of 62 percent of total person trips. This is followed by rickshaw (13.3%), bus (10.3%), auto rickshaw (5.8%), and car (4%). In consideration of person trips by vehicle, rickshaw takes the highest share, accounting for 35 percent followed by bus (21%), auto rickshaw (1.5%), and car (10.5%) (JBIC, 2000).

The majority of NMT is provided by cycle-rickshaws. There are no exact statistics of the number of rickshaw in the Dhaka city. It is estimated that about 350,000 and 500,000 rickshaws are operating in Dhaka City Corporation area and Dhaka Metropolitan area respectively. Although officially, the government would like to phase the rickshaws out, and a ceiling had been set on rickshaw licenses (currently 79,000, plus 8,000 rickshaw van licenses). In practice, the ceiling had no impact on rickshaw numbers. But it has caused much hardship for rickshaw operators, and also deprived the City Corporation of a great deal of potential revenue. The cycle-rickshaw is widely used because it provides a service which buses and tempos (10-12 Seater auto-rickshaws) cannot easily provide. It serves areas where bus services are insufficient or absent, and caters particularly to the needs of women and children, and people carrying small loads.

A huge number of people are employed in the rickshaw sector. From the field survey it is found that most of the rickshaws (about 60%) are operated by two drivers, who change shifts at around 2 pm. If the average employment is 1.6 drivers per rickshaw, then overall there could be 800,000 rickshaw drivers employed in the Dhaka city area, plus another 50-70,000 people employed in ancillary occupations (owners, repairers, shopkeepers selling spare parts, and so on). Hence roughly 20% of the city’s population are employed in providing rickshaw services, and a further one and a half million people in Dhaka and in the rural areas depend on these people’s earnings.

The cycle-rickshaw is cheaper than the auto-rickshaw, but considerably more expensive than buses and Taxi cab. According to the estimation, the relative economic costs per passenger-kilometre in 2008 were: rickshaw Tk. 10; auto-rickshaw Tk. 5; Taxi cab 12 Tk.; minibus Tk. 1.25; large bus Tk. 0.80. However, cars and jeeps, at Tk. 5.5 to Tk. 6.8 per passenger-kilometre, are far more expensive than any of these modes.

A 16-hour traffic count by the Dhaka Urban Transport Project in 1996 indicated that buses and tempos carried 65% of all passengers, but took up only 18% of the road space. Rickshaws occupied 40% of the road space to carry 15% of the passengers compared to 18% of the space occupied by auto-rickshaw to carry the same percentage of passengers. According to the estimation of DITS 1994, road space occupied by rickshaws is 73%, and by cars, buses and tempo is 19.7%, 4.4%, and 0.4% respectively. In this study it is observed that in the old Dhaka like Lalbagh, Chakbazar, almost 80 percent of the road space occupied by rickshaw where as in the major arterial roads where rickshaw is prohibited, around 80 percent of the road spaces are occupied by private car and three wheelers. This analysis indicates clearly that rickshaws contribution a great deal to traffic disorder in rickshaw permitting route, but do not pay even a fraction of the road user's charges.

From the questionnaire survey which has been described in the articles 4.7 it is evaluated that rickshaw puller come in Dhaka city from almost all over the country due to in particular poverty. A significant number of rickshaw puller (38 percent among the respondent) come in the capital city by loosing their job or work in their local areas. Almost all of the rickshaw puller lives in fringe areas where social status and living conditions as well as living facilities are very low because of their poor income (32 percent replied that their daily income per day 251 to 300 TK, followed by 28 percent 201 to 250 TK, 28 percent 301 to 350 TK and 12 percent 100 to 200 TK) as well as ill planned development and maintenance. From this survey it is evaluated that they choose this profession because of extreme poverty (26%), easy and income is comparatively better (22), lack of alternative job (18%), there has not required any qualification, there has not any restriction (12%). Even they do not require any educational background, training, certificate and original numbered rickshaw. Almost 62 percent agreed that the number of their rickshaw is duplicate and actually is would be more than 80 percent. Even, in the cantonment area where enforcement of legislation as well as traffic rules and regulation is very strict, almost 20 percent rickshaw puller among the respondent agreed that the number of their rickshaw is duplicate. Almost 92 percent have not any formal training. Results uncountable number of rickshaw is operating in the Dhaka's road by the poor, uneducated and frustrated rickshaw puller who has not any training, knowledge on traffic rules and regulations and understanding on traffic signs and markings.

Now it is a great shout that rickshaw should be eliminated or restricted from Dhaka's road. Obviously, to improve the operational and functional condition of the road network, it could be required. But it is reality that which has been demonstrated also from the questionnaire survey and road network quality and quantity analysis, the elimination or controlling or proper management of this rickshaw in the city road is almost impossible at this stage because of the following reasons:

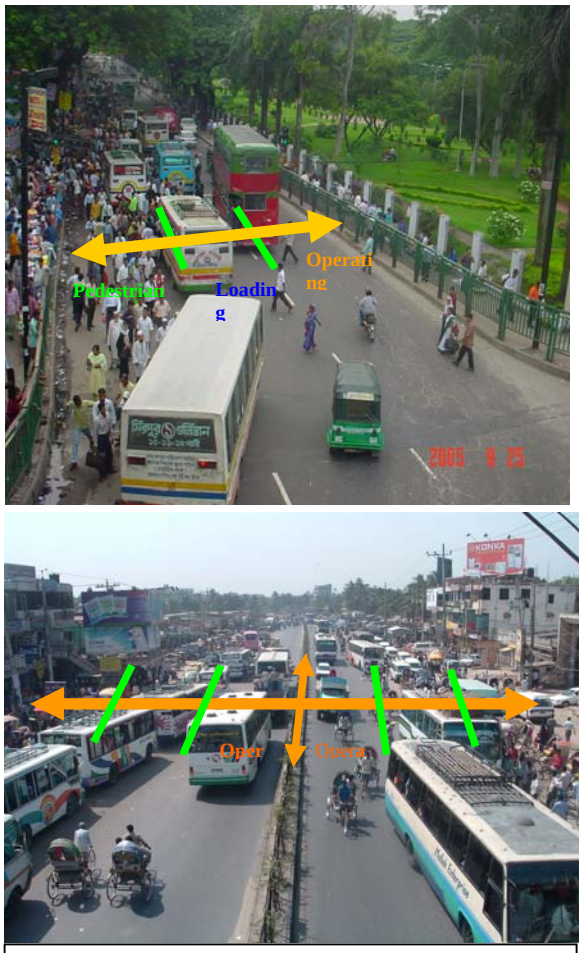
- Huge poverty: Almost 800,000 family depends on a rickshaw. If they become jobless, it will create extra problem on the society.
- Huge rickshaw puller: The number of rickshaw puller is almost 1.6 times more than that of rickshaw.
- Lack of sufficient job facility in the local market.
- Uneducated people: More than 90 percent of the rickshaw puller have not any understanding of the traffic signs and marking. Providing training is also impossible of these huge numbers of uneducated groups.

- Huge demand, as about 90 percent of its trips are within 4 km in Dhaka city and it is more comfortable particularly for the children and women and it provide door to door service.
- Public transport is not quite good for the causes of various deficiencies.
- Finally, the road network pattern and the condition of the roads in terms of road width and alignment of the city and many local areas landuse and road network pattern are not fully supportive for the other mode of transport like motorized transport. Indeed, the road pattern makes it very difficult to introduce large public transport in many parts of the city. Almost 40 percent of the road in Dhaka city is accessible only for rickshaw.

So, the city will have to sustain with this huge number of unregulated, uncontrolled, unguided rickshaw. This also poses a serious inherent weakness of the city.

7.3.3 Road and Road Side Hazards

Hazards associated with the road and roadside landuse pattern are one of the major inherent operational problems of the city transportation system. From the observation, it is found that almost two third lanes of most of the major roads in Dhaka city are not properly used for these hazards. Several steps have been taken to eliminate this hazards in different times by the government as well as local communities but all of them are go in vain after a few day. Indeed, army supported caretaker government is failed to enforce by executive order under the emergency.



Photograph 7.2: One-third of the Road Spaces are Functional on Different Road Segments

Presence of dustbin, construction materials, commercial materials etc. on roads is very common in Dhaka city. This significantly reduces the effective road width for traffic use. Road spaces are also occupied by hawkers, and retailer traders. In many places, huge pedestrian movement, random crossing, walking reduce the effective width of road and making the road unsafe for vehicles and users both. Again, illegal on-street parking, loading and unloading in inappropriate place also reduces road spaces and hinders smooth flow of traffic and occupy almost two-third of the operational space of the major road (Photograph 7.2). Now question is the possibility of the removing of the roadside hazards. As discussed in several times that in Dhaka city there are very lacks of road infrastructure as well as road furniture and it becomes very difficult to overcome these shortcomings at present condition.

7.3.4 Cutting and Digging of the Roads by Different Agencies

It is a common practice that a busy road is narrowed to half on cutting and digging by different agencies like T&T, WASA, Titas Gas, and DESA for utility services, causing a horrible situation of traffic congestion for months together. The sufferings of the commuters worsened as the road digging works of different utility service providers in different parts of the city interrupted smooth

vehicular movement. The situation aggravates during the rainy season. Trenches lie open for a couple of months and the road remains unprepared for the next few months.

With the utility service providers, at present mobile phone companies added with this activities and it seems that the utility service providers and mobile phone companies apparently competing with each other. In 2007, Dhaka City Corporation (DCC) allowed service providers and mobile phone operators to cut 74,000 square metres of road. Bangla Link cut 2,694 square metre footpath and 151 square metre road from Mohakhali Kaderia Tower to Banani rail crossing and 8,680 square metre road from Mirpur- 1 to Bhasantek, City Cell cut 3,838 square metre road from PacificTower to Kuril Biswa Road, Aktel 740 square metre from Mohakhali Brac Centre to Khwaza Tower, Grameen Phone 1,784 square metre from Mohakhali Khwaza Tower to Gulshan Shooting Club and 921 square metre from Mirpur Gol Chokkor to Grameen Bank building to get optical fiber connection. Service providers also road cut for various tasks at various points in Dhanmondi, Moghbazar and Gopibagh areas. Sidewalks of the roads are also being cut near Karwan Bazar market, Dhanmondi Boys' School and in some other areas. In the opinion survey, many of the urban experts argued that this situation to lack of coordination among the DCC, Dhaka Wasa, Rajuk and other organisations concerned.

Photograph 7.3: Cutting and Digging of the Roads and Structural Integrity

Earlier in 2003, the DCC had framed guidelines for road cutting and repair but to no effect. The guidelines said there should be no road cutting during June to October. Besides, there must be signboards at the sites mentioning the timeframe of digging and repairing, and earth must be removed within 24 hours of digging so as not to block the way for vehicles and pedestrians, it said. But in blatant violation of the guidelines, mounds of earth are found on roads at the digging sites, and apart from a few red flags, nothing is there giving information about the time limit for the task. Despite the establishment of a One Stop Cell to facilitate road cutting by utility service providers and timely repair of those, there has been no improvement in the situation. People of affected areas allege unplanned cutting and delayed repair. Photograph 7.3 shows a clear view of the cutting and digging of the roads and failure of structural integrity. Besides this, for the causes of cutting and digging reduce structural integrity of road structure results road fracture or damage of road structure, reduce the life time of road, increase road side friction and reduces effective width of road/capacity due to low riding quality and affect wiring/detectors of signals. Because of the lack of additional area for the utility service in the road side and uncoordinated different institutional activities, it becomes very difficult to control or remove this bad practice.

7.3.5 Parking Facility in the City

Insufficient parking facilities at shopping centers as well as the commercial areas have remarkable impact on traffic flow in adjacent roadways. Illegal on-street parking reduces at least one lane to its road width. In case of the roadway section in front of the Gausia Market the roadway gets almost closed due to the parked vehicles and rickshaws. In Motijheel commercial area only 26.06% of the buildings have parking facilities (Rahman 2001). The regulations pertaining to parking are DMP 1976 Ordinance, The Motor Vehicle Ordinance 1983 (Amended 1990), and Dhaka Municipal Corporation Ordinance 1983 etc. Since 1984, Building Code Regulations provided by RAJUK, have required buildings to allocate 20% of ground area to parking for each

story built. Despite the presence of multiple regulations on paper, the net effect has been minimal. Traditionally, the regulations have not been enforced.

Though, in Dhaka Metropolitan city according to Building Code Regulations provided by RAJUK only basement base parking is mandatory, almost 12 percent of tall building (7+ floor) has not any parking facility. Figure 7.5 shows the percent of tall building in different thana where has not any parking facility. From this Figure it is evaluated that old Dhaka like Kotwali and Lalbag thanas' almost 67 percent and 54 percent tall building have not any parking lots or facilities. Even, in New Dhaka particularly Mohammadpur and Mirpur where most of the areas are pre-planned, almost one forth tall building has not any parking facilities (Figure 7.2).

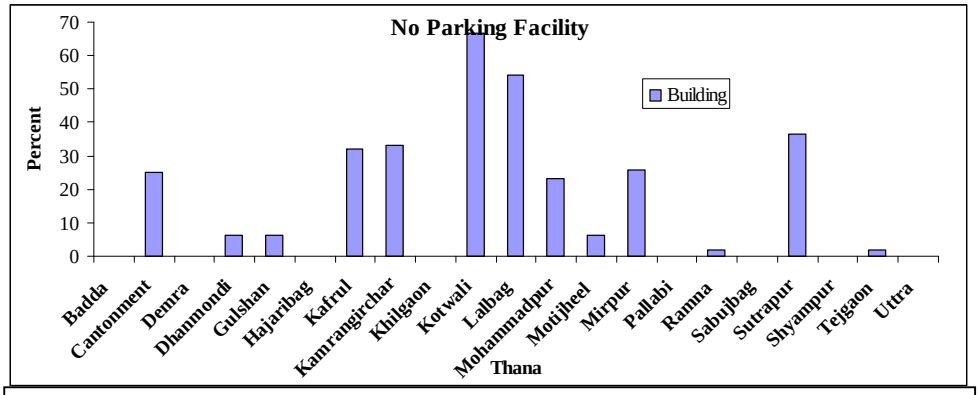


Figure 7.2: Percent of no Parking Facility tall Building in Different Thanas *(Source: STP Survey, 2004)*

Besides this, from the field observation and review of various survey reports it is found that the buildings which have underground or ground parking facilities, most of the space are used for another purpose not for parking like storage room, garage, rent for shop or hawkers, even bed room for servants etc. particularly in the busy road side multistoried market. Parking for public bus also become a great problem all over the city. For the lack of sufficient parking space, so many buses are parked on the road like mirpur, abdullapur, azimpur, gulistan etc. results huge demandable and crisis road space becomes malfunctioned. For the lack of open space, this problem is turning also an increasing and decisive weakness of the city.

7.3.5.1 Parking at Motijheel area

Motijheel is Dhaka's main commercial area. It was laid out in the 1950's on agricultural land to the north of the old city. Today it lies at the center of modern Dhaka and is the location for head offices of the main banks and insurance companies as well as many nationalized sector corporations and private companies.

Since the 1980's, Motijheel's main roads have become heavily congested during peak hours. Vehicles are parked all along them, and are often double and triple-parked. Traffic jams are quire common, especially on the secondary roads. The problem is compounded because much of Motijheel's traffic is through traffic. The lack of east-west roads of Dhaka, and congestion on existing links such as Gulistan/Fulbaria, means that a lot of traffic approaching Dhaka from Chittagong side has to pass through Motijheel. Hence the parking problem is not simply local in effect, but strategic too. This is surprising in view of the 1985 committee's recommendation that no buses should be parked in the entire Motijheel C/A. It is also present a problem because these buses take up a lot of valuable road space, and they represent a serious underutilization of a scarce and valuable resource.

From the field observation it is found that less than half of the existing off-street parking space (in car parks, basement parks, building forecourts and vacant plots) is being illegally occupied for different activities by different organization or grabbers. In general, the basement car parks appear to be rather underutilized and that is almost half of the available space.

Photograph 7.4: On Street Parking in Motijheel Area

- In this condition, to overcome the parking problem in the CBD Motijheel area, a 37 storied parking cum commercial building named City centre is under constructed.

7.3.5.2 Location of the proposed parking cum complex building

- The proposed city center building is situated exactly in front of an existing use T-junction
- No multi-stored car park exit or entrance should be within at least 50m of a street junction to avoid possibility of blocking entry and exit of the car park. Since, the proposed site is situated exactly on a T-junction it may suffer from this type of problem.
- From the field traffic survey it is observed that most of the time, particularly both at morning and evening peak hours, the junction become congested due to heavy traffic flow from all approaches of the junction.
- During field visit it is also observed that the queue built-up at the Dainik-bangla more in the afternoon peak hour becomes so long that it extends up to the proposed construction site.
- In general the commuter/office-staff that stay for long time mainly use the multistoried parking facility. As such, it is expected that the potential users of the facility will arrive and depart the parking lot over a short period of time and in consequence it may cause adverse effect on the main road traffic flow operation.
- Moreover, active use of two existing side roads situated besides the proposed city center building will make the junction layout very complicated and signal operation difficult.

7.3.5.3 Expected impact of the proposed development

- In consideration of expected commercial usages of the proposed 37-storied complex building, it is obvious that the building will attract a huge number of both vehicular and pedestrian trips in front its main entrance.
- Since the building is situated exactly on the busy t-junction, it is expected that even if enough frontage space is provided, though such provision could not be found in the working drawing, in front of the building for passenger pick and drop purposes-it will severely affect the junction operation. This will in turn act as a potential bottleneck for traffic flow along the Bangladesh bank and dainik-bangla-more roadway segment.
- Before construction of the building, the proposed area could easily provide a total 80 numbers of parking spaces including 16 numbers on-street stalls in front of the plot and after construction, the multi-stored parking lot will provide a total of 415 number parking spaces.
- After construction, the complex building itself will act as a parking generator and in consideration of expected commercial usages of the building and corresponding floor space, its parking demand is conservatively estimated as 500 numbers.

- As such, it is clearly evident that the construction of the proposed multistoried building would not solve the existing chronic parking problem of motijheel c/a, instead it will induce extra parking demand and result in an adverse effect on junction operation.

7.3.6 Parking Facilities for Trucks in the City

In Dhaka metropolitan city, thousands of trucks entering the city every day have not any designated modern, equipped truck terminal or parking facility with minimum conveniences for operators, users and owners. There are only two designated space to use as truck terminals at Doyaganj on the road to eastern and northwestern parts of the country and Amin Bazar, linking up the northern, southern and southwestern regions authorized by the Dhaka City Corporation (DCC), which can accommodate 750 trucks altogether, but according to the Bangladesh Road Transport Authority (BRTA), the number of trucks plying in and out of the city could be as a many as 10,000 every day. As a result more or less thirteen unauthorized truck terminal developed in the city area like Pagla, English road armanitola, Tongi, Mohammadpur, Saidabad, Tejgaon, Dolaikhal, Keranigonj container port, Kamalapur Inland Container Port, Wise-ghat, Chankhar Pool and Siddirgonj.

The BRTA data shows that there were 22,605 trucks registered within the city until 2004 and the number has grown fast ever since. The problem is not only trucks blocking the entrances of the city, it is even worse within the city area where it is forbidden for the heavy vehicles to ply between 8am and 8pm. Thousands of trucks queuing up at the three entrances to enter the city in the evening hours are regularly causing heavy traffic jams, disrupting inter-district communications. With the number of trucks rapidly growing, the problem is set to worsen throughout the city and its entrances if the authorities do not create proper parking spaces for these heavy goods vehicles bringing in arrays of daily commodities to keep the city dwellers fed and supplied with various other items.

According to the DCC official, under the DUTP they tried to establish a truck terminal on a 5-acre area of Bangladesh Railway, but it could not be done because of ownership dispute between the railway and the city corporation. The piece of land is being used illegally for nearly 50 years by the encroachers. As the corporation has no ownership on the land, it could not develop the area. So, it becomes almost impossible to develop a well organized truck terminal.

It is mentioned earlier that Earshad Government has developed three bus terminals but that government did not develop any designated truck terminal. Development of truck terminal was the foremost responsibility of the following government. Unfortunately, three governments have been passed and two comprehensive transport improvement projects have been completed but no governments have not been developed any truck terminal in the city area or entrance of the city.

7.4 PEDESTRIAN FACILITIES IN DHAKA CITY

Pedestrians clearly form by far the single largest group of road users in terms of total catered number of trips in urban areas of Bangladesh like Dhaka. According to the DITS report, it can be seen that over 60 percent of all link trips in Dhaka involve walking alone, followed by rickshaws 13 percent. According to the recent study STP, pedestrian is by far the highest number of road users in Dhaka city. They estimated around 37 percent of the trips are pedestrian alone. This is particularly prevalent (about 65 percent) for short trips up to one mile. Walking as primary mode of travel is dominant in all age groups and income classes. It is most prevalent for low income groups, nearly 80 percent.

This characteristic will continue to grow in the future as a large part of the urban population would hardly afford any kind of motorised or non-motorised transport of their own. Indeed

walking appears to be a major contributor to a sustainable transport strategy. Yet pedestrian can still claim to be our most forgotten and neglected road user group. It is the motorist not pedestrian who normally receives the attention and greater share of priority. Pedestrians need protection in the form of facilities by ensuring their safety and convenience. But, unfortunately there is huge lack of pedestrian facilities and these limited available facilities could not used properly for the causes of ill maintenance and management. A summery of different types of pedestrian facilities available in Dhaka city is presented below:

7.4.1 Footpaths

Footpath is major and crucial component of pedestrian walking. Roadside facilities for pedestrian include footpath fencing, guardrails etc. The DITS surveyed approximately 460 kilometers of road that included 167 kilometers of footpath. The survey further determined that there are 2231 kilometers of paved footpath in Dhaka Metropolitan City.

7.4.2 Others Facilities

Others facility which are available in the city like Zebra Crossings, Signalized Pedestrian Crossings, Guard Rails, Overpasses, and Underpasses etc. are shown below in Table 7.10.

Table 7.10: Summaries of Different Types of Pedestrian Crossing Facilities Available in Dhaka City

Serial No.	Type of Pedestrian Facility	Quantity
1.	Walkways	167 km based on DITS report. According to DCC source, at present 210 km new footpath is newly constructed. According to DCC, the city has 388 km of footpaths.
2.	Zebra Crossings	No statistics is found from literature and DDC
3.	Signalized Pedestrian Crossings	Most of the newly geometrically improved intersections are with this facility
4.	Guard Rails	No statistics is found.
5.	Overpasses	20 nos. concrete footbridges and 29 steel footbridges (In very recent period few steel bridge also constructed by DCC like Shabagh, Paribagh, Bangla motor, Zia colony)
6.	Underpasses	3 nos. in the city

Source: DITS,1994 & DCC profile, 2006

7.4.3 Limitation and Deficiency of Existing Pedestrian Facilities in Dhaka City

In the recent years, it is seen that some growing awareness of the need for adequate pedestrian facilities. Dhaka City Corporation has been improving the condition of footpaths, delineating zebra crossings, installing channelized islands at wide junctions, constructing overpasses and underpasses etc. These improvements of pedestrian facilities are not sufficient for the 13 million

Photograph 7.5: Market on Footpath

people's mega city Dhaka. Besides these, there is so much deficiency in the existing facilities of the city which is described below:

7.4.3.1 Inadequate and Indiscriminate Use of Footpath

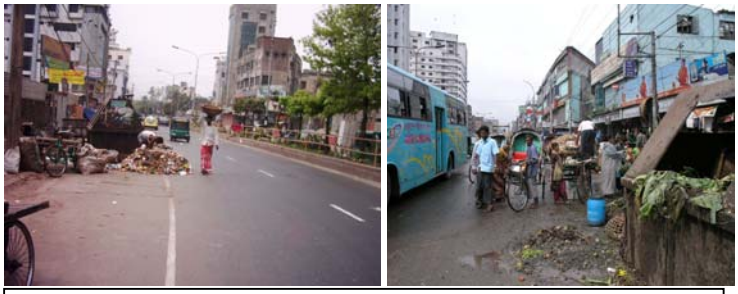
There are many kilometers of roads without walkway facility in Dhaka city. Moreover, there are a lot of problems relating use of footpaths by the pedestrians. The most serious problem is the retailer traders and hawker problem. Most of the Footpaths in commercial areas are encroached by them. A survey conducted under the Strategic Transport Planning (STP) before the latest eviction drives revealed that about 40 percent of the footpaths are occupied by hawkers and with construction materials. From this study it is also revealed that series of hawkers market are on the footpath and in many areas they are serially occupied 2 to 3 kilometers footpath both side and single side like newmarket area, Fulbaria, Merun Badda, Jatrabari, Kazipara etc. For this type of problem, pedestrians are forced to walk along the road rather than the footpath creating serious safety hazards (Photograph 7.5).

Other causes of reduction of effective width of footpath are found as building materials on road and footpath, rickshaw stands, rent-a-car service parking, garages etc. Encroachment of footpath by building materials is a common picture in almost all over the city. Another problem seen in the city, which is created, by the homeless people as well as daily migrated laborer living on the footpath. This number is increasing rapidly day by day. There are also many big size dustbins on the streets close to the footpath in many areas of the Dhaka city. These dustbins cause problems to pedestrians when the garbage stored inside these overflow on the streets and footpaths (Photograph 7.7).

Photograph 7.6: Hazards by Business and Construction Activities

At many areas of the city, people use the footpaths for toilet purpose creating problems in walking. This problem eventually forces the pedestrians to move on the roads rather than on the footpaths. But no regulatory measure is seen at all. In the streets of the Dhaka city, another serious threat to the safety of the pedestrian is posed by the 'traps of death'. This refers to the open manholes on the roadways as well as on the footways. So, what is not on footpath? Footpath is for all, only not for pedestrian. Now, footpath is used of all purpose except walking.

Besides the illegal encroachment, occupation and use, there are huge geometric and structural problems of the existing footpath. Many of the places, foot path is not sufficient wide, frequent access cutting the footpath, serious of big opening of drain on foot path and finally lack of maintenance of chevron or other using materials damages the geometry of the foot



Photograph 7.7: Illegal Occupation by Dustbin on Footpath

path and makes unusable (Photograph 7.8).

Dhaka City Corporation (DCC) and Dhaka Metropolitan Police (DMP) are responsible for maintaining footpaths and dealing with hawkers but they failed to keep footpaths clear for smooth movement of pedestrians. The government evicted hawkers from footpaths and rehabilitated them at some specific places but most of them have returned and occupied footpaths and roads again. Now questions, why the footpath are illegally used? Why dustbin or dumping materials are on road? What is reason behind this? Has they are any solution?

Lack of planning and uncontrolled growth of the city land and population. The city authority develop road network considering only vehicle as a travel mode. Walking is a travel mode which are totally ignored. Even, newly developed strategic transport did not consider walking as a mode of travel in their trip distribution model. Where as, according to DITS report, 62 percent of trips are walking alone. So, city road network is developed is only for vehicle not for pedestrian results huge lack of pedestrian facilities particularly footpath. Uncontrolled and unplanned population development particularly migration of poor people is also another region for the encroachment of footpath. From the field observation, it is revealed that one of the major cause of dustbin or dumping materials are on road is insufficient space in the locality for dumping of the rubbish. Authorities develop land only for residential or commercial purpose without providing sufficient space for utility services like daily necessaries, shop, waste disposal facilities etc. results all most all of the dustbin are on the effective road. So, planning which is the fundamental of a efficient and sustainable city, totally mishmash in the Dhaka city results an unhealthy, sick, detrimental city which is not fit for modern, healthy and vigorous society.

Photograph 7.8: Geometric Fault of Footpath

The previous Caretaker Government rehabilitated the evicted hawkers at two holiday markets and 20 hawkers' markets at some specific spots but the plan virtually failed to achieve its goal of easing traffic congestion in the city. The little number of markets and odd location of holiday and hawkers' markets could not prevent the hawkers from returning to the footpaths taking the advantage of little monitoring by the DCC and DMP.

Faulty geometric design or planning of the footpath is also a major problem of the existing insufficient footpath. For the cusses of wrong design or plan, most of the footpath are narrow, ups and down for cutting at abating access, damage of surface, excessive height. Open drain or manhole is become a death trap on footpath for the causes of yield maintenance, monitoring and technological intervention. Theft problem is one of the major problem is the maintenance of road furniture. So, innovative low cost measures should be provided.

Photograph 7.9: Improper Use of Zebra Crossing

7.4.3.2 Poor Zebra Crossings

In the metropolitan Dhaka city, many zebra crossings are found on the roadways but the physical condition and visibility of them are very poor. In most of the zebra crossings, the pavement marking is not visible enough for the attraction of attentiveness of the motor drivers to make the pedestrian crossing safer. Maintenance works are done periodically but the frequency is not suited with the deterioration rate of marking. It is also revealed that for the lack of crossing facilities at link, pedestrians cross road haphazardly at the link of the road. This attitude of the pedestrian are also induced from the lack of planning of the transport planner.

7.4.3.3 Uncontrolled Junction

Due to the high congestion on roads the motor drivers have a tendency to cross the junctions speedily. At such moments, some of the late coming vehicles attempt to beat the road signal. Even immediate after the starting time some vehicles practice this approach. But at that time, pedestrians get the green light to cross the road. Eventually this condition causes serious safety hazards for the pedestrians.

Photograph 7.10 Uncontrolled Junctions

Another problem in crossing the roads at intersections is created by the motor vehicles. The vehicles do not stop beyond the stop line at intersections. They attempt to go as far as possible in the leg of the intersections and occupy the pavement marking for pedestrian crossing. It is observed that from the field investigation and different survey conducted by this study commensurate with the previous study, these problems poses from the road network planning problems, transport operational planning problem as well huge number of low educated, ignored traffic operators and low enforcement.

7.4.3.4 Problem in Overpass & Underpasses

The overpasses in this city are not also free from problems. Some of the overpasses are encroached by the hawkers. The aesthetic condition of the overpasses is also not good enough. The geometric condition of the foot over bridge is also deficient. Most of the overpasses are in excess height which is highly energy consuming and inefficient (nearly equivalent to two storied building), the slope of the stairs are very steep and are not quite wide to accommodate both way pedestrian simultaneously.

Photograph 7.11: Problem of Foot Over Bridge

Even most of the case there have not sufficient entrance and exist with sufficient wide footpath and guidance with guard rail etc. The philosophy that should be followed are:

- Staircase width should be wide enough to allow both way pedestrian movement simultaneously.
- Staircase slope should not exceed 60 percent, preferably 50 percent

- Footpath width should be adjusted so that at-grade pedestrian flow is not affected.

The underpasses of the city possess serious safety hazards especially at night time. Various unsocial and crime works take place in the underpasses at night time although there are lighting facilities. Generator service is also provided for the time of load shedding. But at many times, it does not work. The study revealed that many of the overpass is not in proper place coupled with discomfort to use for the structural or architectural point of view propagate to be unused or misused of that infrastructure. Interrupted traffic flow that generates from the planning problem as well as low enforcement is also strong cause of this problem that aggravated the problem is such a position from where come out seems very difficult.

7.4.3.5 Lack of Bus Layout on Road Side and Dangerous Alighting and Boarding

There is very few designated place for bus stoppage in roadside of Dhaka city. Most of the bus stop in road side haphazardly with competition attitude and alighting and boarding passenger dangerously. This makes always crowed on roadside and influence pedestrian to move on road. In the present road and roadside condition, it is difficult to provide sufficient facility for alighting, boarding because of there has not sufficient space at first, and secondly it will affect the already problematic walking facility.

7.5 DEFICIENCIES IN EXISTING MASS TRANSIT SYSTEM

Current supply of mass transit is much lower than the actual demand. At present, only 31% of daily trips made by mass transit where as this were only 22% in 1994. Not only the lack of this supply, there are also many other deficiencies in the existing system of mass transit. In this study to evaluate the deficiencies in existing mass transit system, data has been colleted from the field survey and different organizations like BRTA, BRTC and field observation has been made focusing on some particular points. The observed deficiencies have been pointed out in three different views like Road and Roadway Deficiencies, Operational difficulties and users points of view. A short description of the observed deficiencies is in below:

7.5.1 Road and Roadway Deficiencies

According to description in the Chapter 6, the most significant road and road deficiencies which are hindered the mass transit facility in Dhaka city are as follows:

- Limited road space
- Lack of accessible road for four wheeler motorized vehicles
- No road network pattern
- Unorganized and non-integrated road network
- Absence of east-west continuous road
- Lack of continuity of main road
- No alternative road in different corridors

From the observations and the analysis of road data, it can be concluded that the city road network is not a perfect candidate for a well operated mass transit system. These deficiencies results from the fundamental planning problem of the city. The city road network is not developed considering the future implementation of mass transit system. Therefore, it would be very difficult to overcome these problems and provide an organized, efficient and high productive mass transit system in the city.

7.5.2 Absence of Bus Priority Measures

Public transport is currently not given any priority over other vehicle types and road users. Various forms of bus priority ranging from traffic signal priority measures and bus lanes to possibly dedicated bus-ways should be considered for application in Dhaka. There is no bus-only routes or segregated bus lane on roads.

When considering bus priority measures, care should be taken to ensure that measures are devised to improve bus service and travel times rather than being devised to remove obstacles to the flow of other modes of traffic. For example, given the very high flow of buses in Dhaka, bus lanes could be counterproductive and could exacerbate bus congestion if they are poorly designed. As discussed in Article 7.2.6.8, it is extremely difficult to provide bus priority measures in the present road network condition.

Photograph 7.12: Buses Stopping at a Bus Stop to Block the Buses

7.5.3 Lack of Bus Lay on Road

There is very few designated place for bus stoppage in road side of Dhaka city. Most of the bus stop in road side haphazardly with competition attitude and alighting and boarding passenger dangerously. This makes always crowed on road side and influence pedestrian to move on road as well as decreases the effective width of the carriage way. In the present road and road side landuse condition which has been described in Chapter 5, Article 5.8, it is almost impossible to develop or to provide additional space for the construction of bus in most of the area of the city.

7.5.4 Fragmented Ownership

Buses, which are main mass transit system in Dhaka, are operated by government authority and by privately. The BRTC, which operates under immunity from regulation by licensing authorities, owns a total of 306 buses operating on 15 routes in Dhaka. BRTC does not actually operate the buses, but sub-contracts out the operations to private operators. BRTC's financial performance has deteriorated between 2000 and 2003. Revenues have more than doubled; costs have nearly tripled over this period. The loss for the year ending 30 June 2003 was Tk 384,594,000 (USD 6.4 million) excluding depreciation and interest payments. Revenues from all areas rose substantially but costs increased at an even greater rate in the period 2000 to 2003 (STP, 2004).

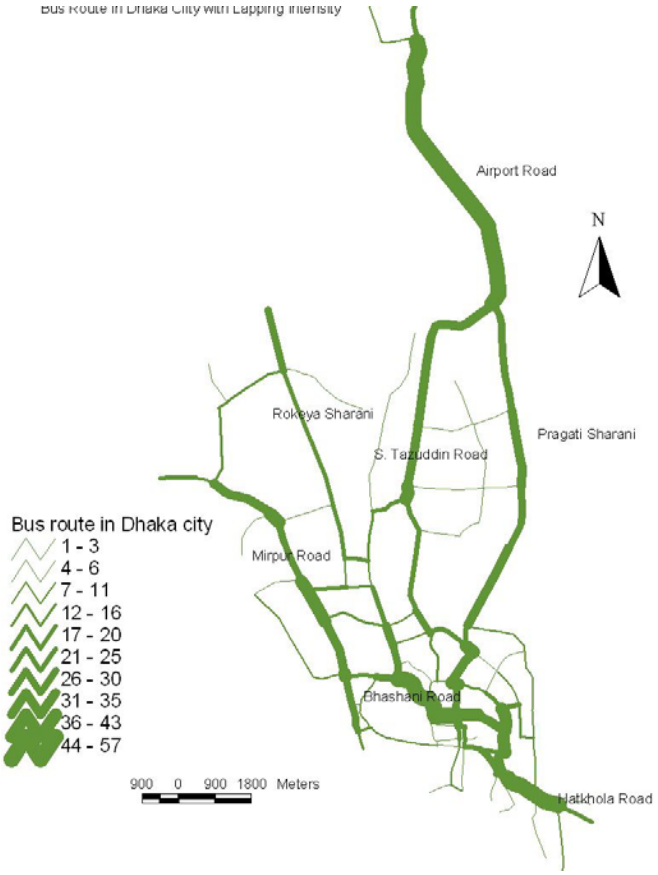
According to the BRTA statistics, there are 149 permitted bus routes in Dhaka city. Among them, 92 bus routes are single company based and other 57 routes are multi-company or individual fragmented ownership based bus service. But, for the overlapping bus route, most of the road of the single company based bus route required to make competition with the other route bus service.

Photograph 7.13: Alighting and Boarding on Road

However, most to the time, single company based bus route performing as an individual fragmented ownership based bus service route. The main problem of privately operated bus services is that buses are owned by a large number of operators. There are around 5000 registered private bus in the Dhaka city and owner of this buses is more than 1200. There are many operators who have only 2 to 3 buses and some private bus operators have 30 or more buses. In many case, there are multi owner of a single bus. Drivers and crew in this category either own the vehicle individually or rent the bus on a daily or monthly basis. They then operate the vehicle at their own revenue risk, requiring enough passengers per day to repay the bus rental fee, cover fuel and basic maintenance costs, and make a profit. For the causes of such fragmented ownership and passenger base payment system, most of the buses are always in a competition and feel competitor to each other. The competition attitude between the bus operators results indiscipline lane changing behavior, risky overtaking, improper stopping for alighting and boarding of passenger, inappropriate speeding as well as huge safety problem particularly for the pedestrian. No employment guarantees or professional management is provided, and the driver and crew handle all fare payment on the bus. From the field experience and discussion with the transport professional and worker, it is revealed that the franchising of bus service under one or two big company by removing the existing buses or companies are extremely difficult in the city. An exercise is doing in the Azimur to Uttra route, but outcome is not in expectable level.

7.5.5 Less Service Area

In order to evaluate the service area of bus facility, bus route map has been illustrated according to the BRTA permissible route, width base road data has been analyzed and field observation has been made to observe the possibility of introduction of bus service in others road. Map 7.4 shows the service area of bus service in Dhaka city. The total road length of the bus operating route is only 120 km. If the buffering area of the route is considered 500 meter (walking distance considering the city local road network situation) in both side of the route then the maximum total service area would be 120 km including overlapping area which is significant particularly in the south part of the city (Appendix F) which is only one-third of the city area. From this Map, it is also found that the southern part of the city, old Dhaka i.e. Lalbagh, Kamrangichar etc.-the most densely part of the city has not any bus service facility. Besides, there has not any bus service facility in the almost all of the fringe areas of the city. Indeed, for the lack of well connectivity between the bus route and the local trip generating areas, the buffer area of the existing bus route is very poor. On the other hand, at the present road network condition particularly the road width and alignment which has been



Map 7.4: Bus Route in Dhaka City (Illustrated by the author)

described in Chapter 6 is quite bad that there has not no more additional road in which public transport particularly bus service could be provided.

7.5.6 Deficient and Improper Place of Bus Terminal

Dhaka is served by three inter-city bus terminals which are conveniently located with respect to the corridors they serve: Saidabad- Southern Corridor, Mohakhali- Northern Corridor, Gabtoly North-Western Corridor. The areas at Gabtoli and Saidabad (3.15 and 4.10 hector) are very limited to comply with existing demand. All terminals are poorly designed with respect to terminal system requirements. Many components of the system are totally absent along with some basic amenities. Utter disorder in using the terminal space, lack of management and indiscipline of drivers and passengers are other reasons for congestion all those inter-city bus terminals. Fulbaria Road is the main terminus for intra-urban buses, which also experiences extreme congestion, mainly induced by buses lying over the whole road haphazardly and absence of terminal facilities.

Moreover, there is an acute shortage of bus stands with adequate facilities throughout the city (except recently introduced Premium/BRTC services). Hence buses frequently stop here and there affecting smooth flow of traffic. Objectionable Driver's behavior is sometimes responsible for further miseries particularly near intersections. Besides this there are so many deficiencies in regulatory measure like poor loading and unloading, on street ticket counter etc.

7.5.7 On Road Ticket Counter

Photograph 7.14: On Road Ticket Counter

It is difficult to estimate the exact number of ticket counter in the Dhaka city and there has not any statistics of DCC or other involving agencies regarding this. Almost all of the busiest place of roads segment with intersection points have ticket counter at least on bus ticket counter. But, unfortunately, almost all of the bus ticket counters are on road or on the foot path of the road with a temporary infrastructure particularly only with a chair and a banner encroaching operational space. There is very little designated and permanent ticket counter in the entire city routes. As there is not any designated bus in a particular route as well as designated space for counter, it is also difficult to provide such facility without interrupting the other facility.

7.5.8 Deficiencies from User Point of Views

It is revealed that most of the existing bus services are uncomfortable, inconvenient, and unsafe for the passengers. Most of the buses are owned privately and they operate it completely from commercial point view. They seek more and more profit and don't care about passengers' facilities. They always compete with other buses to pick up the passengers from route and try to get the pick up spot first and to do so; they often cause safety problems for passengers. During off peak hour, they wait for long time at bus stops to full the bus and cause a huge delay for passengers to get their destinations. There are many other difficulties for the people who are using the buses such as:

7.5.8.1 Lack of Passenger Information

Passenger information, in terms of route maps, schedules, or service time coverage, is virtually non-existent. Furthermore, most buses are not identified by route number. Some are identified with display boards showing the origin and destination of the route. For the majority of buses in

the city, however, passengers rely either on familiarity with the route, or on the instructions shouted out by the bus conductor/helper while the bus slows down or stops at bus stop. In the present infrastructural condition, it is difficult to provide and maintain such facility in the city road. Indeed, as there has not any well organized franchising bus route system, until happening is would be very difficult provide such facility.

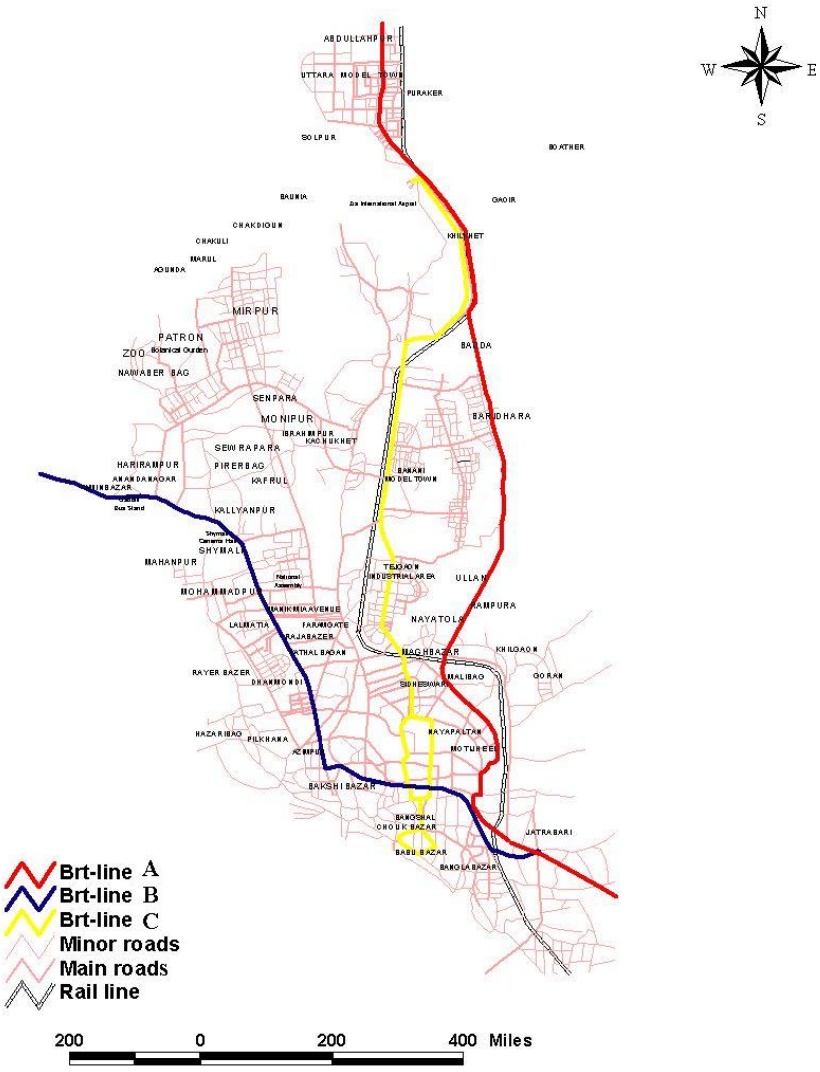
7.5.8.2 Lack of Passenger Shelter

Bus shelters in Dhaka are generally absent, or, where provided, are generally unused (at least by bus passengers) and often in a derelict condition. Passengers waiting for buses do so in poor conditions unprotected from wind, rain, and sun or passing vehicles. Passengers waiting for buses in Dhaka generally do not have access to bus shelters, passenger information, shelter from weather, or any other facilities.

DCC are responsible to construct and maintain passenger shelter on road side in Dhaka Metropolitan city. But, no statistics has been found to the DCC official about the number passenger shelter, maintenance and management mechanism of the passenger shelter (questionnaire survey). Recently, few passenger shelters have been constructed to the major roadside of the Dhaka city, but most of the shelters are not properly operated, maintained. Even most the existing passenger shelters are occupied by traders, hawkers, dealers and used only for business purpose rather than passenger shelter. All of these illegal tasks are going on openly in front of DCC officials, police personnel. Indeed, most of the cases, DCC provide legal permission to use the shelter for business purpose in the name of lease for maintenance and management purpose. But, in reality, the hidden fact is to generate revenue which is the result of wrong policy framework of the DCC. In addition, there has very minimum scope to construct passenger shelter without hampering the walkway facility as roadside is not planned considering these facts.

7.5.8.3 Problems of Bus Journey

In an questionnaire survey conducted by STP, many of the bus riders express the view that bus journeys in Dhaka are hazardous. In reply to the question 'what are the existing problems you face in bus travel mode' they mentioned several problems. About 56% mentioned that bus stop is away from their residence; another 32% said there is no bus service to their localities. Again 20% said the bus take longer travel time and another 18% said they



Map 7.5: Proposed BRT Line

need several transfers. Besides, almost 52% said the bus is not comfortable and another 16% said they are unreliable. About 4% of the respondents feel bus journey is dangerous (attack during political program, fire incident, death and injury, etc.) and 15% feel they are unsafe (pick pocketing, hijacking, robbery, mal-treatment, abuse and physical assault by crew staff).

7.6 IMPLEMENTATION OF BRT

An analysis of travel forecast revealed that the level of transportation activity in 2024 would be about 2½ times the activity of 2004. Future transportation system would need to be designed for 1.3 million public transport trips and 3,00,000 vehicle trips.

To meet the future demand and to address the problems indicated above STP has been suggested the following three BRT route in the city area like many other cities of the world:

BRT Line 1: This BRT line is planned to serve the eastern corridor between Uttara and Saidabad Bus Terminal. The main route is based on Pragati Sarani and DIT Road.

BRT Line 2: This BRT line is planned to serve the western corridor and runs between Gabtali and Saidabad Terminal. Primarily it is based on Mirpur Road and then crosses over to Zahir Raihan Sharani Road.

BRT Line 3: This BRT line is planned to serve the central corridor and runs between the International Airport and the Old City. Primarily it is based on Airport Road, Shaheed Tazuddin Road and the Ramna Area (Map 7.5).

7.6.1 Conflicting Issues for Implementing BRT

In spite of having huge benefit and large potentials, there are so many conflicting and constraining issues on the existing transport system of the city, which directly conflict the implementation of the proposed Bus Rapid Transit BRT successfully. These issues not only creates question on its feasibility but also possibility at all. In the following section, some of the associated implementation difficulties are explored which has been pointed out through field data collection, discussion with the experts and literature review.

7.6.1.1 Insufficient Road Width

Sufficient road width in the route is the first and foremost requirement for implementation of BRT to provide separate lane. As proposed in STP, 2004 the space requirement for implementation of BRT is presented below:

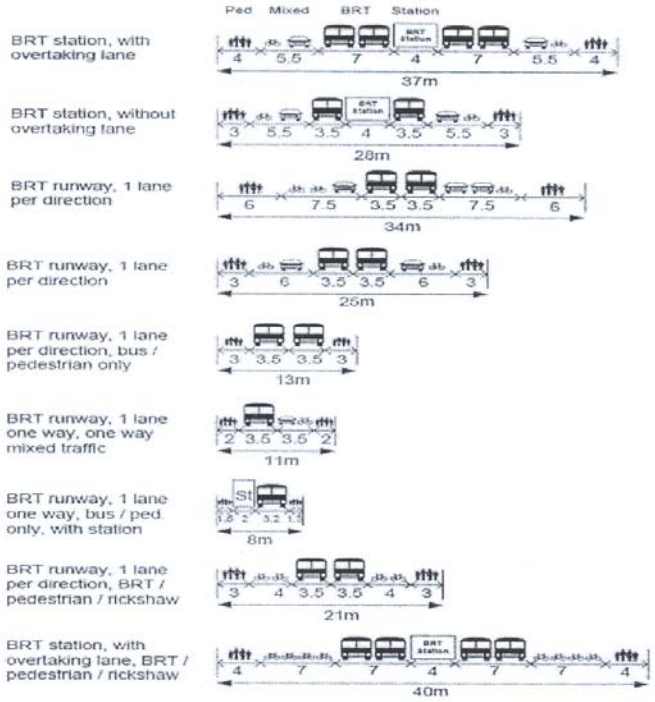


Figure 7.3: Proposed BRT System for Dhaka City by STP, 2004.

According to the Figure 7.3, minimum road with is required for BRT station with overtaking road is 37 meter, followed by BRT station without overtaking road is 28 meter and BRT runway 1 lane per direction is 25 meter. But, space along the entire route is not sufficient and it is highly difficult to expand or acquire land for the expansion of the road space in the proposed road segment. The following table is presented to show the existing roadway width of different segment of the route, the required road width for BRT runway and the adequacy of the roadway width.

Table 7.11: Route, Road Segment, Road Width and Possibility to the Existing Space

Route	Link Road	Stat Point	End Point	Avg. Pavement Width (m)	Avg. Road Width (m)	Posibility to implenent (component)
Route A (Uttara-Saidabad)	Airport Road	Uttara house building	Kuril Bishaw Road	25	40.0	Station with OverTaking lane
	Pragati Sharani	Kuril Bishaw Road	Rampura Bridge	21.6	31.8	Station without Over Taking lane
	DIT Road	Rampura Bridge	Mouchak more	22	28	Station without Over Taking lane
	New Circular Road	Mouchak more	Malibagh More	17	21	Land required 4 meter for runway only
	Kakrail Road	Malibagh More	Kakrail More	28	30.8	Station without Over Taking lane
	Kakrail VIP Road	Kakrail More	Nightangle	28	32.6	Station without Over Taking lane
	Toynbee Circular Road	Nightangle	Motijheel	30	36	Station without Over Taking lane
	Hatkhola Road	Motijheel	Sayedabad	16.2	23.89	Land required 2 meter for runway only
Route B (Gabtoli – Saidabad)	Mirpur Road	Kalabagan	Bridge	28.5	32	Station without Over Taking lane
	Mirpur Road	Kalabagan	Nilkhet	28	33.7	Station without Over Taking lane
	Azimpur Road	Nilkhet	Azimpur Bus Stand	22.4	26.6	Runway One Lane
	Polashi Road	Azimpur Bus Stand	Polashi Bazar	18	22.4	Land required 4 meter for runway only
	Jahir Raihan Sharani	Polashi Bazar	Nazimuddin Raod	18	22.45	Land required 4 meter for runway only
	Kamruzzaman Sharani	Nazimuddin Raod	Banga Bazar South side	19.2	23.1	Land required 3 meter for runway only
	Kamruzzaman Sharani	Banga Bazar South side	Joy Kali Mondir	17.5	18	Land required 7 meter for runway only
	Folder Street	Joy Kali Mondir	Rajdhani super Market	20	27	Runway One Lane
Route C (Airport-Old Dhaka)	Airport Rd	Uttara house building	Kuril Bishaw Road	25	40.0	Station with OverTaking lane
	Airport Rd	Kuril Bishaw Road	Mohakhali Police Box	25	40.0	Station with OverTaking lane
	S. Tajuddin road	Mohakhali Police Box	Panthopath Road Intersection	23.8	36.3	Station without OverTaking lane

Table 7.9 Continued

	S. Tajuddin road	Panthopath Road Intersection	Moghbazar Goal Chatter	23	29	Station without Over Taking lane
	S.C. M. Ali Sharani	Moghbazar Goal Chatter	High Court Gate	19	26.35	Runway One Lane
	Toup Khana Road	High Court Gate	Paltan More (Police Box)	20	27.35	Runway One Lane
	Shaheed Sayed Nazrul Islam Sharani	Paltan More (Police Box)	Fulbaria Market (Police Box)	22.8	29.3	Station without Over Taking lane
	Northsouth Road	Fulbaria Market (Police Box)	Malitola Biponi Bitan	17	18	Land required 7 meter for runway only
	English Road	Malitola Biponi Bitan	56 Midfod Road, Babu Bazar	25	26	Runway One Lane

Source: RMMS and Field Survey, 2006-2008

From the Table 7.11, it is found that in route A (Uttara to Saidabad), Mouchak to malibagh more is the most unfit section for BRT in which minimum 4 meter widening is required for runway only and for station al least 7.0 meter widening needed. Also, at least 2 meter widening is need for runway and 5 meter for station. Route B (Gabtoli to Saidabad) is more unfit in respect of road width than route B. There has not any segment in which BRT station with overtaking road can be provided in the existing road space. Indeed, in the entire route, only Mirpur road found quite space in which only BRT station without overtaking lane could be provided. To provide minimum one lane per direction, 3 to 7 meters road widening is needed and for station facility, at least 8 to 12 meters widening is essential in the entire road segment except Mirpur road. Table 2 also represent for the case of Route C (Airport-Old Dhaka), upto Moghbazar there has sufficient space for BRT lane with station if the entire road space can be utilized. But, after that, it is highly difficult to provide separate lane for BRT. Mainly in old Dhaka road segment like North-South road and English road required huge space acquisition for road widening for successful implementation of BRT. Unfortunately, these roads are in the old Dhaka and roadside as well as entire areas are highly haphazardly densified and widening of road is extremely difficult.

7.6.1.2 Insufficient Space for BRT Station and Interchange

BRT station location and spacing are primarily in the realm of operations planning because they strongly influence operating speeds. Map 7.1 shows 37 m is sufficient for a BRT station, bus lanes, 2 lanes for mixed traffic and non motorized vehicles, and a 4 m pedestrian walkway, 28m is sufficient without overtaking lane.

The location of the existing ticket counters may provide a good indicator for possible BRT station locations. From the Table 2, it is observed that most of the location of existing road, BRT stations could be placed without widening of the road width. Though, route A is the best position in respect to road width, for providing station at Mouchack at least 7 m road widening is needed and only for runway at least 4 m widening is needed. But, The road side land is used mainly for commercial purpose; furthermore the land is occupied by multi storied markets i.e. heavily built-up area as such there is minimum road widening scope. For the case of other route, there has several spot in which extensive amount of road widening is needed to provide station for BRT. For effective and efficient BRT system, there should have interchange facility with the local modes and BRT in certain location. This required huge space and well connecting road network between the interchange and the local traffic generating areas. But, not only in the proposed road network but also all of the major roads which servicing in the city areas, has not required location where sufficient space and internal connectivity is available to provide interchange facility. For the lack of such facility, the expected outcome as well as productivity could not achieved.

7.6.1.3 Uncontrolled and Excessive Access Road

Uncontrolled access is one of the major operational problem in Dhaka Metropolitan City. Table 7.8 shows that number of per kilometer access in side by side in major three road of Dhaka city in which the BRT is proposed. The huge number of uncontrolled access directly conflict with the present mass transit operation and obviously will conflict with the BRT system. As discussed in Article 7.2.8, it is difficult to reduce these excessive and uncontrolled access road.

7.6.1.4 Huge Pedestrian Movement

Walking is a commonly used mode of transport in Dhaka. While the proportion of trips that are made by walking is substantial and, for some people walking is a matter of choice and convenience, the reality is that for many people, walking is a matter of economic necessity.

According to the estimation of STP, pedestrian volumes of 10,000 to 20,000 per day are common and reach as high as 30,000 to 50,000 per day in the Old City area. This huge number of pedestrians are walking along the road, most of the case instead of footpath for illegal occupation and randomly crossing the road here and there. For safe and efficient movement of BRT, sufficient walking and grade separated crossing facilities must be provided and proper use would be ensured. Obviously, at grade crossing of the pedestrian must be controlled, particularly in link of the road. Indeed, it is a great challenge to provide sufficient grade separated facilities for such gigantic number of pedestrians and to ensure proper use for BRT implementation of the city network.

7.6.1.5 Huge Number of Bus Operators

As discussed in Article 7.5.4, fragmented ownership is one of the major problems in the mass transit system in the Dhaka city. The non-scheduled and scheduled buses are owned by a large number of operators in Dhaka city. According to BRTA, 2007, 57.6 percent buses are owned by individuals. There are many operators who have only 1 bus, even one single bus is owned by different owners. Some operators i.e. Winner, Bevco, Ababil, Duldul own 15 to 40 buses.

From the study of Hossain (2003) it can be observed that five company-shape operators including public sector BRTC and about six hundred small entrepreneurs are operating bus services in Dhaka city with varying degree of service quality and fare. Again, the number of rickshaw and auto rickshaw operators would be numerous. It is very understandable these numerous operators cannot work towards a common goal of good public transport system rather this aspect has led to the present condition of indiscipline and mismanagement in this sector. Therefore, this numerous operators may stands against this BRT operation and it would be very difficult to manage such a gigantic strong group.

7.6.1.6 Overlapping Bus Route

Overlapping bus route (Map 7.4) is one of the major challenges to provide separate bus lane for BRT for a particular route. Map 7.6 shows an example of overlapping bus route and route diversion of a typical and major corridor of Dhaka city. From this map it is considered that Matsha bhaban to Shabahg segment operated 100 percent of buses in this corridor, but among them only 13 percent the go to the Uttra. Other 87 percent are diverted in different road from different junction. Now, if it is provided separate lane for the Gulistan to Urrata route, then only 13 percent routed bus will use this lane, other 87 percent will have to share the space of the rest lane. Table 7.13 presents the comparative overlapping routes in the different segments of the proposed BRT route. Visual illustration of this problems is shown in Appendix F. From this table couple with the previous discussion it could be concluded that this huge overlapping bus route and huge difference beteen the maximum and minimum segments will hindered the total system and maximum benefit could not be achieved from this huge investment. This also results from the road network pattern deficiency as well as planning deficiency and fully recover of this problem is almost impossible.

Table 7.12: Percent of Overlapping Bus Routes Percent Three proposed BTA*

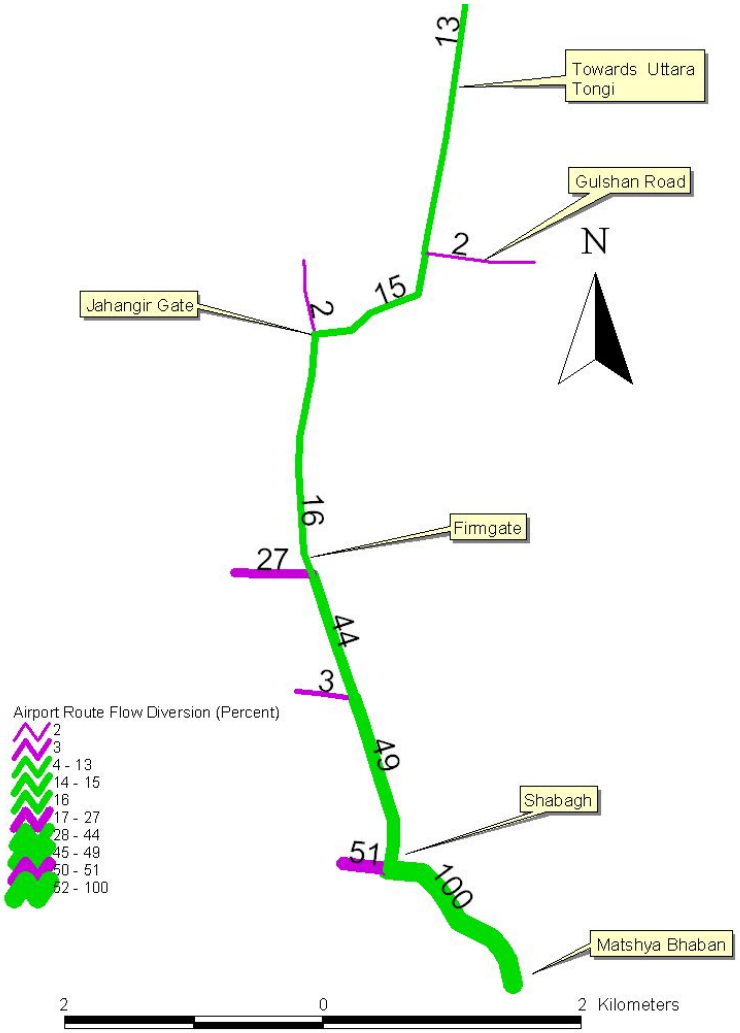
Route	Starting Segment	Percent of routes	Ending Segment	Percent of routes
A	National Scout to Kakrail more	100	Bishawroad to Abdullahpur	28
B	Technical more to Shishu Mela	100	Azimpur to Gulistan	9
C	Abdullahpur to Bishawroad	100	Paltan to Gulistan	5

Source: Analysis of BRTA permitted bus route, 2008

*Note: Comparison is made considering maximum overlapping segment consider as 100 percent.

7.6.1.7 Unorganized and Non-Integrated Road Network

As discussed in the Chapter 6 and also in the Article 7.2.3 and 7.2.4 in Chapter 7, during last twenty to thirty years, significant road development has been taken place to cope with sudden transformation of the city from provincial town to the capital of a sovereign country. But most of the transport developments have been driven by ad hoc considerations having no explicit focus on analysis of existing demand or future requirements. As a result, the road network of the city is not organized and integrated in terms of connectivity. Many strategic links are missing in the network and many areas have inadequate accessibility to it. This also poses a serious problem to provide other network infrastructures for utility services.



Map 7.6: Overlapping Bus Route and Diversion

7.6.1.8 Mixed Operation in Major Roads of the Proposed Route

According to the Article 7.3.1, road network of Dhaka city is characterized by mix traffic system. All types of vehicles, both motorized and non-motorized vehicles are in operation on each and

every road, except some NMT restricted routes like airport road. Where, all types of vehicles are played on the road, majority of road spaces occupied by rickshaw. Because of the presence of non-motorized vehicles, travel speed is significantly reduced for motorized vehicles and a huge congestion occurred. Even where non-motorized vehicles are restricted, three wheeler vehicles occupy the majority of road space. From this chaotic situation, it is highly difficult of separate lane for BRT only.

7.6.1.9 Turning Difficulties of BRT Bus

BRT system use large capacity articulated bus to enhance the passenger capacity. Found almost exclusively in public transportation use, these buses are approximately 18 m (60 ft), while regular buses are 11 to 14 m (35-45 ft). To make them nimble enough to safely navigate streets at their increased length, they are fitted with an extra axle (set of wheels) and a joint usually located slightly behind the midpoint of the bus, behind the second axle. Some models of articulated buses have a steering arrangement on the rearmost axle which turns slightly in opposition to the front steering axle, which allows the vehicle to negotiate turns in a somewhat crab-like fashion, an arrangement similar to that used on long hook-and-ladder fire trucks operating in city environments. Some buses have two joints, and these are called bi-articulated. Traditionally, BRT vehicles have been conventional 40-foot or 60-foot diesel powered articulated bus. Minimum turning radius varies by system, but can be as low as 35.1 feet, for 35-foot buses (Rahman 2008).

In the many intersections of the proposed routes, the minimum requirements of turning radius of BRT bus can not be attained in this present available road width. So, land acquisition, in the form of corner widening, is essential as well as customized BRT bus such as bi-articulated bus or even tri-articulated (as shown in following photograph) bus can be considered for reducing these turning difficulties otherwise the desired speed and capacity of BRT will not be gained. But, frightening situation is that, most of the intersection has not sufficient space for corner widening as most of the corner points are highly built-up.

7.6.1.10Lack of Traffic Signal

In Dhaka City, there are so many opening where has not any traffic signal, particularly in the proposed route. Only in the route A (Uttara to Motijheel) there are 26 small openings in the route which has no traffic signal system. In these locations traffic signal should be installed so that BRT can get the uninterrupted movement throughout the entire section by providing signal priority as well as exclusive right of way. The experience of electronic traffic signal is not quite good in Dhaka city. Almost all of the intersection which is signalized expanding vast amount of money just two years ago is manually operated by traffic police.

7.6.1.11Lack of Passenger Information

Passenger information, in terms of route maps, schedules, or service time coverage, is virtually non-existent. Furthermore, most buses are not identified by route number. Some are identified with display boards showing the origin and destination of the route. However, passengers rely either on familiarity with the route, or on the instructions shouted out by the bus conductor/helper while the bus slows down or stops at bus stop. Besides this, deficient or improper landuse patter, poor maintenance and surface condition of roads, deficient and improper place of bus terminal, less productive intersections, non-coordinated transport system , poor interface provisions directly road and roadside hazards, unacceptable Railway level Crossings conflict with the introduce of the BRT system.

From the above discussion it is revealed that the present landuse and road network is not suitable candidate for implementing BRT as the city was not planned considering this facility. Bogota or Curitoba which are the great success example of the BRT system, developed binary, even trinary road network system considering the future implementation of the BRT system. In Dhaka city it will have to superimpose by force as the patient is not a supportive candidate to digest such high-power medicine. So, the expected outcome of BRT i.e. efficiency and productivity would not achieved from this huge investment.

7.7 OVERVIEW

In this chapter, the deficiencies related to transport management and operation in Dhaka city have been described with a broader perspective. From this analysis, it is revealed that the city has significant lack of functional roadway facility as well as the transport system is not integrated to each other. It is evaluated that low cost transport managements tools like one way operation, tidal flow operation, signal coordination, exclusive bus lane, entry restriction etc. are almost impossible to implement in the present transport system of the city. Even, high cost management tools like grade separation, construction of proper well design flyover, implementation of BRT is also difficult for the causes of unplanned haphazard development of the road and road side as well as for wrong policy for the transport system. Besides, for the lack of proper management and operation, most of the existing facilities of road network (almost two third) are used other than traffic operation. Unfortunately, it is the real fact that this illegal occupation is one of the most important inherent weaknesses of the entire transport system of the city as it could not be eliminated by providing massive strength, expanding money of previous different governments. So, these could have to be carry on until the city sustains and in reality, a city could not alive with this irreversible weaknesses and deficiencies.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 GENERAL

With the increasing demand resulting from the population boom and infrastructural and economic revolution in the world, it is a great concern and required urgent attention for all to prepare capital city as a high potential richly developed sustainable city for the restraining of forthcoming demand of the 21st century as a mega city. But for the misunderstanding of the real problems of this city, every approach has taken the city to the odd condition day by day. In every step, to overcome the problem, the authorities are providing piecemeal solution without a long term vision which is becoming an extra burden on the city infrastructure. That is, the city is developed with the decaying growth. If these conditions further continue for a years, there will not be any option to recover or renew the condition of the city and it will become a dead city and eventually the city will have to be abandoned. So, there is no time to sit idle. Before the starting of further step, authority will have to identify the root causes of the problem and inherent weaknesses of the city.

This chapter has presented the study findings as well as point out the inherent weaknesses of the city particularly related to the transportation system of Dhaka city. It is expected that the findings of this research would immensely help the city authorities, policy makers, professionals, academicians, planners, developers as well as civil society to identify the root cause of the transport and land use problems and to take appropriate policy for improvement of the current deteriorating situation and changing the traditional mindset in addressing the land use and transportation problems of the city to make a livable city for all the city dwellers.

Important recommendations are also made here based on the findings of the study work which would help the policy makers to adopt long term, medium term and short term policies and measures to tackle the forthcoming challenges on the land use and transportation system as a capital city of a country and to prepare commensurate policy for developing a well planned, livable, potential, healthy sustainable capital city. The limitations of the research work followed by the proposals for the further studies are also presented in this chapter.

8.2 SUMMARY OF FINDINGS

General findings of this study as well as inherent weaknesses of Dhaka Metropolitan city in particular relations to transportation system, which have been revealed in the previous chapters, are summarized below according to the chapters name and headlines.

8.2.1 Landuse and Transport Planning

Some major inherent weaknesses related to the landuse and transports planning of Dhaka Metropolitan Area are presented below:

Unpredictable Growth of Population: Dhaka City has been witnessing a tremendous growth of population and physical expansion, over 30 and 20 times respectively within the period of 1951 to 2001. After the liberation of Bangladesh in 1971, the development processes rapidly increased and the population of Dhaka city has grown extreme fast (8% per annum). However, the major factor that brought serious land use and transportation problems in Dhaka city are the unpredictable rapid growth of population and associated indiscriminate land use patterns. The city has been planned forecasting 1.75 percent annual growth in 1959 but actual growth rate of the city is almost three and half times higher than that results uncontrolled and unplanned as well as unguided settlement of the population and colossal densified development (around 45 thousands per sq.km) of the different areas of the city to survive in the limited areas (134 sq. km) in the city areas. The main reasons for rapid growth of population are the centralization of development works, centralization of political & administrative power, high investment in already developed areas, potential employment opportunities, discrepancy of income level between the city and other regions of the country. Decentralization of the city is a topic of discussion in the seminar, symposium since the last thirty years but any effective and fruitful steps not yet taken by any government.

Lack of Legislation and Uncontrolled Growth: Though 3 so called master plans and 7 construction and improvement acts have been developed for the legislation and control of Dhaka city development in the last fifty years, no complete master plan has been developed yet. Due to inadequate government intervention and major share by private sector entrepreneur in the physical development of the city as well as for the absence of proper implementable legislation and guidance by the concerned authorities, serious system deficiencies have been observed in the land use pattern of the city (among the 90 wards of the Dhaka City Corporation (DCC) only 15 wards are partially pre-planned which covered only 27 percent of DCC area and 10 percent of the Dhaka Metropolitan areas). Failure of government intervention to guide and control land development process is primarily responsible for uncontrolled conversion of the city area like wetland to urban use.

Piecemeal Development through Executive Order: The city road network development takes place in an amalgam of actions and inactions that have evolved over a long time in distinct and often disparate ways that prevailed at such times. Unfortunately, most of the roads of the city have developed by executive order by army government as a reactive piecemeal solution (25% of the primary road) not by planner with long term sustainable plan. Even, the space which has been opened by relocating the bus terminal from Fulbaria, that's are developed haphazardly without providing parking space, service road, bus layout, wide footpath, there are constructed multistoried market, office and residential building etc. So, overall development of the city as well as the transport network progress in ad-hoc consideration and at present the city come to extreme level from where undo is almost impossible.

Low Topography: The elevation of Greater Dhaka is 2 to 13 meters above the Mean Sea Level (MSL) and most of the urbanized areas are at elevation of 6 to 8 meters above the MSL. The land area above 8 meters MSL covers about 20 sq.km (8%) . The land ranging from 6 to 8 meters MSL covers 75 square kilometers (28%) while 170 square kilometers (64 %) of Dhaka is below 6 meters. However, the first and foremost problem of Dhaka city is the shortage of suitable buildable high land (in present condition only 25 percent of the Dhaka Metropolitan Areas)

around the city areas which is free from annual flooding for the causes of low topography. So, selection of this topography for a capital city was not fully appropriate decision particularly considering the present condition.

Lack of Buildable Land: As for the low topography, most of the areas (75 percent) are below the natural water level, pre-planning of the city and control of development becomes really difficult. Besides, city development organization do not provide plan on the submersed land. However, the city has developed with post planning approach and almost 90 percent local planning comes after the surface development by the haphazard construction of the residential building with the demand of the local users and almost 80 percent of the local roads of those areas are developed on the donated land with the negotiation of different local land owner results narrow, zigzag, haphazard, pattern less road network in 73 percent in the DCC areas. It could not solve the proper demand of road, drainage facility, gas line, sewer line, as well as the necessity of the fire brigade and ambulance of a community. So problem is being ever lasting. An ideal city cannot buildup in this way. This is the one of the fundamental problem of this city and come out from this problem is very difficult at this moment.

Excessive Flooding and Extreme Economic Lose Due to Low Topography: Around 95 percent of the area of the city, the food level is within 5 to 7 meter. In fringe area it is less than 4 meters. The city has been subjected to periodic flooding since its early days due to its river system and low topography.. The City authority had to spend about Taka 7 to 8 billions every year to replace and maintain infrastructures damaged by water logging which is huge burden for our fizzle economy. There are altogether 133 pumps in different place of the city. Every year almost 810 lac taka is required only for the operation and maintenance of these pump stations. This pump station act as a cathedra for survival of the city and it will have to continue for everlasting of the city.

Unplanned and Unrestrained Expansion of the City: The percent of land uses in DCC area is 62 percent residential (25% per-planned and 37% unplanned), 8 percent commercial, 9 percent administrative, 4 percent open space including water bodies, 10 percent cantonment and 7 percent airport area. Within the twenty years 1984 to 2004, unplanned residential areas have increased almost two and half time than the earlier in 1984. For the causes of unplanned expansion, many blocks (almost 7 major blocks have been identified in this study) have been developed in the city area which have not 5 percent of road compare to other preplanned grid-pattern zones. For the causes of deficient land use pattern, many big institution/infrastructure has been developed in the central part of the city and occupied around 12 percent of the city area and seriously affects the overall landuse and transport system of the city. For the causes of uncontrolled growth coupled with planning deficiencies, most of the planned areas are now converted as a mixed use zone. With this conversion, the posh areas of the city are also passing away from the city.

Unplanned and uncontrolled exposition of the city also induce around 4000 indiscriminate and unexpected road side garments industries with more than 1 millions employee which is generating almost 2.5 millions trip per day. Almost 75 percent of those industries are located along the primary roads and the rest are along the secondary roads and creating mammoth adverse impact on the city. In order to get access to work sites, almost 95 percent garments workers go on foot and walk almost 1 to 1.5 km per trip. These huge numbers of frequent, haphazard and unguided, indiscriminate trips greatly influences the traffic flow parameters in the arterials. This also imposes serious safety hazards for the workers as it increases the possibility of pedestrian-vehicular conflicts.

Loses of Green Areas and Water Bodies: In the first master plan 1959, there were 1338 Acreage (5%) open space comprising around 20 notable open park, lake and recreational space. Among them at present, there are only 853 acre of land for open space comprising only 13 notable park and lake in all over the city. Within the thirty years, open space areas decreases from 5% to 3.09% and the urban green decreases by 1.5%. In 50 years back, Dhaka city city has altogether 50 canals (250 km). Among them 26 canals are under Dhaka WASA (65 Km) at present. Yearly rate of loss of wetland during 1999-2003 periods is 5.67 percent where as during 1989-1999 period; yearly rate of loss was 1.23 percent. Almost 0.096 sq km (23.7 acre) of designated permanent water body is reduced after 2000 in Dhaka city. Retention pond areas have been decreased from 12 percent to 5.5 percent within the period of 1992 to 2006.

Huge Interaction between Road and Roadside Landuse: In Dhaka metropolitan city, there has not any rule or regulation to control the direct access in the different classes of road and people are frequently connected their buildings/abating properties with the main road through direct access road, even with the principal arterial road (more than 100 direct connection in per kilometer of the major primary road). Even, 90 percent of multi-storied commercial building is buildup without any adequate space, proving sufficient setback for walking, parking etc. Indeed, around 50 percent of the landowners have not the knowledge about the building rules and regulation and around 70 percent of the fringe areas buildings have not approval from the RAJUK. Besides, almost 95 percent of the plots adjacent the road were developed without considering any access facility for rear side properties. In addition, all most all of the major junctions corner points are developed without considering sufficient turning space as well as without considering future development possibilities for improving capacity and creating adverse impact on the performance of the whole road network.

Unacceptable Railway Level Crossings: There are altogether 51 (Fifty one) railway level crossing from Shyampur high school to Abdullahpur, 37 authorized and 14 unauthorized (13 are in Kamalapur-Narayagonj corridor and others 38 are in Kamalapur-Tongi corridor). Every day 78 trains in Kamalapur-Tongi corridor interrupt on road vehicle on both sides of rail gates on an average of 5 to 6.0 hours in each day in each level crossing. Losses of man hour per day around 150,000 and loses of fuel for that interruption around 300 liter in a major single level crossing per day. On the other hand, 238 employees are engaged for the controlling of the authorized level crossing and excluding other expenditure per month around 7.5 lac taka is losing only for their salary purpose.

Lack of Functionally Efficiency: Most of the development of the city took place by sprawling and scattered way and there has very little linkage between the activity areas and the ease of movement. However, most of the case the city dwellers requires more effort, more time as well as more cost to perform in the city area. That's way; it is evident that, the city is not functionally efficient.

8.2.2 Road Network

Scarcity of Road: The total road length in the DCC area is 1286 km comprising 61.35 km, 116.40 km, 219.54 km, 569.87 km, and 318.27 km of primary, secondary, connector, local and narrow roads respectively. The total area of these five types of road is only 12.09 sq. kilometer among them 8.84 sq. kilometer is pavement area which are respectively 9.01 percent and 6.59 percent of the total land area of the city. The length of roads in Zone-1 is 170.22 kilometer which is the highest compared to other zones and the length of roads in Zone-10 is 62.45 km which is just reverse. On the other hand, the highest primary road in the zone 5 (14.7 km) and followed by zone 7 and 9 (11.1 km) where as in zone 2 & 8 only 0.5 and 2.5 km of primary road respectively.

Inadequate Wider and Accessible Road: There are only 107 kilometers road which width more than 24 meters. Indeed, there are only 45 km of road which pavement width more than 24 meter. About half of the roads are not sufficient width from where a motorized vehicle can move among the existing road. Indeed, 821.61 (64%) km road width is more or equal to 4.75 meter but according to pavement width, that's are only 618.14 (48%) km. That almost 52 percent of the roads are inaccessible for motorized traffic. About 464 (36%) km pavement width could not be increased without demolishing existing road side development but that's are almost impossible as this problem is started from very beginning of the planning of the city and both side roads is highly buildup by multi-storied building and huge densified with about 0.1 million people per sq. kilometer. On the other hand, a city could not sustain with this huge amount of so thin vein which is totally blocked or plugged or out of use.

Lack of Per Capita Road: The availability of major roads in terms of either km per thousand populations or km per square kilometer of area is too low as compared to the other cities of different developed and developing countries. In Dhaka City Corporation area, there are per capita road is only 0.213 meters is whereas many other cities including developing cities, it varies between 4.5 to 0.5 meters. This scarcity of the road length or area will be sustaining until the city remain. That's this is one of the fundamental inherent weakness of the city of Dhaka for their yield land use and transport panning.

Insufficient Road after the Implementation of STP: The existing road in the entire city road network is not quite enough and is the one-forth of the minimum requirement of a modern city. Even, after the implementation of STP, total road network would be around 1413.67 km and road and pavement area would be 15 (11%) and 11 (8%) sq.km respectively. Obviously, it is the very lower than the minimum standard of a modern city.

No Classical or Functional Road Orientation: Besides this huge scarcity of the road network, the unplanned and haphazard orientation of road networks viz. no road network pattern, faulty road orientation at micro/local level, un-organization and non-integration of road network, no bypass, ring or functional arterial road, no east-west continuous road, huge missing links (9 major links missing in the major roads), staggered & T-junction (six staggered junctions within the 5.19 kilometer of Mipur road and 19 major T-junctions in three major roads), right angle bend (5 in major roads), no classical and functional hierarchy, lack of functional gate way, discontinuity of the main road also leads to built-in problems on the operational and management aspects of the transportation system and functionally sabotages the entire street network performance

Patternless Road Network: The layout of major roads e.g. primary, secondary and tertiary are neither straight nor diagonal, neither grid nor orthogonal. Indeed, the primary, secondary even tertiary roads are scattered and haphazard without well-linked and functional connectivity with each other. Primary roads are separated from each other and ended by creating either a T-junction or staggered junction with tertiary road which are crating permanent bottleneck on the enter city road network. Indeed, the city road network was developed without any well-defined pre-plan. Even, until today, the city is expanding without any long-term vision, following any detailed road network master plan.

8.2.3 Functional and Operational Deficiencies

8.2.3.1 Functional

Lack of Functional Classification: There has not any classical as well as functional hierarchy in the road network of Dhaka city. For developing a functional road classification for the network of roads of Dhaka city by DITS, 20 desirable features are also depicted considering mobility and functionality. Indeed, hierarchical road classification could not satisfy almost 90 percent desirable features and unfortunately it is almost impossible to provide a full fledged functional primary road in the future on the existing city areas by the city authority for the city dwellers. There is very little possible way to overcome this deficiency and this inherent weakness of the city road network will be containing until the city will exist in this location without major demolishing or shifting particularly in Dhaka City Corporation Areas.

Non Integrated Transport System and Lack of Interchange Facilities: The share of intercity passenger by different modes bus, train and launch are 76, 9 and 15 percent respectively. Interchange or interface facility between the three modes are very poor. Though Kamalapur railway station is only 0.5 kilometer away from the CBD almost 90 percent of the people go to the station by rickshaw from the CBD for the lack of well connectivity. There has not also any connecting service with the Gabtoli and Mohakhali and Sadarghat terminals. On the other hand, the nearest bus stoppage is almost 1 km away from the Sadarghat launch terminal. The main railway station Kamlapur is 4 km away from the terminal but does not have any good access or interface. There has not also any connecting bus route with Mohakhali and Saidabad bus terminal.

There are approximately 18.7 million intra city trips per day among them the share of intra city commuter train and launch are 5000 and 2000 passenger per day respectively. Lack of interchange facility as well as connecting facility with final destination to railway station is the major cause of less demand of the commuter train service. Shawrighat to Khlomor is the only one intra city waterway passenger flow route carrying around 1500 to 2000 passengers par day. For freight transport there are some other extended routes along the circular waterway. Only 11 percent of the total passenger of the Shewari Ghat use the circular route and other 89 percent only cross the river. Almost 90 percent of the passengers use these stations only for crossing the river not for circulating from one station to another station. However, the number of passengers which have been shown in the feasibility study in both phases I and II is confusing. On the other hand, 14 low roads and railway bridges are cutting off the circular water way facility. In addition, there are almost 30 passenger crossing stations in the both side circular waterway and every day thousands of passenger cross the river using that stations. Almost 60 percent of the stations have not any functional road connectivity. For the lack of connecting road or interchange facility people are bound to go their final destination either by rickshaw or by foot and their share in some selected stations is 50 to 60 percent and 30 to 40 percent respectively. In present condition, most of the spaces are occupied by haphazardly developed multi-storied residential and commercial building and it is almost impossible to develop connecting road or provide well facilitated interchange facility with the city center.

There are five intercity bus terminal in Dhaka city i.e. Gabtoli (23%), Mohakahli (6%), Gulistan (7%), Fulbari (15%) and Saidabad (25%) bus terminal. But, unfortunately there has not any designated intra city bus terminal. In Gabtoli bus terminal, there are only two connecting intra city bus route is available and serve almost 65 percent of the passengers. Around 23 percent passengers' pre travel origin is mirpur and Mokhali and 35 percent passengers' post travel destination is that place, but there has not any connecting bus service route. In Saidabad bus terminal, there are around 12 intra city connecting bus routes but almost 75 percent of the

passenger make pre and post trip by other than bus (rickshaw 45%, walk 17% and auto-rickshaw 10%) particularly for the operational deficiency of the bus service. Around 15 percent of passenger pre and post travel origin and destination is Sadarghat and Basabo (Sadarghat 9%, Basabo 6%), but there has not any connecting bus service facility from this terminal. In consideration of these, it is obvious that for certain areas of Dhaka city, physically as well as functional integration of different modes of public transport would be a very challenging job and feasibility of which needs a very comprehensive study.

Immense Geometric and Operational Delay: Almost 2 to 3 km extra distance have to travel in the every route in Dhaka city due to the faulty road alignment in compare to the transverse-grid system of road network which poses immense geometric delay. In addition, it is also revealed that every bus route 20 to 30 minutes geometric and 50 to 70 minutes operational delay occur in the city. The geometric delay results from the default road network plan, turning of vehicles for the default road alignment and staggered link i.e. results from the planning problem. However, it will have to continue and minimization is almost impossible.

Minimum Possibility to Implement of Modern Short Term Traffic Management Tool: There are only about 4 km one way road which is only 0.31 percent of total road network of DCC. There is very few option to introduce the one way operation in other road for the lack of alternative or twin road in the city. The city has not any tidal flow operational road and it is almost impossible to introduce such tool for the mixed land use of the entire city. For the lack of well orientation of road network as well as alternative road, there have very few options to restrict right turn of an intersection by accommodating the vehicle in alternative road in Dhaka city. About 86 percent of major X-junction are 4 phases and about 90 percent of T-junction are 3 phases. Among the newly signalized 59 intersections, 47 (80%) intersections phases are equal to its approaches. For the lack of alternative road, or link road or for the lack of east-west connectivity there is very few opportunity of reducing signal phases of the major busy intersections. It is also difficult to provide coordinated signal in the intersection of the city. For the lack of interconnection between the side roads or for the absence of service road it is also difficult to close the side street. At present condition, it is nearly impossible to construct bus bay on road side, as most of the side of the road are fully buildup without sufficient setback. There is also minimum scope to provide exclusive bus lane in present road network. This is a built in problem for the mega city of Dhaka and the city is detriment such a cost effective modern traffic management tool everlasting.

Difficult to Implement Long Term Measure: On the other hand, for the causes of haphazard densification and unplanned development, road side and junction corner point development, conflict between other utility service as well as conflict between different existing and proposed road project, it becomes vary difficult to provide effective and well designed grade separated (elevated or underground) facilities in the major road and intersection of Dhaka metropolitan city. Technological measures such as intelligent/automated highway/vehicles, advanced traffic information system, adaptive traffic signal control, active marking and headlight, auto-surveillance/incident detection/enforcement measures is also difficult to implement in the present indiscipline traffic condition of the city.

Less Productive Intersections: Around 90 percent major intersections phases are equal to its approaches. In addition, lack of junction clear way, illegal parking, loading unloading, absence of appropriate channelization devices, roadside land use pattern etc also reducing the productivity of the intersection. Besides, inappropriate road sides land use activities, corner point development not only further decreasing the capacity of the intersection but also deteriorating the future improvement options.

8.2.3.2 Operational

Mixed Traffic: Road network of Dhaka city is characterized by mix traffic system. All types of vehicles, both motorized and non-motorized vehicles are in operation on each and every road, except some VIP routes. At present, rickshaws poses dominate mode of the roads which one of the major weakness of the entire transport operational system particularly for the through arterial road. There are no alternative routes for through traffic and local and through both the traffic moves in same way sharing the inter city road. This problem is now become a major concern issue and becomes an irreversible problem for the causes of yield land use and transport planning and uncontrolled development.

Excessive Dependency on Non-Motorized Transport: Officially there are altogether 79,000 rickshaws in Dhaka city but is estimated that the actual number of rickshaw could be around 5 lack and around 800,000 rickshaw pullers employed in the Dhaka city area, plus another 50-70,000 people employed in ancillary occupations. At present, the elimination or proper management of these massive number of rickshaws is almost impossible because of fully ignorance of traffic rules and regulations of the rickshaw pullers (92%), lack of basic minimum education and training (90%), huge number of families' economically dependency on rickshaws (0.8 millions), lack of alternative sufficient job facilities in the local market (around 0.9 millions are employed in providing rickshaw services) as well as inaccessible road in the local area (around 52%), poor public transport and mixed landuse pattern in all over the city. So, the city will have to sustain with this huge number of unregulated, uncontrolled, unguided rickshaw. This also poses a serious inherent weakness of the city.

Road Side Friction: In many places, almost two-third spaces of most of the major roads in Dhaka city are not properly used for the road and roadside hazards which is creating adverse impact almost entire road network performance. This is now one of the major inherent operational problems of the city transportation system as different legislations, movements, steps for eliminating of these friction became fully unsuccessful so many times, even executive order by army government under the emergency.

Lack of Parking Facility: Almost 12 percent of tall building (7+ floor) has not any parking facility at all. Old Dhaka like Kotwali and Lalbag thanas' almost 67 percent and 54 percent tall building have not any parking lots or facilities. For the causes of incorrect placement, lack of entry and exist facility as well as wrong planning and design, the proposed parking cum commercial complex (city center) will create negative impact on the road network of this area as well as entire the city area.

No Designated Parking Facilities for Trucks in the City: There are only two designated space to use as truck terminals in Dhaka metropolitan city, which can accommodate 750 trucks altogether but the number of trucks plying in and out of the city could be as a many as 10,000 every day. As a result more or less thirteen unauthorized truck terminal developed in the city area. Indeed, there have not any well design, modern, equipped truck terminal or parking facility with minimum conveniences for operators, users and owners. At present for the lack of ownership on the land, it becomes almost impossible to develop a well organized truck terminal in the city area or entrance of the city.

Huge Lack of Pedestrian Facility: Walking as primary mode of travel is dominant in all age groups and income classes and pedestrian is by far the highest number of road user (62% according to DITS and 37% according to STP of all trips). But, unfortunately there is huge lack of pedestrian facilities, only 388 kilometers of paved footpath and 53 over pass and 3 under pass.

Unfortunately, these limited available facilities could not used properly for the causes of ill maintenance and management.

Poor Mass Transit System: Bus are main player of the mass transit system in Dhaka city and the total road length of the bus operating route is only 120 km which service are is only one third of the metropolitan area. For the causes of limited road space (around 6%), lack of bus accessible road (around1%), unplanned road network pattern, unorganized and non-integrated road network, absence of east-west continuous road (one third of total bus operating road comprising 22 links), lack of continuity of main road, huge side friction (more than 100 abating connectivity per km), uncontrolled access (more than 10 per km), less productive intersection (96% equal phases of approach), lack of loading and unloading facility (no except banani to uttara), inadequate bus stops, lack of bus lay on road, poor allocation of road space, deficient and improper place of bus terminal (no intra and inter city interchange facility) and for the lack exclusive right of way, the mass transit system is not quite good and seems very difficult to improve the condition in present situation.

Implementation of BRT: A Huge Challenging Task: In spite of having huge benefit and large potentials, there are so many conflicting and constraining issues like insufficient road width (17 m in some segment), insufficient space for BRT station, uncontrolled and excessive access road (around 10 per km), overlapping bus route (120 km road but 149 route, 57 routes in one segment, varied between 100 % to 5% at start and end segment)), fragmented ownership (around 5000 bus, 1200 owner) huge pedestrian movement (10,000 to 20,000 is some busy point), huge number of bus operators (57.6% buses are owned by individuals), unorganized and non-integrated road network (lack of interface and interchange facility), mixed operation in major roads of the proposed route (motorized & non-motorized; local and through), turning difficulties of BRT bus (corner point development), lack of traffic signal (96 % equal phase of it approach), lack of passenger information etc. on the existing transport system of the city, which directly conflict the implementation of the proposed Bus Rapid Transit BRT successfully. These issues not only creates question on its feasibility but also possibility at all.

8.3 RECOMMENDATIONS

To cope with the existing demand and to get relief from the deficiencies mentioned above, integrated and holistic measures should be taken encompassing with different sectors related to Dhaka transport system in different phases like short term, intermediate term and long term. Some of the short term, medium term and long term measures both in physical/infrastructural/operation and policy measures to improve the existing system of transport are listed below:

8.3.1 Immediate Measures

- Proper and satisfactory use of all of the road spaces should be ensured by reclaiming road space which is currently occupied by uses other than traffic. In the process, road side friction should be managed and NMT (rickshaws, etc.) should be banned from all major roads to achieve faster movement of vehicles leading to higher productivity.
- The widening of road is essential especially at some segment of road and station location. Moreover, the road side land is still developing rapidly. It is very urgent to consider the implementation of BRT otherwise it will be more difficult to implement in the near future and lead to adapt the most costly Metro system.

- Encourage consolidation of the industry into larger operating units which operate under a company rather than an individual basis. This will ensure regular movement of buses and pick up passengers from the predefined bus stoppages and no competition for getting passengers. Buses that are operated under a company, wages are paid to driver in monthly basis rather than contact basis. So, drivers will feel more secured themselves and drive their buses safely.
- Government should give subsidy if the buses are owned by a company, so that they are able to maintain a bus depot for parking of their buses. This will reduce parking the bus on the road and ensure through movement of other vehicles.
- Buses may be owned by the government and opened to the share market. If the shares are taken by public then automatically sympathy will be gained for the bus since they will think it as their own property.
- Restrict on-street parking that will ensure through movement of traffic without getting hinder by parking vehicles. Therefore, off-street parking needs to be created and at the same time restriction on on-street parking should be strictly enforced for certain periods of the day, and on certain days of the week.
- Considering that substantial number of people use "walking", as a mode, emphasis should be given to develop required pedestrian facilities in terms of user friendly footpaths, zebra crossing and foot over-bridges at link with ramp to make walking more safe and interesting.
- Not to allow further deterioration of the level of service of the existing roadway capacity by allowing indiscriminate densification of road adjacent landuse pattern.
- The major intersections should be kept free from non-motorized vehicles. For the relocation of it, further details study is required.
- Submission of completion report like permission report should be mandatory by RAJUK or any other concern organization for any development project initiated by private, individual or by public which could prevent to break the permissible limit and encourage following the rules and regulation.
- DCC should take completion report in black and white before taking maintenance responsibility.
- There is an urgent need to develop separate policy and controlling mechanism to control the haphazard development of the low land.
- There must be a restriction on the import of vehicles for private use, but import of buses and mini-buses should be encouraged.
- There should have a policy/regulation for mandatory development of their own access road by own finance for any large structure developer as like as parking space regulation.
- Bank loans for purchase of private cars should be discouraged. Major companies should reduce their expenses by having picked up and drop facilities through micro-bus.

8.3.2 Medium Term Measures

- To ensure sustainable and efficient development details land use and transportation plan should be developed on the basis of details observation, analysis and future requirements with a coordinated and integrated approach of different organization.
- Physically separated service road must be constructed along the both sides of the selected section of three major gate ways.
- Physically separated exclusive bus lane should be provided on all the primary roads in Dhaka city without any compromising for ensuring mobility, safety, efficiency as well as sustainability of the majority of the people and to improve the mass transit facilities of the entire transportation system.

- Alternative gate way should be find out to increase the connectivity of the city with the other part of the country and to easy and quick enter and exist of the city.
- To encourage the development of the city in all directions as well as to provide easy accessibility of the all parts city, more than one ring roads/circular roads need to be constructed circulating of the entire peripheral area of the city.
- To ensure development of well defined functional local roadway system, land division criteria should be such that each property would be accessible by emergency vehicles and at least a Fire brigade vehicle and an Ambulance can get in side by side. In case of R/A development preference should be given to organized land developer than the individual developer.
- To plan primary and secondary road network along with to prepare side road entry plan to facilitate planned development of local road network and thereby to ensure accessibility of the localities particularly those situated behind the roadside frontage development.
- As the fringe areas are the crossroads of the urban area and the rural area where the development becomes very fast, those areas should need a comprehensive planning effort to regulate the unplanned growth.
- Alternative routes should be facilitated by constructing some of the east-west missing link to provide continuous connectivity with east part to west part of the city and to distribute traffic in all direction.
- Relocate of existing ICD and realignment rail line to eliminate the conflict between road and rail through reducing the level crossing.
- High occupancy vehicle like Bus rapid transit (BRT) and commuter train service should be introduced to recover the existing demand and near future demand.
- Travel demand or exposure should be controlled by increasing ICT or telecommunications facilities. The development of telecommunication infrastructure should be given extra attention and take necessary steps to make it accessible to mass public.
- Interchange facility between different intercity and intracity modes would be increased through providing connectivity bus service, developing intra city bus terminal facility or bus circulating facility at the inter city terminal, constructing connecting road between the landing station and city center etc.
- Finally it is recommended that keeping in view the rapid growth of urbanization in Bangladesh, Government should work out a long term plan to develop large capacity rail based mass transit system (monorail and underground railway) along high-density corridors in major urban areas, with priority action in the context of Dhaka.
- The garments industries should be cleared out from the city.

8.3.3 Policy Measures

- Setting Planning Goals: The authorities must formulate a Development Plan for Dhaka city with well identified social goals. Planning must be for the people and not just for the privileged ones. The future of Dhaka is very closely linked with national urban planning. Thus planning for Dhaka must be in conformity with national physical plans or economic plans. Since the government of Bangladesh has already decided to decentralize urban development and create growth incentives in smaller urban centres, the growth of Dhaka may be contained within a limited scale, otherwise the city hill emerge as a large metropolis with more serious problems. The sooner this is realized, the better.

- Development and maintenance should be under one agency and any land development should maintain the sequence.
- It is imperative to integrated transport and land use planning and the responsibility for such an integrated plan should be given to a single authority to ensure its success.
- For better utilization of manpower and to develop responsible vast experience group of expert, large scale capital intensive road infrastructure projects should be developed under a single organization and in this regard this could be done by a single lead agency i.e. city authority.
- To prepare roadway densification plan and accordingly restrict conflicting roadside development works.
- Specific policy regarding future roadside development projects particularly those would be initiated by DCC and RAJUK with their own finance to adopt EIA and TIA studies before undertaking the project. Most importantly, in consideration of scarcity of road adjacent empty space as well as acute shortage of different transport facilities within the built-up areas, in the first place DCC and RAJUK should be discouraged to construct any road adjacent commercial project on the government land before ensuring road widening works, providing adequate on-street parking facilities, bus-lays, para-transit waiting place etc.
- The role of private sector should clearly define. In order to secure competitive access to industrialised economies and global trade generally and also to exploit the potentials of providing transport services to the sub-region, needs an active participation of private sector to bring in efficiencies of service operation and access to capital.
- Reformation of concern institution and decentralization of responsibilities and proper dissemination of resources to the local authorities should be ensured by appropriate policy; building capacity of all sectors (institutions, groups and individuals) to contribute fully to decision-making and urban development processes through proper training and exchange; and facilitating networking at all levels of different organizations.
- Controlling body or coordinating body like DTCB should be strengthen or city government could be established. The adoption of a good governance policy, incorporating transparency, accountability, predictability, and beneficiary participation are becoming the governance issues to bring in to strengthen the structure of local government for Dhaka.

8.3.4 Long Term Ultimate Measures

Dhaka is considered as one of the densely populated mega city of the world. Since the road network system of the city is not planned or did not build to cater the needs of present days and future requirements, it becomes now difficult to upgrade roads with proper realigning or widening. Because, major portion of the roads now pass through densely populated area and numerous permanent residential and commercial multi storied buildings are constructed on both sides of the roads and the city is growing with a pattern of decaying growth. For the causes of such decaying growth, what we have we are loosing day by day. In other word, we have little, we do little and that we have, we are deteriorating.

So, it can be said that at present, the city is affected as a chronic cancer affected patient whose recovery is ultimately impossible. Most of the cell are already affected and exaggerated from larger to larger with the passing of time and eventually it will die. So, all the investment to survive this is just to make delay of its death, not to full recovery. However, so many investments could be invested, all the investment will sack by this patient as a black hole and ultimately it will die. The short time and medium time recommendations are only for the

survival of the city for few years, not the ultimate solution of the problems of the city. The weaknesses of the city which have developed in the last 100 years stands in such a position which are irreversible and come back or renewal from this position is almost impossible.

Therefore, like many other countries of the world viz. Pakistan, India, South Korea etc. the capital city of Bangladesh should be gradually shifted in a suitable location of the country where sufficient build able land is available and connectivity with different part of the country by different modes is quite well.

8.4 LIMITATIONS OF THE STUDY AND RECOMMENDATIONS FOR FUTURE STUDY

In birds eye view, it was seems that the study area and topics covered a wide range area and in-depth evaluation to fulfill the objectives in this topics was a complicated and difficult issue due to the scarcity of data, manpower, resource, expertise and time constrains. To overcome these difficulties, the study was elaborated in breath but in depth it is shallow. If the following important aspects and issues could have been considered in this research study, it would have been more comprehensive and complete.

This study in particular on the basis of secondary data due to wide area coverage and for the lack of time, resource and complexity of the collection of primary data. Also, in this study, more emphasis has been made on the qualitative data base not quantitative data. The study would be more reliable and authentic if this study is carried out considering primary data with quantitative analysis by segregating is different phase and sectors or areas which are particularly recommended for future study. In this study, mostly depends on the secondary data to evaluate the land use planning and development weaknesses. Sector base or zonal base micro level land use data could not be analyze comprehensively due to lack of time, resource and complexity to collection. Therefore separate studies are required for these analyses to explore the micro-level land use inherent weakness. Impact of road side and junction corner development was not evaluated in a comprehensive and quantified manner.

More parameters like inherent weakness of sub-sector development like commercial and industrial development, residential development, inhabitants responsibilities and their behaviors with impact of land use and transport development and management, private sectors and NGOs weakness etc. Infrastructural requirements and economic feasibility of the implementation of modern transport modes and systems are not evaluated in this study for which comprehensive studies are required which are recommended in this study.

The study has been performed with particular emphasis on the role of road based passenger transport system in Dhaka. Similar studies should be carried out to investigate the significance, potentiality of the introduction of modern city railways and waterways system in passenger transport to survive the city as a capital city. Literature review reveals that land use and transportation infrastructure have geometric, maintenance, management, functional and operational effect and configuration. In this study, particular emphasis has been made on the functional and operational aspects. Geometric, maintenance aspects should be considered with due considered to evaluate more comprehensive and fruitful findings.

Taking into consideration of above issues and items, in future sector wise studies may be conducted to have more authentic, reliable, definite, comprehensive and wide-ranging findings and for subsequent recommendations and decisions.

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APPENDICES

APPENDIX A

ROAD NETWORK DATABASE ANALYSIS

Road Data Summary of Zone-1

Road Type	Total Rd Len (km)	Avg Pavt Wd (m)	Road Width			Area		% of road	
			Min. (m)	Max. (m)	Avg. (m)	Pavt (Sq. km)	Road (Sq. km)	Length	Road Area
Primary	3.03	22.93	23.90	36.50	29.13	0.065	0.085	1.77	8.68
Secondary	8.92	12.35	7.95	23.00	14.92	0.118	0.148	5.22	15.24
Connector	15.00	8.00	6.10	16.20	9.47	0.111	0.133	8.77	13.63
Local	100.90	4.16	3.10	13.50	4.73	0.443	0.510	59.01	52.40
Narrow	43.14	1.93	0.80	3.05	2.12	0.090	0.098	25.23	10.06
Total =	**170.99**					**0.827**	**0.974**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod Rd Len (km)	% of Road	Accessible Rd km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m				
0.000	3.030	3.030	3.030	1.600	0.750	>24.5	1.600	0.94	74.81
0.000	8.920	8.470	4.665	0.000	0.000	>18<=24.5	6.095	3.56	
0.000	15.003	8.016	0.000	0.000	0.000	>8.25<=18	17.229	10.08	**% Acc. Rd**
53.046	47.856	5.408	0.000	0.000	0.000	>4.75<=8.25	49.885	29.17	43.75
43.135	0.000	0.000	0.000	0.000	0.000	<4.75m	96.181	56.25	
96.181	**74.809**	**24.924**	**7.695**	**1.600**	**0.750**	**Total**	**170.990**	**100**	

Pavement Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area (sq. km)	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m				
0.000	0.065	0.065	0.065	0.041	0.024	>24.5	0.041	5.01	0.55
0.000	0.118	0.114	0.075	0.000	0.000	>18<=24.5	0.098	11.90	
0.000	0.111	0.067	0.000	0.000	0.000	>8.25<=18	0.146	17.61	**% Acc. Rd**
0.187	0.255	0.039	0.000	0.000	0.000	>4.75<=8.25	0.264	31.99	66.50
0.090	0.000	0.000	0.000	0.000	0.000	<4.75m	0.277	33.50	
0.277	**0.550**	**0.285**	**0.140**	**0.041**	**0.024**	**Total**	**0.827**	**100**	

Road Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area (sq. km)	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m				
0.000	0.085	0.085	0.085	0.050	0.027	>24.5	0.050	5.17	0.67
0.000	0.148	0.145	0.099	0.000	0.000	>18<=24.5	0.133	13.70	
0.000	0.133	0.083	0.000	0.000	0.000	>8.25<=18	0.183	18.82	**% Acc. Rd**
0.206	0.305	0.055	0.000	0.000	0.000	>4.75<=8.25	0.303	31.12	68.81
0.098	0.000	0.000	0.000	0.000	0.000	<4.75m	0.304	31.19	
0.304	**0.670**	**0.367**	**0.184**	**0.050**	**0.027**	**Total**	**0.974**	**100**	

Road Data Summary of Zone-2

Road Type	Total Rd Len (km)	Avg Pavt Wd (m)	Road Width			Area		% of road	
			Min. (m)	Max. (m)	Avg. (m)	Pavt (Sq. km)	Road (Sq. km)	Length	Road Area
Primary	0.48	17.50	18.00	18.00	18.00	0.008	0.009	0.48	1.54
Secondary	9.25	12.80	6.20	26.00	13.40	0.119	0.126	9.17	22.50
Connector	7.53	9.49	5.20	18.00	9.99	0.073	0.077	7.47	13.76
Local	56.71	4.63	3.10	15.20	4.93	0.270	0.288	56.22	51.47
Narrow	26.90	1.86	0.90	3.00	2.06	0.055	0.060	26.67	10.73
Total =	**100.866**					**0.525**	**0.559**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod. Rd Len	% of Road	Acces Rd
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(km)		
0.00	0.48	0.48	0	0	0	>24.5	0.31	0.31	43.84
0.00	9.25	7.57	2.685	0.31	0	>18<=24.5	2.38	2.35	
0.00	7.53	4.59	0	0	0	>8.25<=18	13.37	13.25	**% Acc. Rd**
30.13	26.58	3.412	0	0	0	>4.75<=8.25	27.79	27.55	43.46
26.90	0	0	0	0	0	<4.75m	57.03	56.54	
57.03	**43.84**	**16.052**	**2.685**	**0.31**	**0**	**Total**	**100.866**	**100**	

Pavement Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.008	0.008	0.000	0.000	0.000	>24.5	0.008	1.48	0.37
0.000	0.119	0.108	0.054	0.008	0.000	>18<=24.5	0.046	8.81	
0.000	0.073	0.054	0.000	0.000	0.000	>8.25<=18	0.151	28.67	**% Acc. Rd**
0.105	0.165	0.035	0.000	0.000	0.000	>4.75<=8.25	0.161	30.59	69.55
0.055	0.000	0.000	0.000	0.000	0.000	<4.75m	0.160	30.45	
0.160	**0.365**	**0.205**	**0.054**	**0.008**	**0.000**	**Total**	**0.525**	**100**	

Road Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.009	0.009	0.000	0.000	0.000	>24.5	0.008	1.44	0.39
0.000	0.126	0.114	0.057	0.008	0.000	>18<=24.5	0.049	8.70	
0.000	0.077	0.057	0.000	0.000	0.000	>8.25<=18	0.160	28.62	**% Acc. Rd**
0.112	0.175	0.037	0.000	0.000	0.000	>4.75<=8.25	0.170	30.41	69.17
0.060	0.000	0.000	0.000	0.000	0.000	<4.75m	0.172	30.83	
0.172	**0.387**	**0.217**	**0.057**	**0.008**	**0.000**	**Total**	**0.559**	**100**	

Road Data Summary of Zone-3

Road Type	Total Rd Len (km)	Avg Pavt Wd (m)	Road Width			Area		% of road	
			Min. (m)	Max. (m)	Avg. (m)	Pavt (Sq. km)	Road (Sq. km)	Length	Road Area
Primary	3.68	16.38	13.30	26.60	20.53	0.059	0.075	3.75	12.59
Secondary	14.90	9.13	9.50	15.10	12.09	0.104	0.151	15.18	25.55
Connector	19.97	6.23	4.05	12.00	6.74	0.134	0.144	20.35	24.40
Local	19.04	5.08	4.00	21.00	5.48	0.101	0.110	19.40	18.52
Narrow	40.56	2.29	1.00	4.40	2.56	0.101	0.112	41.33	18.93
Total =	**98.149**					**0.500**	**0.592**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod Rd Len (km)	% of Road	Acces. Rd
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m				
0.00	3.68	3.68	2.83	0.585	0	>24.5	0.59	0.60	48.15
0.00	14.895	14.895	0	0	0	>18<=24.5	2.55	2.59	
1.95	18.02	4.35	0	0	0	>8.25<=18	21.42	21.82	**% Acc. Rd**
7.49	11.552	1.62	0.3	0	0	>4.75<=8.25	23.60	24.05	49.06
40.56	0	0	0	0	0	<4.75m	50.00	50.94	
50.00	**48.147**	**24.545**	**3.13**	**0.585**	**0**	**Total**	**98.149**	**100**	

Pavement Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area (sq. km)	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m				
0.000	0.059	0.059	0.051	0.013	0.000	>24.5	0.013	2.63	0.36
0.000	0.104	0.104	0.000	0.000	0.000	>18<=24.5	0.043	8.66	
0.007	0.126	0.046	0.000	0.000	0.000	>8.25<=18	0.170	34.11	**% Acc. Rd**
0.029	0.072	0.017	0.005	0.000	0.000	>4.75<=8.25	0.135	27.06	72.45
0.101	0.000	0.000	0.000	0.000	0.000	<4.75m	0.138	27.55	
0.138	**0.362**	**0.227**	**0.056**	**0.013**	**0.000**	**Total**	**0.500**	**100**	

Road Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.075	0.075	0.063	0.016	0.000	>24.5	0.016	2.63	0.44
0.000	0.151	0.151	0.000	0.000	0.000	>18<=24.5	0.054	9.12	
0.008	0.136	0.049	0.000	0.000	0.000	>8.25<=18	0.225	37.94	**% Acc. Rd**
0.032	0.078	0.019	0.006	0.000	0.000	>4.75<=8.25	0.146	24.61	74.29
0.112	0.000	0.000	0.000	0.000	0.000	<4.75m	0.152	25.71	
0.152	**0.440**	**0.294**	**0.070**	**0.016**	**0.000**	**Total**	**0.592**	**100**	

Road Data Summary of Zone-4

Road Type	Total Rd Len (km)	Avg Pavt Wd (m)	Road Width			Area		% of road	
			Min. (m)	Max. (m)	Avg. (m)	Pavt (Sq. km)	Road (Sq. km)	Length	Road Area
Primary	10.10	24.75	26.27	36.00	30.09	0.239	0.289	6.07	18.81
Secondary	18.33	18.10	13.15	32.00	22.74	0.350	0.438	11.02	28.55
Connector	17.75	8.91	5.20	31.00	11.66	0.143	0.188	10.67	12.24
Local	66.57	4.99	2.40	14.70	6.94	0.340	0.453	40.04	29.55
Narrow	53.51	2.73	1.00	6.20	2.95	0.155	0.166	32.18	10.84
Total =	**166.263**					**1.227**	**1.534**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod Rd Len	% of Road	Acces Rd
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(km)		
0.00	10.1	10.1	10.1	10.1	4.7	>24.5	21.43	12.89	99.79
0.00	18.33	18.33	15.02	10.785	4.485	>18<=24.5	5.90	3.55	
0.00	17.748	10.47	2.215	0.545	0.545	>8.25<=18	25.33	15.23	**% Acc. Rd**
13.21	53.368	13.761	0	0	0	>4.75<=8.25	47.13	28.35	60.02
53.26	0.247	0	0	0	0	<4.75m	66.47	39.98	
66.47	**99.793**	**52.661**	**27.335**	**21.43**	**9.73**	**Total**	**166.263**	**100**	

Pavement Area (sq. km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area (sq. km)	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m				
0.000	0.239	0.239	0.239	0.239	0.119	>24.5	0.492	40.10	1.02
0.000	0.350	0.350	0.311	0.239	0.113	>18<=24.5	0.100	8.11	
0.000	0.143	0.100	0.042	0.014	0.014	>8.25<=18	0.190	15.51	**% Acc. Rd**
0.051	0.288	0.092	0.000	0.000	0.000	>4.75<=8.25	0.240	19.54	83.27
0.154	0.001	0.000	0.000	0.000	0.000	<4.75m	0.205	16.73	
0.205	**1.022**	**0.782**	**0.592**	**0.492**	**0.245**	**Total**	**1.227**	**100**	

Road Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area (sq. km)	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m				
0.000	0.289	0.289	0.289	0.289	0.147	>24.5	0.603	39.30	1.31
0.000	0.438	0.438	0.390	0.297	0.139	>18<=24.5	0.129	8.41	
0.000	0.188	0.139	0.053	0.017	0.017	>8.25<=18	0.276	17.99	**% Acc. Rd**
0.055	0.398	0.142	0.000	0.000	0.000	>4.75<=8.25	0.306	19.93	85.63
0.165	0.001	0.000	0.000	0.000	0.000	<4.75m	0.221	14.37	
0.221	**1.314**	**1.008**	**0.732**	**0.603**	**0.303**	**Total**	**1.534**	**100**	

Road Data Summary of Zone-5

Road Type	Total Rd Len (km)	Avg Pavt Wd (m)	Road Width			Area		% of road	
			Min. (m)	Max. (m)	Avg. (m)	Pavt (Sq. km)	Road (Sq. km)	Length	Road Area
Primary	14.72	23.47	23.10	37.00	29.51	0.354	0.445	11.77	23.52
Secondary	22.36	21.42	16.20	40.10	27.07	0.451	0.573	17.87	30.26
Connector	30.87	10.95	4.35	31.50	13.72	0.346	0.439	24.68	23.18
Local	38.92	7.36	3.50	28.25	8.23	0.324	0.373	31.11	19.68
Narrow	18.22	3.18	0.95	8.00	3.28	0.060	0.064	14.57	3.36
Total =	**125.089**					**1.535**	**1.893**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod Rd Len	% of Road	Acces Rd
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(km)		
0.00	14.723	14.723	14.723	13.562	10.062	>24.5	25.57	20.44	97.22
0.00	22.358	22.358	17.858	8.393	8.193	>18<=24.5	18.82	15.04	
0.39	30.477	26.039	6.657	3.405	1.84	>8.25<=18	34.64	27.69	**% Acc. Rd**
10.17	28.748	15.907	5.148	0.21	0.21	>4.75<=8.25	18.20	14.55	77.72
17.30	0.916	0	0	0	0	<4.75m	27.87	22.28	
27.87	**97.222**	**79.027**	**44.386**	**25.57**	**20.305**	**Total =**	**125.089**	**100**	

Pavement Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.354	0.354	0.354	0.332	0.264	>24.5	0.652	42.48	1.43
0.000	0.451	0.451	0.399	0.230	0.226	>18<=24.5	0.326	21.22	
0.002	0.344	0.319	0.140	0.084	0.052	>8.25<=18	0.347	22.59	**% Acc. Rd**
0.044	0.280	0.200	0.085	0.005	0.005	>4.75<=8.25	0.109	7.08	93.36
0.056	0.004	0.000	0.000	0.000	0.000	<4.75m	0.102	6.64	
0.102	**1.433**	**1.325**	**0.978**	**0.652**	**0.547**	**Total**	**1.535**	**100.00**	

Road Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.445	0.445	0.445	0.418	0.327	>24.5	0.808	42.66	1.79
0.000	0.573	0.573	0.498	0.287	0.282	>18<=24.5	0.407	21.49	
0.002	0.437	0.412	0.164	0.097	0.057	>8.25<=18	0.465	24.54	**% Acc. Rd**
0.044	0.329	0.249	0.107	0.006	0.006	>4.75<=8.25	0.112	5.93	94.63
0.056	0.007	0.000	0.000	0.000	0.000	<4.75m	0.102	5.37	
0.102	**1.792**	**1.679**	**1.215**	**0.808**	**0.672**	**Total**	**1.893**	**100.00**	

Road Data Summary of Zone-6

Road Type	Total Rd Len (km)	Avg Pavt Wd (m)	Road Width			Area		% of road	
			Min. (m)	Max. (m)	Avg. (m)	Pavt (Sq. km)	Road (Sq. km)	Length	Road Area
Primary	4.78	26.00	29.50	46.00	37.30	0.119	0.158	3.98	13.01
Secondary	7.10	22.80	12.30	58.05	29.42	0.160	0.215	5.91	17.74
Connector	38.40	5.88	4.45	22.70	9.17	0.241	0.374	31.97	30.83
Local	48.94	5.19	3.60	29.10	7.76	0.255	0.390	40.75	32.16
Narrow	20.89	2.59	1.00	5.70	3.36	0.058	0.076	17.39	6.25
Total =	**120.102**					**0.833**	**1.212**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod Rd Len (km)	% of Road	Acces Rd
<4.75m	**>=4.75m**	**>8.25m**	**>18m**	**>24.5m**	**>27m**				
0.00	4.78	4.78	4.78	4.78	4.78	>24.5	9.27	7.72	96.12
0.00	7.095	7.095	6.55	4.242	4.242	>18<=24.5	5.97	4.97	
2.43	35.969	19.448	2.415	0	0	>8.25<=18	34.61	28.82	**% Acc. Rd**
3.04	45.898	18.534	1.501	0.25	0.25	>4.75<=8.25	46.26	38.52	80.03
18.51	2.378	0	0	0	0	<4.75m	23.98	19.97	
23.98	**96.12**	**49.857**	**15.246**	**9.272**	**9.272**	**Total**	**120.102**	**100**	

Pavement Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area (sq. km)	% of Road	Accessible Rd sq. km**
<4.75m	**>=4.75m**	**>8.25m**	**>18m**	**>24.5m**	**>27m**				
0.000	0.119	0.119	0.119	0.119	0.119	>24.5	0.241	28.95	0.76
0.000	0.160	0.160	0.156	0.120	0.120	>18<=24.5	0.081	9.76	
0.009	0.232	0.152	0.031	0.000	0.000	>8.25<=18	0.224	26.92	**% Acc. Rd**
0.010	0.245	0.115	0.017	0.002	0.002	>4.75<=8.25	0.217	26.05	91.68
0.050	0.008	0.000	0.000	0.000	0.000	<4.75m	0.069	8.32	
0.069	**0.764**	**0.547**	**0.323**	**0.241**	**0.241**	**Total**	**0.833**	**100**	

Road Area (sq. km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.158	0.158	0.158	0.158	0.158	>24.5	0.324	26.76	1.12
0.000	0.215	0.215	0.208	0.159	0.159	>18<=24.5	0.125	10.35	
0.011	0.363	0.253	0.052	0.000	0.000	>8.25<=18	0.375	30.97	**% Acc. Rd**
0.013	0.377	0.200	0.032	0.007	0.007	>4.75<=8.25	0.299	24.66	92.74
0.064	0.012	0.000	0.000	0.000	0.000	<4.75m	0.088	7.26	
0.088	**1.124**	**0.825**	**0.450**	**0.324**	**0.324**	**Total**	**1.212**	**100**	

Road Data Summary of Zone-7

Road Type	Total Rd Len	Avg Pavt Wd	Road Width			Area		% of road	
			Min.	Max.	Avg.	Pavt	Road		
	(km)	(m)	(m)	(m)	(m)	(Sq. km)	(Sq. km)	Length	Road Area
Primary	11.10	26.30	30.53	32.15	31.34	0.294	0.349	8.18	31.40
Secondary	8.80	21.87	19.15	38.40	26.48	0.198	0.239	6.49	21.56
Connector	16.65	5.69	4.20	15.05	7.14	0.092	0.116	12.27	10.40
Local	44.92	4.67	4.00	12.00	4.90	0.211	0.223	33.12	20.05
Narrow	54.16	3.22	1.50	5.40	3.26	0.181	0.184	39.94	16.58
Total =	**135.627**					**0.976**	**1.111**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod Rd Len	% of Road	Acces Rd
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(km)		
0.00	11.1	11.1	11.1	11.1	11.1	>24.5	15.10	11.13	56.67
0.00	8.8	8.8	8.8	4	4	>18<=24.5	4.80	3.54	
5.15	11.495	3.715	0	0	0	>8.25<=18	4.21	3.10	**% Acc. Rd**
20.84	24.075	0.49	0	0	0	>4.75<=8.25	32.57	24.01	41.78
52.96	1.2	0	0	0	0	<4.75m	78.96	58.22	
78.96	**56.67**	**24.105**	**19.9**	**15.1**	**15.1**	**Total**	**135.627**	**100**	

Pavement Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.294	0.294	0.294	0.294	0.294	>24.5	0.411	42.06	0.69
0.000	0.198	0.198	0.198	0.116	0.116	>18<=24.5	0.082	8.38	
0.023	0.069	0.025	0.000	0.000	0.000	>8.25<=18	0.027	2.77	**% Acc. Rd**
0.089	0.122	0.002	0.000	0.000	0.000	>4.75<=8.25	0.169	17.32	70.54
0.176	0.004	0.000	0.000	0.000	0.000	<4.75m	0.288	29.46	
0.288	**0.689**	**0.519**	**0.492**	**0.411**	**0.411**	**Total**	**0.976**	**100.00**	

Road Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.349	0.349	0.349	0.349	0.349	>24.5	0.486	43.72	0.82
0.000	0.239	0.239	0.239	0.137	0.137	>18<=24.5	0.103	9.25	
0.023	0.093	0.042	0.000	0.000	0.000	>8.25<=18	0.047	4.25	**% Acc. Rd**
0.089	0.134	0.005	0.000	0.000	0.000	>4.75<=8.25	0.185	16.67	73.89
0.178	0.006	0.000	0.000	0.000	0.000	<4.75m	0.290	26.11	
0.290	**0.821**	**0.636**	**0.588**	**0.486**	**0.486**	**Total**	**1.111**	**100.00**	

Road Data Summary of Zone-8

Road Type	Total Rd Len (km)	Avg Pavt Wd (m)	Road Width			Area		% of road	
			Min. (m)	Max. (m)	Avg. (m)	Pavt (Sq. km)	Road (Sq. km)	Length	Road Area
Primary	2.50	24.00	36.00	36.00	36.00	0.060	0.090	1.57	6.76
Secondary	7.81	20.40	23.00	34.50	28.54	0.150	0.227	4.91	17.08
Connector	21.34	7.81	5.60	21.05	10.46	0.168	0.237	13.42	17.84
Local	69.84	4.94	3.15	505.00	7.75	0.338	0.499	43.91	37.45
Narrow	57.55	3.28	0.00	15.00	4.86	0.191	0.278	36.18	20.87
Total =	**159.046**					**0.908**	**1.331**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod Rd Len	% of Road	Acces. Rd
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(km)		
0.00	2.5	2.5	2.5	2.5	2.5	>24.5	9.17	5.76	105.31
0.00	7.81	7.81	7.81	6.56	6.16	>18<=24.5	3.14	1.97	
0.00	21.343	13.047	1.89	0	0	>8.25<=18	25.33	15.93	**% Acc. Rd**
17.73	52.111	10.277	0.105	0.105	0.105	>4.75<=8.25	67.67	42.55	66.21
36.00	21.547	4.003	0	0	0	<4.75m	53.74	33.79	
53.74	**105.311**	**37.637**	**12.305**	**9.165**	**8.765**	**Total**	**159.046**	**100**	

Pavement Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.060	0.060	0.060	0.060	0.060	>24.5	0.186	20.54	0.72
0.000	0.150	0.150	0.150	0.126	0.116	>18<=24.5	0.044	4.88	
0.000	0.168	0.120	0.021	0.000	0.000	>8.25<=18	0.169	18.58	**% Acc. Rd**
0.074	0.264	0.055	0.001	0.001	0.001	>4.75<=8.25	0.317	34.94	78.94
0.117	0.074	0.014	0.000	0.000	0.000	<4.75m	0.191	21.06	
0.191	**0.716**	**0.399**	**0.231**	**0.186**	**0.176**	**Total**	**0.908**	**100**	

Road Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.090	0.090	0.090	0.090	0.090	>24.5	0.342	25.66	1.13
0.000	0.227	0.227	0.227	0.199	0.188	>18<=24.5	0.068	5.10	
0.000	0.237	0.176	0.039	0.000	0.000	>8.25<=18	0.290	21.79	**% Acc. Rd**
0.075	0.424	0.166	0.053	0.053	0.053	>4.75<=8.25	0.426	32.00	84.56
0.131	0.147	0.041	0.000	0.000	0.000	<4.75m	0.206	15.44	
0.206	**1.126**	**0.700**	**0.410**	**0.342**	**0.331**	**Total**	**1.331**	**100**	

Road Data Summary of Zone-9

Road Type	Total Rd Len (km)	Avg Pavt Wd (m)	Road Width			Area		% of road	
			Min. (m)	Max. (m)	Avg. (m)	Pavt (Sq. km)	Road (Sq. km)	Length	Road Area
Primary	11.06	23.47	31.90	40.00	36.08	0.258	0.396	7.50	19.07
Secondary	10.75	18.81	12.05	43.20	26.72	0.210	0.293	7.29	14.10
Connector	48.69	6.88	5.20	25.65	13.85	0.333	0.662	33.04	31.86
Local	70.52	5.17	3.10	29.90	9.99	0.364	0.702	47.86	33.81
Narrow	6.34	2.95	1.60	12.05	3.74	0.019	0.024	4.30	1.16
Total =	**147.35**					**1.184**	**2.078**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod Rd Len (km)	% of Road	Acces. Rd
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m				
0.00	11.055	11.055	11.055	11.055	11.055	>24.5	20.53	13.94	137.26
0.00	10.746	10.746	8.258	6.883	6.883	>18<=24.5	10.42	7.07	
0.00	48.688	41.86	7.299	1	0	>8.25<=18	70.94	48.14	**% Acc. Rd**
4.25	66.264	38.022	4.339	1.596	0.242	>4.75<=8.25	35.37	24.00	93.15
5.84	0.507	0.208	0	0	0	<4.75m	10.09	6.85	
10.09	**137.26**	**101.891**	**30.951**	**20.534**	**18.18**	**Total**	**147.35**	**100**	

Pavement Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area (sq. km)	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m				
0.000	0.258	0.258	0.258	0.258	0.258	>24.5	0.447	37.75	1.15
0.000	0.210	0.210	0.194	0.165	0.165	>18<=24.5	0.105	8.88	
0.000	0.333	0.298	0.067	0.005	0.000	>8.25<=18	0.439	37.09	**% Acc. Rd**
0.015	0.350	0.224	0.033	0.019	0.004	>4.75<=8.25	0.161	13.63	97.35
0.017	0.002	0.001	0.000	0.000	0.000	<4.75m	0.031	2.65	
0.031	**1.152**	**0.991**	**0.552**	**0.447**	**0.427**	**Total**	**1.184**	**100**	

Road Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.396	0.396	0.396	0.396	0.396	>24.5	0.686	33.04	2.04
0.000	0.293	0.293	0.257	0.224	0.224	>18<=24.5	0.219	10.52	
0.000	0.662	0.617	0.156	0.025	0.000	>8.25<=18	0.907	43.67	% Acc. Rd
0.018	0.685	0.504	0.095	0.042	0.007	>4.75<=8.25	0.227	10.95	98.18
0.020	0.004	0.002	0.000	0.000	0.000	<4.75m	0.038	1.82	
0.038	**2.040**	**1.812**	**0.905**	**0.686**	**0.627**	**Total**	**2.078**	**100**	

Road Data Summary of Zone-10

Road Type	Total Rd Len	Avg Pavt Wd	Road Width			Area		% of road	
			Min.	Max.	Avg.	Pavt	Road		
	(km)	(m)	(m)	(m)	(m)	(Sq. km)	(Sq. km)	Length	Road Area
Primary	0.00	na	0.00	0.00	na	0.000	0.000	0.00	0.00
Secondary	0.00	na	0.00	0.00	na	0.000	0.000	0.00	0.00
Connector	5.16	8.37	9.50	33.48	20.68	0.042	0.100	8.25	12.37
Local	57.38	4.65	3.60	33.50	11.07	0.288	0.707	91.75	87.63
Narrow	0.00	na	0.00	0.00	na	0.000	0.000	0.00	0.00
Total =	**62.541**					**0.330**	**0.807**	**100.00**	**100.00**

Length (km) Under Diff. Width of Road						Road Type*	Mod Rd Len	% of Road	Accb. Rd**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(km)		
0.00	0	0	0	0	0	>24.5	3.60	5.76	62.44
0.00	0	0	0	0	0	>18<=24.5	5.94	9.49	
0.00	5.158	5.158	2.233	1.688	1.195	>8.25<=18	51.32	82.05	% Acc. Rd
0.10	57.283	55.699	7.307	1.915	1.915	>4.75<=8.25	1.58	2.53	99.84
0.00	0	0	0	0	0	<4.75m	0.10	0.16	
0.10	**62.441**	**60.857**	**9.54**	**3.603**	**3.11**	**Total**	**62.541**	**100**	

Pavement Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.000	0.000	0.000	0.000	0.000	>24.5	0.046	13.92	0.33
0.000	0.000	0.000	0.000	0.000	0.000	>18<=24.5	0.038	11.39	
0.000	0.042	0.042	0.025	0.020	0.014	>8.25<=18	0.238	72.27	**% Acc. Rd**
0.000	0.287	0.280	0.059	0.026	0.026	>4.75<=8.25	0.008	2.33	99.91
0.000	0.000	0.000	0.000	0.000	0.000	<4.75m	0.000	0.09	
0.000	**0.329**	**0.322**	**0.083**	**0.046**	**0.040**	**Total**	**0.330**	**100**	

Road Area (sq.km) Under Diff. Width of Road						Road Type*	Mod. Pav. Area	% of Road	Accessible Rd sq. km**
<4.75m	>=4.75m	>8.25m	>18m	>24.5m	>27m		(sq. km)		
0.000	0.000	0.000	0.000	0.000	0.000	>24.5	0.112	13.86	0.81
0.000	0.000	0.000	0.000	0.000	0.000	>18<=24.5	0.113	14.05	
0.000	0.100	0.100	0.063	0.051	0.038	>8.25<=18	0.570	70.64	**% Acc. Rd**
0.000	0.707	0.695	0.162	0.061	0.061	>4.75<=8.25	0.011	1.40	99.96
0.000	0.000	0.000	0.000	0.000	0.000	<4.75m	0.000	0.04	
0.000	**0.807**	**0.795**	**0.225**	**0.112**	**0.099**	**Total**	**0.807**	**100**	

* According to road width

APPENDIX B

QUESTIONNAIRE SURVEY ON RICKSHAW PULLER
(Part I)

Name of the Surveyor: Location: Date

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01. bvg-

02. evox (†Rjv)-

03. XvKv evmv-

04. wiKmvi wU wb‡Ri bv fvov -----(K) wb‡Ri (L) fvov

05. hw` wb‡Ri nq: Z‡e KZ w`‡q wK‡b‡Qb-

06. hw` fvov nq: cwZ w`‡bi Rgv KZ-

07. KZ eQi wiKmv Pvjvb-

08. wiKmv Pvjv‡biv c‡e wK Ki‡Zb-

09. ‡Kb wiKmv Pvjv‡bv ïi“ Ki‡jb-

10. ‡Kvb cwk¶b wb‡q‡Qb-

11. cwZ w`†b wK iKg Avq nq-

12. wiKkvi AwiwRbvj b¤i Av‡Q---

QUESTIONNAIRE SURVEY ON RICKSHAW PULLER
(Part II)

13. iv¯vq AvBb Kvbb mvBb wmMbvj †ev‡Sb (K) m¤úb (L) wKQ wKQ (M) wKQ bv

K. GB mvBbwUi A_ wK?

N. GB mvBbwU Øviv wK †evSvq?

L. GB mvBbwU ej‡Z wK †ev‡Sb?

O. GB mvBbwU ‡Kb †`Iqv nq?

M. GB mvBbwU ej‡Z wK †ev‡Sb?

P. GB gwKswU Øviv wK †evSvb nq?

14. covïbv ‡Kvb chš K‡i‡Qb?

APPENDIX C

TERMINAL INVENTORY

Gabtoli Bus Terminal

Table C1: Mode of Travel in Gabtoli Terminal

Mode type	Pre Travel		Post Travel	
	Survey Passenger	%	Survey Passenger	%
8 No Bus	270	57%	240	35%
7 No Bus	60	13%	150	22%
Leguna	42	9%	112	16%
Rajanigandha	66	14%	132	19%
Rickshaw	6	1%	4	1%
CNG	12	3%	27	4%
Taxi	6	1%	6	1%
Other BUS	12	3%	24	3%
Total	474	100%	695	100%

Source: Field survey, 2009

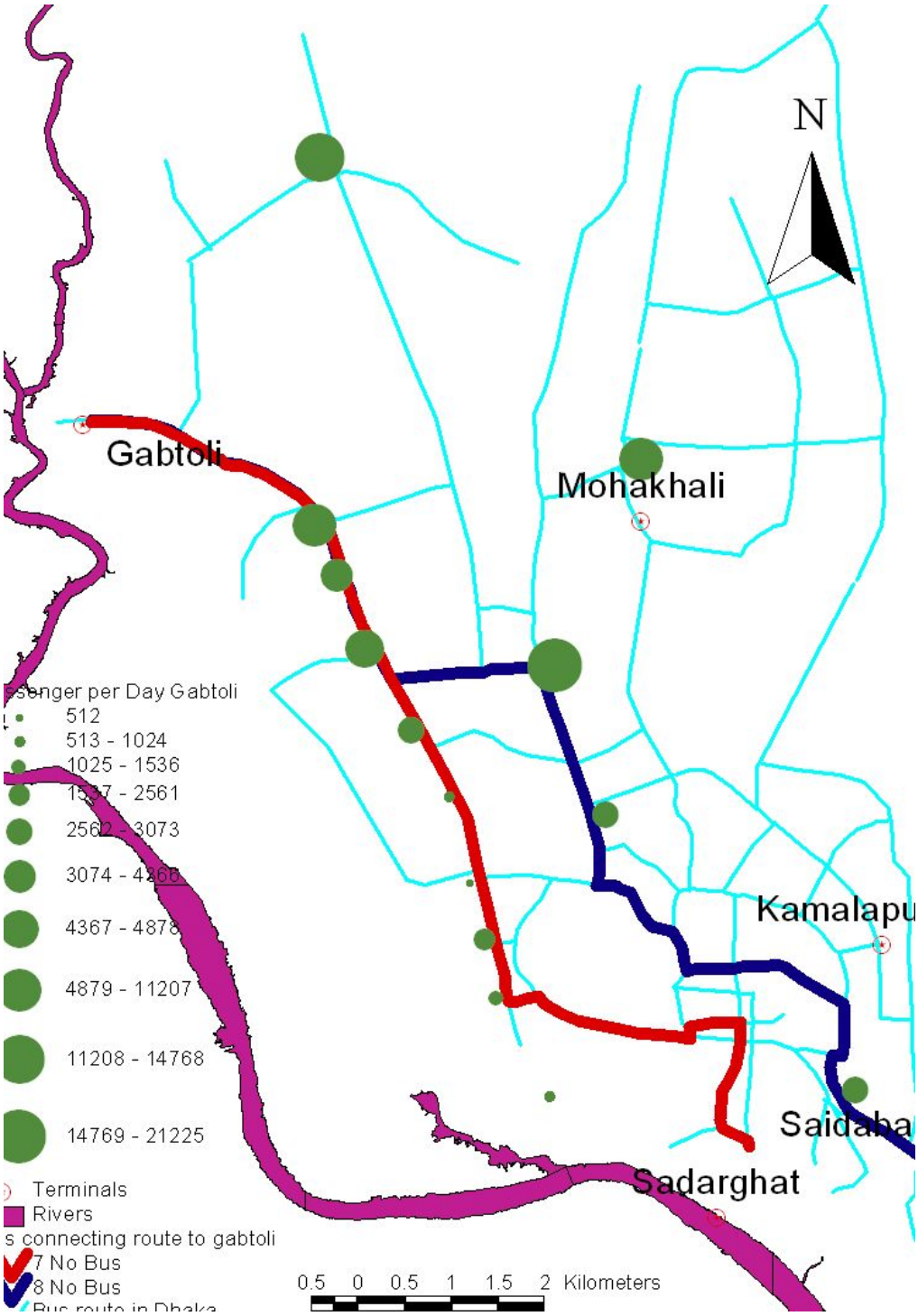
Table C2: Origin or Destination of the Pre and Post Travel in the Gabtoli Terminal

Location of the Origin or Destination	Pre Travel		Post Travel		Average Flow	Total Passenger per day
	Survey Passenger	%	Survey Passenger	Percent		
Kallanpur	64	13%	70	10%	12%	10538
Shamoli	25	5%	32	5%	5%	4366
Asad Gate	27	6%	37	5%	5%	4878
Shukrbad	12	3%	30	4%	3%	3073
Kalabagan	4	1%	10	1%	1%	1024
Science Lab	2	0%	5	1%	1%	512
New Market	10	2%	25	4%	3%	2561
Azimpur	6	1%	15	2%	2%	1536
Forward towards old dhaka	4	1%	10	1%	1%	1024
Firm gate	140	29%	124	18%	24%	21225
Banglmotor	19	4%	17	2%	3%	2830
Forward towards Saidabad	19	4%	17	2%	3%	2830
Mirpur	66	14%	132	19%	16%	14768
Mohakahli	41	9%	111	16%	12%	11207
Others	37	8%	62	9%	4%	4041
Total	474	100%	695	100%	100%	90000

Source: Field survey, 2009

Table C3: Connecting Intra City Bus Route

Name of bus	Route Description
8 No Route Bus	Gabtoli to Jatrabari via Firmgate, Shabagh, Motijheel, Saidabad
7 No Route Bus	Gabtoli to Sadarghat via Asadgate, Azimpur, Gulistan



Map C1: Connecting Route and Passenger Flow in Gabtoli Terminal

Saidabad Bus Terminal

Table C4: Mode of Travel in Saidabad busTerminal

Mode of Travel	Person Survey	Percent
Walk	48	17%
Auto-rickshaw	28	10%
Car/Jeep	1	0%
Taxi	6	2%
Bus	11	4%
Minibus	66	23%
Rickshaw	126	44%
Other	3	1%
Total	289	100%

Source: Field survey, 2009

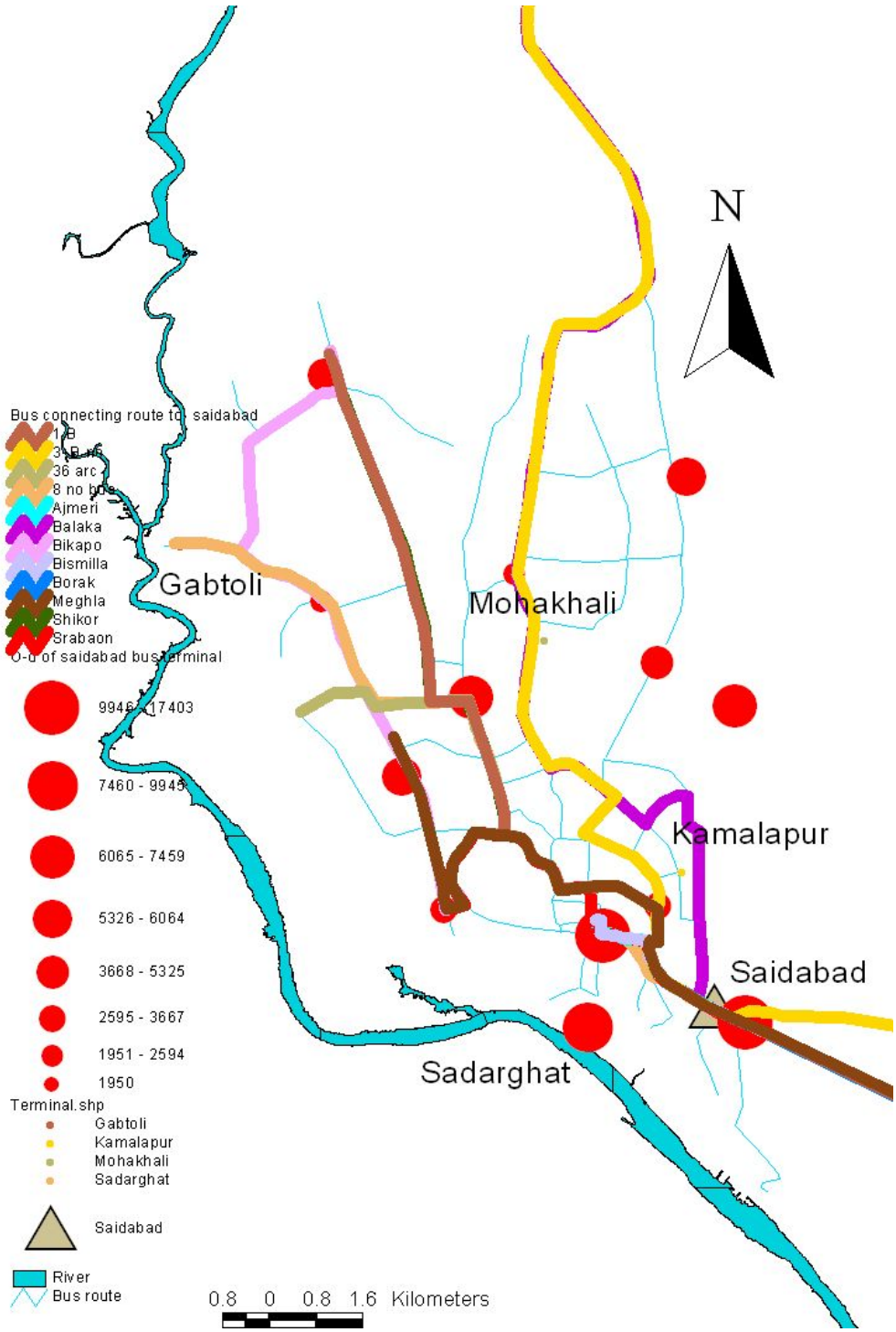
Table C5: Origin or Destination of the Pre and Post Travel in the Saidabad Bus Terminal

Location of the Origin or Destination	Person survey	Percent	Passenger Per Day
Jatrabari	44	17%	17403
Gulistan	39	16%	15511
Sadarghat	25	10%	9945
Basabo	19	7%	7459
Dhanmondi	15	6%	6064
Shabagh	5	2%	1950
Mirpur	13	5%	5325
Firmgate	18	7%	7298
Azimpur	9	3%	3478
Kallanpur	6	3%	2594
Mohakhali	6	2%	2373
Rampura	13	5%	5195
Badda	15	6%	5806
Motijheel	9	4%	3667
Others	15	6%	5933
Total	289	100%	100000

Source: Field Survey, 2009

Table C6: Connecting Intra City Bus Route

Bikalpo	Mirpur to Jatrabair via Azimpur, Shabagh
Balaka	Saidabad to Gazipur via Mohakhali, Kamalapur
Shikor	Mirpur to Jatrabair via firmgate, Shabagh
8 no	Gabtoli to Saidabad via Firmgate, Shabagh
Borak	Muktangon to Pagla via Jatrabari
36 ARC	Mohammadpur to Chittagon road via Firmgate, Motijheel
Ajmeri	Gulistan to Jatrabari
Srabon	Azimpur to Jatrabari via Gulistan, Shabagh
Bismilla	Gulistan to Chittagong road via Jatrabari
3B no bus	Tongi to Demra via malibagh
1 (B)	Mirpur to jatrabari via Firmgate, Shabagh
Meghla	Vhulta to Kalabagan via Azimpur, Shagabh



Map C2: Connecting Route and Passenger Flow in Saidabad Terminal

Mohakhali Bus Terminal

Table C7: Mode of Travel in Mohakhali Bus Terminal

Mode of travel	Person survey	Percent
Walking	45	14%
Bus	81	25%
Rickshaw	54	17%
CNG	120	37%
Taxi	15	5%
Others	12	4%
Total	327	100%

Source: Field survey, 2009

Table C8: Origin or Destination of the Pre and Post Travel in the Mohakhali Terminal

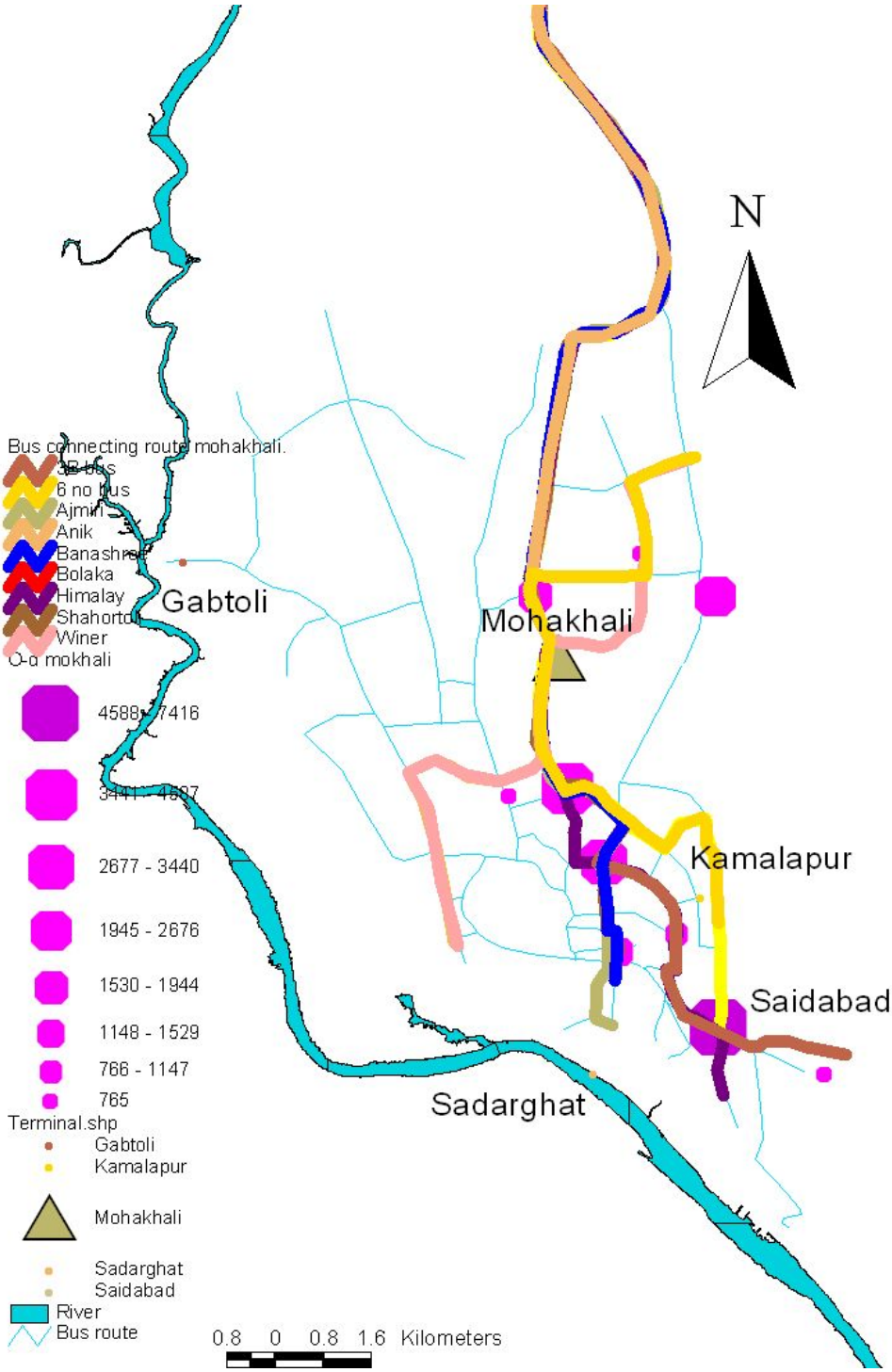
Location of the Origin or Destination	Person survey	Percent	Avg. Passenger per Day
Saidabad	97	30%	7416
Moghbazar	60	18%	4587
Kakrail	45	14%	3440
Motijheel	15	5%	1147
Chittagong Road	10	3%	765
Mohakhali	25	8%	1911
Kawranbazar	10	3%	765
Badda	35	11%	2676
Gulshan	10	3%	765
Gulistan	20	6%	1529
Total	327	100%	25000

Source: Field survey, 2009

Table C9: Connecting Intra City Bus Route

Bolaka	Gazipur to Saidabad via Kamalapur
Ajmeri	Chandra to Sadarghat via Mohakhali, Moghbazar
Shahortoli	Gulistan to Gazipur via Moghbazar
Himalay	Madanpur to Abdullahpur via Moghbazar
3 B bus	Demra to Tongi via Saidabad, Moghbazar
Banashree	Kaliakoir to Gulistan via Uttara, Moghbazar
Anik	Azimpur to Uttara via Satrasta
Winer	Azimpur to Natunbazar via Satrasta
6 no bus	Pirjongi Bazar to Natun bazar via Kamalapur, Moghbazar, Mohakhali, Gulshan

Source: Field survey, 2009



Map C3: Connecting Route and Passenger Flow in Mohakhali Terminal

Sadarghat Launch Terminal

Table C10: Mode of Travel in Sadarghat Terminal

Type of Mode	Pre Travel		Post Travel	
	Survey Passenger	%	Survey Passenger	%
10 No Bus	32	8%	48	7%
7 No Bus	16	4%	32	5%
1B No Bus	16	4%	32	5%
Tempo	10	2%	51	8%
Champion/Rahbor	21	5%	106	16%
Rickshaw	194	45%	214	33%
CNG	78	18%	80	12%
Taxi	13	3%	32	5%
Other (including Walk)	49	11%	54	8%
Total	430	100%	650	100%

Source: Field survey, 2009

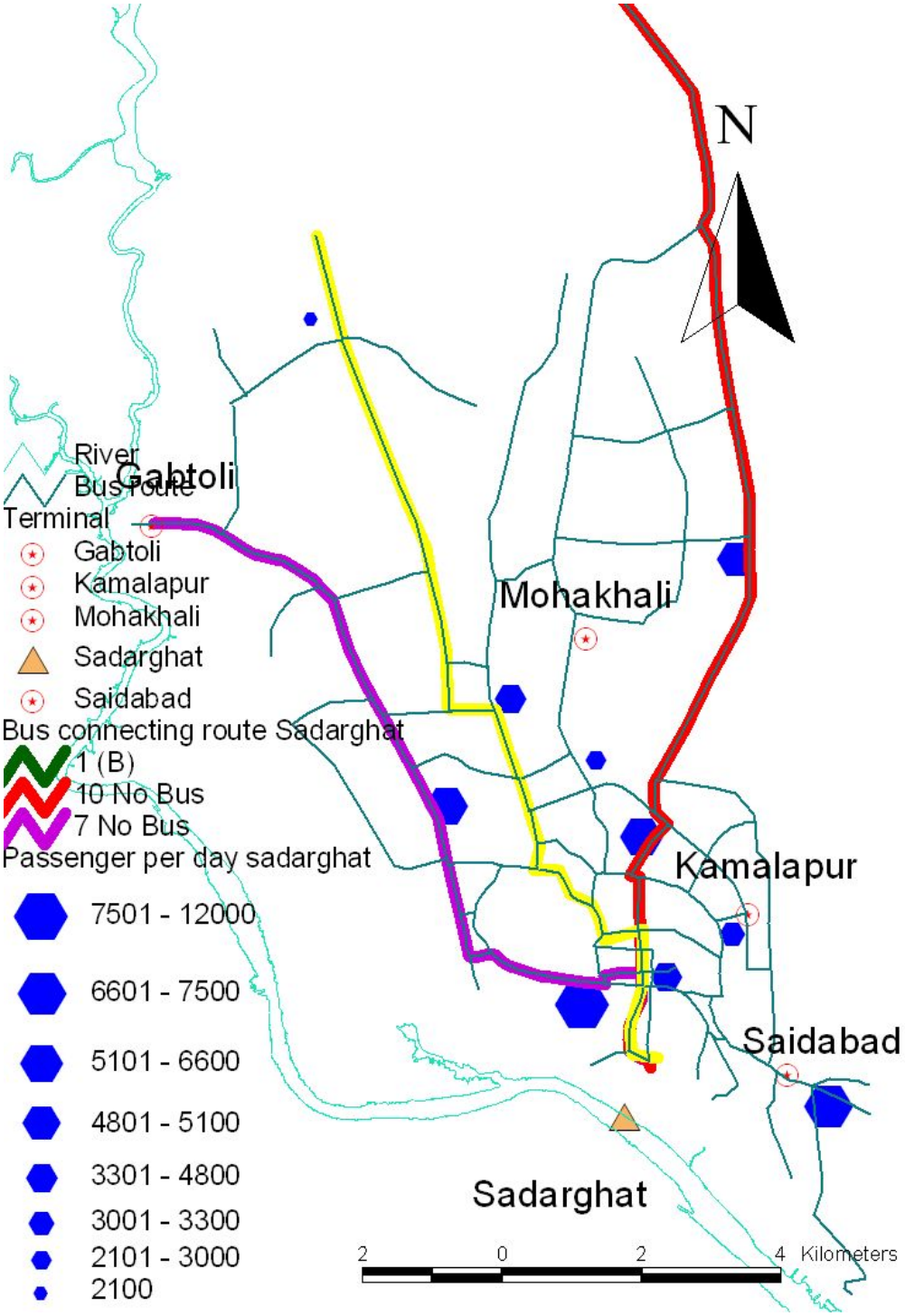
Table C11: Origin or Destination of the Pre and Post Travel in the Sadarghat Launch Terminal

Location of the Origin or Destination	Pre Travel		Post Travel		Average Flow	Total Passenger per day
	Survey Passenger	%	Survey Passenger	%		
Jatrabari	52	12%	84.5	13%	13%	7500
Gulistan	34	8%	52	8%	8%	4800
Old Dhaka	95	22%	117	18%	20%	12000
Malibagh, Kakrail,	43	10%	78	12%	11%	6600
Moghbazar, Tejgaon	22	5%	32.5	5%	5%	3000
Kamalapur, Motijheel	22	5%	39	6%	6%	3300
Rampura, Badda	39	9%	52	8%	9%	5100
Firmgate	34	8%	52	8%	8%	4800
Mirpur	13	3%	26	4%	4%	2100
Newmarket, Kalabagan	34	8%	52	8%	8%	4800
others	43	10%	65	10%	10%	6000
Total	430	100%	650	100%	100%	60000

Source: Field survey, 2009

Table C12: Connecting Intra City Bus Route

Name of bus	Route Description
10 No Route Bus	Sadarghat to Abdullahpur via Gulistan, Malibagh, Rampura
7 No Route Bus	Gabtoli to Sadarghat via Asadgate, Azimpur, Gulistan
1 (B) No Route Bus	Pallabi to Sadarghat via Mirpur, Firmgate, Zero Point



Map C4: Connecting Route and Passenger Flow in Sadarghati Terminal

Kamalapur Railway Station

Table C13: Use of modes pre and post travel in Kamalapur Railway Station

Travel Mode	Person survey	Percent
Walk	17	5%
Auto-rickshaw/CNG	32	9%
Car/Jeep	7	2%
Taxi	18	5%
Bus	17	5%
Minibus	56	16%
Rickshaw	193	56%
Other	6	2%
Total	346	100%

Source: Field survey, 2009

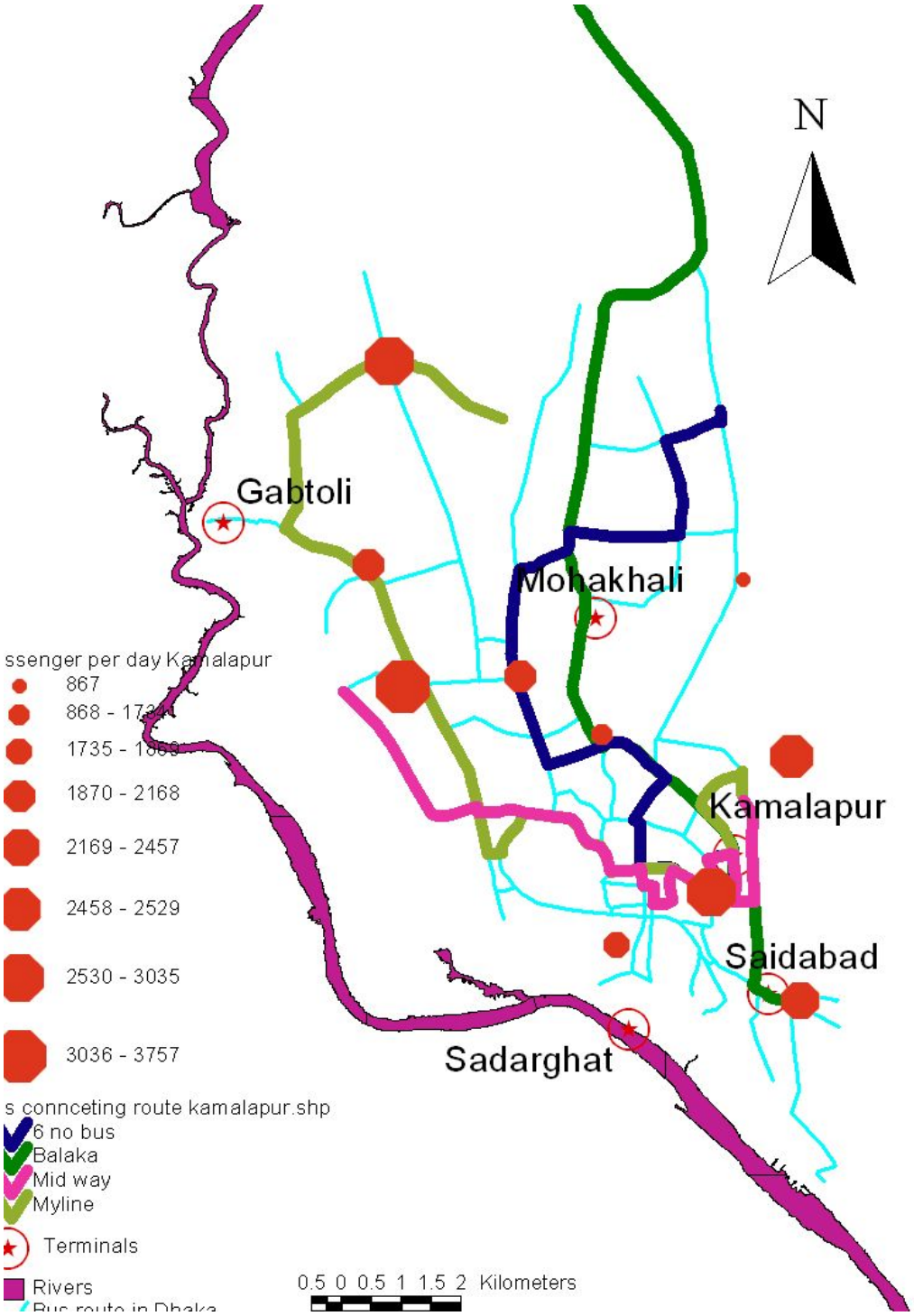
Table C14: Origin or Destination of the Pre and Post Travel in the Kamalapur Railway Station

Location of the Origin or Destination	Person survey	Percent	Total Passenger per day
Mohammadpur, Dhanmondi	52	15%	3757
Mirpur	42	12%	3035
Motijheel	40	12%	2890
Mandda, Mugda, Mathertake	35	10%	2529
Saidabad, Jatrabari	34	10%	2457
Shamoli	30	9%	2168
Firmgate	28	8%	2023
Gulistan, Lalbagh	26	8%	1879
Moghbazar	24	7%	1734
Others	23	7%	1662
Rampura, Badda	12	3%	867
Total	346	100%	25000

Source: Field Survey, 2009

Table C15: Connecting Intra City Bus Route

Name of bus	Route Description
Balaka	Saidabad to Gazipur via pirjongi Bazar, Mogbazar, Mohakhali
Midway	Khligaon to Mohammadpur via Kamalapur, Basabo, Mugda, Gulistan, Motijheel, Zero point, Shabagh, Science lab
6 No bus	Pirjongi Bazar to Natun bazar via Kamalapur, Moghbazar, Mokhali, Gulshan
Myline	Vasantech to Khilgaon via Mirpur, Newmarket, Kilgaon, Taltola



Map C5: Connecting Route and Passenger Flow in Kamalapur Terminal

APPENDIX D

RAILWAY INVENTORY

Table D1: Incoming and Outgoing Train per Day in the Kamalapur Station

Dhaka - Other City Route					
	Train Name	Number		Train Name	Number
Incoming	Inter city	24	Outgoing	Inter city	24
	Mail Train	12		Mail Train	12
	Local Train	1		Local Train	1
	Freight Train	2		Freight Train	2
	Sub Total	39		Sub Total	39
Total		**78**			
Dhaka-Narayangong Route					
Working day	Incoming	10	Holiday	Incoming	4
	Outgoing	10		Outgoing	4
Total		**20**			**8**

Source: Bangladesh Railway, 2009

Table D2: Level Crossing in Dhaka city

Crossing type	Number
Authorized	29
Unauthorized but controlled	8
Unauthorized but uncontrolled	14
Total	51

Table D3: Person Recruited at Level Crossing and Monthly Salary Expenditure

Recruitment Type	Number	Per-month per person Salary	Total Monthly Salary
Permanent	38	6500	247000
Temporary	200	2400	480000
Total	238		727000

Source: Bangladesh Railway, 2009

Table D 4: Delay per Day in Some Selected Level Crossing

Name of Level Crossing		Normalization Time		Total Delay per Signal		Queue length (m)		Delay (h)		**Total Delay (h)**
	Signal time	Peck hour	Off peck	Peck hour	Off peck	Peck hour	Off peck	Peck hour	Off peck	
F. D. C Level Crossing	3	1	0.5	4	3.5	75	40	3.40	1.58	**4.98**
Moghbazar	3.5	1	0.5	4.5	4	100	70	3.83	1.80	**5.63**
Banani Level Crossing	3.25	1.25	0.75	4.5	4	200	100	3.83	1.80	**5.63**

Source: Field Survey, 2009

Table D5: Loading and Unloading Truck or Covered van in Kamalapur ICD

	Date	Number
Import	27-01-10	185
	26-01-10	121
	25-01-10	189
	24-01-10	89
	23-01-10	172
	Average	151.2
Export		
	27-01-10	74
	26-01-10	48
	25-01-10	76
	24-01-10	36
	23-01-10	69
	Average	60.5
Total Average Truck or Covered van per day		212

Source: Kamalapur ICD, 2010

Table D6: Average Commuter Train Passenger Per Day

Route	Number of passenger
Kamalapur to Gandaria	500-600
Kamalapur to Narayangong	800-900
Kamalapur to Tongi	1500-1800

Table D7: Commuter Train Schedule in Kamalapur to Tongi Route

Kamalapur Station to Tongi Station				Tongi Station to Kamalapur Station			
No	Name of Train	Leave Kamalapur St.	Reach Tongi St.	No	Name of Train	Leave Tongi St.	Reach Kamalapur Station
43	Mohuya	4.50	5.45	44	Mohuya	2.20	3.15
47	De. Commuter	5.40	6.19	11	Nokhali Express	3.32	4.27
4	Karnafully	8.40	9.28	1	Dhaka Mail	6.1	7
34	Titas	10.10	10.51	33	Titas	8.08	8.49
49	Balaka	10.30	11.23	10	Shurma Mail	8.2	9.1
39	Ishakha	11.10	12.15	52	Jamalpur Commuter	9.4	10.2
51	Jamalpur Commuter	15.50	16.30	56	Bhawal Express	1.08	2.05
36	Titas	17.35	18.09	35	Titas	15.39	16.15
12	Nokhali Express	20.10	21.05	40	Ishakha	15.39	16.34
9	Shurma Mail	21.00	21.50	50	Balaka	18.02	18.55
2	Chittagong Mail	22.30	23.25	48	De. Commuter	18.34	19.13
55	Bhawal Express	23.30	0.27	3	Karnafully	18.08	18.56
1	Turag	5.10	5.58	2	Turag	8.02	8.5

Source: Bangladesh Railway, 2009

APPENDIX E

CIRCULAR WATERWAY

Table E1: Landing Stations and Passenger and Freight Flow in the First Phase of CWW per Year

Landing Station	Passenger (Lac)	Freight (M.Ton)
Ashulia	8.37	NA
Berulia	10.26	NA
Shinnirtek	15.5	NA
Aminbazar	0	Significant
Gabtoli	0	Significant
Bossilla	12.07	544
Rayer Bazar	10.07	5579390
Kholomora	20.92	2456
Nawaber Bap	6.76	Not Significant
Shewari Ghat	49.15	7158

Source: BIWTA, 2008

Table E2: Landing Stations and Passenger and Freight Flow in the First Phase of CWW per Year

Landing Station	Passenger (Lac)	Bricks (1000 no.)	Sand (1000 cft)	Others 1000 M.ton
Tongi	15.13	13818	18120	0
Harbaid	2.99	0	0	3
Trimukh	3.84	0	3858	0
Hardi	0.97	0	0	11
Isapure	3.46	104	104	14
Beraid	4.12	261	250	23
Kayetpura	2.55	0	0	8
Demra	8.24	29722	25069	39
Kanchpur	00	0	37588	24

Source: BIWTA, 2008

Table E3: Local Landing Stations And Passenger and Freight in the Phase I Area of CWW

Serial No	Name of the Landing Station	Location	Annual Traffic (Lakh)	
			Passenger	Freight (M. Ton)
1	Katasur	East Bank	12.17	70876 & *1564 Nos.
2	Rayer Bazar	East Bank	10.07	5579390
3	Basila	East Bank	12.07	544
4	Waspur	West Bank	7.31	NA
5	Ati Bazar	West Bank	3.01	NA
6	Nawabganj	East Bank	3.54	1500
7	Kholamura	West Bank	20.92	2456
8	Patkajor	West Bank	2.08	NA
9	Barisur	West Bank	6.76	NA
10	Kusharbagh	West Bank	1.04	NA

11	Matbar Bazar	East Bank	1.83	NA
12	Mandail	West Bank	10.55	NA
13	Zinjira (Godarghat)	West Bank	23.73	NA
14	Bot-toli	East Bank	3.65	NA
15	Swarighat	East Bank	49.15	7158
16	Balughat	East Bank	8.21	NA
17	Waisghat	East Bank	9.13	NA
18	Sadarghat	East Bank	17.34	NA

Source: BIWTA, 2007

NA= Data Not Available *= Live stocks

Table E4: Conflicting Bridge in Water Circular Way

1st Phase	2nd Phase
1. Mirpur Bridge,	1. Tongi Bridge -1
2. Mirpur Bailey Bridge	2. Tongi Bridge - 2
3. Berulia Bridge	3. Tongi Railway Bridge- 1
4. Dhaur -1	4. Tongi Railway Bridge - 1
5. Dhaur- 2	5. Trimukh-Rupkanj-Kaligong Bridge
6. Naini Chala	6. Isapur Bridge - 1
7. Kamarpara	7. Demra Bazar Bridge

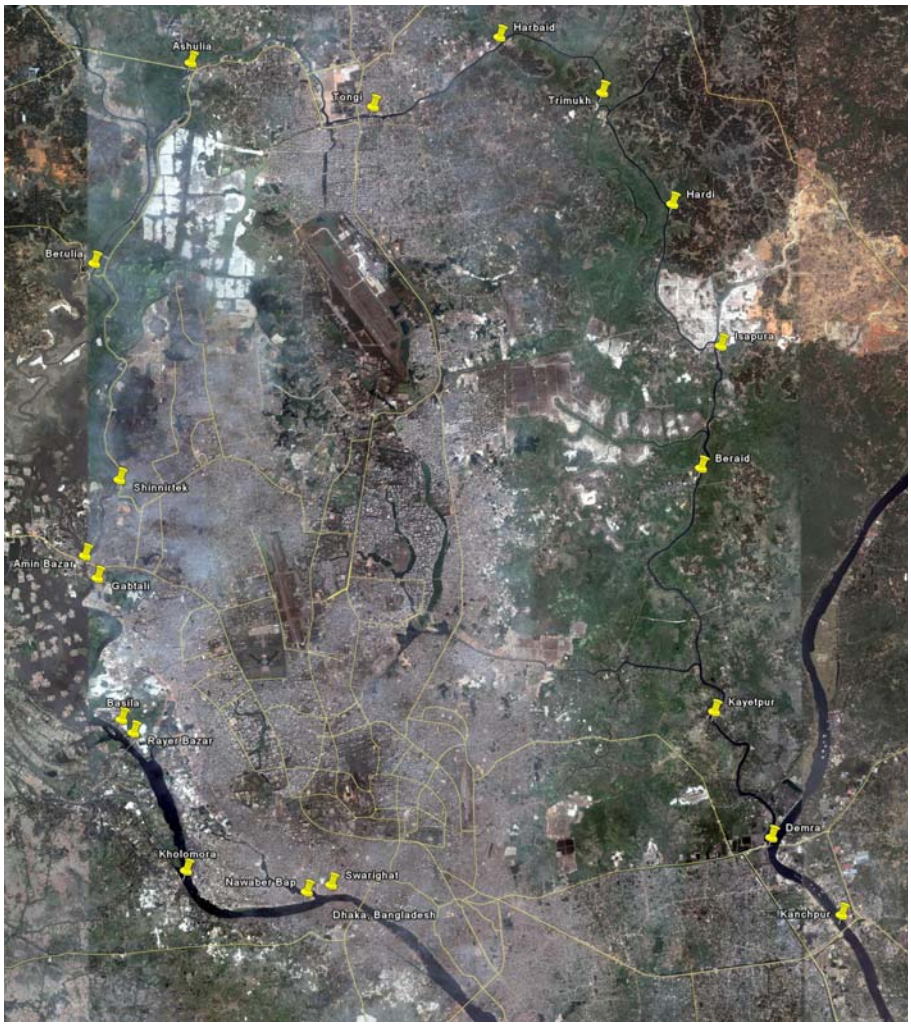


Figure E1: Landing Station and Major Road Connectivity

APPENDIX F

BUS ROUTE DIVERSION AND BUS ROUTE BUFFER AREA

Bus Route Diversion in Proposed BRT Route A

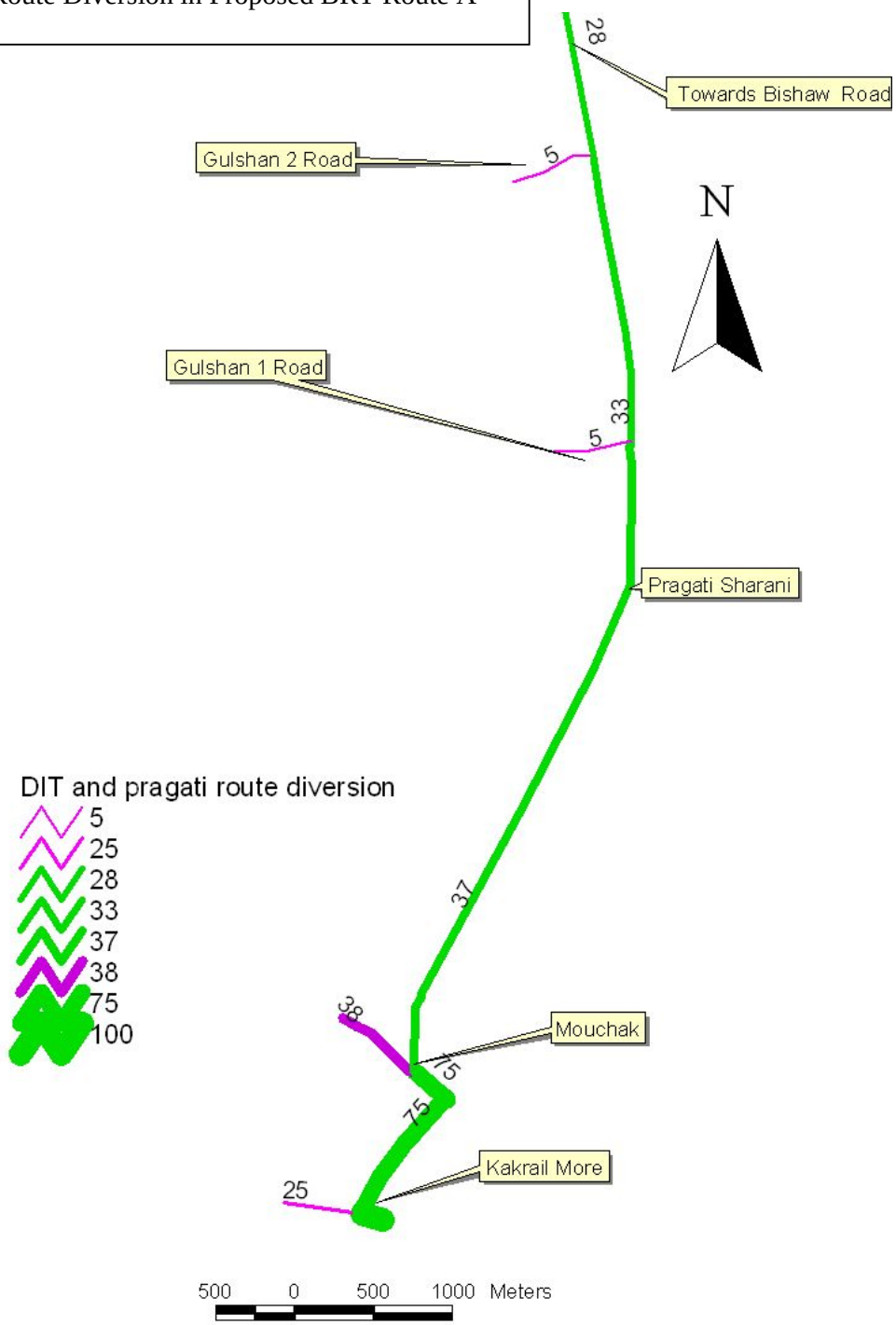


Figure F1: Bus Route Diversion of Kakrail and Progati Road

Bus Route Diversion in Proposed BRT Route B

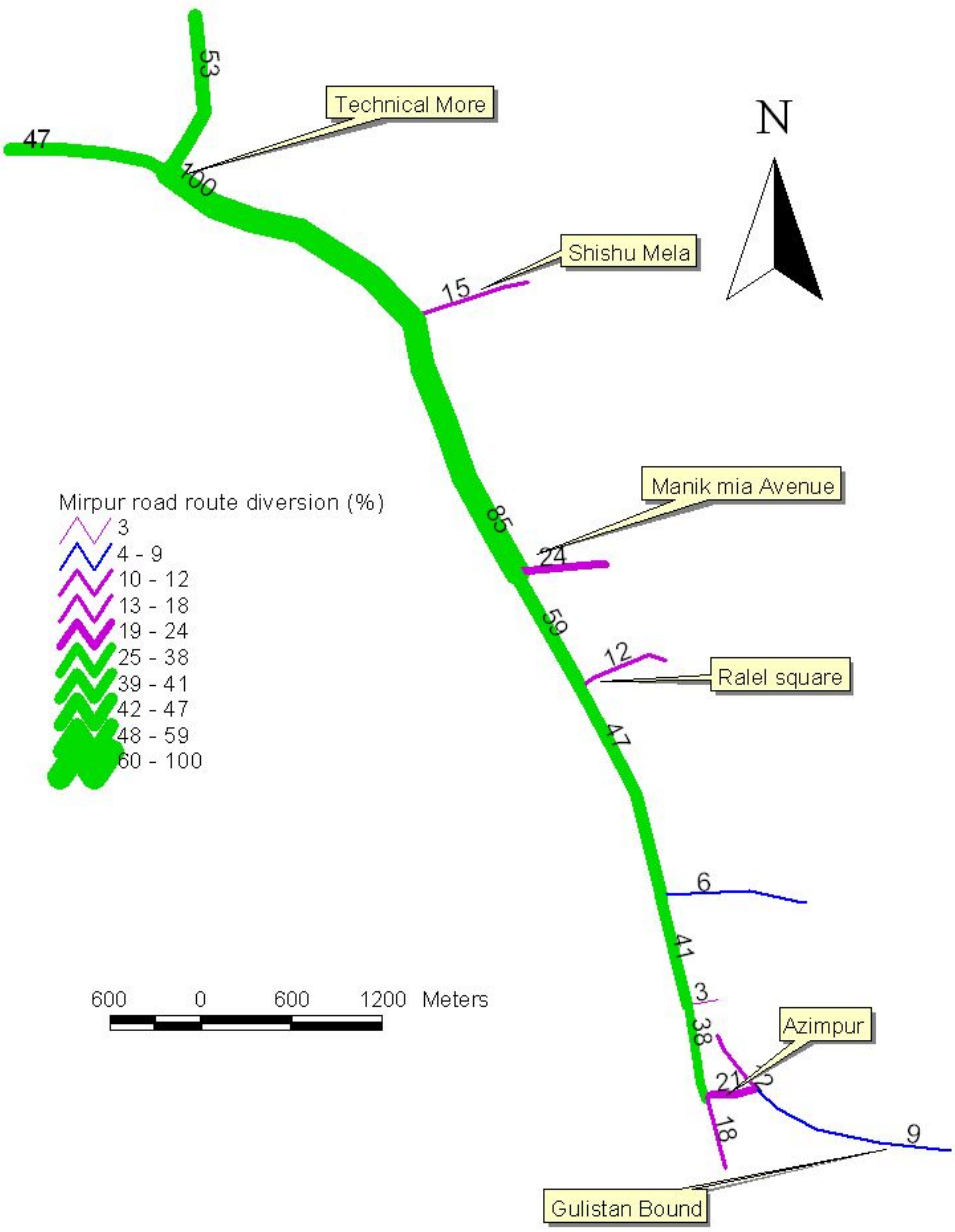


Figure F2: Bus Route Diversion of Mirpur Road

Bus Route Diversion in Proposed BRT Route C

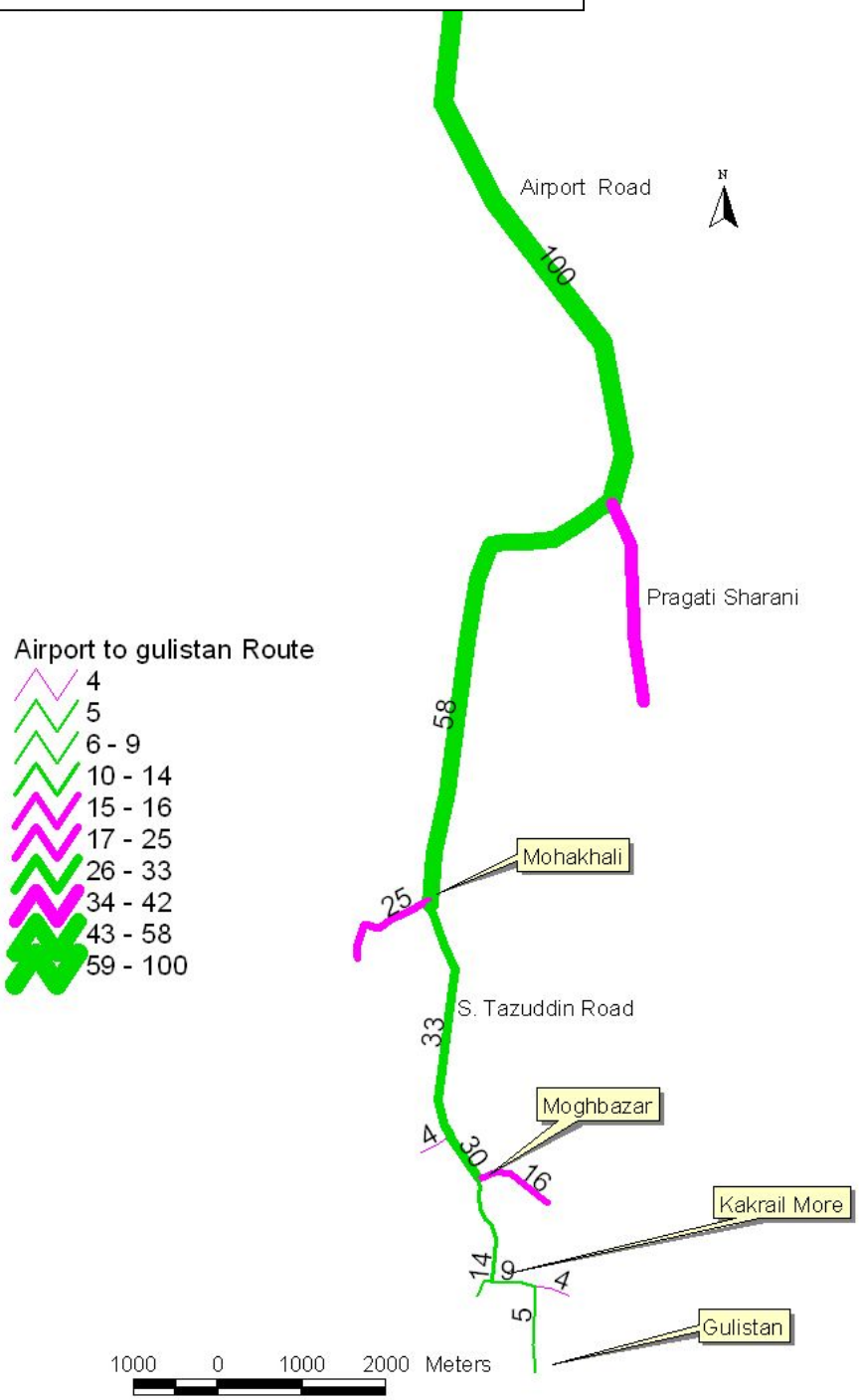


Figure F3: Bus Route Diversion of Airport Road and S. Tajuddin Road

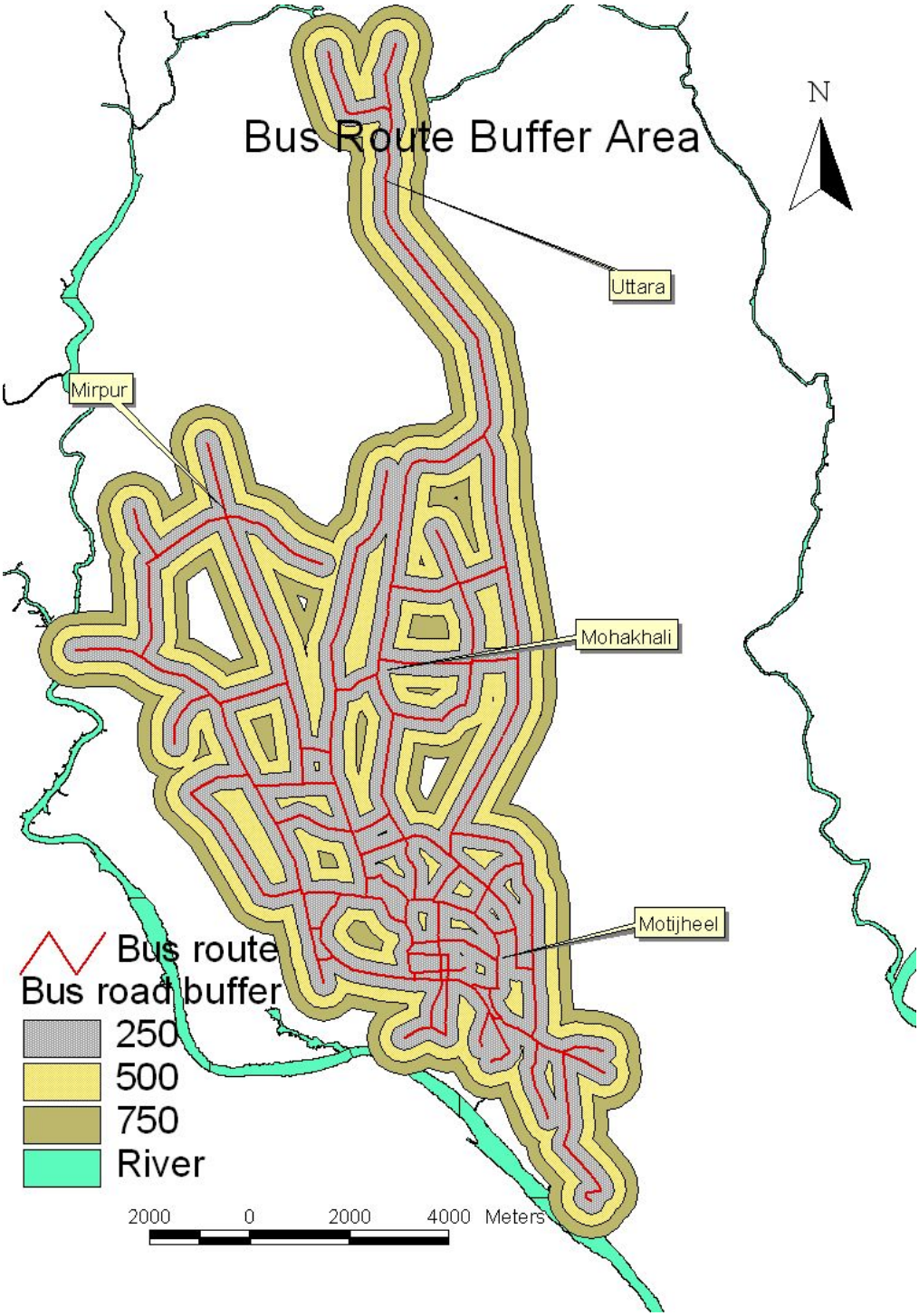


Figure F4: Buffering Area of Existing Bus Routes

APPENDIX G

PUBLICATIONS ON THIS THESIS (ABSTRACT, PUBLICATION PLACE AND DATE)

Inherent Weaknesses of Transportation System in Dhaka Metropolitan City and Challenges for Sustainable Development

S.M. Sohel Mahmud[1], Dr. Md. Shamsul Hoque[2] and Abdus Shakur Qazi[1]

ABSTRACT: *Dhaka is the capital of Bangladesh and the nation's gateway, as well as face of the country, has now been turned into the 26th Mega City and 10th most populous city in the world. The city experiences the proliferation of scattered development without appropriate guidance resulting in urban system difficulties. The lack of integration between land-use planning and transportation system has resulted in uncontrolled and unplanned development, non-compliance and a poor mix of land uses leading to inefficiencies in the Dhaka's transportation system. Continuous focus on road based network system has weakened potentials and attractiveness of other types of transportation system like rail or water transport. Indeed, the amount of road network (only 6 percent), accessibility, efficiency is far less than the minimum requirement (about half of the area has reasonable accessibility). The unplanned and haphazard orientation of road network also leads to built-in problems on the operational and management aspects of the transportation system and functionally weakens the entire street network performance.*

Immense densification and mushrooming development of residential, commercial and other infrastructure, trims down the opportunity to construct new road infrastructure or introduce modern system for improving overall transportation system. Incomplete understanding of the inherent weaknesses of the city, the authorities are providing piecemeal solution without a long term vision which is becoming an extra burden on the overall system of the city and the city is developing with a decant growth. In this paper, an attempt has been made to point out the inherent weakness of Dhaka Metropolitan city in particular relation to transportation system and identifies some of the forthcoming challenges for sustainable development. At the very outset of the paper, a brief outline of the existing land use and transport scenario and detailed quantitative analysis with accessibility and functionality of the existing road network has been presented.

Publication Place and Date: 13th Conference of the Road Engineering Association of Asia and Australasia (REAAA), 23-26 September 2009, Songdo Convensia, Incheon, Korea.

Deficiencies of Existing Mass Transit System in Metropolitan Dhaka and Improvement Options

S.M. Sohel Mahmud[1], Dr. Md. Shamsul Haque[2] & Golam Md. Muradul Bashir[3]

ABSTRACT: *The rapid rise in population along with increased and versatile land use patterns and increase in motor vehicle ownership along with non-motorized vehicles on streets have resulted in enormous travel demand and traffic congestion in Dhaka, the Capital city of Bangladesh. The demographic trends of the last decade that have resulted in rapid population growth (8%) are expected to continue in the coming decades. The impact of such rapid growth has major consequences on the ability of the transport sector to provide mobility for all people as they seek to take advantage of employment, education, health and social opportunities.*

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The transport sector in Dhaka, which comprised of many different modes of travel - both motorized and non-motorized - often using the same road space – resulting in a high level of operational disorder, that significantly diminishes the efficiency and effectiveness of the existing transport uses. In the absence of a dependable and adequate public transport system, major share of road space remains occupied by the small capacity vehicles. The existing mass transit system has not been able to increase its shares (31% of vehicular trip) of catering demand for the causes huge of road infrastructural, operational, management and maintenance deficiencies like scarcity of road space, lack of accessibility, unorganized and non-integrated road network, mix operation, poor maintenance and management, fragmented ownership etc. Again, due to rapid growth of population in Dhaka, the projected trip generation per day for the next 20 years period is 159.63 million which is about 8 times higher than the current trip generation per day. Therefore, there is an urgent need to introduce a well-organized, properly scheduled rapid mass transit system minimizing the existing deficiencies. In this paper, an attempt has been made to identify the deficiencies of existing mass transit system to put forward for an appropriate rapid mass transit system to recover the huge demand. An overview of the existing modes of travel and operation characteristics has been described. Finally, some potential rapid mass transit options are highlighted with the context of prevailing land use and transport characteristics, socio-economic context of Dhaka Metropolitan city.

Publication Place and Date: CODATU-XIII International Conference on Sustainable Development Challenges in Transport in Cities of the Developing World: Doing what Works, Session 4A, 12-14 November 2008, November 12-14, 2008, Ho-Chi-Minh City, Vietnam.

Deficiencies of Existing Road Network in Dhaka Metropolitan City

S.M. Sohel Mahmud[1] & Dr. Md. Shamsul Haque[2]

ABSTRACT: *Dhaka is one of the fast growing metropolitan cities with a highly dense and increasing population in the world. Haphazard urban expansion with a minimum attention to the living environment has been the most common scenario here and existing transportation system has become hazardous for the entire city system due to its inherent transport as well as road network deficiencies. Although, the city mainly depends on road-based transportation system, the amount of road network is far apart from the minimum requirements. Only 9 percent of roadways and 6 percent of pavement area is available, in which 62 km functional primary and 108 km secondary and 221 km connector road serve the city transport service. It is evaluated that bus service plays the dominant role in providing public transport facilities (58 % passenger by only 8% trip) but lack of proper land use and transport planning, uncontrolled development and due to post planning approach, about half of the area do not have the bus service facilities. In this study, the authors tried to quantify the existing road network with various dimensions viz. length, percent of road and pavement area, categories with different functions and width, density, accessibility, per capita road network etc. for the whole city and for different zones using statistical methods. This study also points out the inherent weaknesses of Dhaka's road network in particular relation to road quantity, road orientation or layout, functionality and operational and management aspects.*

Keywords: Transportation deficiency, Road alignment, Regulatory measures, Functional deficiency.

Publication Place and Date: 10th Pacific Regional Science Conference Organization (PRSCO) Summer Institute 2008, Hosted by Bangladesh Regional Science Association (BRSA), 15-17 May 2008, Dhaka, Bangladesh, P.N. – 52.

A Preliminary Feasibility Study of Bus Rapid Transit System in the Context of Present Road Network in Dhaka

S. M. Sohel Mahmud[1] & Mohammad Ibna Anwar[4]

ABSTRACT: *Like many other cities in developing countries Dhaka is struggling with the problem of how to upgrade and improve existing transit services at a low cost. The ever-increasing chaos and congestion, high rate of accidents and rapidly deteriorating transport operational, management and environmental condition calls for immediate considerations of an alternative transport option that could reduce the transport problem. In the way of searching a fruitful solution to the transport problem, various options are available. The experience of other developing countries (like Columbia, Jakarta) shows that implementation of a bus rapid transit option may come out successful. But, it is still questionable whether the modern space efficient mass transit system particularly introduce of BRT is feasible or not for the present road network system viz. quantity, quality, orientation, functionality as well as land use and transport network structure of this city. This study presents the prevailing transport and traveling scenario and the characteristics of existing mass transit system in Dhaka Metropolitan city. Particular emphasis has been made to assess the feasibility of BRT options as compared to the physical and infrastructural capacity of the road network of Dhaka city. Finally, a set of recommendations have been proposed to improve the physical, infrastructural and operational condition of the transportation system aims at introducing modern mass rapid transit system in Dhaka Metropolitan City to meet the future enormous demand.*

Key Word: Feasibility Study, Mass Transit System, Infrastructural Characteristics

Publication Place and Date: 10th Pacific Regional Science Conference Organization (PRSCO) Summer Institute 2008, Hosted by Bangladesh Regional Science Association (BRSA), 15-17 May 2008, Dhaka, Bangladesh, P.N.- 94.

Pedestrian Safety Problem, Existing Facilities and Required Strategies in the Context of Dhaka Metropolitan City

S.M. Sohel Mahmud[1], Mohammad Mahtab Hossian[5], Dr. Shamsul Hoque[2] & Dr. Md. Mazharul Hoque[6]

ABSTRACT: *Pedestrians form the largest single road user and most vulnerable road user group is manifest by data from police report showing that more than 48 percent of reported road accidents and 72 percent of reported fatalities were pedestrians in the context of Dhaka Metropolitan City. In addition, pedestrian population is dramatically increased for huge number of urban migration for by the establishment of so-called labor intensive many garment industries, all head offices, business, better communication, better employment, good and higher educational opportunities, health facilities and higher income etc. But there are very lacks of pedestrian facility and which are available that are not proper use for the cause of enormous deficiency. In this paper, try to evaluate the causes of pedestrian generation, problem (safety and moving) and lack of existing facility of the city. Finally, on the basis of analysis measure have been proposed which should be required immediately for safe, efficient and appropriate movement of huge number of pedestrian in Dhaka city.*

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Publication Place and Date: International Conference Proceedings on "Road Safety in Developing Countries", BUET, Dhaka, 22-24 August, 2006. Pp 68-77, P. N. – 13

Road Safety of Garment Industry Workers in Dhaka City

Dr. Md. Shamsul Hoque[1], Ashim Kumar Debnath[7] and S.M. Sohel Mahmud[1]

ABSTRACT: *There are about 4,000 garment industries in Bangladesh, most of which are clustered in and around the capital city. Together they account for 75 percent of the country's export earnings and employ around 1.8 million people which is almost one half of the total industrial workforce of the country. Though it is the most important economy sector of Bangladesh, unplanned and haphazardly built garment factories are also inducing many social, housing and most importantly urban transportation problems which are a great cause of concern. This study investigates the impact of garment industries on transportation, in particular road safety issues of garment workers. Data is collected to identify the locational problems of garment factories, spatial distribution of worker residences, and their travel patterns as well as to assess their walking and road crossing problems. Finally, recommendations are put forward to tackle transport problems arising from these unplanned establishments of export oriented garments industries in Dhaka Metropolitan City.*

Publication Place and Date: International Conference on "Road Safety in Developing Countries", 22-24 august, 2006, Accident Research Centre (ARC), BUET, pp-489-498, P.N.-77

Transport System in Bangladesh: Issues and Options for Sustainable Development

S.M. Sohel Mahmud[1], Mohammad Wahidur Rahman[8] & Shahnewaz Hasanat-E- Rabbi[9]

ABSTRACT: *Transport developments have been driven in Bangladesh mostly by improvised considerations having no explicit focus on future requirements and the means of meeting these requirements on a competitive as well as sustainable basis. The unplanned combination of rapid urbanization and motorization has been a key cause of numerous transport problems in Bangladesh. It has resulted in deterioration in accessibility, service levels, safety, comfort, operational deficiencies. The rapid urbanization process, high vehicular population growth and that of the mobility, inadequate transportation facilities and policies, varied traffic mix with over concentration of non-motorized vehicles, absence of dependable transport system and inadequate traffic management practices and parking facilities have created a significant worsening of traffic and environmental problems particularly in urban areas. Traffic accidents are now a very serious and growing problem and the safety situation is very severe by international standard. The problem of road accidents costing the community in the order of US$ 800 million (nearly 2% of GDP) each year. The other serious deficiencies resulting from ad-hoc planning are sectoral bias improper modal mix, un-integrated system, serious institutional weakness, limited role of the private sector etc. The current deficiencies have produced an unsustainable trend of transport development, which is characterized by misallocation of resources, adverse impacts on the environment and lack of competition. The current disturbing trends in transport development indicate the need for guidelines to make such development environmentally and to create a transport system that can meet the growing demand for transport services. In this paper characteristics of transportation and consequent mobility, safety and environmental effects are discussed. The purpose of the present paper is to conceptualized a vision and identify supporting policies for sustainable transport development. The authors also make an attention on key*

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transport issues and possible options for ensuring sustainable transport development in Bangladesh.

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Impact of Garment Industries on Road Safety in Metropolitan Dhaka

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Abstract: *There are 4,000 garment industries in Bangladesh, most of them are clustered in and around the capital city. Together they account for 75 percent of the country's export earnings and employ around 1.8 million people which is almost half of the total industrial workforce of the country. Though it is the most important economy sector of Bangladesh, unplanned and haphazardly built garment factories are also inducing many social, housing and most importantly urban transportation problems which are a great cause of concern. This study investigates the impact of garment industries on transportation, in particular road safety of garment workers. Data is collected to identify the locational problems of garment factories, spatial distribution of worker residences, and their travel pattern as well as to assess their walking and road crossing problems. Finally, recommendations are put forward to tackle transport problems arising from these unplanned establishments of garments industries in Dhaka City.*

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