Efficiency Analysis of Public Transit systems in Bangladesh:

A Case Study of Dhaka City

by

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A thesis
presented to the University of Waterloo
in fulfilment of the
thesis requirement for the degree of
Master of Arts
in
Planning

Waterloo, Ontario, Canada, 2013

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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ABSTRACT

Dhaka is the capital city of Bangladesh and the centre of administrative, political, economic and social life for the country. An efficient transit system is needed in this city to provide services in every corner and to the people of all socio economic standing. This city is characterized by both motorized and non-motorized transport services, though there is a huge demand on the bus transit system. Dhaka is also one of the fastest growing global cities, which is contributing to even higher transit demand. There is a need, therefore, to investigate the present transit system with a view to understand the opportunities and potential of the current public transport system given available policy support and resources. This research is an initiative to identify the current efficiency status of transit services and explore the opportunities to increase the efficiency of this system for the people of this mega city. To carry out this research, along with literature and policy review, interviews with stakeholders and a survey of transit operators was undertaken. From the analysis of the operator's survey and literature review, the current underperforming status of transit services was identified. From the discussion of interviews and policy frameworks, strategies to improve the current status and guidelines for future initiatives are outlined. This includes a separate and powerful institutional authority solely for transit services and taking regulatory measures by this authority to speed up STP implementation. For bus transit only, the recommendations are: consolidating bus industry and exclusive bus lanes to improve current status of bus transit service. Finally by achieving and fulfilling the recommendations of this study, it is hoped that a more efficient transit system in Dhaka city would result.

ACKNOWLEDGEMENTS

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
ADP	Annual Development Program
BBS	Bangladesh Bureau of Statistics
BDT	Bangladesh Taka
BRF	Bus Route Franchising
BRT	Bus Rapid Transit
BRTA	Bangladesh Road Transport Authority
BRTC	Bangladesh Road Transport Corporation
DCC	Dhaka City Corporation
DHUTS	Dhaka Urban Transport Network Development Study
DITS	Dhaka Metropolitan Area Integrated Transport Study
DMA	Dhaka Metropolitan Area
DMP	Dhaka Metropolitan Police
DMTA	Dhaka Mass Transit Authority
DTCB	Dhaka Transport Coordination Board
DUTP	Dhaka Urban Transport Project
LRT	Light Rail Transit
MRT	Mass Rapid Transit
RAJUK	Rajdhani Unnayan Katripakkha (Dhaka Metropolitan Development Authority)
RHD	Road & Highway Department
RTC	Regional Transportation Committee
SMA	Statistical Metropolitan Area
STP	Strategic Transport Plan
UNDP	United Nation Development Program

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

Dhaka is the capital city of Bangladesh and the centre of administrative, political, economic and social life for the country. Dhaka is centrally located within Bangladesh and an important destination for millions who decide to change their lives by migrating from rural to urban areas. According to the Bangladesh Bureau of Statistics, the Dhaka Statistical Metropolitan Area (SMA) is home to 14.54 million people (BBS, 2011), which is 35.06% of the total urban population of Bangladesh (World Bank, 2012). Given immigration levels and natural growth, it was predicted by the United Nations that Dhaka would be the 6th largest mega city in the world by the year 2010 and it would continue growing to become the second largest mega city of the world by the year 2015 (Islam, 2005).

Not surprisingly, transportation is a major issue in Dhaka, not only does the transportation system provide day to day mobility but it is a critical part of the growth pattern of Dhaka City. There are current challenges related to rapid urban growth such as increasing housing rents, new amenities, and infrastructure investments which have shifted lower income people to the periphery of the city. Given the resultant increasing distances and lack of viable alternatives (auto), public transportation is viewed as the only way to provide mobility for many on the periphery. However, the transit system faces its own issues as a key part of the transportation system and its ability to meet these new demands is questionable. The focus of this research is on exploring the potential for Dhaka's transit system to innovate and improve its performance in the face of dispersed growth in an already complex urban system.

The transportation system of Dhaka city is characterized by a combination of both motorized and non-motorized vehicles, an absence of an organized mass transit system, poorly organized traffic control, and poorly maintained and deficient amounts of roadways in the metropolitan area. According to the recent Strategic Transportation Plan for Dhaka city– the primary mode of transport for personal trips is - about a third (34%) non-motorized rickshaws, another one third (34%) buses and the remaining 30% using walking or other motorized vehicles. For trips that involve several modes, "primary mode" is defined as the mode used for the longest (distance) part of trip (STP, 2005). Gwilliam offers the follow assessment of Dhaka's transport system: "In

Bangladesh the combination of public supply and fare control had a negative impact on traditional bus service. The public sector supplier, BTB, has found urban operations commercially unviable, and has leased its vehicles instead to the private sector, which has often found it more profitable to operate them in the inter-city rather than the urban market. Meanwhile private sector minibuses and cycle rickshaws have taken an increasing proportion of the market" (Gwilliam, 2000, p.4). Present public transit supply system. A preliminary estimate of vehicular trip demand on the city's 18 major bus routes showed a demand range of 150,000 to 350,000 trips per day, with peak hour per direction demand in the range of 4,500 to 9,000 per hour (Hossain and Hossain 2003; Hossain et al. 2003). While it is clear that the transit system is heavily utilized, nearly one third of personal trips involve non-motorized modes that are challenged to adequately serve the increasingly dispersed and growing population.

There are also serious concerns about the current service levels within the existing transit system. The present emphasis on bus passenger transport has not been able to increase its mode share of primary trips and meet the growing and dispersed demand. Japan Bank for International Cooperation (JBIC) data sources from the year 2000 reveal that bus service deficiencies indicated by rickshaw users are crowded conditions on buses, long waiting times, lack of easy transfer, inadequate stop locations, and long boarding times. Further service deficiencies indicated by bus users are discomfort and congestion (Hoque and Hossain, 2004). If bus transit is going to become a more effective part of Dhaka's transportation system, these challenges need to be addressed.

An efficient and effective urban transportation system can promote urban development and renewal while providing adequate access and mobility to all of Dhaka's people. In fact, cities of developing countries are often the major engines for economic growth and improvements in city transportation can make them much more efficient and productive (Button 1993). The present deficiencies and inadequacies of the transportation sector in Bangladesh may be seen as one of the major impediments to the socioeconomic development of the country (Andaleeb et al.2007). Dhaka city being the national focus needs to have an efficient and effective transit system to play its productive role.

1.2 Objectives of the Study

The discussion above has highlighted the status of Dhaka as a global mega city with serious concerns over the current status and future prospects for its transit systems. Given this context, this research seeks to address the following research questions:

1. **What is the current status of transit services in Dhaka City?**

The first objective is to portray the transit situation in Dhaka City in detail along policy and performance dimensions.. There are several stakeholders present in the entire transit system and a range of influences on transit operations and services. The present system is a mixture of different providers using different vehicle technologies operating in a complex environment without a significant platform for organizing services and clear policy framework. Any study of performance definitely depends on the context of the system and key characteristics that influence transit operation, hence there is need to better understand transit services in Dhaka city as a starting point in this research. To address the first question, key stakeholders, existing policies, and strategic planning documents will be incorporated into the analysis.

The stakeholders of public transit consist of four groups: transit system operators, transit system users, society and all levels of government (Philips, 1999). To establish an understanding of their roles in the current system, different stakeholders and their linkages to transit services will be explored. Given the interest in improving the future performance of the system, the current policy framework and transportation plans will be critically investigated.

A second aspect of this first research question is to analyze the current performance status of Dhaka's transit system. Performance is typically defined as the manner in which, or the efficiency with which something reacts or fulfills its intended purpose (Stein, 1983). Transit performance could therefore be defined as the manner in which or the efficiency with which public transit provides mobility to those who demands it (Philips, 1999). The intended purpose of public transit in Dhaka city is to provide reliable, frequent and efficient services. In the literature, the most common transit performance measurements are grouped in terms of efficiency or effectiveness. According to Fielding (1985), efficiency indicators define the relationship between resource input and produced output. They include indicators of overall cost efficiency, labor utilization and vehicle utilization. Effectiveness indicators generally reflect the ability of transit

operations to meet certain goals. These include service utilization, service quality and accessibility of service.

Data Envelopment Analysis (DEA) is a widely used performance measurement system dedicated to the efficiency and effectiveness of transit services. For example, Viton (1997), Karlaftis (2004), Odeck and Alkadry (2005) analyzed transit performance using DEA to find out the productive and economic efficiency of the transit industry. In all cases, indicator selection depends on the objectives and goals of transit services. In this study, labor, vehicle-km, expenses and ridership are used as indicators to study output oriented efficiency of the system in Dhaka. Due to limited resources, this thesis investigates these measures of transit performance for a selected limited number of prominent service providers in Dhaka city.

2. **What are the opportunities and challenges for improving performance of the present transit system?**

Stakeholders have very different perspectives on transit performance and historically this has been recognized as a key part of understanding the potential for improvement. In the literatures, for example Odeck and Alkadry (2001), and Sampaio et al. (2008) investigated transit performance and later described key strategies from the evaluation of transit industry. Others (Dajani and Gilbert, 1978, Talley and Anderson, 1981) investigated the viewpoints of different stakeholders to evaluate the system. To address the second research question, transit operators from the public and private realm and other stakeholders are interviewed to find out their perspectives on opportunities and challenges in transit performance. In part, these opportunities and challenges are identified through meeting the objectives of question1. The goal is to better understand the potential for transit performance improvement in Dhaka as well as addressing those opportunities to improve transit performance.

1.3 Rational of the Study

Large scale urbanization in Asia is creating a complex situation in terms of providing necessary infrastructure, particularly transport infrastructure. Since the megacities of Asian developing countries are still growing, policy makers may not find a directly replicable model from elsewhere to address this situation. What is needed is to consider the future scale of the city and

take a long term strategic view point to plan the transport infrastructure suitable for the city of such scale (Morichi, 2005). Dhaka, being one the fastest growing megacities in Asia, is also experiencing the same rapid urbanization, high density and a scarcity of infrastructure resources.

Dhaka's present transit system consists of buses of various types that work in conjunction with privately operated and low capacity motorized (taxis) and non-motorized vehicles (rickshaws). While there is no institutional setup for engineered operation and management of transport in general and public transport in particular, the problems of mass transit here are multi-dimensional. There are numerous operators, owners, companies and government agencies involved leading to an uncoordinated and mismanaged situation (Hossain et al. 2003). In this situation there is an opportunity to study the performance of current transit services and point out the core of inefficiencies. Given that high density, mixed land uses generate sufficient demand there is justification for high-frequency coordinated public transport service, which further strengthens the convenience of public transport for passengers. An integrated network of high frequency services can unleash the benefits for passengers of the network effect to make all parts of the urban area accessible to all and allowing public transport to serve random trip destinations and actually compete with the convenience of private vehicles (Laube, 1995; Mees, 2000). And, transit performance measures are used because they can provide perspective, understanding, and context to what has gone on and what is going on within an organization (TRB, 2003). So, there are needs to investigate the present transit system in Dhaka with a view to realize the opportunities and potentials of public transport system with available policy support and resources. There is also substantial gap between the user's perception of their actual demand and what policies are trying to incorporate for future initiatives. There should be a proper accumulation of both public and private operators views to enhance the present public transit scenario and therefore to initiate any future investments.

1.4 Organization of the Report

The first chapter provides the basis for this study arguing that Dhaka city has a complex transportation system and huge transportation demand but the bus transit system is seemingly inefficient. It also presents objectives and rational for this study.

The second chapter describes Dhaka's transit system, key stakeholders and policy frameworks. This chapter also addresses part of the first objective, describing the organizational setup of transit services. How these institutions perform in the transit system will also disclosed and their activities will be described. Current and past policies that are applicable in Dhaka's transit systems will be described.

In the third chapter, an overall background of transit performance definitions and how there are studied in the literatures are presented. It will include exploring the role of stakeholders and decision makers and their views in the context of understanding efficient public transit systems. Finally, how policies influence transit service performance in other megacities will be provided to make a linkage with study area.

Methodologies that are followed in this study are described in the fourth chapter. Certainly it includes why this particular methodology is applicable in this study. Especially the background of why stakeholders are interviewed to explore the transit system and to explore the future initiatives are explained here. Data collection procedures are described in detail in the later part of the chapter. Data collection is divided into three parts, namely survey of transit system providers, interview of stakeholders and secondary data collection.

Chapter five offers the results and discussion organized in terms of the three key data sources. Another important part of this chapter is to describe the current policy framework, in light of the research findings.

The final chapter presents the conclusions and includes significant strategies (recommendations) to improve transit services in Dhaka city. These are divided into current and long term strategies. As the scope of the study only incorporate policies and part of service providers, there are also some limitations in the study. So, future research scopes will be provided at the end.

CHAPTER 2: TRANSIT SYSTEM IN DHAKA CITY

2.1 Study Area

The city of Dhaka was established around 1600 AD during the period of Mughal regimes in South Asian sub continent. After several changes in political structure, the country of Bangladesh became independent from Pakistan and Dhaka became its capital in 1971. Previously a provincial city, it is now exercising the power of a global capital city.. The city corporation is formalized in legal statutes introduced as the Dhaka Municipal Corporation Ordinance in 1993. One of the key motivations was to democratize the power of the City Corporation to an elected body. The City Corporation of Dhaka area is divided into 90 wards and each ward is vested to an elected ward commissioner who typically serves a five year term.

2.1.1 Demography

The area of the City Corporation is approximately 360 km^2 with a population of 8,846,400 according to the year 2011 census. In 2001, population was 5,994,572 which represent the very fast growth rate of population in this area requiring more city amenities by these years. City Corporation area is administered by Dhaka City Corporation authority and they are also responsible for ensuring city services along with other authority. For most of the plan preparation for this city, Dhaka Statistical Metropolitan area was taken under consideration which included two more nearby cities and in total cover 2161 km^2 area with a population of 14,543,124.

2.1.2 Land use

The city (see Figure 2.1 for reference map) is predominantly residential and continues to attract people from all over the country. The old part of the city beside the river Buriganga is now a mixed use area which was developed for commercial activity. Over time, the city has grown towards the north side as it is surrounded by river and floodplains on the south side. The core commercial area named Motijheel is located just past the old city and the major public universities are also located adjacent to the commercial area. Planned residential areas like Dhanmandi, Mohammadpur, Mirpur were developed afterwards to provide necessary infrastructure facilities accessible to all residents. Whereas in unplanned mixed use areas these facilities specially proper roadway standard are not maintained at all. Newer housing areas like

Basundhara and a number of small residential blocks are now developing just beside the flood plains of the eastern periphery. Several restricted areas inside the city like the Dhaka Cantonment which is the military headquarters occupying huge amount of land area, creating an issue of controversy between the planning authority and the city government. With the intent to create a second commercial district, Karwan Bazaar was developed besides the Tejgaon industrial zone. Several small manufacturing industries are now prevailing in the old part of Dhaka city creating environmental pollution and also degrading living quality. Hajaribag Tannery is also another major issue in Dhaka city, contributing a tremendous amount to the pollution of the river Buriganaga.
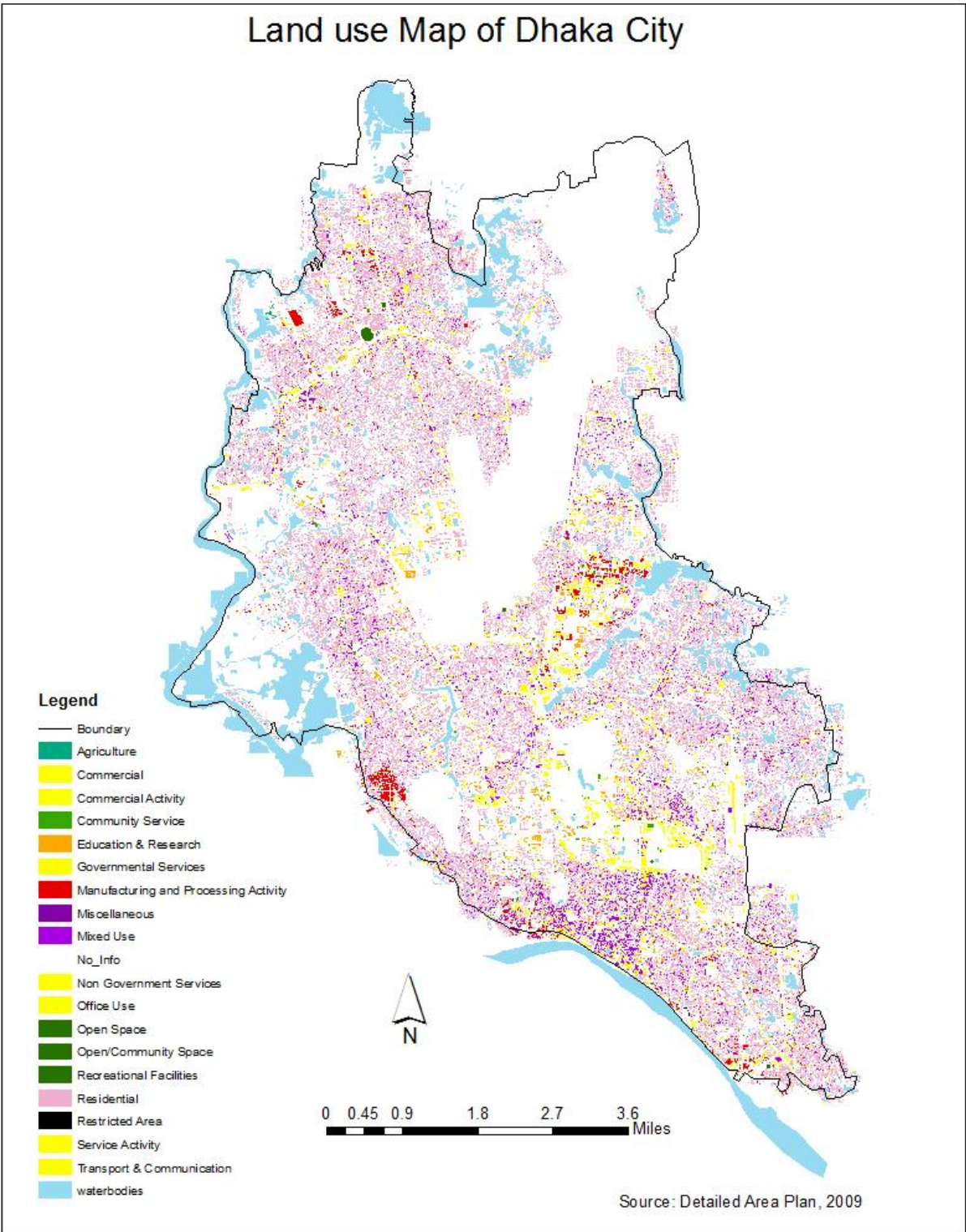
Figure 2.1: Land use map of Dhaka City

2.1.3 Transportation

Dhaka developed besides river Buriganga as a trading city around 400 years ago,. Over time, people have migrated to this city, creating immense growth pressure and eventually contributing to an unplanned road network system which emerged beside a few planned areas. The old part of the city has the most narrow road network, which basically works for pedestrian walkways but with a mixed land use pattern, it becomes congested with all kinds of vehicles. Dhanmandi, Mohammadpur and Mirpur (see figure 2.1) were built as planned residential neighborhoods with a gridiron patterned road network. More recently built residential areas like Basundhara and Uttara are well planned areas that have a good transportation network. Beyond these examples, unplanned areas in the middle and eastern side of the city have an unplanned road network but still attract people and jobs given their proximity to the core commercial and office areas..

During 2002, as part of the Dhaka Urban Transport Project (DUTP), a database was created for the city corporation area. According to this database, there were 1286 km of road network, divided into five road categories as follows:

Road Category	Kilometres	Percentages (%)
Primary	61	5
Secondary	117	9
Connector	220	17
Local	570	44
Narrow	318	25
Total	**1286**	**100**

Table 2.1: Road categories in Dhaka city (Source: DUTP 2002)

Nowadays, city corporation area has around 1868 km of road network with 163 km footpath. Dhaka Integrated Transport Study presented a different road classification for the Dhaka Metropolitan area which is as follows:

Category	Kilometers	Percentages (%)
Primary	200	7
Secondary	110	4
feeder	150	5
Narrow	2540	75
Total	**3000**	**100**

Table 2.2: Road categories in Dhaka Metropolitan area (Source: STP 2005)

According to Detailed Area Planning survey on 2005, it was found 250 km of around 3000 km road network of the city area are eligible for large size bus operation. Major roads of the city Mirpur Road (north-westerly); Begum Rokeya Sharani (northerly); Airport Road and Pragati Sharani (northerly); Dhaka-Chittagong Road (easterly) and Dhaka Sylhet Road (north-easterly); Dhaka-Naryanganj Road (south-easterly); and Dhaka-Mawa Road (southerly). Most of the major roads inside the cities are in north south direction which makes transit operation time consuming. However, cantonment area inside the city is a major impediment for public bus operation, as only private car, taxi and rickshaws have permission to access in the area.
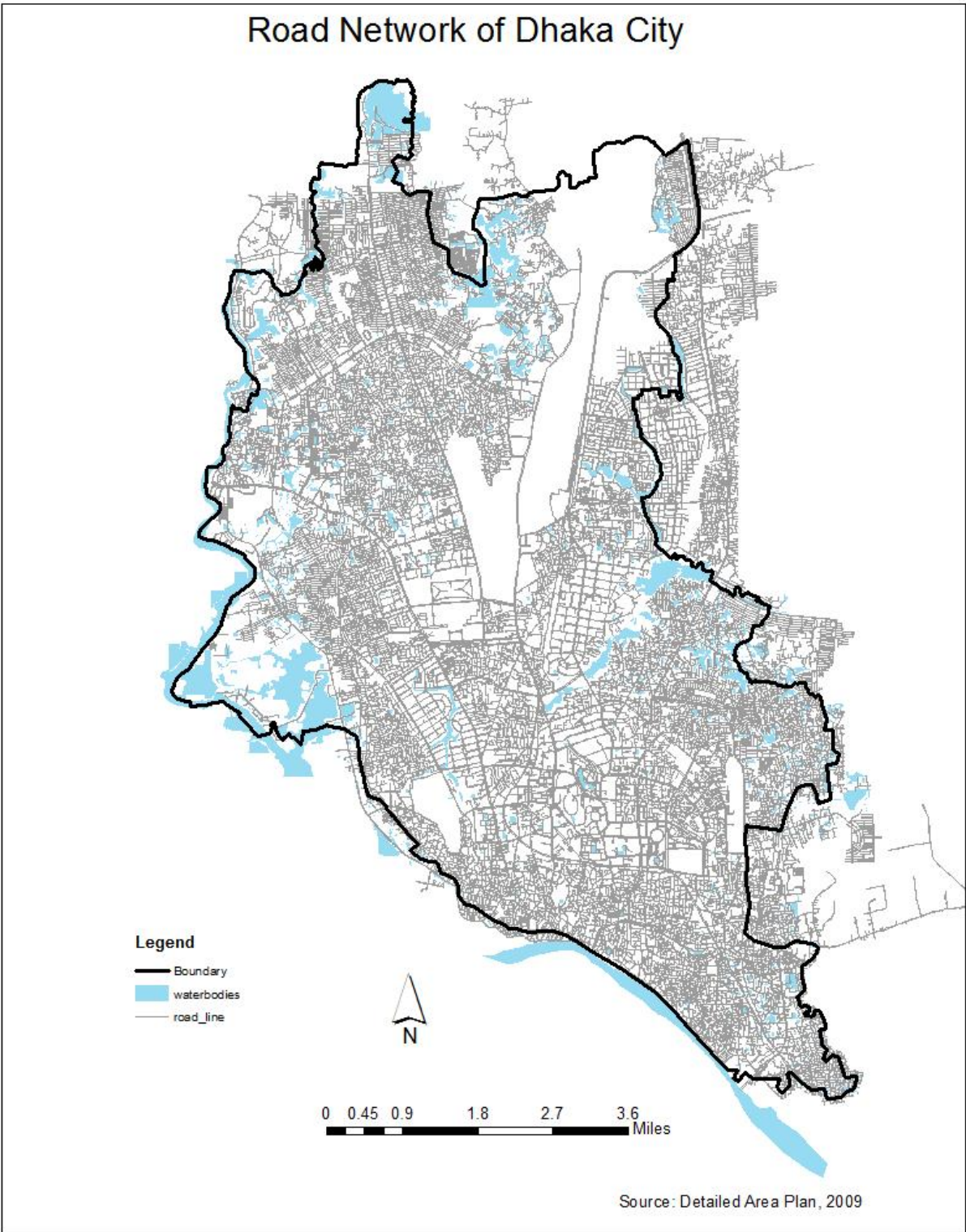
Figure 2.2: Total Road Network of Dhaka city.
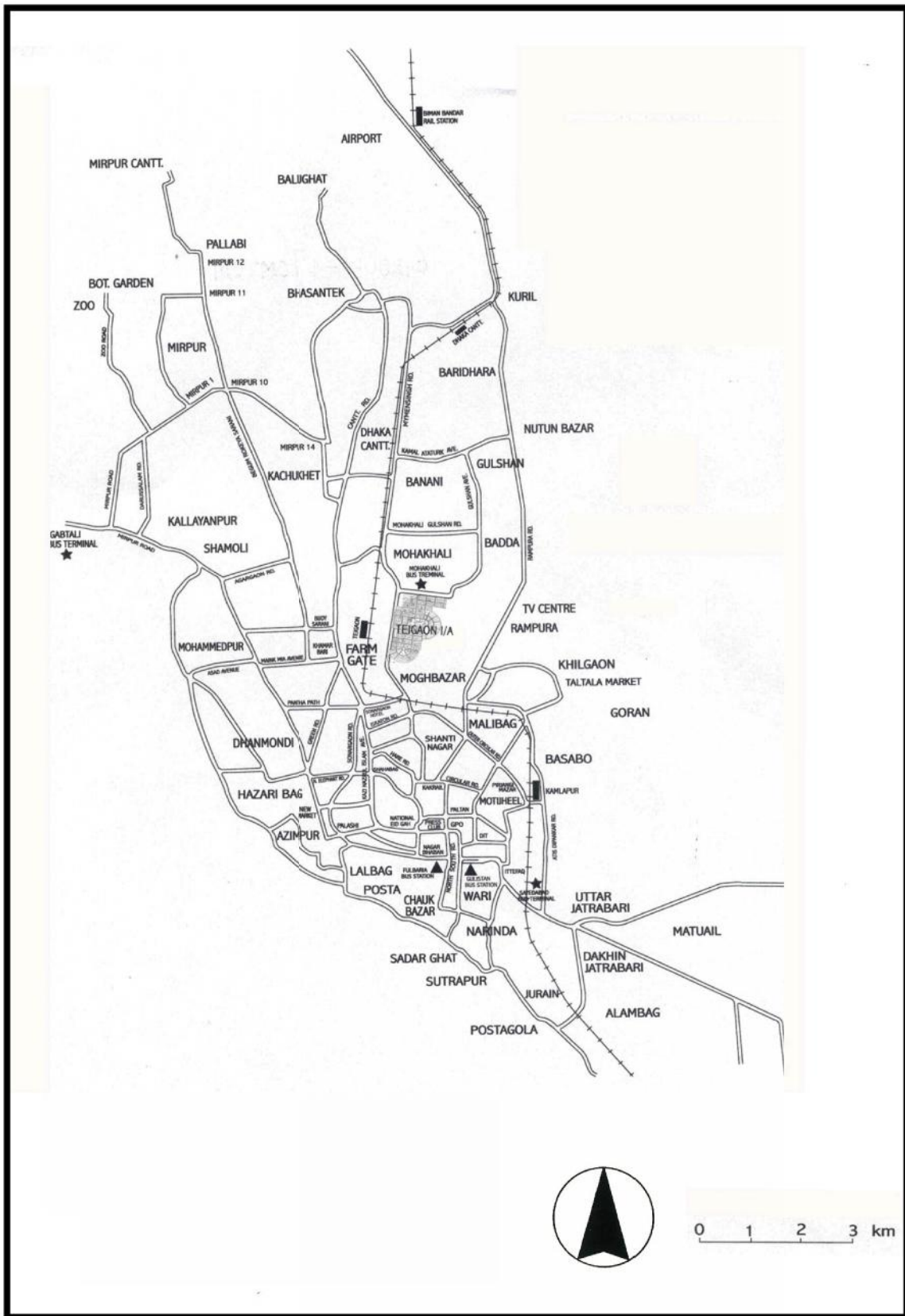
Figure 2.3: Major Roads of Dhaka City

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2.2 Transit System

2.2.1   Transit Operation

Dhaka City's transit industry is a complete mixture of different types of vehicles including motorized vehicles like buses, mini buses, private car, taxies, human hauler, and non-motorized vehicles (rickshaws). There is no mass rapid transit system present in the city, so for long distance travel, people mostly depend on bus transit. To enhance speed, safety and to reduce congestion on roadways, rickshaws were banned from several main roads in 2005. Separate lanes for different vehicles are also being introduced, including left lanes reserved for public buses and most right lanes for private buses. According to Bangladesh Road Transport Authority (BRTA) there are 156 bus routes (see Figure. 2.4) approved for the Dhaka region with some of the routes beginning beyond the city area. Most of the bus routes share the same carriageway and start and end points are only a few. From the bus route maps it is apparent that most of the starts are from residential areas like Mirpur, Uttara or Mohammadpur and the ends are either Motijheel (commercial core) or at Jatrabari covering residents from the south-east edges of the city. The following table presents the number of motor vehicles that are newly registered in the respective year to operate in Dhaka. This table is also showing that vehicle share of buses and mini buses are only 7.4%.

Type of Vehicles	Until 2006	2007	2008	2009	2010	2011	2012 (jan to june)	Grand Total	%
1 Motor Car	105636	10244	13749	17654	19557	10913	4494	182247	25.73
2 Jeep/St. Wagon/ Microbus	42356	4372	5077	6803	6687	4841	2094	72230	10.20
3 Taxi	10672	0	0	10	0	0	0	10682	1.51
4 Bus	5070	1082	1144	814	1101	1214	535	10960	1.55
5 Minibus	8021	77	107	112	142	104	20	8583	1.21
6 Truck	24204	830	1642	3180	4543	4711	2319	41429	5.85
7 Auto-rickshaw/ Auto-tempo	13400	121	155	1144	1362	2463	1646	20291	2.87
8 Motor-Cycle	156334	17303	23713	22093	30264	34357	18116	302180	42.67
9 Others	19576	2913	2550	4868	12225	12741	4463	59336	8.38
TOTAL								**708197**	

Table 2.3: Registered vehicles in Dhaka. (Source: BRTA, 2012)
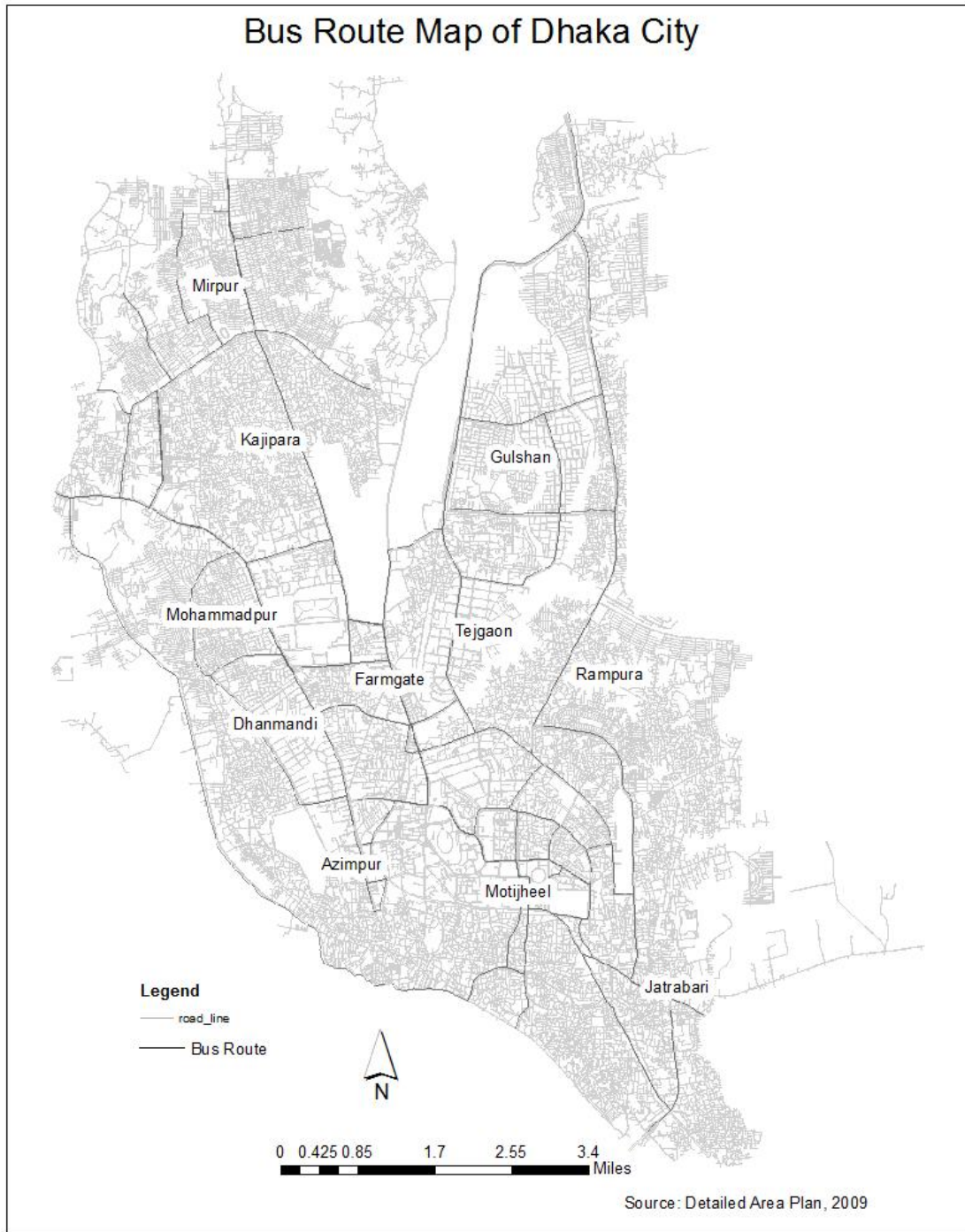
Figure 2.4: Bus routes map of Dhaka city.

2.2.2 Stakeholders in Transit Services

There are different stakeholders present in the transit industry of Dhaka city. It is a complete mixture of several organizations, companies and even a single bus owner could be a stakeholder with his only bus providing services in the city. Although there is no single agency, primarily, the Ministry of Communication is the highest authority responsible for transit, construction, development, expansion and maintenance of roads and railway transportation. A number of organizations working under this ministry, - Bangladesh Road Transport Authority (BRTA), Bangladesh Road Transport Corporation (BRTC), Dhaka Transport Coordination Board (DTCB) and Roads and Highways Department (RHD) are directly involved in the transit services. Without previously mentioned authorities, Ministry contracts foreign companies and academicians for research and provision of public transit. The following figure depicts the transit system stakeholder's core activities in a single frame.
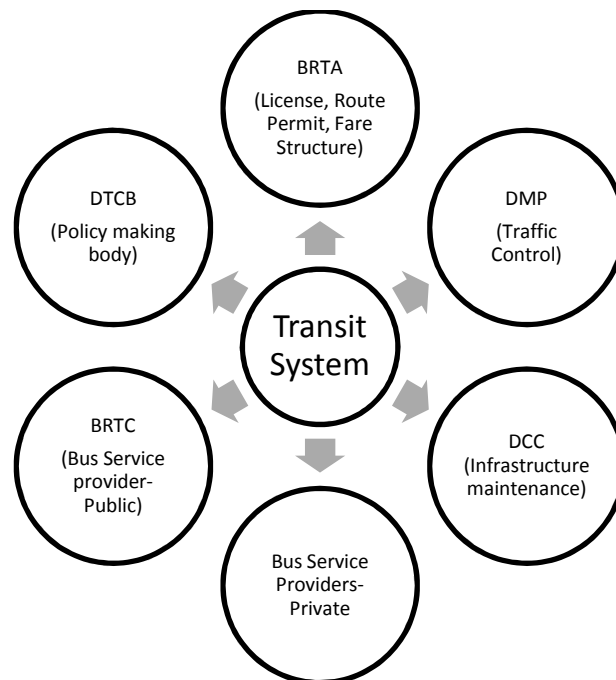
Figure 2.5: Stakeholders involved in transit services. (Source: STP, 2005)

Different stakeholder's involvement in the transit industry is described as follows:

Bangladesh Road Transport Authority (BRTA)

The Bangladesh Road Transport Authority works under the Ministry of Communication, and was established under the Motor Vehicle Ordinance of 1983. It is a regulatory body to control, manage and ensure rules and regulation in the road transport sector and road safety related areas in Bangladesh. It divides the country into 62 zones and the Dhaka zone is responsible for the activities in Dhaka Metropolitan area. The activities are-

- Controlling and regulating road transport by executing motor vehicle Acts, issuing route permits and fixing rates and fares of buses and trucks
- Conducting regular activities like: issuing driving licenses, fitness certificates, registration certificates and driving instructor's license
- Registering schools for motoring
- Organizing and conducting workshop seminars for delivering information regarding safe driving and traffic regulations
- Conducting research and development for ideas and methodologies to improve road safety and the traffic system.

Bangladesh Road Transport Corporation (BRTC)

The Bangladesh Road Transport Corporation (BRTC) is the only public transport service provider in the country, established under the Bangladesh Road Transport Corporation Ordinance of 1961. It provides bus services that are international, intercity and intra-city. Dhaka based public bus services include both double decker and single decker buses and also exclusive services for women, employees and students. The main objectives and activities of this organization are-

- Operate road transport services for both passengers and cargo.
- Facilitate private sector in transport service and introduction of new routes.
- Play strategic interventional role at the time of emergency.
- Provide training facilities for Drivers, Mechanics and in transport management.
- Research vehicle and engine types and safety considerations.

Bus Service Providers (Private)

There is no exact database of how many operators provides bus services in Dhaka. It is estimated that many thousands of operators are now present in the industry as per the recent strategic transport plan. These operators are divided into two distinct associations, maintaining a strong influence in the overall provision of transit services. Government stakeholders have tried to maintain a close liaison with these two association for delivering any now policy or fare structure.

Dhaka Transport Co-ordination Board (DTCB)

The Dhaka Transport Co-ordination Board (DTCB) works under the same Ministry as the other boards, and plays the role of policy making body for the transport sector in Dhaka. To make a safe and efficient transport system, it is working on the integration of concerned agencies and place strategic plans. DTCBs' main objectives are-

- To advise concerned agencies on an integrated and safe traffic and transportation system for Dhaka and to make necessary arrangements with those agencies to pursue that goal;
- To co-ordinate traffic and transportation infrastructure development plans with the overall development strategy plan for Dhaka as envisaged in the structure plan;
- To formulate strategic planning for transportation sector of Dhaka and to co-ordinate inter agency co-operation.

Dhaka Metropolitan Police (DMP)

Dhaka Metropolitan Police works under the Ministry of Home Affairs to provide safety and prevent crime in civil society. A separate traffic division within this organization enforces the rules of the Motor Vehicle Act and works to more effectively control traffic movement. To provide efficient services, it maintains connection with other concerned agencies in the transport sector. DMP Traffic pursues the following activities-

- To ensure smooth traffic flow every day.
- To take actions against traffic violations.
- Enhance the comfort of pedestrians and passengers.

- Take measures to reduce road accidents.

Dhaka City Corporation (DCC)

Dhaka City Corporation has a limited regulatory role on transit services. City Mayor also chaired the board of directors of DTCB. DCC is responsible for the maintenance of road infrastructure in the city area. All the transit terminals, shelters and stops are constructed and maintained by DCC.

2.2.3 Transit Financing

Infrastructure Financing

Every year, the Government of Bangladesh announces the Annual Development Program (ADP), which details approved budgets for any development projects going on in the country. For Dhaka, there are about 14 agencies that receive funds through this program for transport related development projects (STP, 2005). A large part of the budgets obtained by the Roads and Highways Department (RHD) and DCC are for road construction and maintenance, while a smaller portion is for research and policy analysis.

Fare

Dhaka's transit fare structure is generally regulated by the BRTA. Fares are reviewed periodically in consultation with transit operators and adjustments do occur, especially when fuel prices increase. The transit fare chart for Dhaka is designed to reflect the distances of the route driven by a bus. According to the survey of transit operators conducted as a part of this research (July 2010), the fare for any transit trip is calculated as follows: it has a fixed rate of 5BDT for the first stop and a distance varying component which is 1.2 BDT/km. Minibuses with 36 seats (seating services) normally operates a fixed rate fare for the entire route of trip.

Bus transit services (large bus) use a counter system at every stop, where a counter man sells bus tickets to passengers according to the described fare structure. These counterman are also an important information service for passengers as they know the time schedule and fare rates very well. There is no transfer system in place, and no monthly passes, so the tickets are one time use only. In every bus there is a driver and a helper who remains inside the bus to maintain the

ticketing system, to help the driver follow the routes and deal with traffic. In mini buses with seating services, the helper also sells tickets inside the bus.

Figure 2.6: Passengers lined up at the bus stop besides the ticket counter waiting for buses.

2.3 Policy Framework

All of the relevant transport studies and policy documents for Dhaka city undertaken by the Government are presented here in order of their documentation year:

2.3.1   DITS

The Greater Dhaka Metropolitan Area Integrated Transport Study (DITS) (1991-1993) was the first initiative of the Government of Bangladesh that involved assistance from United Nations Development program (UNDP). The project was aimed at the collection of information about the demand for transport services and the infrastructure to deliver those services to greater Dhaka

and preparation of an immediate action plan for the effective management of the existing traffic and transport system. Preparation of a sound basis for the development of policies and the strategic planning of longer term transport infrastructure investments in the Greater Dhaka Metropolitan Area was also a priority.

2.3.2 DUTP

Recognizing the need for a sustainable increase in investment in Dhaka's transport sector, the Government of Bangladesh with the help of World Bank (WB) approved a project named the Dhaka Urban Transport Project (DUTP). DUTP was a technical assistance project. It started in two phases. DUTP I ended in 1998 and DUTP II started in 1998 with reference to work of DUTP I. The main objective of this project was to provide detailed plans and scope for structural improvements of the road transportation system of Dhaka city. DUTP-I provided the following main recommendations:

- Promotion of the operation of public busses
- Provision for pedestrian only areas in old Dhaka
- Provision of NMT (Non Motorized Transport) main route network
- Improvement of function of the major intersections by constructing flyovers at three locations
- Improvement of existing truck stands
- Development of a comprehensive parking policy
- Enhancement of management and enforcement capabilities of DCC, DMP and BRTA
- Provision of adequate compensation and reinstatement elsewhere for families, commerce, and establishments affected by the projects (new construction)
- Addressing a broad context of environmental issues

2.3.3 STP

The need for a coordinated land use and transport plan for greater Dhaka gave rise to the Strategic Transport Plan (STP). In 2004, a project was undertaken by the Government of Bangladesh with the help of World Bank to prepare a long-term strategic level plan for the transportation system of the Dhaka Metropolitan Area. As a part of the STP project, an urban transport planning model (UTP Model) was developed and used to forecast future travel demand

resulting from different land use scenarios and transport strategies and to predict the performance of the existing, committed and alternative development strategies for Dhaka's urban transport network infrastructure, services and policies (STP, 2005).

The objectives of the STP (2005) study were to guide the development of transportation infrastructure over the next 20 years with aims:

• To provide the nucleus of a data base for Dhaka and to begin the process of establishing common standards and control for infrastructure planning and design;

• To provide knowledge regarding the simulation model used in the study and to ensure that future work in the area can be continued using the same methodology;

• To demonstrate a method for defining and evaluating alternative transportation strategies such as that future strategies can be evaluated with the same common approach; and

• To list the actions required to be taken in a systematic manner such that the ultimate strategic plan can be realized within a logical framework.

Besides a strategic plan for the next 20 year period, the STP study also provides urban transport policies and institutional strengthening and capacity building plans for Dhaka metropolitan area.

Summary

The primary initiative if this chapter is to provide a detailed description of the transit system and relevant land use and transportation information to establish the background for the study area of Dhaka city. It is an overpopulated city because of it being the centre of all important activities in this country. Other than a predominant residential character, most other parts of the city are showing mixed land use characteristics. With few planned residential areas, the city has mostly gone through unplanned development which has a direct and largely negative affect on the transportation system of the city. Roadways of these areas are not even capable of incorporating a major bus transit system. As long as there is no mass transit system, the only available transit services are the public buses.

Stakeholders involved in the transit services also present a complex system characteristic. Unlike a single transit service authority, there are six prominent stakeholder agencies present in the system. Each of the agencies has their definite different activities and responsibilities for the efficient performance of the transit industry. At the same time, each o bus service provider has to go through a long diplomatic procedure for aspects of their service delivery from route permits to

new infrastructure and even for policy formulation. This creates incompetency in the overall system.

Though both public and private bus service providers are present in the industry, all of them have to follow same fare structure. And also, as there are no subsidies available for the private bus service provider's, rapid fuel price changes sometimes create inefficiency in their services. As an independent nation, in the last 42 years, there are only three transportation related large scale projects that have been completed in Dhaka. Among these, only the last one, which is the strategic transportation plan, includes background study, policy formulation and long term plans for the next 20 years. The present situation of STP implementation is discussed further in chapter 5.

CHAPTER 3: LITERATURE RIVIEW

An extensive set of literature is explored to present the understanding of earlier transit performance studies. From this literature, several issues are focused on according to the objectives of this study. Besides transit efficiency measurement, policy strategies in relation to the transit services and related methodologies are also studied. This literature has been divided here into three parts, on the basis of geographic regions that share the same administrative setup and similar transport problems and to explore their views to address their system inefficiencies. First of all, studies on transit performance and indicators in developed countries are explored. In the second part, transit service studies in Asian countries are discussed. In the last part, transit related studies in Bangladesh and other mega cities experience with successful transit initiatives will be explored to better understand the transit situation in Dhaka.

3.1 Efficiency of Transit Service Studied in Developed Countries

Efficiency analysis of transit systems comes to be a focus of research within transit industry and advanced during the 1980's (Takyi 1993, Karlaftis 2004). A number of researchers started to analyze efficiency, along with describing the particular indicators of it. To have improved management and better utilization of existing facilities of transit services, Fielding, Glauthier & Lave (1978) were among the first to provide specific indicators of transit performance. They define efficiency indicators as the relationships between input and output and effectiveness indicators as providing the measures of actual service produced. Their three indicators of efficiency are -revenue vehicle hours per employee; revenue vehicle hours per vehicle; and operating expense per revenue vehicle hour (Fielding et al. 1978). Further their four suggested indicators of effectiveness are: revenue passengers per service area population; percent of population served; total passengers per vehicle; and revenue passengers per revenue vehicle hour.

Fielding, Babksky & Brenner (1985) advanced their previous framework and utilized data from the National Urban Mass Transportation Statistics of the United States. From a large set of variables, they have identified seven variables through factor analysis and these variables provide the entire spectrum of performance as they represent all the factors of a performance concept. These are revenue vehicle hours per operating expense (RVH/OEXP), unlinked

passenger trips per revenue vehicle hour (TPAS/RVH) and operating revenue per operating expense (OREV/OEXP), total vehicle hour per employee (TVH/EMP), total vehicle mile per peak vehicle required (TVM/PVEH), total vehicle mile per maintenance employee (TVM/MNT) and total vehicle mile per accidents (TVM/ACC).

As there are multiple indicators used to analyze performance, debate is going on to select the best single measure of efficiency. Benjamin and Obeng (1990) analyzed Total Factor Productivity as a single indicator of transit performance. They defined productivity as the difference between the percentage growth in outputs and inputs in two time periods and used a weighting scheme to combine the growths in inputs as well as the growths occurring in all outputs. They related total factor productivity with urban area characteristics and also with the financial policies of federal, state and local governments. The efficiency measures they used are the number of employees per peak vehicle-mile, maintenance hours per vehicle, and vehicle efficiency. They used a formula which has a resulting operating cost function to calculate total factor productivity. They found no relationships between subsidy and productivity and no statistically significant relationships between vehicle productivity (miles/vehicle) and federal and local assistance. Results also indicated higher needs of transit in highly populated areas because of high population and high consumption rate. Only significant relationship they found between system efficiency and productivity is between vehicle mile labor productivity and vehicle efficiency which validates that there will be more productivity with system efficiency as more efficient use of vehicles leads to more efficient use of drivers.

Most of the studies explored in this research use single measures to evaluate transit performance through efficiency analysis. However, Takyi (1993) looked through the overall scenario of transport service efficiency and discussed the dimensions of transport services and performance, appropriate data analysis technique and their interpretation. Service dimensions were grouped into i) organizational context and ii) evaluation process dimensions. The first one is important for organizational decision making and the second one is for operation, design and service techniques s. In Takyi's (1993) approach, Transit performance is evaluated from efficiency, effectiveness and utility perspectives. Three alternate data analysis techniques are used to examine the interrelationships of the variables. Variables relating to the use of techniques and

standards, service area criteria, planning and design criteria and, finally, operating criteria were revealed as the most effective indicators. Finally, one of the advantages of this study is that it provides the most innovative way and guideline to incorporate all the faces of transit efficiency in the one platform.

Viton (1997) also analyzes US transit systems operating conventional motorbus or demand responsive services using Data Envelopment Analysis (DEA). In 1990, he examined the technical efficiency of 217 decision making units (DMU) where each DMU operated either conventional motor bus or demand responsive services or both. He used both vehicle miles and passenger trips as output measure. Input measures came from three sources: the first one is environmental variables expressed by average speed of mode, second is conventional inputs including fleet size, fuel used and labor inputs, and the last one is system costs including tires and other supplies. The basis of this article is to find out whether a DMU can produce their existing services with fewer physical resources and if their inputs can yield more output. The final outcome for their case is that the amount of inefficiency present is small and DMUs could increase their services to some extent without additional inputs. In this case, public and private services share the same level of technical efficiency.

Karlaftis (2004) also used the DEA approach to analyze the performance of 256 US transit systems. In his article, after a background analysis of the indicators, he depicted the relationship between two important criteria- efficiency and effectiveness. Data from National Transit Database (NTD) over five years used in his work which fulfill analysis both from cross-sectional perspective and also from different time frame. In this paper, labor, capital and fuel were used as input to the transit industry. To analyze efficiency, vehicle mile was used as output and ridership used as an output to analyze effectiveness. By evaluating the transit system from both of these criteria and their combination, it provided a new look in the performance ranking of the industry. Performance ranking which is a important tool for managing the overall system, assessing the progress and also financing the transit industry also proved in this research that if a system performed well in efficiency dimension it also perform well in effectiveness dimension. Finally by measuring transit system economies, this paper produces an interesting result for the optimal size of the groups from efficiency and effectiveness dimensions. It found that the

optimal size of system changes significantly with the changes of selection of output and also dimension of performance estimation.

In Europe several recent studies have been carried out to analyze transit service efficiency. Odeck and Alkadi (2001) analyzed the performance of the Norwegian bus industry using non-parametric DEA approach. Both private and publicly owned services are analyzed and both are subsidized by government. Their study focuses on efficiency rankings, distribution and scale properties in the bus industry, potential for efficiency improvements, and the impact of ownership, area of operation and scope, and ways of improving efficiency in the sector. A sample of 47 comparable bus companies was evaluated with the outputs being seat kilometers and passenger kilometers. The inputs used in analyzing efficiency within the bus industry include total number of seats offered by the company, fuel consumption in liters and equipment used such as oil and tires. From the DEA results it was found that there is a great potential for efficiency improvement in the Norwegian bus industry. For input oriented efficiency the potential is about 28 percent. The average company may improve their performance by being larger than they actually are, yet company ownership and economies of scope are not found to influence performance in the Norwegian bus industry. It is argued that policy implications include that managers with inefficient companies can learn from the frontier companies and most importantly seek to understand the causes of their inefficiencies. According to the authors, the central authority can then isolate the companies that use public funds inefficiently from those that perform satisfactorily. More administrative attention may then be paid to those that perform poorly.

Pina and Torres (2001) compares the private and public transit services in Spain using a DEA approach, multiple regression analysis, logit and cluster analysis. Since the European Union was encouraging more privatization, this article focuses on comparing the transit services where public operators have subsidies and are also bound to improve management and services. In their study, they use fuel/100km, cost/km cost/traveler and subsidy/traveler as inputs to analyze efficiency in 14 medium and small size cities in Spain. Four types of indicators used as output: productivity indicators, service level indicators, quality indicators and size indicators. Environment or population variables are found to show no statistically significant relationships

with efficient or inefficient transit behavior whereas distance travelled, cost and fuel use showed statistically significant relationship. From the analysis they found no significant relationship between the efficiency and management of services either for public or private transit providers. As in Dhaka city both the public and private transit providers have significant influences on the transit services so it becomes useful to explore the management options in other cities.

There are also some literatures of methodologies for transit efficiency evaluation that are used over the time periods. Like Brons, Nijkamp, Pels & Rietveld (2005) summarizes literatures and used samples from those literatures to identify key determinants of technical efficiency of the transit service operators. This article also found that different database, region, output specification and assumptions also have significant impact on efficiency. From this research it is found that technical efficiency values are similar for parametric and non parametric studies and among the non parametric approaches 89% are using DEA for analyzing technical efficiency.

Tsamboulas (2006) uses DEA method to identify efficiency and effectiveness rankings of transit systems in several European cities and find out the sources of inefficiency. As there are changes in regulatory systems in these cities, how the improved transport services could be achieved through public or private ownership are addressed in this study. It also shows that competition in the transit system offer better performance as there are more incentives in relation to the subsidized publicly owned system.

Sampaio, Neto & Sampaio (2008) estimated the efficiency of transport systems by Data Envelopment Analysis (DEA) focusing on the institutional arrangement in the metropolitan area. Institutional arrangements in terms of power division among them, administrative coordination, financing, and selection and operation play an important role in delivering efficient public transit to the passengers. Transport performance of 19 metropolitan areas from Brazil and Europe were analyzed using total operational cost; total number of equivalent vehicles; and number of employees as inputs and total numbers of passengers traveled as output, in this model. The resulting efficiency scores were used to evaluate power partition of the metropolitan agencies to have the exclusively efficient system. An index was developed which resulted that higher participation by central and local governments and also the associations represents efficient

system. This model can be used to measure efficiency of transport systems from many other components.

Summary:

Efficiency analysis in transit services which is basically analyzing the relationship between inputs and outputs in this sector comes to be a focus of research from 1980's. After that a number of researchers provide new insights this analysis and advanced with time. The indicators used in this type of analysis were more or less same for the later studies, but previous studies also looked into the fact of how to choose appropriate indicators, how to find out single measure from a pool of multiple indicators, introduced new techniques over time like Data Envelopment Analysis (DEA). In North American studies, those were mostly analyzed performance of public transit providers, used cross sectional data over year and by using DEA it was possible to find out the most efficient provider, how to increase use of existing inputs and even helps to find out optimum size of transit service provider. In European studies another interesting insights added to the previous findings and this is the evaluation between public and private service provider. These are particularly helpful for efficiency analysis of transit services in Dhaka city, as there are both public and private operators present in the industry.

3.2 Study of Transit Performance and Strategies in Asian Cities

Barter (2000) studied in detail urban transport systems in Asian cities as they share the same characteristics like high population density, traffic problems, deteriorating public transport service and a lack of investment funds. After a long-term comparative analysis of the issues he provides insights to the key public policy choices in these cities and reveals potential opportunities for public transport in high density urban areas. According to him high densities results in high traffic intensities, pollution, traffic injuries, congestion and make low availability of road space but also give opportunities to have public transportation with high service levels and these are highly accessible and profitable as long as have huge number of potential customers. Barter concluded that high urban densities in Asian cities are best served by public transportation, walking and cycling.

At the International Mayors Forum, Penalosa (2004) identified high population density as the most important factor in transport policy. High density makes possible low cost, high frequency public transport. A low density suburban structure makes for long average trips and therefore more costly trips. Higher densities are thus necessary in order to have low-cost high-frequency public transport.

Severe resource constraints are identified as the major problem for the cities in Asian developing countries (Morichi, 2005). Both long-term and short-term policy strategies are discussed in this context for transportation systems considering their special dynamics in Asian megacities. Though urban railway as a public transport would be the best for long term approaches but due to resource constraints, less capital intensive technology like LRT could be introduced as a short term strategy. For road based public transport, fare level needs to be lower to increase public transport ridership until introduction of railway.

Ma et al, (2008) examined the policy making process of Beijing, China to understand their transportation problems and how they can be solved. They studied and compared transit services in Beijing and other cities and concluded public transit paired with transportation demand management is an effective approach for sustainable transportation with the presence of appropriate policy measures.

The World Bank (2002) carried out several studies to explore appropriate transportation strategies and transit options in developing countries. They argued that inadequate road infrastructure and poorly developed institutional, fiscal and regulatory arrangements were the major sources for transit performance decline in those cities studied. To make urban transport more efficient they mainly focused on suitable transit policies integrated with private sector inclusion and infrastructure facilities for the system and there should be healthy competition among the providers through tendered franchises and concessions. From a pool of several mass transit options cities should look for their options by comparing cost and benefit, financial sustainability, integration with city planning and a service that can serve all levels of people.

Hidalgo & Graftieaux (2008) summarize the technical, financial, and performance of transit services in 11 cities in Asia and Latin America. These cities have gone through major transit

improvements with the implementation of BRT systems. They review the problems of implementation, planning and other fiscal and institutional constraints in this study. To review the systems they interviewed the major stakeholders like members of the implementation teams and operators. From a number of lessons learned from this study, a significant one is the making regulatory/institutional reformation in setting up a new transportation projects. There should be system/ project specific planning and design, involving other urban development program and integrating with other transport initiatives.

Badami & Haider (2007) provide a chronological financial and operational performance analysis of some major cities of India. Though the authors didn't use any particular analytical method, it provides an overall picture of the public transit performance of publicly owned bus services. The authors changed some measures and rearranged the definitions of factors to have a perfect picture of south Asian cities. Four metro cities and four secondary cities are analyzed from the perspectives of service, fuel and cost efficiency. It is argued that any transit service with greater quality, reliability and efficiency can attract people in such a rapidly motorizing country. They focused on service efficiency and low cost provision as the best way to attract the low income people of these cities.

Summary:

Literature reviews of transit performance of Asian cities were done as most of the Asian megacities have similar characteristics of high population density, rapid urbanization, rapid motorization and lack of investment facilities. Dhaka city shows these characteristics too. From these studies it was found that high densities have positive influence on transit services in a way that transit services will be readily available in a high frequency to a large number of customers and if it's a efficient one, it can draw attention of passengers even in the time of rapid motorization. For efficient transit services, institutional reorganization, proper planning and design and future vision and implementation are also needed.

3.3 Transport studies in Bangladesh

There are no specific studies about the efficiency of transit services in Bangladesh cities. Most studies have looked at the overall scenario of transport in cities like Dhaka and the reasons behind the poor quality transport there. A significant number of studies have been carried out to explore the potential for mass transit in Dhaka city.

Zahir, Matsui and Fujita (2000) studied bus and their passenger travel patterns and transit performance of Dhaka city. Based upon field survey data they evaluated travel and stopping patterns in order to have a better understanding. There is a significant relation between the bus arrival, departure patterns and waiting times according to the time of day and direction of operation. As there is absence of formal time scheduling and driver stopping behavior transit services in the city are inefficient. They discussed several scheduled transit services with fixed stopping criteria to increase transit productivity and fleet utilization.

Andaleeb, Haq and Ahmed (2007) explore ways of improving bus transportation services in Dhaka. They identified eight factors to address satisfaction levels of regular bus users. Using factor analysis and multiple regression, five of the eight selected factors were found to have significant effects on passenger satisfaction. These include comfort levels, staff behavior, number of buses changed to reach destination, supervision, and waiting facilities. Policy implications are discussed in view of these findings.

Barua and Tay (2010) studied safety issues of transit services in Dhaka city. There has been a general increase in the severity of transit bus crashes over the period of 1998-2005. They utilized the transit crash data to understand the factors behind the collisions. They recommended a driver training and education program, traffic enforcement and more police control to be introduced to improve road safety in Dhaka city.

Katz and Rahman (2010) studied transit services in Dhaka city, specifically the overcrowding on bus systems due to a lack of transportation infrastructure in the city and the absence of an appropriate transit system which can handle the volume that exists. Though there is no mass transit (metro service) as well as a poorly organized bus system, there exists overcrowding which lessens safety, performance and comfort. They argue that only with an improved traffic system

on roads and the introduction of planned mass transit system either by rail o BRT can changes to the situation occur.

Bose (2011) studied urban transport scenarios in South Asian Cities namely Bangalore, Dhaka and Colombo. Because of rapid urbanization there is faster growth of motorization in these cities which puts huge pressure on the transport system and increases energy use, emissions, pollution and road space demand. Though this study is mainly concerned with energy emissions and fuel efficiency, it concludes with an emphasis on the potential for public transit as a solution. Bus dominated transit services combined with a well maintained transport systems should be the goal in these cities for reducing traffic congestion and decreasing energy use and emissions.

To establish an overall framework for the complex and multi-modal transport system in Dhaka city, a Strategic Transport planning study was undertaken in 2004. Its goal was to fulfill one of the objectives of Dhaka Urban Transport Plan which is policy support and future studies. This study successfully identified three components as follows-

1. Strategic Transport Plan (STP)
2. Urban transport policy
3. Institutional strengthening and capacity building

The long term strategic transport plan is based up on the relationship between land use and transportation. To make future predictions, a detailed analysis of the current situation is done to explain the city and its characteristics.

Both socio economic characteristics and populations trends are depicted and forecasts are made based on present conditions. Existing land use patterns are also described taking into consideration all the land use plans applicable in the study area. To have a view of existing travel characteristics, a number of specific surveys were conducted, these are-

- Screen Line Survey (vehicles, vehicle occupancy and pedestrians)
- Internal Cordon Survey (vehicles, pedestrians, origin-destination)

- External Cordon Survey (vehicles, pedestrians, origin-destination)
- Household Interview Survey (family members, dwelling, income, trips, travel modes,

Origin-destination)

- Travel Time Survey (speed and delay)

- Bus Passenger On/Off Travel time survey

- Public transport terminal survey

- Traffic Generator Survey (terminals, markets, institutions, centers)

- Parking Survey (inventory, turnover)

Existing financial sources and processes are analyzed to make an inventory of financial resources in the city. Based upon the STP analysis, a sum of BDT 6000 million per year (USD 100 million) is a representation of what financial resources would be available in the future. If more amounts of money are required for plan implementation, potential sources are- (a) new or expanded sources of local funding; (b) an increase in the Dhaka share of the total transportation budget for Bangladesh; (c) a redistribution of funds from other sectors to the transport sector; (d) new sources of donor funding; (e) higher levels of existing donor funding; and (f) private investment in transport projects.

Present transport services and facilities of Dhaka city are described in the study with the following transport mode specific issues-

1. Pedestrians
2. By-cycles
3. Non-motorized transport
4. Taxi and auto-rickshaw
5. Automobiles
6. Buses
7. Mass rapid transit (At present there is no MRT system. But appropriate terminologies are presented here with advantages and disadvantages of these options for future purposes)
8. Railway
9. Trucks
10. Waterways
11. Traffic management

12. Travel Demand management

13. Roads

14. Parking

15. Pricing

A Travel Demand Forecast model is used in the Strategic Transport Plan to test and evaluate the interrelationships between land use and transport. To propose a preferred option, three land use alternatives are developed and tested in this model. These are developed to be consistent with current land use plans and all other forecasts and assumptions. The Land use scenarios are-

1. Urban Corridor - Strong Central Spine Scenario

2. Growth Pole-Satellite Community Scenario

3. Dispersed Settlement Development Scenario

Future population and employment distribution are also developed according to these scenarios.

The travel demand forecast model for Dhaka was developed using a software package called EMME/2. Data from the previously conducted surveys are used in this model as inputs.

This strategic transport plan defines certain goals to achieve by the proposed time period.

1. Efficiency: Ensure that the maintenance, operation, reliability and expansion of the transport sector services and facilities occur in an efficient and effective manner with emphasis on maximizing the use of the potential of the existing resources and investments.

2. Mobility & Accessibility: Provide a basic level of mobility and accessibility for all segments of society to ensure reasonable access to employment, education, health, social and other programs, services and opportunities.

3. Safety: Develop and implement a coordinated and comprehensive set of safety improvement measures addressing all aspects of the transport system to reduce the number of transportation related deaths and the number and severity of transportation related injuries and property damage.

4. Affordability: Ensure a suitable balance between the transport sector's financial requirements for maintenance, operations and capital investments and anticipated financial resources.

5. Achievability: Develop transport operations and capital investment projects and services that fit within the skills, capabilities and constraints of the institutions responsible for implementation and having a higher probability of implementation and operational success.

6. Economic Development: Support economic growth and competitiveness, both domestically and internationally.

7. Social Development: Support programs and efforts directed toward the alleviation of poverty and the promotion of self-sufficiency together with the provision of opportunities and services that serve the requirements of both women and men, equally.

8. Environment: Minimize the transport sector's negative impact on the environment and create increased transport related environmental awareness in society.

For each goal, a sub-set of strategies are pointed out to make sure the achievement of these goals.

Top-down approaches are taken for the strategic planning of transport sectors in Dhaka. That is first identifying the desired endpoint (goals), next establishing the preferred direction or approach (strategy) and then developing specific ways and means (projects, programs and actions) for implementation that are consistent with the strategy and lead toward the goal.

Four transport strategies are selected at this stage to examine appropriate transport development in the city. This are-

    a. Transport Strategy One (TS1) – Auto/Roadway Emphasis

    b. Transport Strategy Two (TS2) – Bus/Transit Emphasis

    c. Transport Strategy Three (TS3) – Auto/Roadway & Bus/Transit Mix

    d. Transport Strategy Four (TS4) – Continuation of Current/Recent Practices

Previously described transport issues are taken as the key element in this part, relevant for every strategy.

Transport element	TS1	TS2	TS3	TS4
Pedestrian	LOW	HIGH	MEDIUM	LOW
Bicycle	LOW	HIGH	MEDIUM	LOW

Non-Motorized Transport	LOW	HIGH	MEDIUM	LOW
Taxi & Auto-rickshaw	HIGH	MEDIUM	MEDIUM	MEDIUM
Automobile	HIGH	LOW	MEDIUM	MEDIUM
Buses	LOW	HIGH	MEDIUM	LOW
Mass-Rapid Transit	LOW	HIGH	MEDIUM	LOW
Railroad	LOW	HIGH	MEDIUM	LOW
Trucks	HIGH	MEDIUM	MEDIUM	LOW
Waterways	LOW	HIGH	MEDIUM	LOW
Traffic Management	HIGH	MEDIUM	MEDIUM	LOW
Demand Management	LOW	HIGH	MEDIUM	LOW
Roadways	HIGH	LOW	MEDIUM	LOW
Parking	HIGH	LOW	MEDIUM	LOW
Pricing	LOW	HIGH	MEDIUM	MEDIUM

Table 3.1: Importance of transport elements on different transport strategies.

Then for each transport elements, sub elements are defined as a. Major improvement b. Moderate improvement c. Basic improvement and what types of sub-elements are needed for every strategy are pointed out.

In the next step, specific programs and projects are identified for the strategies. Afterwards each transport strategies are evaluated for every land use scenarios.

Recommendations:

A set of seven recommendations have been labeled as 'Primary Recommendations' after detailed study of the scenarios presented in STP. All the recommendations are described with detail implementation procedures as follows:

1: Traffic Management

Establish a program to reclaim the full potential capacity of the existing roadway space.

2: Bus Consolidation

Restructure the bus operations from a large number of small and individual operators into a smaller number of large operators.

3: Integrated Mass Rapid Transit System

Proceed with the planning, design, development and implementation of an integrated mass rapid transit system.

4: Selected Highway Projects

Provide selected highway projects that serve basic access requirements to major areas of development.

5: Safety Improvements

Improve methods of driver training and testing, vehicle roadworthiness inspections and design layouts of highways.

6: Pedestrian Facilities

Develop and implement a major program of pedestrian facility provision and improvement to serve pedestrians better and encourage people to walk from choice rather than from necessity.

7: Railway Resolution

Commission a feasibility study to evaluate and resolve the options of improving railway transport within Dhaka-

Urban transport policies were formulated as part of the strategic transport plan to guide urban transport development, operations and management in Dhaka Metropolitan area. Detail Policies were given for the following key transportation sectors-

1. Safety
2. Pedestrians
3. Public Transport
4. Non-motorized transport

5. Travel Demand Management

6. Urban Freight Transport

7. Mass Transit

8. System Integration

9. Traffic Management

10. Parking

11. Environment

12. Transport and Land Use Planning

13. Social and Political Aspects

14. Institutional and Financial

15. Privatization, De-regulation and Subsidies

Summary:

Strategic transport plan study from 2005 is the most recent study for transport sector in Dhaka city done by the government with assistance from World Bank. It deals with overall transportation system of the city and carried out a detail background study of the current status and current transport needs. After studying the current status and from analyzing detail data and strategy options, it provides recommendations and policies for future implementation and the implementation period is 20 years. To answer the first research question this study that is to know the present status of transit services in Dhaka city, reviewing of STP was particularly important to find out key themes, current status of services from the phases of STP and the challenges. The challenges and opportunities/recommendations are also cross examined in this study by interviewing key stakeholders of the transit industry of Dhaka city.

3.4 Experience from Other Mega-cities

Bogota Transit Initiatives:

Bogota, with a population of 6.5 million, experienced a transit industry which suffered from many market failures, an excess supply of slow and empty buses, low quality service and was an example of widespread inefficiency (Penalosa, 2004). There was a time when the city had a fleet of 30000 buses which were practically individually owned. City transportation was in the hands of private entrepreneurs, and local authorities regulated the system and maintained the road

infrastructure. With an average travel speed of near 10km/hour, Bogota's transit industry was an example of total inefficiency (Echeverry et al 2005; Penalosa, 2004).

After experiencing such a poor quality transit industry, Transmilenio, a hybrid public-private scheme was initiated to overcome those service inefficiencies, market failures and to improve urban transport quality. It is a city-owned company created for managing the system. Transmilenio periodically issues competitive bids to find companies that will operate a number of buses for a defined period, under a concession contract. These buses operate in exclusive lanes, refurbished by the city, with no competition in the same corridors from conventional buses. Operators are required to own the bus fleet, operate it, and maintain it along terms specified in the contract and enforced by Transmilenio. A third party collects the fares, which passengers pay on entering the station (Ardila, 2008).

The inefficiencies of previous system were addressed by several well examined provisions. Firstly, Transmilenio has exclusive use of the left lane of the streets, and only accessible transit stations facilitates transfers in different directions and improves the speed of passenger's movements. Secondly, in this system, fares were set in a way that they finance the long-term cost of provision, defined through a route-tendering process in which potential providers compete for the exclusive use of the roads based on the lowest cost bidding. Fares are developed on the basis of a change in input prices and the number of passengers transported (Echeverry et al 2005). Thirdly, the problem of a passenger oriented revenue system was replaced by introducing a new arrangement where bus owners are charged per kilometer traveled, not per passenger.

After launching in January 2001, Transmilenio significantly improved the transit situation in Bogota resulting in reduced travel times by 32 percent, reduced pollution by 9 percent in some areas of the city, and accident rates decreased by 90 percent in the Transmilenio corridors. It currently supplies more than 20 percent of daily trips. By 2015, the complete Transmilenio system is expected to transport 80 percent of the city's population at an average speed of 25 kilometers per hour. At the 1st phase of this system, the terms of reference issued by Transmilenio obligated that bidders incorporate the existing bus companies in the conventional mode. Sixty-six of 68 of these companies partnered with venture capitalists and assembled the

four operators that won the right to operate the initial fleet of 470 articulated buses on the first 42 km of network.

"However, despite Transmilenio's success, the competition in the market against the conventional mode is putting both modes in peril. Both modes compete in the market because despite Transmilenio's bus ways, conventional bus routes are found on nearby streets, less than 0.8 km. Away" as quoted by Ardila (2008).

Curitiba Transit Initiatives:

Among many other major cities, Curitiba achieved excellence in their transit industry by providing an efficient transit system to the people. In Curitiba, bus sector reform began in 1955 when the city commission recommended establishing competition for the market by splitting the city into nine zones, each to be serviced by an individual operator. The city government convinced the former 150 operators, to group into 13 companies that would submit bids. Gradually, the 13 companies were consolidated into nine still-existing companies (Ardila, 2008). The first significant changes in the transportation system began in 1974 by the implementation of a road hierarchy system with the construction of two out five structural roads. During that year, express buses on those corridors carried about 54000 passengers per day. In 1981, the city mayor wanted to establish bus services from one exclusive area to another, which clashed with the interests of the operators for the issues of exclusive zone. The operators agreed to the new system when necessary fleet amount was divided among operators according to the share each one's exclusive area. In this process The Integrated Transit Network (ITN) was initiated in 1981. Urbanizacao de Curitiba (URBS) is a public company founded in 1963 to administer routine operation of ITN and Mass transit system. URBS controlled bus terminals, ITN and MTS, distribute revenues and negotiates with the private bus transit providers. Another agency namely Curitiba Research and Urban Planning Institute (IPPUC) works closely with the URBS to shape future extension of ITN in relation to land use initiatives.

Revenue sharing system in Curitiba is same as Bogota, which is number of kilometers traveled by a particular vehicle from each company. So, Curitiba is practically an example of non-competition where private providers are following and maintaining appropriate routes and time

schedules, City government manages and administered the entire system even fare is collected centrally.

Summary:

Bogota and Curitiba faced the similar challenges that transit system of Dhaka city is having now. Through system reorganization, these cities take new transit initiatives and made successful implementation of those. How the problems of large number of entrepreneurs/operators are managed and how to keep fare competition and the experience of institutional organization will provide key insights to both the research objectives of this study.

CHAPTER 4: METHODOLOGY OF THE STUDY

4.2 Development of Survey Materials

From the basic understanding of Dhaka's transport system it was found that bus transit services are not providing efficient services to the passengers. Later, thorough literature review on the transit industry, its performance, Dhaka city's policy documents and experiences from other mega cities revealed a way out. For a complex transit industry comprising both motorized and non-motorized vehicles, the situation in Dhaka city needs detailed exploration as it is also projecting a huge transit demand as described in the Strategic Transport Plan. Survey materials were developed to acquire both quantitative data on the transit industry and qualitative (open ended question) on stakeholder's opinions.

For evaluating transit performance, it is important to identify significant indicators to measure overall performance of the transit operators. As Fielding (1985) specified, these indicators could be further used by the administration to distinguish good and bad performance of the operators. For this study, common and widely used indicators are selected to measure transit performance through Data Envelopment Analysis (DEA). With a view to identify the relationship between the input indicators (labor, fuel, capital) and output indicators (vehicle-km) within the transit operators, the following data were collected **(See appendix A)**-

- Transit Fare per km
- Number of active vehicles
- Number of employee
- Operating expenses per vehicle
- Type of fuel used

Stakeholder opinion is the most important part of this study because it allows one to explore the current situation and to discover operator's thoughts on the opportunities for better transit performance. This qualitative approach was primarily selected to achieve detailed understanding of the stakeholders views in transit operation system. From the basic understanding of the system it was expected that the thousand operators operating in the same industry might have some connection or basic views.. Again the situation also creates differences in their viewpoints, contributing to a more complex transportation system. As this research also involves recent

policy reviews, this approach is an intention to validate those policies from the stakeholders understanding too. From interviewing different stakeholders, it will be possible to recognize their diversified experiences and views and if those views are different from the policy understanding and also to incorporate their experience for future policy recommendation. A semi structured interview technique has been applied in this part of the research and a separate questionnaire is developed so that the interview stays within the scope of the research objectives. **(See Appendix B).** Semi structured interviewing involves using an interview guide, in which questions are content focused, such that the issues discussed in the interview are those considered relevant to the research question, from the perspective of the researcher. However, questions are not fixed and directed as in structured interviewing (Dunn, 2000). From the literature review and review of current policies and plans in Dhaka, we're able to discover important issues facing Dhaka city's transit industry and discuss these issues during the interview session.

4.3 Study Participants

- **Survey of transit operators**

Dhaka city has thousands of operators currently involved in the transit industry. There are 36 bus transit routes with several different categories in one route. For operating in these routes, operators have to obtain a permit from the authorities with a limit of a certain number of vehicles. But in a number of routes, there are no formal or individual transit operators. In these cases, anyone with a route permit for that bus route can operate vehicles. So, it was nearly impossible to identify all the operators in the transit industry of Dhaka city. However, for this study, the intention is to cover most of the currently used transit routes in order to have an overall picture of transit in Dhaka city. From the latest route permit list collected from BRTA (Bangladesh Road Transport Authority), seven transit routes were selected for receiving the questionnaire survey of performance indicators. Among them 6 are private operators and the other one is the only public transit operator present in the industry. The operator's survey was started by collecting data from the government transit operator, BRTC. Among the key personnel from this organization, the general manager was available that day to provide survey data. He was also helpful to inform this researcher about the important private transit operators in the transit system and provide contact numbers of the president of Association of Bus Companies (one of the two key associations for private operators). After that it was easy to get detailed information about them. The president was contacted first by phone call and a meeting was

scheduled for both the survey and interview. From him, contact numbers of other selected operators was collected and afterwards the procedure was to set up a meeting schedule first by phone call and doing survey and interview of them at the same time. All the surveyed personnel were either Chairman or Managing Director of that particular company. The list of operators surveyed is given below:

Public Operators:

1. BRTC

Private Operators

1. Suchona Associates.
2. Transilva Group
3. Ekushe Paribahan Ltd.
4. Pubali Paribahan Ltd
5. Bahan Paribahan Ltd
6. Shatabdi Paribahan Ltd.

- **Interview of stakeholders**

The unique transit industry of this city, with a huge number of stakeholders, requires an extensive effort to identify the most appropriate decision makers to interview. There are several separate divisions of government agencies that work with the transit industry. Each of these has a different set of goals and objectives though all of them are working towards a more efficient public transit service. Selection of the important stakeholder agencies was mostly influenced by the Strategic Transport Plan study. Afterwards a detail review of recent transportation related studies in Dhaka city helped to finalize the list of stakeholder's to be interviewed. For each stakeholder agency, one key personnel is identified who can clearly describe their views on the current status and opportunities for the transit system.

For transit operators (private), the CEO/owner of the particular transit operator were contacted through phone calls and surveyed afterwards according to their time schedule. For the public transit operator, the general manager of BRTC (Bangladesh Road Transport Corporation) is interviewed to provide detailed information on plans and policies, interaction with private operators and opportunities for future improvement of transit performance.

From other stakeholders involved in transit policy making, transit operation and research, key personnel were identified and interviewed accordingly. To do so, ten key personnel from the respective stakeholder agencies were interviewed for this study. Following is the list of agencies interviewed:

1. BRTC (Government operator)
2. Shatabdi Paribahan Ltd. (Private operator)
3. Suchona Associates (Private operator)
4. Transilva Group (Private operator)
5. Ekushe Paribahan Ltd. (Private operator)
6. Pubali Paribahan Ltd. (Private operator)
7. Bahan Paribahan Ltd (Private operator)
8. DTCB (Policy making body)
9. BRTA (Rout permit, licensing organization)
10. BUET (University/research)

The interview of transit operators was done during the same time of the performance survey. For the three government agencies, contact information from their website was collected first and the researcher went to each office first to set up an interview schedule. The next day was the actual interview session for the selected agencies. All of these were long discussions (90 minutes approximately) and they were very helpful in providing their inputs for understanding the transit system.

4.4 Survey Overview

This section intends to summarize the overall survey procedure that was administered in August 2010, at Dhaka city, Bangladesh. For the operator survey, the current route and operator list and their addresses were needed. Route lists were acquired from the BRTA and important routes were selected for survey. In order to obtain their addresses, the bus operators association needed to be contacted. After contacting the key personnel of the selected operators and with their consent, they were surveyed with a one page questionnaire on indicators. These provided the concrete data for the quantitative measures developed in this study.

The next part was the administering the interview questionnaire to service providers, professionals, and policy makers. Key issues related to the transit system of Dhaka city namely: current challenges for transit operations, interaction between public and private operators, influence of current policies, opportunities for system improvement and their future initiative about transit provisions were explored through the interview. These were open ended questions and they were asked to feel free to include any related topics for transit operation. And also several documents for further reading of their goals and initiatives were collected from them by this time.

4.5 **Data collection and analysis methods**

- Data Envelopment Analysis from inputs of operators survey

DEA is non parametric mathematical programming method which calculates the relative efficiency of each decision making units (DMU) and produces a production frontier. To analyze data in this method, input and output variables were collected through the operator's survey detailed previously. The basic understanding of the DEA technique can be described as follows:

Suppose, there are three decision making unit named as A, B and C

Name	Veh-km	Labour	Fleet size
A	4000	30	200
B	3500	25	150
C	3000	20	150

Efficiency is the ratio of output and input and to create the score, the output variable (Veh-km) is divided by input variables (Labour, Fleet size). Then the ratio becomes:

Name	Veh-km/Labour	Veh-km/Fleet size
A	133.33	20
B	140	23.33
C	150	20

If both of these ratios are plotted in a coordinate system, it is found that both B and C are showing efficiency level more than A. The line created to enclose the variables is called the frontier line and it envelopes the data to show the relatively efficient decision making unit.
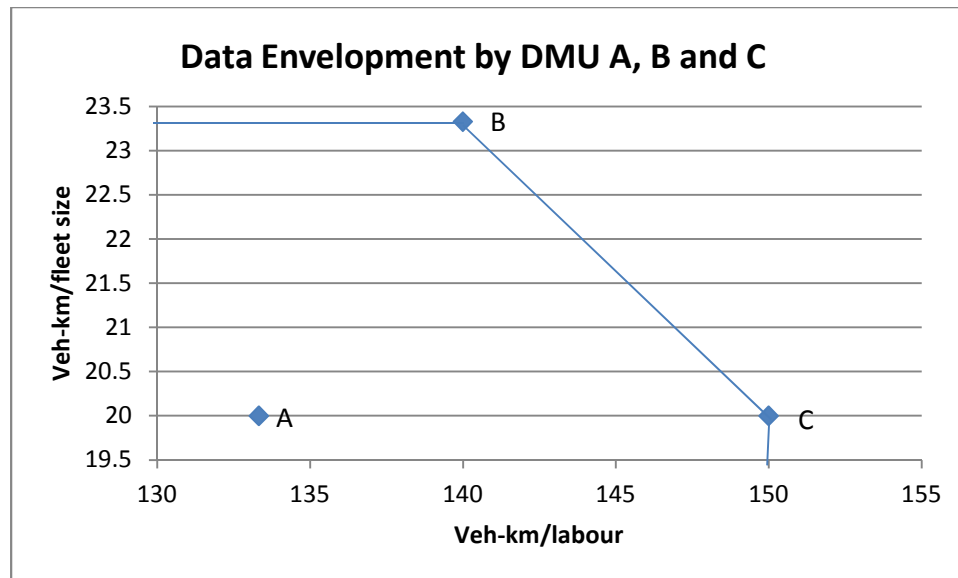
Figure 4.1: Data Envelopment basic model

This is the basic model followed in the DEA analysis to find out the efficiency level of the selected operator. In this study, online software named as DEAOS is used to calculate efficiency score of the surveyed operators.

- Discussion of inputs from interview

A semi structured interview method was followed to find out stakeholders viewpoint on five key issues to cover contents of the study objectives. All of the discussion during interview sessions was copied in a document made for each interview. Among these five key issues, two are opportunities and strategies regarding the current status of transit system and an efficient system in future. Their viewpoint for this two issues was found to be similar to some extent and could be summarized through a long quotation attributed to a single reference. For example, in the problem of a lack of road infrastructure, most of them found it as a challenge and explained their views. Again most of their answers for these two topics could be divided into three section such as infrastructure, institutional and technical to make a framework for future analysis and recommendation. To discuss their views, this researcher put those single point summaries in an

excel table and found out how many of the stakeholders expressed the same viewpoint. From this table, an order of importance for key challenges and strategies were found and further discussed in detail in the later section. For the other three key issues of the interview script, the intention was to discuss in detail about their understanding for that specific topic and their direct quotations are also arranged in the later chapter of discussion. It was expected that there will be differences in their opinion and all of them were discussed in detail. But, as they operate in the same transit system and also there is has been no major changes in Dhaka city's transit industry for a long period, their experiences and perspectives followed a similar structure.

4.5 Relating Survey Materials to Answer Research Questions

This research seeks to answer two questions:
11. What is the current status of transit services in Dhaka City?
12. What are the opportunities and challenges for improving performance of the present transit system?

To answer the first question, extensive literatures/ recent policy documents of transportation system in Dhaka city were reviewed to portray the current status for transit services. During the survey period at the study area, more documents were collected in person to review in detail. Using the indicator data from the survey of seven prominent transit operators, current efficiency status of those operators are investigated using Data Envelopment Analysis (DEA) and presented to find out how the inefficient one can increase their efficiency level.

To answer the second research question, the second part of questionnaire survey (interviews) will be explored with a view to understanding their perspectives on improving performance. The literatures including the Strategic transport plan and experience of other mega cities also provide significant background information on how to overcome these challenges that are present in the transit system of Dhaka city.

Afterwards a triangulation procedure is done to incorporate results from both the quantitative and qualitative approach used in this study to develop future policy recommendations. Triangulation is a method used by qualitative researchers to check and establish validity in their studies by

analyzing a research question from multiple perspectives (Guion, Diehl & McDonald, 2011). From several types of triangulation, methodological triangulation involves results from both quantitative and qualitative approaches to be compared to validate the final outcome. As a confirmatory approach, triangulation can overcome challenges related to a single-method, single-observer and single-theory biasness and thus can be applied to confirm the research results and conclusions (Denzin, 1989 in Shih 1989). In the last part of discussion in this study, results from policy reviews, DEA analysis (using input from the operator's survey) and discussion of interviews are compared.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 Transport Policy Review

5.1.1 Strategic Transport Plan and current status

Dhaka city has a complex transport system with both motorized and non motorized vehicles, heavy transport demand, and a situation that is worsening day by day. According to a recent study person trips are expected to increase from 35.9 million trips in 2009 to 65.5 million trips in 2025, with an average annual growth rate of 3.8% (JICA, 2010). To meet this growth, a Strategic Transport Plan was done in 2005, providing several recommendations for the overall transport sector of Dhaka city. According to the plan, public transportation remains one of the most important challenges that need to be addressed properly. The STP recommended seven broad sector proposals with explanation and means to support those proposals. The following discusses the recommendations which are closely related to the public transport sector:

- **Recommendation 1: Traffic Management**
  Establish a program to reclaim the full potential capacity of the existing roadway space.

This recommendation is meant to ensure the best use of present right of ways (roads) and improve traffic behavior with existing resources. In Bangladesh, it is a common practice to use the footpaths (sidewalk) for small trading which is mostly illegal on footpaths, as the traders have designated spaces elsewhere. But due to their current practice, it results in pedestrians using roadways. When combined with illegal parking trends, the result is in most cases the 2 side lanes are used by the pedestrians and parked vehicles in a 6 lane road. The resulting loss of capacity hinders regular traffic and transit speed and creates a chaotic situation with higher traffic congestion because of the deprivation of traffic management. The other issue relevant here is the lack of correct behavioral practices by drivers in those prevailing situations. To regain proper use of existing roadway space, there is a need for well administered traffic management to alleviate some of the congestion, rather than a need for new infrastructure. The three stakeholder organization involved to make this recommendation a reality are:

1. Dhaka City Corporation (DCC)
2. Dhaka Metropolitan Police (DMP)

3. Dhaka Transport Coordination Board (DTCB)

- **Recommendation 2: Bus Consolidation**
  Restructure the bus operations from a large number of small and individual operators into a smaller number of large operators.

According to the STP, a bus oriented transit industry is still the only option for public transit in Dhaka city but it needs to be significantly reorganized in order to become a more efficient industry. To address the situation, the Strategic Transport Plan provides several bus sector recommendations mostly concentrating on bus industry consolidation. The current fragmented ownership of many small operators makes it difficult to implement policy change, implement financing decisions, and provides less quality services to the users. The goal is to bring the many individual bus owners under one franchise company with supportive legislative reorganization including bus route franchising. BRF started to implement this recommendation on one of the most important routes (Uttara-Azimpur) in April 2009. This has not succeeded due to several reasons. It was supposed to be only one company operating their buses on this route, but BRTA also gave permits to other owners on the same route, making it difficult for BRF to be successful.

Other important STP recommendations such as discouraging route permits to individual owners is working in a limited fashion but priority measures like the introduction of bus only lanes is still only a Recommendation. The fare system in the transit industry is quite a success as there is no change recommended for this system. But, the STP suggests that there should be a well managed fare collection system that is enhanced through installing advanced collection technology. Despite some modest attempt to follow through on the transit recommendations, government has failed to provide sufficient opportunity and guidance in this sector. The fragmented ownership remains, and excessive on street competition within the owners is not resolved. It is argued in the later part of this chapter that only a consolidated bus industry can be an efficient one in this circumstance.

The stakeholder agencies associated with this recommendation are:
1. Bangladesh Road Transport Authority (BRTA)
2. Dhaka Transport Coordination Board (DTCB)

- **Recommendation 3: Integrated Mass Rapid Transit System**

  Proceed with the planning, design, development and implementation of an integrated mass rapid transit system.

In a metropolitan city like Dhaka, the huge travel demand provides a strong argument for a mass transit system. As the city is still growing and users of public transit increasing as well, there should be a more efficient system that can provide high quality, affordable transit services. The STP considered three options: Heavy Rail Metro (Metro), Light Rail Transit (LRT) and Bus Rapid Transit (BRT) as appropriate mass transit systems in the city. Considering capital cost, capacity of the system and construction ability, these options were studied under different probable land use scenarios. After in depth study, integrated systems of fully segregated metro rail and on street bus rapid transit were selected. The detailed design of the routes with stop locations and cost estimates are described more fully in the transport plan.

The stakeholder agencies involved in this recommendation are:

1. Dhaka Transport Coordination Board (DTCB)
2. Foreign funding agencies

Following maps showing the routes of integrated mass transit system as recommended in STP:
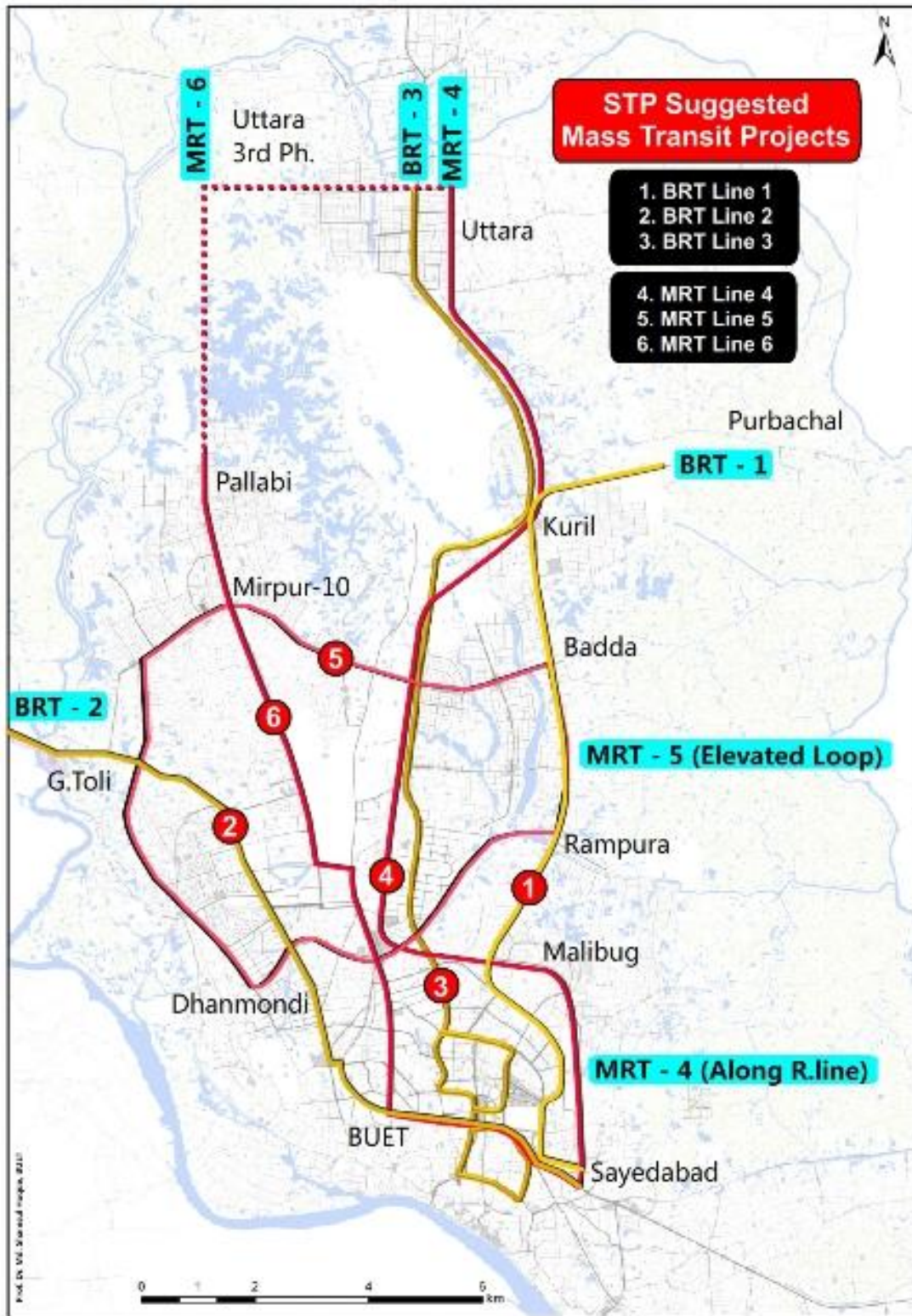
Figure 5.1: Integrated Mass Transit System proposed by STP.
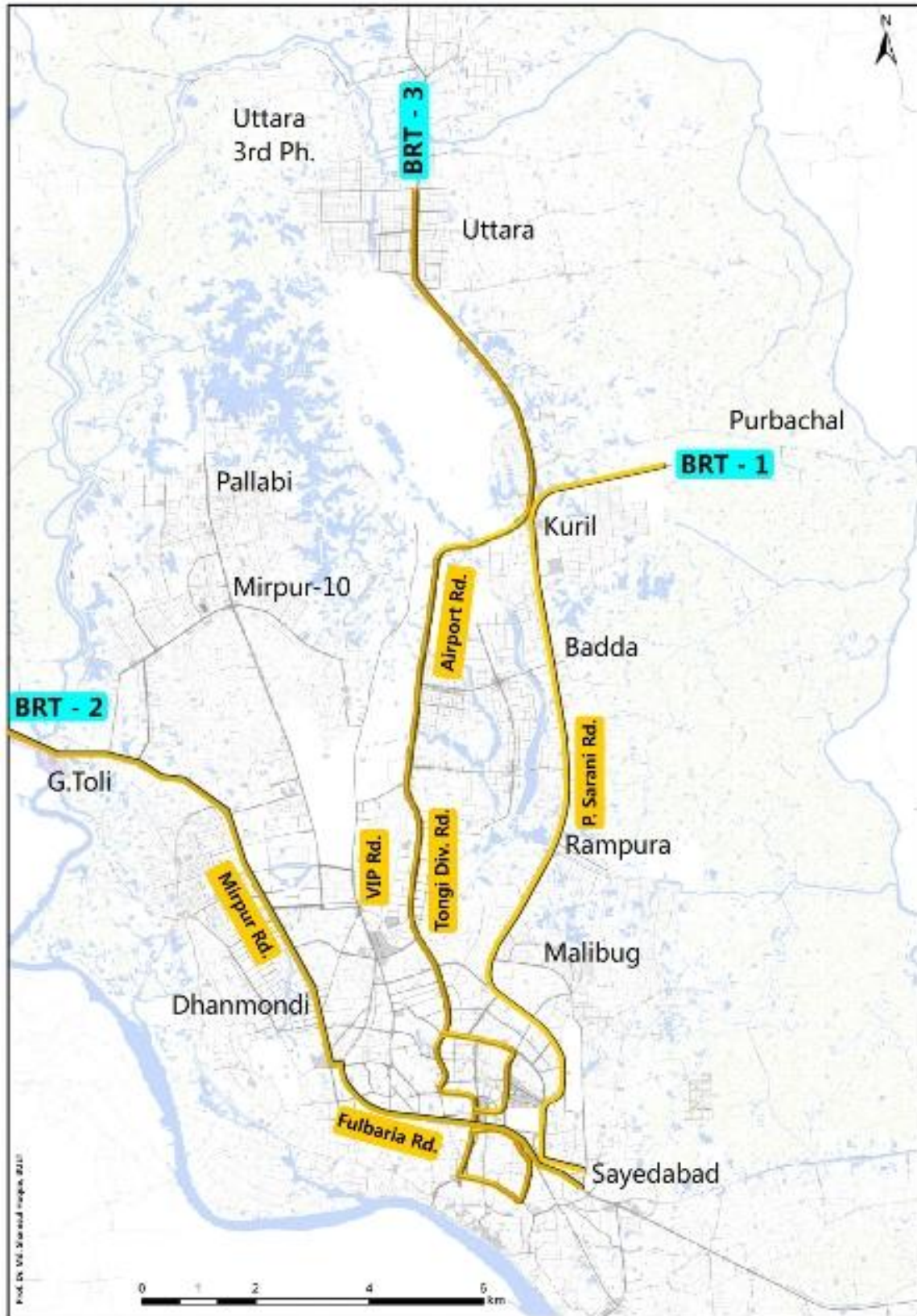
Figure 5.2: Bus Rapid Transit routes proposed by STP.

Proposed Phases of STP Implementation

A) Transit Schemes for Phase 1 (2005 to 2009)

Name	Description	Status
Bus Route Survey	A comprehensive survey of facilities, routes, fares, personnel, equipment, operating companies etc should be undertaken make a complete and detailed inventory of all aspects including in **Stakeholders:** BRTA, BRTC and private operators.	Not Done
Bus Priority Measures	A gradual program of up grading bus transit services including Bus Only Lanes, Re-organization of Stops, Streamlining of Ticketing, etc. **Stakeholders:** BRTA, DCC, RAJUK	Not Done
Mass Rapid Transit Guidelines	A guideline for MRT (BRT and Metro) system should be adopted including operating and performance specifications of the system and a realistic cost estimate. **Stakeholders:** DTCB and Foreign Funding Agencies	Not Done
BRT Study and Construction	BRT line 1 planned to be operational by the 3rd or 4th year of this first phase. The study will need to address the issue of how the operating company will be formed and how the project will be financed. **Stakeholders:** DTCB, Foreign Funding Agencies, RHD, LGED	Not done
Bus System in Old City	The twin loop system should be implemented in Old Dhaka with some traffic management signing and bus stop provision. **Stakeholders:** DCC, RAJUK	Not done

Table5.1: STP implementation phase 1

B) Transit Schemes for Phase 2 (2010 to 2014)

Name	Description	Status
Bus Re-organisation and Priority Measures	Further study of MRT System should be considered and the provision for bus priority measures on other main highways should be introduced. **Stakeholders:** DTCB, DCC, RAJUK	Not Done
BRT Study	BRT line 3 planned to be operational by the 1st year of this first phase and fully operational by year 4 of the phase. The operating company will already be formed and should plan for the further expansion to the next phase. **Stakeholders:** DTCB, Foreign Funding Agencies, RHD, LGED	Not Done
Metro Design	Preliminary Design for the Metro system including the completion of studies on station location, interchanges, operations and investment decisions. **Stakeholders:** DTCB, Foreign Funding Agencies, RHD, LGED	Not Done

Table5.2: STP implementation phase 2

C) Transit Schemes for Phase 3a (2015 to 2019)

Name	Description
BRT Construction	The complete BRT system should be in operation by this phase. **Stakeholders:** DTCB, Foreign Funding Agencies, RHD, LGED
Metro Design	Final Design for the Metro system and the complete investment decision with the final cost estimation and financial analysis. **Stakeholders:** DTCB, Foreign Funding Agencies, RHD, LGED

Table5.3: STP implementation phase 3a

D) Transit Schemes for Phase 3b (2020 to 2024)

Name	Description
Metro Construction	The Metro system will be completed and will be fully operational. **Stakeholders:** DTCB, Foreign Funding Agencies, RHD, LGED

Table5.4: STP implementation phase 3b

From the above tables it is clearly evident that the STP implementation is severely lacking phase at the present time. Whereas DTCB, the policy making stakeholders of the government in transit sector in Dhaka, takes separate study and implementation schedule in cooperation with the foreign funding agencies.

5.1.2 Urban Transport Policy and Current Status

The final outcome of strategic transport plan study was three different plans and policy document. Since government approved this as official document, these are meant to be followed by the relevant stakeholders. These documents are- a) Strategic Transport Plan, b) Urban Transport policy, c) Institutional Strengthening and Capacity Building. Among these the second one is the Urban Transport Policy document which is designed to guide the implementation of transport plans through the current time period and beyond. To provide guidelines for the overall transport system of Dhaka city, it touches on all the key policy issues related to the system. For guiding transport development in accordance with the STP, there is a strong recommendation to setup of a unified authority that will manage the overall system including transportation and land use planning. It requires a firm management authority at the strategic level to ensure that the relevant agencies are doing their implementation part accordingly. This authority is recommended to be named as "DAMERA" (Dhaka Metropolitan Regional Authority). But at present, it is not possible to setup this separate organization; rather government is trying to reorganize DTCB to meet the authorization capability. Recently DTCB has been renamed to DTCA (Dhaka Transport Coordination Authority) as a part of the reorganization.

5.1.3 Recent Projects

Though most of the projects/study recommended in the first phase (2005-2009) of the STP has not been done yet, the following two most important development projects have been undertaken

for public transit improvement in Dhaka city. These particular studies have been undertaken by the donor agencies along with DTCB to implement STP recommendation and provide future assistance and funding:

Dhaka Urban Transport Network Development Study (DHUTS):

The Japan International Cooperation Agency (JICA) conducted the "Dhaka Urban Transport Network Development Study (DHUTS)" with DTCB in 2009, to formulate the projects for the JICA assistance program. This two years long study recommended the following for the target year of 2025 as per their evaluation of traffic, system efficiency and economic and financial matters:

- Construction of Mass Rapid Transit Railway (MRT) line 6.
- Upgrading of existing Bangladesh Railway
- Bus Rapid Transit (BRT)

Greater Dhaka Sustainable Urban Transport Project:

The second major project undertaken by the Asian Development Bank (ADB) was to develop a sustainable urban transport system for the Dhaka City Corporation (DCC) area. This study was started in 2010 and finished in 2012 with recommendations and grant estimations from ADB. Considering the city's urban development trends and current status of the transport system, this study recommended transport solutions with appropriate guidelines and setup a formal project framework to make it workable. The recommendations of this study include:

- Restructuring one of the most important urban corridors of Dhaka city, including construction of 20 km of BRT line (part of BRT line 3), construction of other traffic lanes, sidewalks, drainage systems and terminal facilities along this route.
- Organisational development such as the development of a Special Project Organisation (SPO) to implement and monitor BRT operations, capacity building and supporting bus transit operations in the city in conjunction with BRT operation, training and awareness campaign.
- Provide quality urban services along this route by construction of supporting urban and transport facilities.

In 2012, ADB estimates that $255 million would be needed to finance this project and they would finance 60% of this total. The project will be implemented by three government agencies: (i) Roads and Highways Department (RHD) (ii) Bangladesh Bridge Authority (BBA) (iii) Local Government Engineering Department (LGED). The SPO will be introduced as a fourth implementing agency here, as a corporation owned by the government and run in a public private partnership (PPP) scheme.   The project implementation period is five year from June 2012 to June 2017.

5.1.4 Current Status of BRT Implementation:

According to STP recommendations, there should be a major implementation of BRT in Dhaka city, but after 7 years it is just getting started at the end 2012. From the three routes recommended in the STP, line 3 was taken as the most priority project. The World Bank has already carried out a feasibility study of this route and as described already, the main construction work ($277 Million) will be funded by ADB. This 22 km route contains two parts: (i) Gazipur to the airport railway station and (ii) airport railway station to Keraniganj. Other investments like the purchasing of 50 special articulated buses has been completed, each designed with a vehicle capacity of 130-140 people. After BRT route 3 is implemented, it will serve a population of 1 million people and carry 170 thousand people each day.

5.1.5   Current Status of Mass Transit Implementation:

The People's Republic of Bangladesh and the Japan International Cooperation Agency (JICA) has undertaken a project under the DTCB namely 'Feasibility Study of Mass Rapid Transit Line 6 under the Phase 2 Study". The project aims to improve the public transport system in Dhaka city, introducing rail based MRT (Mass Rapid Transit) in Bangladesh. The length of MRT Line 6 is 20.1 km and includes 16 stations. The line starts from Uttara and ends at Saidabad passing through Pallabi – Mirpur 10 – Begum Rokeya Sharani – Bijoy Sharani – Farm Gate –Sonargaon –TSC-Press Club-Paltan and Bangladesh Bank (See Figure 5.1). Construction is supposed to start by the 2012-2013 fiscal year, with work funded by JICA. Though the cost is not finalized yet, according to a primary feasibility report, it will be $1.8 billion, with 80% of the cost will financed by JICA. One problem is that several stakeholder agencies oppose the current route of MRT line 6. DTCB initiated a stakeholders meeting to resolve the situation and are currently

trying to finalize the route. As the project has not started yet, the development cost is increasing day by day, already increasing to $2.7 billion.

5.2 Efficiency Analysis

The level of efficiency of a particular transit service provider, the sources of inefficiency as well as the means to improve efficiency, all combine to construct a significant path for policy makers and the transit industry. In this study, the technical efficiency of the surveyed transit service providers are computed using Data Envelopment analysis (DEA). DEA is a nonparametric linear programming method which produces a piecewise empirical external production surface that reveals the best practice production frontier. In Data Envelopment Analysis, relative efficiency of each Decision Making Units (DMUs) is calculated in relation to the best practice DMU, using the actual observed input and output values. DEA is advantageous to any service provider as it is simultaneously incorporates multiple input output observations for efficiency measurement.

Model Orientation and Returns to Scale

There are two types of model orientation present in the literature of DEA practices. These are input oriented and output oriented models. An input-oriented technical efficiency model examines the vector of inputs used in the production of any output bundle, and measures whether a firm is using the minimum inputs necessary to produce a given bundle of outputs. Efficiency is measured by the maximum reduction in inputs which will still allow a given output bundle to be produced. Output technical efficiency is a measure of the potential output of a DMU given that inputs are held constant (Walden and Kirkly, 2000).

There are two different scale assumptions employed in the efficiency measurement: Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS). CRS means that if there is two units of input employed, it will produce two unit of output. According to VRS, two units of input could produce either increasing, constant or decreasing returns to scale. Input and output based efficiency measures are only equivalent under the assumption of constant returns to scale.

Scale efficiency scores examine the extent to which an organisation can take advantage of returns to scale by altering its size towards an optimal scale (Most Productive Scale Size or

MPSS). The gap between constant returns and the variable returns frontiers determines the scale efficiency component.

Efficiency Indicators

Efficiency analysis is largely dependent on the identification and collection of data for inputs and outputs. Total fulltime employees (operators, maintenance and administration), fleet size and operating expenses per month are used as inputs in this research. From the literature review, it is discovered that both vehicle-mile and passenger-mile are used as output measures. From the literatures it is found that passenger-mile is mainly associated with service effectiveness and vehicle-mile is used to evaluate transit efficiency. Since only revenue vehicle-kilometre data has been collected, in this study transit efficiency of selected providers will be explored.

As described in the methodology, the data is collected from the only government transit service provider and six other comparable private transit companies. This sample incorporates major transit companies and covers most of the major routes that provide services to the people.

Data Interpretation

DEA is employed to measure efficiency scores of the seven significant providers in the city, including one more "average unit" (made from the average values of inputs and outputs of the seven sampled units).

DMUs	Labour (input)	Operating cost (input)	Fleet size (input)	Veh km (output)
BRTC (Government.)	450	370000	243	1549125
Shuchona (Private)	180	250000	70	105000
Transilva (Private)	347	120000	22	33000
Ekushe (Private)	352	210000	40	66000
Pubali (Private)	246	208000	30	49500
Bahan (Private)	173	170000	27	50625
Shatabdi (Private)	230	180000	30	45000

Average unit	283	215429	60	271179

<div align="center">**Table 5.5: Descriptive statistics for the sampled transit companies.**</div>

Before exploring these results, it is important to consider the appropriate model orientation for any industry. In Dhaka city, the transit industry presents a complex structure where even having only one bus with one owner can be regarded as a transit provider. It is not reasonable to compare these single operators in this analysis.. The private bus companies (regardless of size) generally run their organizations in a competitive nature and try to maximize their profit. Hence, the output oriented model could best describe their nature, though in this study both models will be examined.

No.	DMU	Efficiency Score
1.	BRTC	100.00%
2.	SHUCHONA	23.53%
3.	TRANSILVA	23.53%
4.	EKUSHE	25.88%
5.	PUBALI	25.88%
6.	BAHAN	29.41%
7.	SHATABDI	23.53%
8.	AVERAGE	70.90%

<div align="center">**Table 5.6: Efficiency score of DMUs for CRS assumption.**</div>

Table 5.6 represents the efficiency score of decision making units with an assumption of constant returns to scale. According to the score, it is found that only the government transit company is efficient having the score of 1 in relation to the other companies. The input orientation shows that other companies could have produced the same amount of output with much less input, which is for an average company 70.90% and respective percentages for other DMUs provided. It also shows that there is an opportunity for these companies to reduce their inputs. by 29.10% for an average company and as much as 76.47% for DMUs 2,3 and 7.

	LABOUR	OPERATING COST	FLEET SIZE	VEH KM
BRTC	450 to 450	370000 to 370000	243 to 243	1549125

SHUCHONA	180 to 31	250000 to 25078.67	70 to 17	105000
TRANSILVA	347 to 10	120000 to 7881.87	22 to 5	33000
EKUSHE	352 to 19	210000 to 15763.74	40 to 10	66000
PUBALI	246 to 14	208000 to 11822.80	30 to 8	49500
BAHAN	173 to 15	170000 to 12091.50	27 to 8	50625
SHATABDI	230 to 13	180000 to 10748	30 to 7	45000
AVERAGE	283 to 79	215429 to 64769.62	60 to 43	271179

Table 5.7: Improvement options for DMU's for input oriented CRS model.

Table 5.7 relates to the previous table's results in that it illustrates how much inputs can be reduced by each operator to produce the same level of efficiency. Surprisingly, it was found that there is huge amount of inefficiency in the labour sector of transit industry. This table represents that with only few labours and the respective reduced amount of fleet size, these operators can run on a similar vehicle-km of output, that they are producing now with inefficient input use.

No.	DMU	Efficiency Score Input oriented-VRS	Efficiency Score Output oriented-VRS	Scale Efficiency Score
1.	BRTC	100.00%	100.00%	100.00%
2.	SHUCHONA	100.00%	100.00%	23.50%
3.	TRANSILVA	100.00%	100.00%	23.50%
4.	EKUSHE	72.00%	42.26%	35.90%
5.	PUBALI	87.50%	63.48%	29.60%
6.	BAHAN	100.00%	100.00%	29.40%
7.	SHATABDI	89.28%	58.85%	26.40%
8.	AVERAGE	96.61%	94.83%	73.40%

Table 5.8: Efficiency and Scale Efficiency score of DMUs.

The variable return to scale (VRS) always represents higher efficiency scores than models built on the constant return to scale (CRS) assumption. In VRS, DEA wraps the observed data more closely and the best production frontier corresponding to variable returns to scale is lower than the production frontier corresponding to constant returns to scale. According to the input oriented VRS assumption, DMU 2, 3 and 6 are most efficient along with DMU 1 as shown in Table 5.8. With the lowest score, DMU 4 could produce the same amount of transit service by lowering their input by 28%. According to the output oriented VRS, an average company could produce 5.17% more service with the given input while DMUs 4, 5, and 7 also have the potential to improve their productivity (output), respectively providing 57.74%, 37.62 and 42.25% more output fort the given inputs.

	Labour	Operating Cost	Fleet Size	Veh/ Km
BRTC	450 to 450	370000 to 370000	243 to 243	1549125 to 1549125
SHUCHONA	180 to 180	250000 to 250000	70 to 70	105000 to 105000
TRANSILVA	347 to 347	120000 to 120000	22 to 22	33000 to 33000
EKUSHE	352 to 352	210000 to 141214.30	40 to 40	66000 to 156164.77
PUBALI	246 to 246	208000 to 155387.10	30 to 30	49500 to 77977.64
BAHAN	173 to 173	170000 to 170000	27 to 27	50625 to 50625
SHATABDI	230 to 230	180000 to 159410.81	30 to 30	45000 to 76464.43
AVERAGE	283 to 283	215429 to 183535.12	60 to 60	271179 to 285963.40

Table 5.9: Improvement options for the DMU's for output oriented VRS assumption.

Table 5.9 is showing the potential for transit operators to increase their output with the same labour and fleet size they are currently using. Specifically Ekushe, Shatabdi and Pubali paribahan have an opportunity to increase efficiency in operating vehicle-km to a great extent even with lower operating cost and keeping other inputs the same size.

The scale efficiency score indicates that the only efficient production unit is the government provider (DMU 1), which also represents the maximum production size scale (MPSS) within the surveyed service providers. As all the other DMUs are showing a value less than 1, they are running on an increasing return to scale. According to the input oriented measure, all the other

DMUs are smaller than optimal size and would be more productive if the capacities of these units are increased.

Summary

Considering both the CRS and VRS assumption and with both input and output oriented models, the government owned transit service provider (DMU 1) proves to be the most efficient in the transit industry. This coincides with the assumption that being the government organization, it has the opportunity to have financial subsidies, better organizational setup, and have readily available buses to serve the people. There are also clearly opportunities for the other providers to improve their services with the inputs they currently use. The increasing returns to scale for scale efficiency present the potential for these companies to increase their size too. From the literature it has been found that DEA analysis and scores are heavily used in the transit industry to explore sources of inefficiencies. In the literature, where transit industry has both public and private operators, there are only subtle differences found in the efficiency level among those operators. But in the case of Dhaka city, the efficiency of public and private operators are showing major differences in their scores. The reason for these differences might be that in Dhaka city, thousands of small private operators compete with minimal financial help from the government and the clear argument that there is an oversupply of operators.

5.3 Stakeholders Interview

One of the most substantial parts of this study is to investigate stakeholder's opinion about present public transit services and ongoing policy restructuring in Dhaka city. It focuses on the second research question and explores current challenges and future transit initiatives. From the analysis of the current status of transit services, a number of stakeholder's agencies are identified as responsible for the total industry. A structured questionnaire is used to interview key informants of these agencies and answers to open ended questions analyzed. The following sections are organized according to the order of the questions asked in the interviews (See Appendix B):

5.3.1 Current Challenges for Transit Operation

The transit stakeholders of Dhaka city, either bus operators or policy makers, bring different viewpoints to the challenges facing the industry. When they were asked about their views on these challenges, it was a long conversation of around an hour for almost every stakeholder interviewed. From a detail discussion with the participants, each answers could be grouped into three broad themes of infrastructure, institutional and technical issues and within each themes their views are described here in order of the most important needs identified by them:

Infrastructure

Dhaka has a huge demand for public transportation, because it is one of the most populous cities of the world. It also has a high growth rate as many rural people are drawn to the opportunities in Dhaka. Poor road infrastructure negatively impacting this sector is identified from the interview as the most vital challenge to look after.

Less number of buses couldn't meet their demand where as the demand is increasing day by day and they couldn't afford to increase their fleet size (private operators) due to financial incapability.

Less road space for public transportation compared to total amount of roadways in the city makes the situation worse for bus operators as identified by themselves during interview. The entire city was not developed in a planned way and only the newly developed areas have the opportunity of large public bus transportation. Specifically, the roadways in the sections of old

Dhaka are inappropriate for large modern buses. Additionally, there is less roadway capacity in an east-west direction across the whole city, which puts more negative pressure on current conditions. Less road space in conjunction with mixed traffic operation from non motorized vehicles to transit buses in the same roadways creates traffic jams and causes traffic speeds to average 5-10 km/hour.

Figure 5.3: Small businesses occupying footpaths causing passengers to use roadway and at the same time on street parking causing less active use of road space.

Figure 5.4: Mixed type vehicles in the road, traffic jam and occupied footpaths.

The absence of any type of mass transit system is argued to be the continued cause for the inefficient public transit system in Dhaka city. Numerous interviewees suggested that the huge demand for public transit can only be met through MRT. Further, there was no specific difference in stakeholder's views on the infrastructure needs for the public transportation system. All of them share the same sorts of thoughts that an improved infrastructure system will results in a much improved public transport system in Dhaka city.

Institutional

In the case of institutional challenges, the most evident one is the absence of a formal institutional arrangement exclusively for public transportation. All the stakeholders who participated in the interviews share a similar view of the need for a common platform to look

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after every aspect of the transit industry. Currently, the proper management of the system or taking new initiatives are quite impossible for the individual participant organizations in this transit industry. As quoted by one the participants from Transilva Ltd "Government changes their decision according to their choice and most of the decisions were taken in such a manner that we don't have available time or opportunity to follow them accordingly. Such as their recent decision on counter system ticket selling is not possible for us to maintain right away as we don't have that much manpower. And we are not following their decisions too; though this is creating problems as other operator are following this decision. We need time and also have to apply more funds on this part of our management".

The fragmented ownership of bus operators was stated as a major hindrance to more efficient public transportation, specifically by the policy making stakeholders interviewed. It is quite interesting that while bus operators might be aware of this problem, they didn't point out this issue as a problem in the interviews. Perhaps an awareness program and information sharing about the negative impact of fragmented ownership towards the city's transportation problem would be helpful in this case as stated by the policy making/government stakeholders. In other cities in a developing country context, like in the case of Curitiba, Brazil or Bogota Colombia, bus industry consolidation was the first step of transit industry reorganization and subsequent improvement (Ardila 2008).

Political interference or the absence of proper transit management behavior from the current government stakeholders are the types of problems mostly noted by transit operators, rather than need for yet another government organization. There are two; self organized associations for private bus operators, which mainly represent the two prominent political organizations in Bangladesh. Consequently, when one of these parties is elected for ruling the country, their respective bus owners association is in a favorable situation for any kind of negotiation with government stakeholders for any decision like a transit fare or fuel price change. Some operators also pointed out that corruption exists inside the route permit process which also tends to lessen transit performance. Other issues mentioned include the improper behavior of transit users, including non-payment or under payment of transit fares. And if there is any political incidences occurred like strikes, first consequences of this type of occurrences are the no or limited operation of transport system and picketers fires the tires and breaks window of the buses.

Combined, these improper behaviors can result in a 15% loss of operator's monthly income as stated by one of the private operators interviewed.

Non-cooperation by the private operators regarding conforming to rules, fares and the stop system are the type of challenges predominantly stated by the public transit operators and government stakeholders. The previous problem that is the poor transit management behavior from the public stakeholders and this problem are mostly two sides of same coin, as both the public and private stakeholders of this industry are competing in the same market . This also reflects the most important institutional challenge which is the absence of a common platform that will look after the needs of the operators and changes in the current decisions consequently with time.

Figure 5.5: Bus stop at new market area, where it has never seen to stop a bus and actually use this bus stand.

Figure 5.6: Passengers getting off from the bus in the middle of the road at the bus stop of figure 5.5

Technical

There is no central computerized management system available for either the bus operators or government stakeholders. Transit users have to depend on in-person counter services to follow timely departing or arriving schedules or even to purchase tickets. Though the BRTC, the public bus operators, introduced a mechanized ticketing system on some of their routes, for private operators, the "counterman" oriented ticketing system at bus stops creates a chaotic situation as many of the bus companies use the same route and the same bus stops.

Figure 5.7: Only computerized ticketing system available at BRTC bus stop.

5.3.2 Interaction between Public and Private Transit Operators/agencies

A positive interaction among public and private transit operators/agencies will make a more balanced transit industry in Dhaka city. BRTC is the only government transit operator and it provides a small proportion of service in relation to the private operator's involvement. Regardless of the level of involvement, there should be positive interaction which is the fair competition between public and private operators and within the private operators themselves. There is also active need for better interaction between all operators and the other stakeholder agencies involved in the transit industry where as positive interaction defined as the conformity to rules and regulations from the operators and better transit management behavior from the government stakeholders. To better understand the current level of interactions, key personnel from each of the selected stakeholder agencies are interviewed.

In the case of interaction between public and private transit operators, responses to questions about the nature of interaction were almost always affirmative which suggests a high level of positive interaction among them. Interactions among private transit operators were also reported to be very positive. But there are also negative influences of trade unions reported inside transit operator organizations. In the case of interactions among private operators and the other stakeholder agencies, a complex problem is reported. For example, as there are many more agencies present for a single transit operation, such as route permit and traffic control, private operators feel that there should be a common agency to which would improve their experience. As quoted by the key personnel from the Ekushe Paribahan Ltd. "We usually buy our vehicles after achieving route permits from BRTA. Then suddenly government changes approved route location as well as destination of those routes too. In practical cases this creates immense problem from our losses to increasing traffic jam on the bus routes. Decisions should be taken with mutual understanding between private operators and government stakeholders but BRTA acts on their own wish in some cases". They suggest that in dealing with issues, it could be readily solved if only there is only one agency and a means for conflict resolution. They feel that without this common agency there remains a gap if for example government agencies change the rules, fare structures or fuel prices. There are potential opportunities to make this interaction more productive and significant through the introduction of a common agency.

5.3.3 Policy Implications for Transit Operation

To allow the industry stakeholders to cope with any changes according to new policy implementation, fair information dissemination is necessary for every stakeholder agency   The Strategic Transport Plan (STP) is the most recent policy development for the transit service stakeholders of Dhaka city. The policy period of the STP is 20 years: from 2004-2024. During this period, many new projects will be undertaken for the betterment of transit services which will also result in changing agency roles. Along with policy changes, construction of mass transit options will significantly impact demand for traditional bus service providers.   In this circumstance, each of the stakeholders interviewed were asked about their views regarding policy recommendations from STP and the related projects found in different phases of STP implementation. Surprisingly, every stakeholder questioned about their views of the recent STP responded consistently that they felt it will have a positive effect to the industry. Even the private

service providers are eagerly waiting for the MRT and the stronger policy recommended in the STP. Interviewees indicated that they will try to adapt to the new technologies, rules and regulations. From the interviewed stakeholders, only one of them made cautious comment on the future of STP implementation in that it might increase the financial burden to the common people. According to his view "I have a chunk of precious land in the centre of the city, where it is supposed to be a new road construction according to STP. This land has a minimum value of 10 million BDT. But I am confused that I will have that much amount of money from the government after the project implementation. And I also think that for metro type mass transit, normal people have to pay much higher fare than now, it might likely to have a negative effect on the low income people of this city". However, they also express concern about the timely implementation of the projects and their ability to change their organizations in a timely fashion. Further, a number of them also indicated a desire for private transit service provider's active participation in any changes in the transit decision making structure.

5.3.4 Opportunities to Improve

All the transit stakeholders pointed out critical improvement opportunities according to their views. Though there were some contrasting views in their response on questions related to transit challenges, when asked about improvement options, the majority share a common view. These answers mostly validate the arguments made on the challenges section of the interviews and the answers from the participants are basically the strategies that are need to be taken to meet those challenges as previously mentioned.

Infrastructure

Dedicated bus lanes are the highest priority infrastructure need as expressed in the interviews. The increasing public transportation demand requires more appropriate infrastructure facilities within the system. With the current absence of any mass transit system, only bus transportation is available for the people of this mega-city. To meet this demand, adequate and up-to-date infrastructure is of vital importance. As in the case of Bogota, exclusive transit bus lanes could be a solution. Interview respondents also felt that their introduction would ease the movement of buses by letting them increase operating speeds which are currently low because of mixed traffic.

There is an acute need for more road infrastructure in Dhaka city especially more east-west connection. Percentage of roadways compared to other megacities is already fewer here. Investment on more construction of passenger friendly roadways with adequate footpaths and stoppage facility for buses is required.

Increasing the fleet size is another strategic priority, revealed by the participants in interviews with the state owned public bus provider, BRTC. Large, passenger friendly buses from BRTC move on all of the important routes in Dhaka city and are also attracting more passengers. These passengers in turn routinely call for increasing the number of buses.

Institutional

The much awaited implementation of the STP is the priority need as stated by all stakeholders from bus providers to policy makers. The Strategic Transport Plan incorporates most of the important strategies to address transit efficiency, but it is already behind in its own periodical implementation cycle. From the bus provider's point of view, there should be a transit only institutional arrangement in Dhaka city, which is included in the STP recommendation. As bus service providers need a platform to share their views and decision with the government stakeholders, a transit only authority could be the best choice for them. When this question was asked of the participants from the policy makers (DTCB), it was answered that there is an ongoing process to set up a Dhaka Mass Transport Authority (DMTA). They identified that the major objectives of this authority would be to implement STP recommendations and to coordinate all mass transit (MRT and BRT) related activities.

More cooperation from both public and private stakeholders is also needed to improve transit services in Dhaka. Participants from most of the private bus providers expressed dissatisfaction that the government sometimes suddenly makes decisions on the issues related to public transportation, which has negative effects on their companies. Sudden changes in fuel price, stop locations, and route permits make them non-cooperative. Whereas, more cooperation from private stakeholders is stated by the government side since there is often a lack of cooperation to follow traffic rules and regulations.

As in the case of Curitiba, bus company reformation is necessary in Dhaka city. Policy makers have their views on the issue, particularly that current trends in the operation of private bus

service providers has negative effects on the overall system. Fragmented ownership of bus companies presents challenges for reorganization and implementation. In Dhaka city, often a single bus owned by a single operator can cause traffic challenges and slow the whole system.

Technical

With the exception of the BRTC, all other private bus operators run on a counter system ticketing by the counterman on the stoppages. There is no computerized system available for them, resulting indiscipline in fare collection as well as system loss for the overall company.

5.3.5 Initiatives

Finally, all stakeholders were asked about their future initiatives to improve transit performance. Answers were more objectively oriented, for example with most of the private bus operators following their own strategies to increase fleet size. To compete with the growing future demand, large bus companies will invest more in increasing their number of passenger friendly buses.

Institutional capacity building through different initiatives is another step to efficient transit industry according to these stakeholders. STP also published separate reports on increasing capacity building.

Increasing the technical efficiency of the transit service providers through different measures like more efficient use of labor and fuels, is yet another important initiatives that is underway as reported by transit providers.

5.4 Triangulation

This research engaged three different methods: document analysis, survey of transit providers and interviews of stakeholders, in order to have a total picture of transit services efficiency and potential in Dhaka city. As this involves both quantitative and qualitative data assessment, a triangulation procedure has been used to establish the most supported view points from the data analysis and discussion. All the three types of analysis and discussion resulted in a number of key points from the respective analysis. But to confirm the validity of those results, a triangulation procedure has been followed by comparing those results. From triangulation of the

resulting key points, the following issues has been found which was discussed at least two of the three methods in this study:

1. Bus Operator Consolidation
2. A Single, Separate and Strong Institutional Arrangement exclusively for public transit
3. Timely implementation of STP recommendations
4. An Efficient Fare Collection System

Finally, it is now confirmed that each of the abovementioned strategy needs to be fulfilled to have an efficient transit industry for Dhaka city.

CHAPTER 6: CONCLUSION

As a dynamic, growing, global city, Dhaka city needs an efficient public transit system. With the absence of any kind of mass transit, the present bus transit system should be providing that efficient service. After exploring the present complex transportation system, this study is an initiative to find out the levels and sources of inefficiency, evaluate the policies and efficiency levels of prominent public and private bus service providers and understand the stakeholders' perspectives.

6.1 Findings of the Study

After establishing the context of Dhaka's transit system, this study proceeds to answer following research questions:

3. What is the current status of transit services in Dhaka City?
4. What are the opportunities and challenges for improving performance of the present transit system?

Following are the findings of the study after a detail exploration of the present transit service characteristics, stakeholder's characteristics (survey) and opinions (interviews)-

- A number of stakeholder agency involved in the bus transit system of Dhaka city. Both the private bus service providers and all other government stakeholders in the system have their particular responsibilities and separate organizational setup. It makes the transit industry a complex system which is less capable of changing any rule, initiating any service and prolonging the ongoing activities.

- Since Strategic transport plan becomes official document by the government from 2005 for 20 year period, it is usual of the phase by phase implementation of STP policies. But from the phases chart of STP it is found that nothing has been achieved according to this chart rather DTCB initiate slightly different projects from those schemes and trying to accomplish but yet not finished.

- Efficiency scores of transit providers proved that among the surveyed transit operators, public operators of Dhaka city (BRTC) is the most efficient operator. From the efficiency calculations it also found that other providers can improve efficiency even with their same input as well as increase their size too.

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- Poor road infrastructure specifically less road space found to be the most important challenges according to the interviewed stakeholders that should take care of to increase transit efficiency. Amount of present roadway appropriate for bus operation is minimal, so it requires more roadway construction along with other infrastructures. STP recommendations also give importance to the optimum use of current roadways through effective traffic management.

- There are lots of stakeholder agencies involved in the transport system of Dhaka city but there is no formal institutional arrangement particularly for public transit sector. It can also decrease time duration wasted for each of the current activities by maintaining a single platform. STP also fulfills this issue by recommending a unified authority to look after overall management.

- Both from STP study and stakeholders interview (Government participants) it is found that, fragmented ownership of bus transit sector is the one of the major obstacle to the efficient bus transit operation but no one from the private bus operators .have mentioned this problem.

6.2 Recommendations of the Study

Triangulation of all three different methods used in this study points out probable initiatives that can contribute to a more efficient transit system of Dhaka city. This are-

- A separate and powerful institutional authority specifically for the transit system is an utmost need for the current transit industry of Dhaka city. Many stakeholders many responsibilities will be concentrated in this single agency and will be managed with regulatory power to perform all the relevant actions needed for transit system.

- To resolve the issue of fragmented ownership, consolidated bus service can be an appropriate solution found in this study. By reducing the number of stakeholders in the private operators part of the industry to a few active stakeholders with many operated bus will also ensure new policy initiatives and timely implementation of those policies.

- To meet the infrastructure needs of the current transit industry, exclusive bus lanes is the resolution found out from the interviews of stakeholders. From the literature, a similar

situation was also found in Bogota where dedicated bus lanes were constructed to reorganize the bus transit system and let it move in more speed apart from mixed traffic.

- Strategic transport plan for the Dhaka city suitably found out all the pros and cons of the current system and recommended accordingly. But only phase by phase timely implementation of those recommendations will make STP a successful one. Another important drawback of Dhaka's transit industry is the absence of a mass transit system, but STP also covered all of these issues too. By initiating regulatory measures to speed up STP implementation as it is already lack in phases and to look for investment opportunities for future to realize STP recommendations.

6.3 Contributions of the Study

This research has a twofold contribution to the existing level of knowledge associated in the transit industry of Dhaka city. Firstly, the quantitative approach used in this research is the first attempt to evaluate the efficiency level of operators using Data Envelopment Analysis. Though the efficiency scores found from this analysis validate the expected notions of government operators being most efficient, it is also found that other operators have an opportunity to increase their scores too. It explains that they can also produce the same output with lower amounts of inputs which signifies how it is possible to save resources in a resource limited city like Dhaka. At the same time, from the output oriented DEA model, it is evident that the operators can also increase their efficiency by a large amount by using the same resources used now. If the operator agency has the intention to provide more efficient services to the passengers, it is doable for them and the DEA analysis suggests areas to address

During literature review, no literature was found which has expressed stakeholders specifically bus operators opinion in transportation related study in Dhaka city. Therefore it can be assumed that their opinion is always overlooked. But during the interview session in a semi structured interview method it is also proved that if they are given the opportunity to speak about their views, it is possible for the researchers to incorporate the topic specific experiences of these operators. This city already has plans and policies for improving the transportation system. Are those recommendations truly reflecting involved stakeholders viewpoints or are there differences too? A qualitative approach like interviews with important stakeholders can shed light on these issues and validate or nullify the recommendations of existing policy and plans.

6.4 Limitations of the Study

To answer both the research question of this study, a lengthy visit in the study area of Dhaka city was needed. But in reality only a month was spent in understanding the present status of transit services and also for the interviews with the stakeholders.

Though representatives from all the prominent stakeholders in the transit industry were identified and interviewed, the large pool of private operators (in the thousands) raises concerns about how representative the selection is. Further, since there is no concrete database, it is practically impossible to systematically incorporate all of their views in this study.

For analyzing transit efficiency, time series data evaluation is another good practice found in the literature. But for Dhaka city's transit industry, there is no time series database available which includes data for all transit operators. In this study, only the transit efficiency of the surveyed operators of that particular survey year was calculated.

6.5 Future Research Implications

Dhaka city's transit industry is very complex involving many stakeholders. This study discovered their views on future initiatives and what is required for an efficient transit industry. But this study only includes the stakeholders concerned with transit operation and policy making leaving one of the most important stakeholders, which is transit user. For a heavily used transit system in Dhaka, transit users might offer different views on efficiency, apart from the transit operators. They might report specific drawbacks which are causing inefficiency and offer their own initiatives to be taken to increase efficiency from their point of view.

Finally, through the process of understanding the present transit system characteristics, this study included recent policy analysis, efficiency calculation and transit stakeholders perception of challenges and opportunities in one of most populated cities in the world. This was the first attempt to calculate efficiency scores of the transit providers in Dhaka city. No other study has applied a similar methodology to find the overall picture of the situation in Dhaka. It also provides insights to the relations between public and private transit providers in the city and opportunities to improve these relationships. By understanding the lessons and fulfilling the

recommendations, Dhaka city's transit system can become a more efficient system and provide better services to all.

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APPENDIX A

Survey Script:

Efficiency Analysis of Public Transit systems in Bangladesh: A Case Study of Dhaka City

Information on Transit Service Provisions by the Institutions

1. Amount of fares for every adult passengers: ....
2. No. of active vehicles operating in the city:...........................
3. Current route of bus transit provisions by the institutions:..............................
4. Types of fuel used in transit services:..............................
5. Employee Statistics:
   - Operators/Drivers-
   - Vehicle mechanics-
   - Other vehicle maintenance and servicing-
   - General administration-
6. Operating Expenses:
   - Transportation operation expenses-
   - Fuel Expenses for vehicles-
   - Vehicle Maintenance expenses-
   - General administration expenses-

APPENDIX B

Interview Script:

Efficiency Analysis of Public Transit systems in Bangladesh: A Case Study of Dhaka City

Interview of service providers/professionals/policy makers

1. What are the current problems/challenges for transit operations in Dhaka City?

2. According to your views how is the interaction between public and private transit operators?

3. What is the influence of current policies/STP/strategies in transit operations?

4. What is your opinion about opportunities/ what strategies can be taken to improve the system?

5. What would be your future initiative about transit provisions?

APPENDIX C

Data Envelopment Analysis:

Economic theory formulates two types of inefficiency; these are technical and economic efficiency. Viton (1997) perceived technical inefficiency as it may be possible for a decision making unit (DMU) to produce its observed outputs (products or services) by using fewer physical resources (inputs), this is input-oriented technical inefficiency. Whereas, if there is possibility to increase output from the observed input bundle, it shows output-oriented inefficiency. So, a DMU is technically efficient if the only way to increase output is to use more of at least one input or if reducing the quantity of any input necessarily leads to a reduction in input.

The DEA method, a non-parametric approach (does not require any priori specification), uses mathematical programming to estimate production frontiers and calculate efficiency scores. This method is based in the seminal paper by Farrell (1957) as later proposed by Charneset al. (1978). Sampaio et al. (2008) described the formula step by step as follows-

The model proposed by Charnes et al. (1978), assuming constant returns to scale, may be represented by N firms or DMUs that use I input to obtain P products. Input and output quantities are represented by x_i and y_i and i refers to the ith DMU. The objective is to obtain a non-parametric frontier that envelope the data in a manner that all united are placed on or under this frontier.

For each DMU the ratio between the weighted sum of inputs and the weighted sum of outputs is maximized, where u is a P×1 vector of weights associated to outputs and v a I×1 vector of weights associated to inputs. The unknown vectors u and v are obtained as a result of the efficiency maximization of each DMU.

For each DMU the following problem is solved

$Max_{u,v}$ $(u^t y_i = v^t x_i)$

Subject to $(u^t y_j = v^t x_j) \leq 1, j = 1,......., N;$ (1)

                  $u \geq 0$ and $v \geq 0$

The model presented obtains infinite solutions. If (u^*, v^*) is a solution, so $(\alpha u^*, \alpha v^*)$ is also a possible solution. This problem was solved by Charnes et al. (1978) imposing the condition $v^t x_i = 1$. Thus, the new programming model is

$Max_{u,v}$ $u^t y_i$

Subject to $v^t x_i = 1$

                  $u^t y_j \_ v^t x_j \leq 0, j ¼ 1,........,N;$ (2)

                  $u \geq 0$ and $v \geq 0$

This new model is known as a multiplicative model and presents a great number of restrictions. Using the linear programming dual property, the problem may be present in an equivalent form but with a smaller number of restrictions $(I + P < N + 1)$.

$Min_{\theta\lambda}$ θ

Subject to $Y\lambda - y_i \geq 0,$

                  $\theta x_i \_ X\lambda \geq 0,$ (3)

                  $\lambda \geq 0.$

Where, h is the efficiency score, λ is the N×1 is the constant vector, X is the input matrix (I×N) and Y is the output matrix (P×N).

The linear programming model is solved N times, one for each DMU. The efficiency score θ might satisfy the condition $\theta \leq 1$.

Adopting the constant returns to scale assumption when not all DMUs are operating with optimal scale, may result in efficiency measures influenced by the scale efficiency. In this case, adopting variable returns to scale allows the measurement of efficiency independent of scale efficiency.

The model for variable returns was developed by Banker et al. (1984), by addition of a convex restriction ($z^t \lambda = 1$):

$\text{Min}_{\theta\lambda} \qquad \theta$

Subject to $\qquad Y\lambda - y_i \geq 0,$

$\qquad\qquad\quad \theta x_i \_ X\lambda \geq 0, \qquad\qquad\qquad\qquad\qquad\qquad\qquad (4)$

$\qquad\qquad\quad z^t \lambda = 1,$

$\qquad\qquad\quad \lambda \geq 0.$

Where, z - N × 1 is the unitary vector.