THE PREPARATORY STUDY ON THE DHAKA MASS RAPID TRANSIT DEVELOPMENT PROJECT (LINE 1) IN BANGLADESH

FINAL REPORT
(SUMMARY)

DECEMBER 2018

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ALMEC CORPORATION
ORIENTAL CONSULTANTS GLOBAL CO., LTD.
NIPPON KOEI CO., LTD.
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Exchange Rate (July 2018)

1USD=110JPY

1USD=83BDT

1BDT=1.32JPY

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ABBREVIATIONS

ADB	Asian Development Bank
AFD	Agence Francaise de Developpement
BBA	Bangladesh Bridge Authority
BIWTA	Bangladesh Inland Water Transport Authority
BIWTC	Bangladesh Inland Water Transport Corporation
BR	Bangladesh Railway
BRT	Bus Rapid Transit
BRTA	Bangladesh Road Transport Authority
BRTC	Bangladesh Road Transport Corporation
BUET	Bangladesh University of Engineering and Technology
C&B	Construction & Building
CASE	Clean Air and Sustainable Environment
CNG	Compressed Natural Gas
DAP	Detail Area Plan
DCC	Dhaka City Corporation
DF/R	Draft Final Report
DFID	Department for International Development
DHUTS	Dhaka Urban Transportation Network Development Study
DMA	Dhaka Metropolitan Area
DMDP	Dhaka Metropolitan Development Plan
DMP	Dhaka Metropolitan Police
DMTA	Dhaka Metropolitan Transport Authority
DMTCL	Dhaka Mass Transit Company Limited
DNCC	Dhaka North City Corporation
DPP	Department of Printing and Publications
DRTM	Directorate of Road Transport Maintenance
DSCC	Dhaka South City Corporation
DTCA	Dhaka Transport Coordination Authority
DTCB	Dhaka Transport Coordination Board
ECNEC	Executive Committee of the National Economic Council
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
F/R	Final Report
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GIBR	Government Inspector of the Bangladesh Railways
GOB	Government of Bangladesh
GOJ	Government of Japan
GPS	Global Positioning System
HIS	Household Interview Survey
IC/R	Inception Report
IT/R	Interim Report
JICA	Japan International Cooperation Agency
LDC	Least Developed Country
LGD	Local Government Division
LGED	Local Government Engineering Department

MOC	Ministry of Communication
MOHPW	Ministry of Housing and Public Works
MOR	Ministry of Railways
MRT	Mass Rapid Transit
NGO	Non-Governmental Organizations
OD	Origin and Destination
ODA	Official Development Assistance
PPPO	Public Private Partnership Office
PT	Project Team
RAJUK	Rajdhani Unnayan Kartripakkha
RD	Record of Discussions
RHD	Road and Highway Department
RTC	Regional Transport Committee
SC	Steering Committee
SEA	Strategic Environmental Assessment
SPA	Survey and Plan Area
STP	Strategic Transport Plan for Dhaka
TDM	Traffic Demand Management
TOR	Terms of Reference
UMRT	Urban Mass Raid Transit
WB	World Bank
WG	Working Group

1 Introduction

1.1 Background

Dhaka City is the capital of the +People's Republic of Bangladesh. The Dhaka Metropolitan Area (DMA) has a population of 9.3 million in 2011. Currently, urban transportation in the DMA relies mostly on road transport, where car, bus, auto-rickshaw, rickshaw, etc. coexist. This creates serious traffic congestion in addition to health hazards caused by traffic pollution including air pollution. With the rapid national economic growth, the urban population is expected to increase and so will the number of privately owned automobiles. Therefore, improving the urban (public) transportation system in the DMA has become a critical issue to ease traffic congestion and arrest environmental deterioration.

With this situation, the government of Bangladesh (GOB) formulated the "Strategic Transport Plan for Dhaka" (STP) in 2005 in cooperation with the World Bank (WB). Since the STP was officially approved by the GOB, it is expected that each donor will hereafter provide the assistance based on this STP to improve the urban transportation situation. And the Japan International Cooperation Agency (JICA) conducted the Dhaka Urban Transportation Network Development Study (DHUTS) Phase 1 from March 2009 with the DTCA as its counterpart agency. The study's objectives were to conceptualize the basic urban development scenario for the DMA by 2025 and to select priority projects that would help build such a scenario. That study recommended the MRT Line 6 as a priority project. As a result, JICA conducted the feasibility study on MRT Line 6 under DHUTS Phase 2. Following these studies, the GOB and JICA concluded the loan agreement on the "Dhaka Mass Rapid Transit Development Project" on February 2013 to construct MRT Line 6. Meanwhile, the World Bank finished the feasibility study and basic design of BRT Line 3 and is now preparing the project's detailed design. On the other hand, the Asian Development Bank (ADB) already completed the basic design of the BRT Line 3 extension project (from the airport to Gazipur) and since April 2013 has conducted the activities for the detailed design stage.

As for the transportation network plan, the STP, which was formulated in 2005, identified three BRT lines (i.e., BRT Lines 1, 2, and 3) that were supposed to commence before 2010. But except for MRT Line 6 and BRT Line 3 above, other projects stated in the STP have not started yet and so the STP needed to be reviewed and updated. And JICA conducted the Project on the Revision and Updating of the Strategic Transport Plan for Dhaka (RSTP) from May 2014 with the DTCA as its counterpart agency.

It is thus under these circumstances that the GOB and JICA have made several preliminary discussions in order to identify priority projects in the field of transport sector, and agreed to make preparation for Dhaka Mass Rapid Transit Development Project (Line 1 and Line 5). Accordingly, JICA dispatched a mission on the project to GOB from March 7, 2016 in order to develop scope and implementing arrangements of a further survey which would study feasibility of the project.

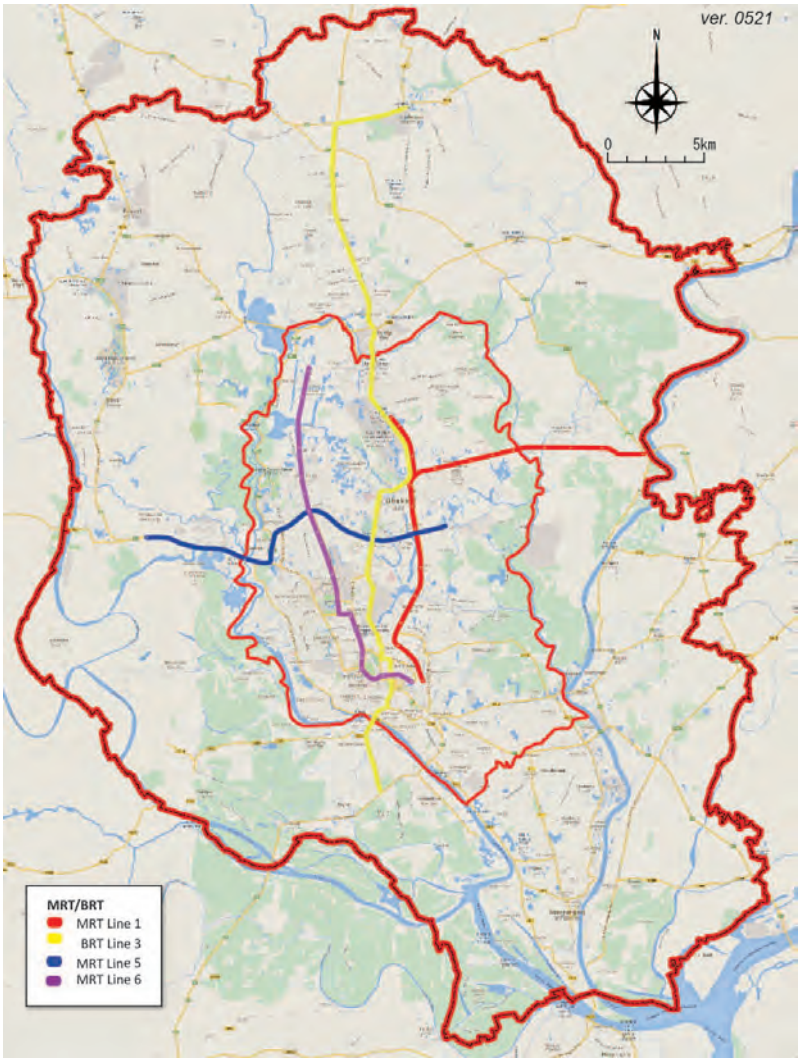
1.2 Objectives of the Project

The objectives of the Project are to alleviate traffic congestion and improve air pollution in the Dhaka City by constructing mass rapid transit system, thereby contributing to the economic and social development and improvement of urban environment.

MRT Line 1 (1st phase) and MRT Line 5 (1st phase) were prioritized as the high priority projects by RSTP. In this project, feasibility study of MRT Line 1 (1st phase) and MRT Line 5 (1st phase) supposed to be implemented and set up feasible project plan and project implementation plan considering of technical, economic and budgeting, and environment and social aspects.

1.3 Scope of the Project

As mentioned in the objectives of the study, when MRT Line 1 and Line 5 will be nominated as an ODA project such as Yen-loan project, the project implementation plan and consultation plan will be required to appraise by international-financing agencies. In the appraisal, the appraisal, the following these issues are essentials.



Source: JICA Study Team

Figure 1.3.1 MRT and BRT Routes in RAJUK Area

1) **Project Site**

Districts of Dhaka, Gazipur, Manikganj, Narayanganj, Munshiganj and Narsingdi.

Source: JICA Study Team

Figure 1.3.2 Project Site

2) **Executing Agencies**

Dhaka Transport Coordination Authority (DTCA)

Dhaka Mass Transit Company Limited (DMTCL)

1.4 Basic Policy and Points of the Study

1) **Key Points of the Study**

Outputs of this study will be the basic information to evaluate the MRT projects as Japan's yean load project. So, the following issues need to be considered with JICA's guidelines when compiling the results.

1. Methods of procurements and constructions (including TORs of BD and DD)
2. Project Costs (including MM of consultant services)
3. Capacity of Implementation and O&M
4. Indicators of Operation and Evaluation

2) Schedule of ECC

This project is the feasibility study of MRT Line 1 and Line 5, and the environmental Impact Assessment (EIA) and the Resettlement Action Plan (RAP) will be made for each MRT Lines.

3) Consistencies with the MRT Line 6

Standardisation of MRT system needs to be required to improve their quality and make them safer, and also in RSTP proposed MRT Lines should be networked each other. Therefore, some system of MRT Line 1 and Line 5 should be installed same with MRT Line 6.

(1) Integration of System, Regulations and Standard

MRT Line 1, Line 5 and Line 6 will be shared tracks and station in the future, so MRT systems, regulations and standards need to be integrated.

(2) Integration of Automated Fare Collection System

Automated fare collection system of MRT Line 1 and Line 5 will be installed same system with MRT Line 6. In order to adopt connected ride discount system with MRT lines and other public transports.

(3) Connectivity of MRT Line 1 with MRT Line 6 at Motijheel Area

At the current situation, planned Motijheel station of MRT Line 6 will be far from proposed Kamalapur station of MRT Line 1. In this project, connectivity between those stations need to be considered.

4) Development around the station

A transit-oriented development (TOD) typically includes a central MRT station surrounded by a high-density mixed-use area, with lower-density areas spreading out from this centre. A TOD is also typically designed to be more walkable than other built-up areas, through using smaller block sizes and reducing the land area dedicated to automobiles.

TOD allows the transport operator to benefit from alternative revenue, and increased ridership. In turn, this provides opportunity for better services to be offered to the public.

2 Characteristics of the Project Area

2.1 Location of the Project Area and Spatial Structure

2.1.1 Location

MRT Lines 1 and 5 were prioritized as high priority projects by RSTP. In this project, the feasibility study of MRT Lines 1 and 5 are supposed to be implemented. The location of Lines 1 and 5 is shown in Figure 2.1.1. The location and depo area are tentative and will be determined in this study.

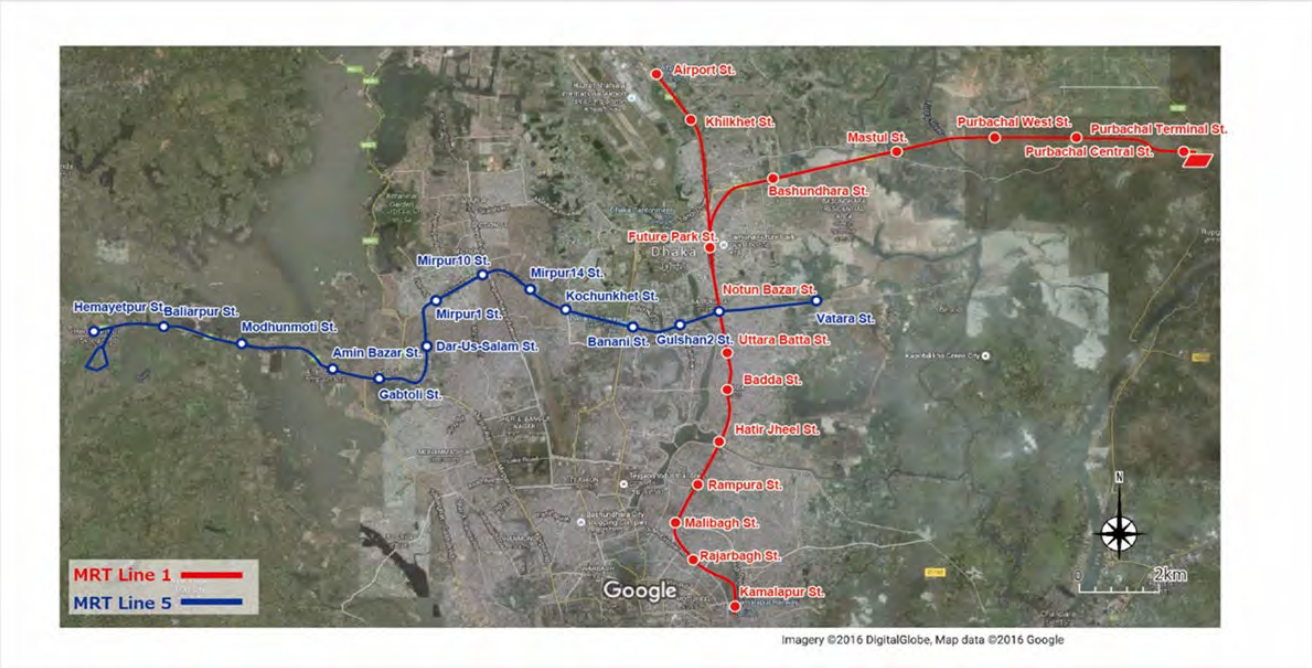


Figure 2.1.1 Location of MRT Line 1 and Line 5

2.1.2 Administrative Units and Land Areas

MRT Lines 1 and 5 are located in Greater Dhaka Area (GDA). The survey area covers the whole GDA that consists of Dhaka, Gazipur, Manikganj, Munshiganj, Narayanganj, and Narshingdi districts. The total area is 7,500 sq. km with 24.4 million or more residents since 2011. The more developed 1,500-km^2 Rajdhani Unnayan Kartripakkha (RAJUK) has 14.8 million residents. In contrast to the low population density of the entire GDA (31 person/ha), RAJUK has a very high density at 111 person/ha. The center of RAJUK can also be expected to have a much higher population density than that of the entire RAJUK.

The project area is generally low, flat, fertile, and flood-prone. While most of the developed area within RAJUK is at an elevation of 6–8 m above sea level, the elevation of Dhaka City Corporation (DCC) varies from 2 to 13 m above sea level. Due to the topographical and geological characteristics of GDA, it is inevitable to experience floods and overflow during the rainy season. There were water channels, natural drainages, and low land areas in and around Dhaka in the past, which contributes to the retention and discharge of rain water. However, the acceleration of urban sprawl has interrupted those water retention areas.

As of 2005, 25% of the national gross domestic product (GDP) was contributed by the gross regional domestic product (GRDP) of GDA. The GRDP of Dhaka City contributes 15% to the national GDP as it is a capital and economic centre of Bangladesh. The agricultural sector is still dominant outside RAJUK, while industrialization has been promoted within it.

There are also two export processing zones (EPZs) in Savar in Dhaka District and Narayanganj City in Narayanganj District. Moreover, the informal economic sector provides significant number of job opportunities in Dhaka.

Like other parts of Bangladesh, GDA is largely dominated by agricultural land use; whilst residential areas spread along the main road and river networks. The large industrial areas and commercial/business areas can be found only in RAJUK. The residential or housing development in RAJUK mainly focus on rich households; therefore, many immigrants from outside RAJUK and low-income households are forced to live in slums where there is no access to the required basic infrastructures. One of the many reasons of urban development delay outside RAJUK area is because of the lack of transport infrastructures. Without transport networks, people and goods cannot be mobilized.

The provision of basic infrastructures varies by GDA district. The electrification rate of GDA, however, is only 63% while 97% of the households in Dhaka district has access to electricity. Coverage of piped drinking water varies between 37–95%. Narayanganj district has the highest coverage in GDA. Provision of sanitary water (with water seal) is very low with only 38% are provided in GDA.

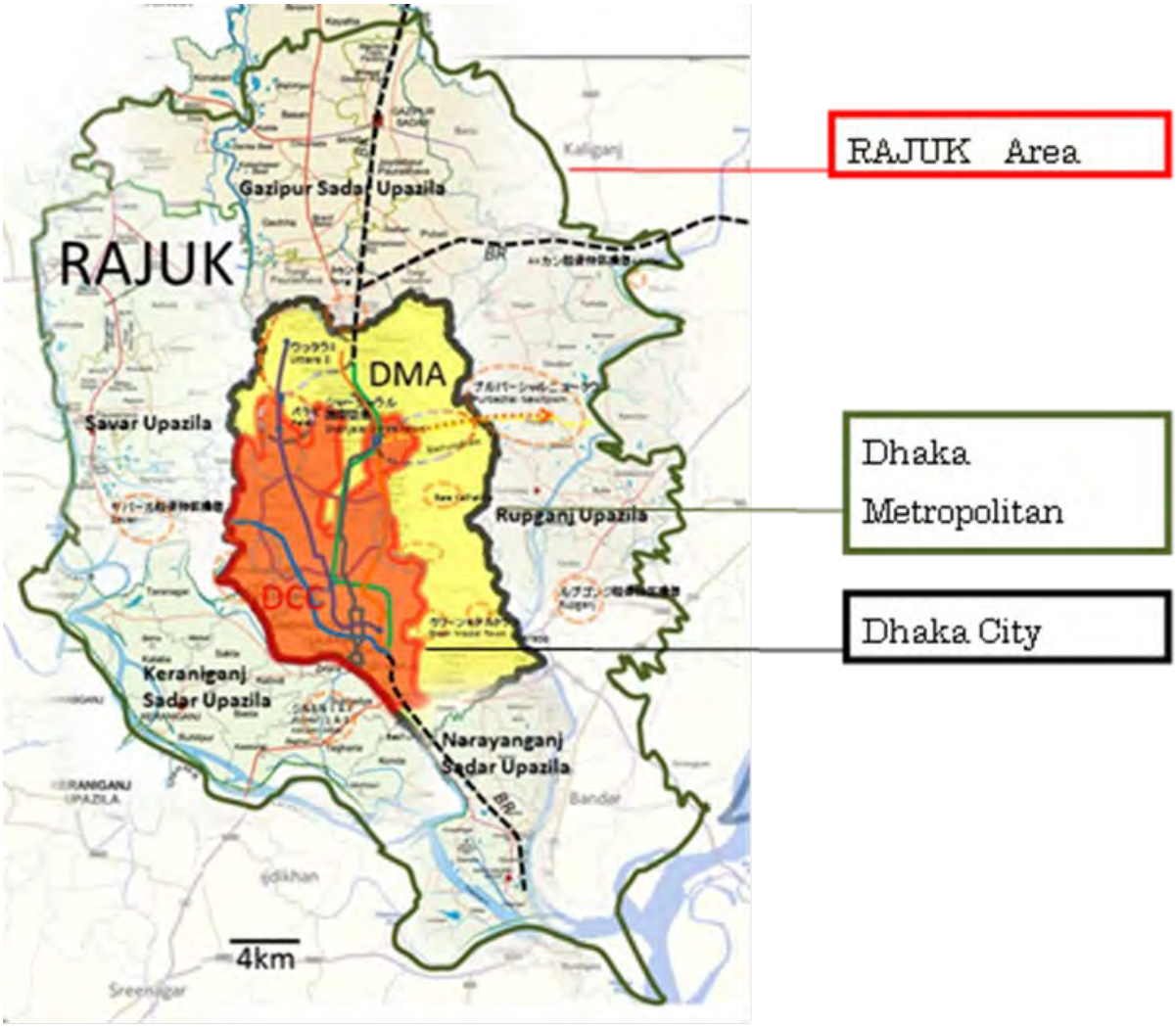


Figure 2.1.2 Study Area

2.2 Socio-Economic Profile

2.2.1 Population

1) Population

The total population of GDA in 2011 was approximately 23.5 million, which was 15.6% of the national population. Among the districts, Dhaka has the largest population with 51.3% of GDA; however, Gazipur showed the most rapid increase of population in the period of 2001–2011 and has the second largest population among all the districts. On the other hand, the populations of Manikganj, Munshiganj, and Narsingdi grew slowly compared to GDA, which suggests centralization of population (see Table 2.2.1).

Table 2.2.1 Population and Area of GDA District

District		Area (sq.km)1)	Population		AGR (%/year)
			2001	2011	
GDA	Dhaka	1,463.6	9,036,647	12,043,977	2.91
	Gazipur	1,806.4	2,143,200	3,403,912	4.73
	Manikganj	1,384.7	1,343,749	1,392,867	0.35
	Munshiganj	1,004.3	1,353,483	1,445,660	0.66
	Narayanganj	684.4	2,300,514	2,948,217	2.51
	Narsingdi	1,150.1	1,983,449	2,224,944	1.15
	TOTAL	7,492,5	18,161,042	23,459,577	2.59
% to National		5.1	13.9	15.6	-
National		147,568.9	124,355,263	149,772,364	

1) Area data from Statistical Year Book Bangladesh 2015
Source: Population and Housing Census 2011

RAJUK planning area covers some parts of Dhaka and Gazipur Districts as well as Narayanganj with 20.1% of the GDA. As per population, RAJUK area has 14.9 million in 2011, and the share of its share to GDA increased from 55.3% in 2001 to 60.7% in 2011 due to its rapid population increase (see Table 2.2.2).

On the contrary, the exterior of RAJUK area recorded lower growth ratio of population, except Gazipur District. RAJUK area which does not fall within the DCC South and North has been developing intensively for urbanization and population. The shape of expanding urbanized area becomes elongated from the north to south.

Table 2.2.2 Population and Area of RAJUK Area

	Area (km^2)	Population		AGR (%/year)
		2001	2011	
RAJUK Area	1502.3	10,037,120	14,819,160	3.99
Outside RAJUK Area	5,990.2	8,123,970	9,585,030	1.39
TOTAL	7,493	18,161	24,404	3.00

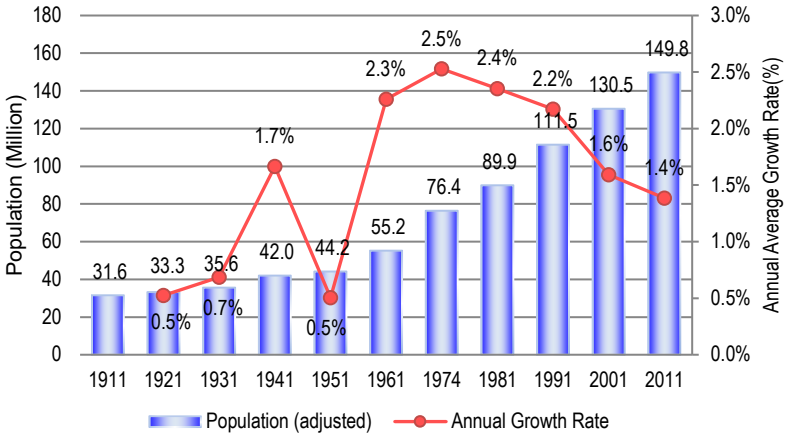
Source: Population and Housing Census 2011

2) Population Growth

The Bangladesh Bureau of Statistics has been carrying out the Population and Housing Census since 1872. As shown in Figure 2.2.1, the average annual population growth rate (population AAGR) increased from 0.5% in 1921 to 2.5% in 1974 except between 1941 to 1951 due to World War II and starvation. More than 3 million people was assumed to have died due to starvation and malnutrition. However, after 1974, the population AAGR decreased from 2.5% to 1.4% in 2011.

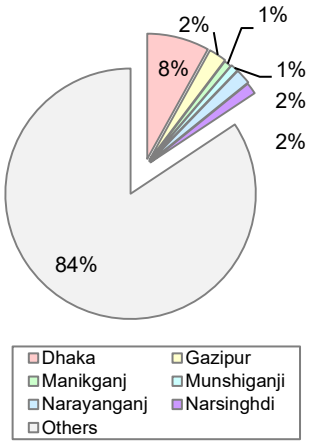
In 2011, the population of GDA is 15.7% of the population of Bangladesh and has a population AAGR of 3.2% against a large number of social growth where only covers 5%

land area of Bangladesh as shown in Table 2.4. Among the GDA districts, the population of Dhaka covers more than half the GDA population. While Gazipur and Narayanganj's population are lower than Dhaka's, their population AAGRs are higher than convenient locations, which makes commute to Dhaka easy and they have a relatively lower land value.



Note: Adjusted population.
Source: Statistical Yearbook of Bangladesh 2012, BBS

Figure 2.2.1 Population and Average Annual Growth Rate



Source: Population and Housing Census 2011, BBS

Figure 2.2.2 Population Distribution in GDA (2011)

Table 2.2.3 Population Growth Rate in the Study Area

	Area (sq. km.)	Population ('000)		Population Share (%)		Growth Rate (%)	Population Density ('000 person/sq.km)	
		2001	2011	2001	2011	2001-2011	2001	2011
Bangladesh	147,570	130,523	149,772	100.0%	100.0%	1.4%	884	1,015
GDA	7,492	17,112	23,460	13.1%	15.7%	3.2%	2,284	3,131
- Dhaka	1,464	8,511	12,044	6.5%	8.0%	3.5%	5,814	8,227
- Gazipur	1,806	2,032	3,404	1.6%	2.3%	5.3%	1,125	1,885
- Manikganj	1,384	1,205	1,393	0.9%	0.9%	1.5%	871	1,007
- Munshiganji	1,004	1,294	1,446	1.0%	1.0%	1.1%	1,289	1,440
- Narayanganj	684	2,174	2,948	1.7%	2.0%	3.1%	3,178	4,310
- Narsinghdi	1,150	1,896	2,225	1.5%	1.5%	1.6%	1,649	1,935
Rajuk Area	1,429	10,804	15,853	8.3%	10.6%	3.9%	7,561	11,094

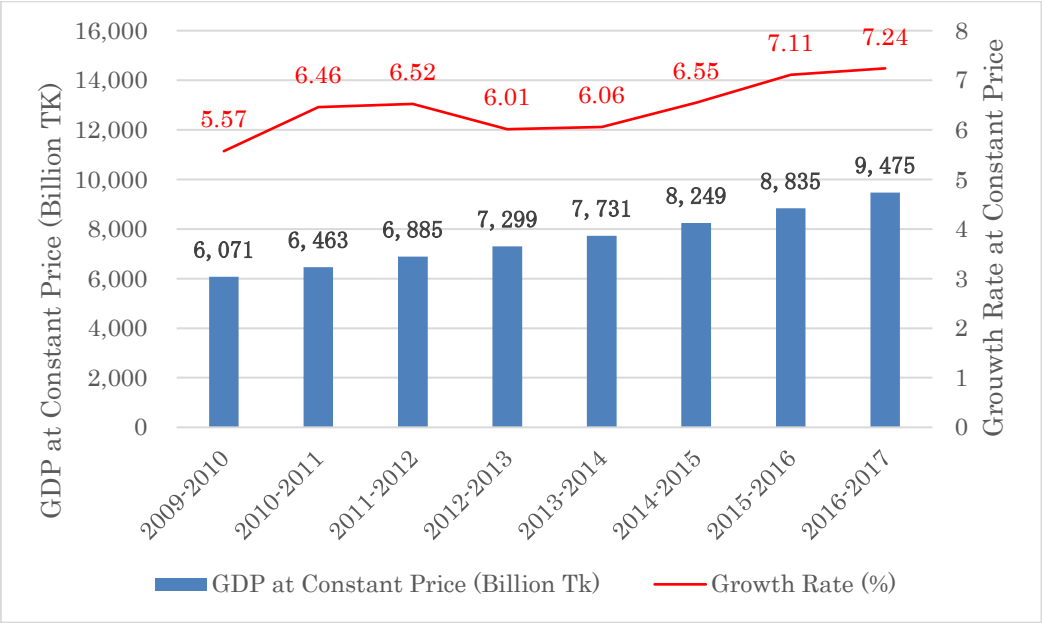
Source: Population and Housing Census 2011, BBS

2.2.2 GDP

1) National GDP and GDP Growth

Since 2009, Bangladesh has been consistent in continuing to achieve high GDP with almost more than 6% growth rate despite the impact of world recession, the European financial crisis in 2007–2008, and especially the growth rate at constant price since 2015 has been more than 7%.

The International Monetary Fund (IMF) published in the "World Economic Outlook, September 2014" the forecasted GDP growth rate of Bangladesh that will increase up to 7.0% by year 2017 based on economic development and potential. The GDP in Bangladesh has even exceeded the forecast in the report. Bangladesh has a high evaluation from international finance institutions that, in 2005, it was regarded as one of the Goldman Sach's Next11 recognizing its potential of becoming one of the world's larger economies after the BRICs (Brazil, Russia, India, and China) and JP Morgan's Frontier in 2007.



Source: GDP of Bangladesh 2013-2014, 2014-2015, 2015-2016,2016-2017, BBS

Figure 2.2.3 GDP Growth of Bangladesh (2009–2017)

Table 2.2.4 GDP Growth of Bangladesh (2009–2017)

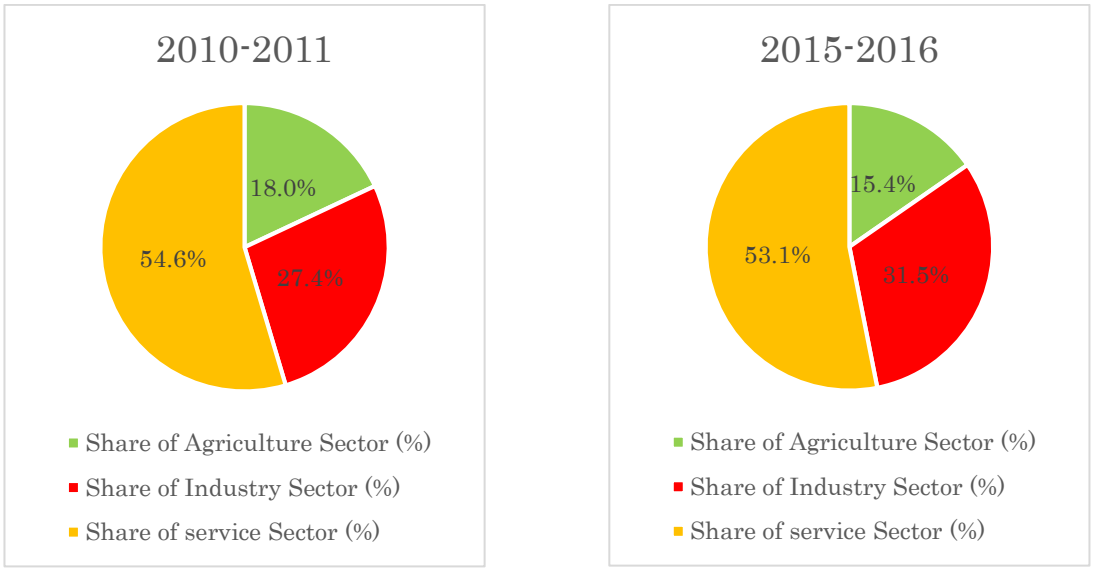
	2009–2010	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016	2016–2017
GDP at Constant Price (billion Tk)	6,071	6,463	6,885	7,299	7,731	8,249	8,835	9,475
Growth Rate (%)	5.57	6.46	6.52	6.01	6.06	6.55	7.11	7.24
Population (million)	147.8	148.7	151.6	153.7	155.8	157.9	159.89	161.75

Note: Constant Price base year is 2005–2006.
Source: GDP of Bangladesh 2013–2014, 2014–2015, 2015–2016,2016–2017, BBS

2) Sectoral Share of GDP

Figure 2.2.4 and Table 2.2.5 shows the proportion of each sector from years 2009 to 2017. During this period, the share of agriculture in GDP has gradually decreased from 18.0% to 15.4%. Contrary to the decrease, the share of industry has changed from 27.4% to 31.5%.

With the underlying “Perspective Plan of Bangladesh 2010–2021 (Vision 21), 2012”, the Government of Bangladesh has set a goal to become a middle-income country by year 2021. Accordingly, the target total GDP growth rate was set to 8% in 2015 and gradually increase to 10% by 2021. In addition, the government aims to increase the industrial sector GDP up to 37% in 2021, which is being assessed through the yearly achievement report.



Note: * Provisional Constant Price base year: 2005-2006
Agriculture: Agriculture, Forestry, Fishing
Industry: Mining, Quarrying, Manufacturing, Electricity, Gas, Water supply, Construction
Service: Wholesale, retail trade, repair of motor, hotel, restaurant, transport, storage, communication, financial intermediations, real estate, renting and business activities, public administration, defence, education, health, social works, etc.
Source: GDP of Bangladesh 2013-2014, 2014-2015, 2015-2016,2016-2017, BBS

Figure 2.2.4 Comparison of GDP between 2010-2011 and 2015-2016

Table 2.2.5 GDP by Industry Sector at Constant Price of Bangladesh (2009–2017)

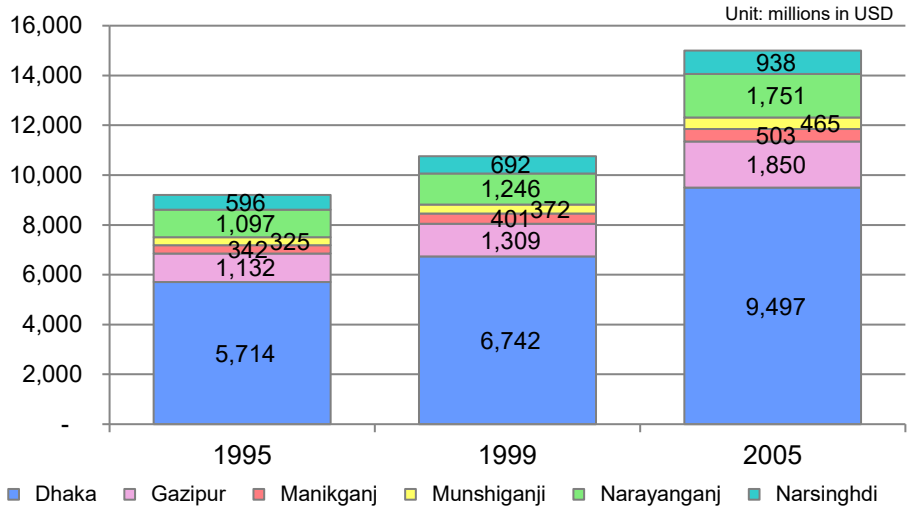
	2009–2010	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016	2016–2017 (p)
GDP of Agriculture Sector (billion TK)	1,065	1,113	1,146	1,174	1,226	1,266	1,302	1,346
GDP of Industry Sector (billion TK)	1,551	1,692	1,852	2,030	2,196	2,408	2,675	2,956
GDP of Service Sector (billion TK)	3,177	3,375	3,597	3,795	4,008	4,241	4,505	4,799
Share of Agriculture Sector (%)	18.4	18.0	17.4	16.8	16.5	16.0	15.4	14.8
Share of Industry Sector (%)	26.8	27.4	28.1	29.0	29.6	30.4	31.5	32.5
Share of service Sector (%)	54.8	54.6	54.5	54.2	53.9	53.6	53.1	52.7

Notes: * Provisional
Constant price base year in 2005–2006
Source: GDP of Bangladesh 2013–2014, 2014–2015, 2015–2016,2016–2017, BBS

3) GRDP in Study Area

The study area (GDA) is known to be the most developed and urbanized area in Bangladesh. As shown in Figure 2.2.5 and Table 2.2.6, the GRDP of the study area has taken 25% of the national GDP. Dhaka, which is the center of Bangladesh economy, contributes about 15% of national GDP and with the highest growth rate (AAGR = 5.9). Subsequently, Gazipur, Narayanganj, and Narsinghdi have a high growth rate of more than 5% per year.

According to Cambridge University survey (2014), the GRDP of Dhaka reached to US$37 billion, accounting for 35% of Bangladesh's economy.



Source: Growth, Income Inequality and Poverty Trends in Bangladesh: Implications for Development Strategy by Center for Policy Dialogue (CPD)

Figure 2.2.5 GRDP in the Study Area

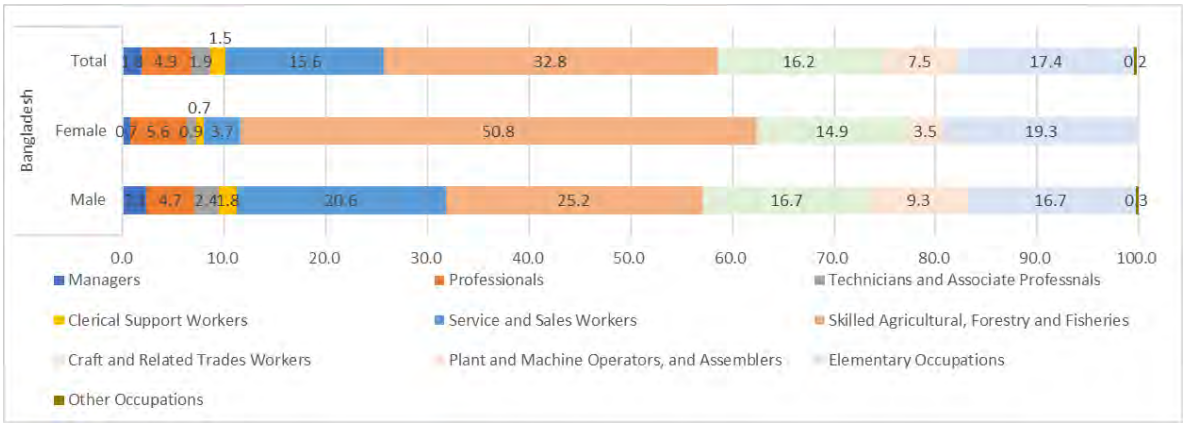
Table 2.2.6 GRDP in the Study Area

	GDP at Current Market Price (Million $US)						AAGR (%)	
	1995		1999		2005		1995-1999	1999-2005
	Million $US	National %	Million $US	National %	Million $US	National %	AAGR (%)	AAGR (%)
Bangladesh	39,065	100.0%	45,447	100.0%	59,748	100.0%	3.9%	4.7%
Study Area	9,206	23.6%	10,762	23.7%	15,004	25.1%	4.0%	5.7%
- Dhaka	5,714	14.6%	6,742	14.8%	9,497	15.9%	4.2%	5.9%
- Gazipur	1,132	2.9%	1,309	2.9%	1,850	3.1%	3.7%	5.9%
- Manikganj	342	0.9%	401	0.9%	503	0.8%	4.1%	3.8%
- Munshiganji	325	0.8%	372	0.8%	465	0.8%	3.4%	3.8%
- Narayanganj	1,097	2.8%	1,246	2.7%	1,751	2.9%	3.2%	5.8%
- Narsinghdi	596	1.5%	692	1.5%	938	1.6%	3.8%	5.2%

Source: Growth, Income Inequality and Poverty Trends in Bangladesh: Implications for Development Strategy by CPD

2.2.3 Labour and Employment

The share of employed population records are available in the Labor Force Survey. Though one-third of employment in Bangladesh engage in skilled agriculture, forestry, and fisheries, their proportion of employment in the urban area accounts for only 9.9%. On the other hand, the rate of manager, professionals, service, and sales workers in the urban area is higher than that in rural area (see Tables 2.2.6 and 2.2.7). There is a great difference between urban and rural areas in terms of distribution of employed persons (see Figure 2.2.7 and Table 2.2.8).



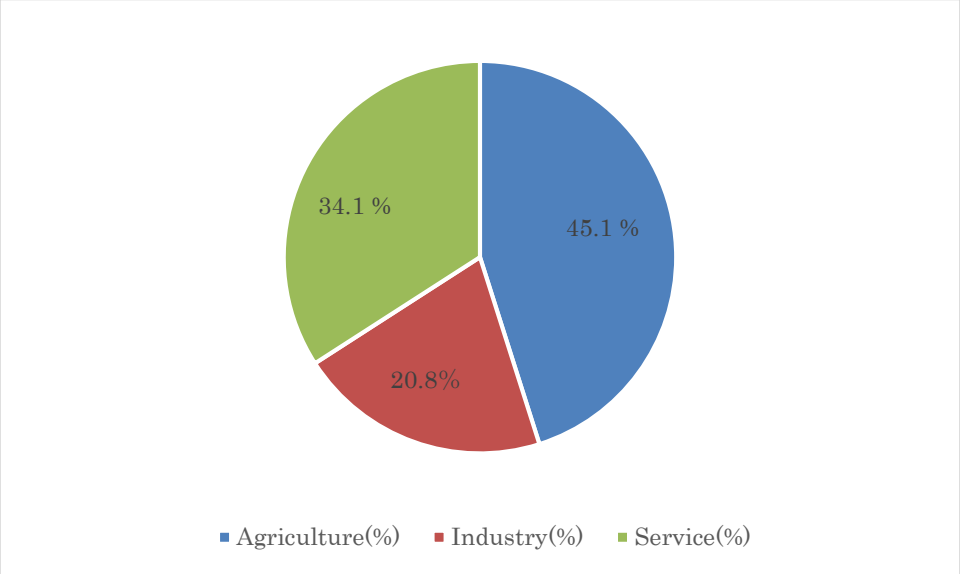
Source: Quarterly Labor Force Survey Report 2015–2016, BBS

Figure 2.2.6 Employment by Occupation and Industry (Age 15 or Older)

Table 2.2.7 Employment by Occupation and Industry (Age 15 or Older)

Occupation	Rural			Urban			Bangladesh		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Managers	1.1	0.3	0.8	5.4	2.1	4.5	2.3	0.7	1.8
Professionals	3.8	3.3	3.7	6.9	12.3	8.3	4.7	5.6	4.9
Technicians and Associate Professionals	1.7	0.6	1.3	4.1	1.8	3.5	2.4	0.9	1.9
Clerical Support Workers	1.3	0.4	1.0	3.1	1.6	2.7	1.8	0.7	1.5
Service and Sales Workers	17.4	2.5	12.7	28.6	7.3	22.9	20.6	3.7	15.6
Skilled Agricultural, Forestry, and Fisheries	32.5	62.0	41.6	7.4	16.9	9.9	25.2	50.8	32.8
Craft and Related Trades Workers	15.2	10.8	13.8	20.5	27.5	22.3	16.7	14.9	16.2
Plant and Machine Operators, and Assemblers	8.3	1.9	6.3	11.6	8.2	10.7	9.3	3.5	7.5
Elementary Occupations	18.6	18.3	18.5	11.9	22.3	14.7	16.7	19.3	17.4
Other Occupations	0.3	0.0	0.2	0.5	0.0	0.4	0.3	0.0	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Quarterly Labor Force Survey Report 2015–2016, BBS



Source: Quarterly Labor Force Survey Report 2015–2016, BBS

Figure 2.2.7 Distribution of Employed Persons by Broad Economic Sectors

Table 2.2.8 Distribution of Employed Persons by Broad Economic Sectors

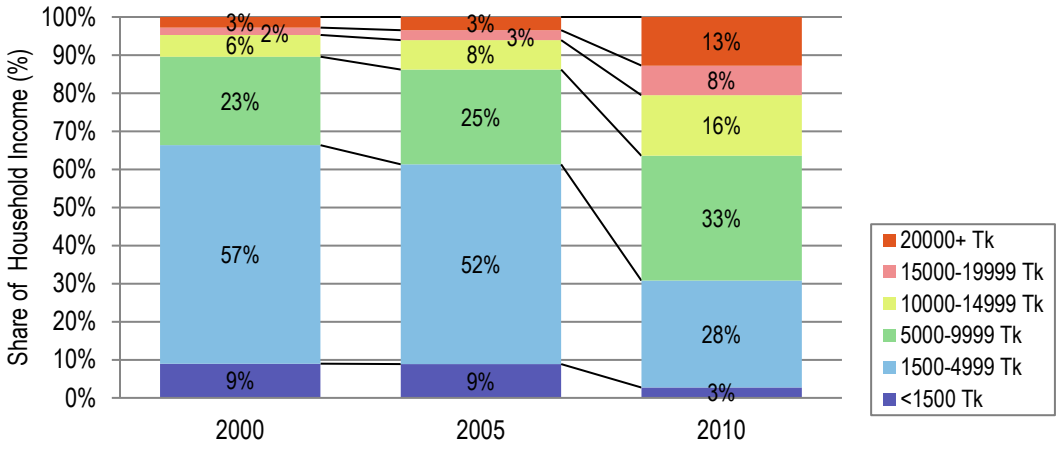
Economic Sector	Rural			Urban			Bangladesh		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Agriculture (000)	15,650	7,920	23,570	1,532	1,088	2,620	17,182	9,008	16,190
Industry (000)	4,880	2,598	7,477	3,201	1,395	4,596	8,081	3,993	12,073
Service (000)	9,088	1,783	10,870	6,876	2,063	8,939	15,964	3,846	19,809
Total (000)	29,618	12,300	41,918	11,609	4,546	16,155	41,227	16,846	58,073
Agriculture (%)	52.8	64.4	56.2	13.2	23.9	16.2	41.7	53.5	45.1
Industry (%)	16.5	21.1	17.8	27.6	30.7	28.5	19.6	23.7	20.8
Service (%)	30.7	14.5	25.9	59.2	45.4	55.3	38.7	22.8	34.1
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Quarterly Labour Force Survey Report 2015–2016, BBS

2.2.4 Income Levels and Poverty

1) Distribution of Household Income and Expenditure

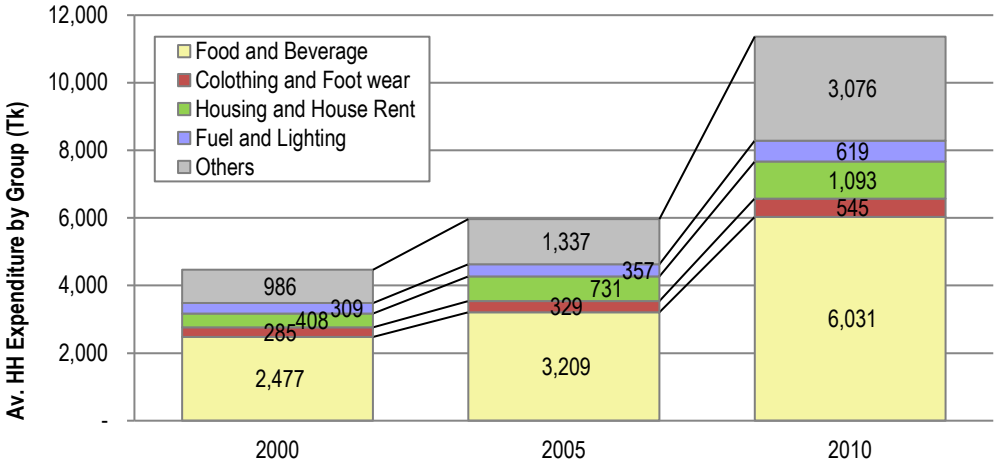
Household income and expenditure in Bangladesh have also increased in 2000–2010 against economic development. As per the Household Income and Expenditure Survey, the average household income was almost BDT12,000 in 2010. As shown in Figure 2.2.8, the share of low-income households (with monthly household income of less than BDT5,000) was decreasing while high monthly income households (with monthly household income of more than BDT5,000) was increasing every year.



Source: Household Income and Expenditure Survey, 2000, 2005, and 2010, BBS

Figure 2.2.8 Share of Household Income from 2000 to 2010

Figure 2.2.9 shows an increasing rate of average household expenditure that went up to BDT11,003 monthly in 2010 at the national level. The monthly average consumption in 2010 increased by 84.5% compared to year 2005 and by 142.5% with year 2000. Expenditure in food and beverage in particular, shows a tremendous increase.



Source: Household Income and Expenditure Survey, 2010, BBS

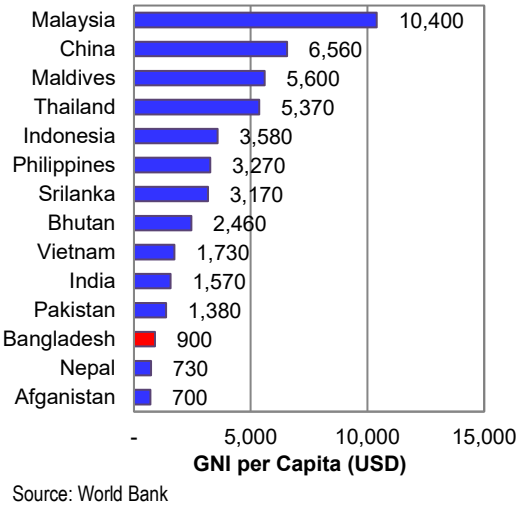
Figure 2.2.9 Increasing Trend of Household Expenditure in Bangladesh

2) Poverty Indices

(1) Gross National Income (GNI) per Capita among Asian Countries

The Bangladesh economy recently shows a rapid growth; however, the country still remains

as one of the poorest in the world. According to World Bank, the GNI per capita of Bangladesh in 2013 was in the third lowest position in South Asia with almost 60% difference from India and less than 30% from Sri Lanka. In order to curb the economic condition, the Government of Bangladesh resorted to increase minimum wage. For instance, the minimum monthly wage of garment workers received an increase from BDT1,661 in 2006 to BDT3,000 in 2010, and continuously went up to BDT5,300 in 2014.



Source: World Bank

Figure 2.2.10 GNI per Capita of Asian Country (2013)

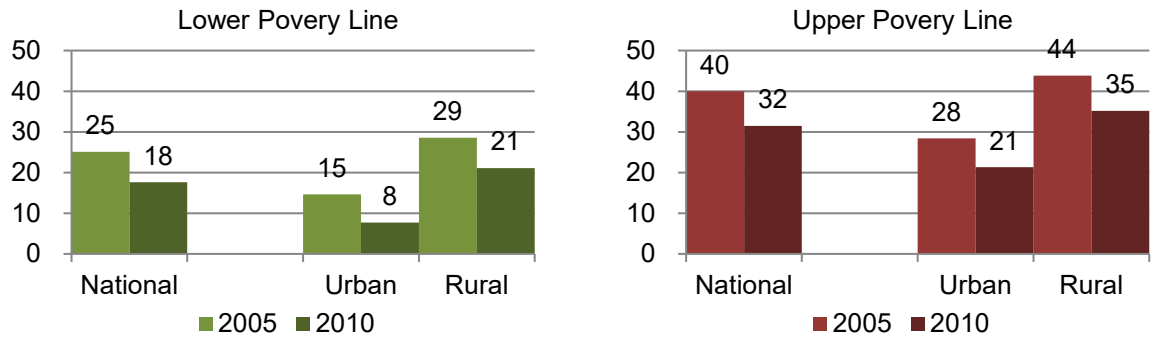
(2) Population of the Poor

The GNI of Bangladesh is quite low due to a large number of poor population. In order to estimate the number of poor people, Bangladesh Bureau of Statistics has been using the Cost of Basic Needs (CBN) method since 1995–1996. In this method, the two poverty lines estimated are lower poverty line (extreme poor) and upper poverty line (moderate poor).

Lower Poverty Line (Extreme Poor). Households with total expenditures on combined food and non-food items equal or less than the food poverty line (less than 2,122 kcal per person in a day) are considered to be under the extreme poor bracket.

Upper Poverty Line (Moderate Poor). Households with total expenditures equal to or less than the upper poverty line (summation of food and non-food poverty lines) are known as moderate poor.

As stated in the Perspective Plan, the government aims to reduce the number of upper poverty population from 32% to 13.5% by year 2021. In reference to Figure 2.2.11 data, the percentage of lower and upper poverty line people has decreased from 2005 to 2010.



Source: Upper Poverty Line: Household Income and Expenditure Survey, 2010 and Target: Perspective Plan of Bangladesh, Planning Commission Bangladesh, April 2012, BBS

Figure 2.2.11 Change of Percentage of Poor People in National Level

(3) Slum Population

People unable to afford their livelihood in the rural areas venture to Dhaka or a sub-urban area to get any job where they eventually engage into a low-skill job such as day labourer, rickshaw puller, luggage carrier, and the like. According to "Slums of Urban Bangladesh, Mapping and Census 2005," slum is defined as a neighbourhood or residential area with a minimum of 10 households or a mess unit with at least 25 members having four of the following conditions prevailing within the area.

- Predominantly poor housing;
- Very high population density and room crowding;
- Very poor environmental services, particularly water and sanitation facilities;
- Very low socio-economic status for the majority of residents; and
- Lack of security of tenure.

According to the above assumption, the number of slum population in Dhaka Metropolitan Area doubled from 1995 to 2005 (from 1.5 to 3.4 million people), while the number of slum communities increased by roughly 70% (from 3,007 to 4,966). Also, the share of slum population increased from 20% to 37%.

2.3 Land Use

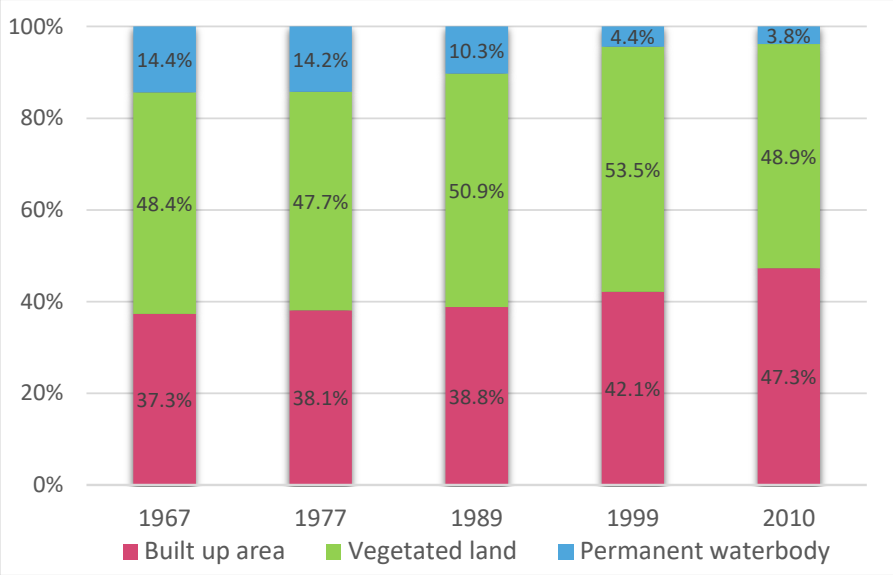
2.3.1 RAJUK Area

1) Overview

Similar with other developing cities, the growth of Dhaka's land use has been changing since 1967. While the vegetation area is almost fixed at 70,000 ha in the past 40 years, the current water body became a quarter since 1967, which is 5,520 ha in 2010 from 206,868 ha in 1967 as shown in Figure 2.3.1. Thus, the waterbody has been converted to built-up area. The lack of growth management and planned urbanization causes extensive urban poverty of low-income people who use the waterbody as domestic use and the fields for agriculture and fishery, recurrent episodes of flash flooding, substantial growth of slums, and exploitation of resources and the mismanagement of limited land resources.

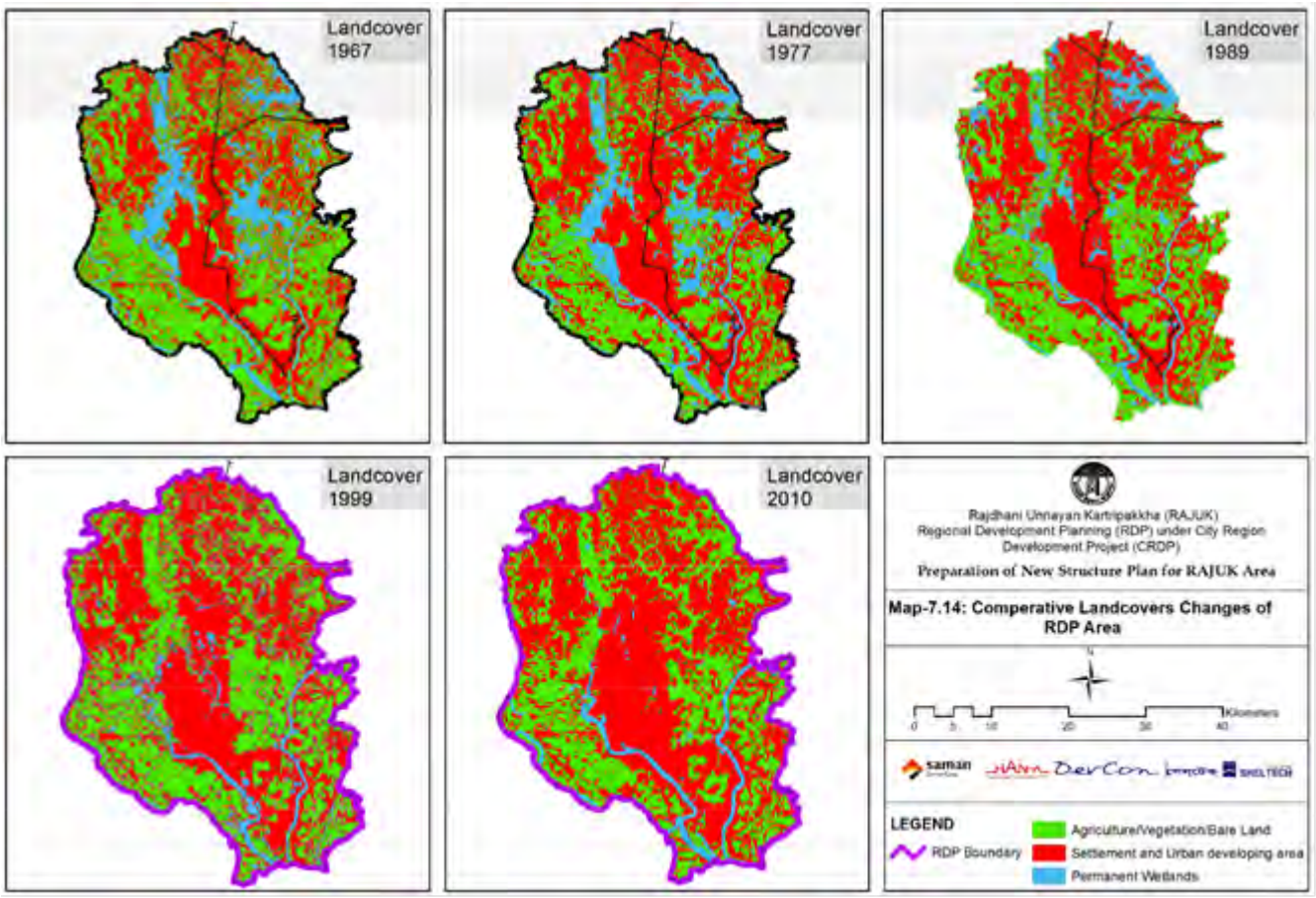
In 1967 to 1989, the built-up area increased gradually from 53,727 to 55,921 ha with 0.2% of the annual increase rate. After that period, urbanization has accelerated. The built-up area increased by about 5,000 ha in 1989–1999 and by 7,500 ha in the period of 1999–2010.

Figure 2.3.2 indicates the speedy expansion of built up area within RAJUK area through transformation of permanent water bodies and vegetation areas. The expansion of built up area mainly occurred to the northern region of RAJUK area specifically towards Savar, Ashulia and Uttara areas.



Source: Japan International Cooperation Agency (JICA) Study Team worked out based on Regional Development Planning (RDP) Survey Report (RAJUK, 2014)

Figure 2.3.1 Land Cover Changes between 1967 and 2010



Source: RDP Survey Report (RAJUK, 2014)

Figure 2.3.2 Land Cover in 1967, 1977, 1989, 1999 and 2010

RAJUK area is further divided into six regions, namely Dhaka Central Region, Northern Region, Eastern Region, Western Region, Southern Region, and South-Western Region. Below is the coverage of each region.

Dhaka Central Region. The existing Dhaka City consisting of 41 Thanas of DMA.

Northern region. All the unions (except Mirzapur union) of Gazipur Sadar Upazila and the entire area of Gazipur City Corporation.

Eastern region. Two Parushava (Kanchan and Tarabo) and six union of Rupjanj Upazila, and one Parushava (Kaliganj) and two unions of Kaliganj Upazila.

Western region. Savar Parushava and 11 unions of Savar Upazila.

Southern region. Two Parushavas (Narayanganj and Siddhiraganj) and seven unions of Narayanganj Sadar Upazila, one Parushava (Kadam Rasul Parushava) and five unions of Bandar Upazaila, and one Parushava (Sonargaon) and seven unions of Sonargaon Upazila (part).

South-Western region. Eleven unions of Keraniganj Upazila of Dhaka District.

The total RAJUK area is 152,000 ha in which the northern region accounts the largest with 23.4% of the area, followed by Dhaka Central Region with 19.8%, and western region with 16.6%. In terms of land use type, the agricultural use is still dominant at more than 40% of the total area in RAJUK. These agricultural lands expand towards the north and west regions. Residential area is the second largest with 56,024 ha, which has been developed

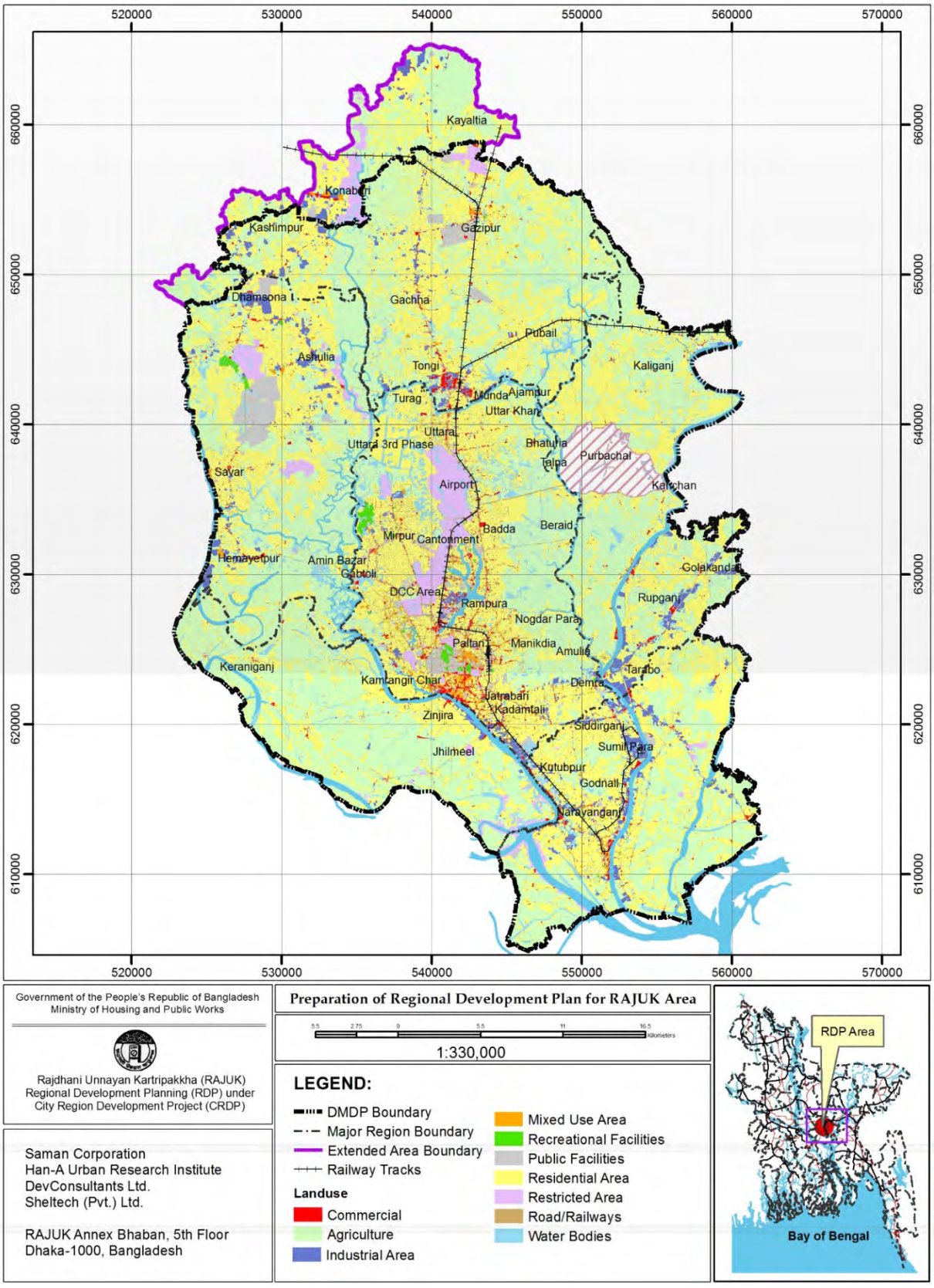
in Dhaka Central and northern regions. The development direction of the residential areas is the same as the urban expansion. Other urban land use, such as commercial and mixed-use, can also be found mainly in Dhaka Central and northern regions.

On the other hand, industrial areas are more concentrated in the northern and southern regions. The western region has relatively high share of public facilities and recreational area.

Table 2.3.1 Existing Land Use of the RDP Area

Land Use Type	Area (ha)							Share (%)						
	Region						Total	Region						Total
	DCR	NR	ER	WR	SR	SWR		DCR	NR	ER	WR	SR	SWR	
Agriculture	7,105	16,560	9,813	11,156	8,095	10,997	63,713	11.1	26.0	15.4	17.5	12.7	17.3	100.0
Industrial Area	541	864	557	727	909	144	3,810	14.5	23.1	14.9	19.4	24.3	3.9	100.0
Commercial	694	291	134	139	242	71	1,572	44.2	18.5	8.5	8.8	15.4	4.5	100.0
Mixed Use Area	612	128	4	82	124	21	971	63.0	13.1	0.4	8.5	12.7	2.2	100.0
Residential Area	12,988	14,248	7,022	8,852	8,759	4,154	56,024	23.2	25.4	12.5	15.8	15.6	7.4	100.0
Purbachal New Town	6	0	2,392	0	0	0	2,379	0.3	0.0	99.7	0.0	0.0	0.0	100.0
Public Facilities	1,294	780	90	1,178	337	89	3,767	34.3	20.7	2.4	31.3	8.9	2.4	100.0
Recreational Area	289	4	0	87	9	0	390	74.1	1.0	0.0	22.4	2.4	0.0	100.0
Restricted Area	2,030	931	30	754	321	303	4,302	46.5	21.3	0.7	17.3	7.4	6.9	100.0
Road/Railways	1,859	553	212	418	423	192	3,657	50.8	15.1	5.8	11.4	11.6	5.3	100.0
Waterbody	2,643	1,203	1,273	1,902	2,416	1,966	11,758	23.2	10.6	11.2	16.7	21.2	17.2	100.0
Total	30,061	35,562	21,528	25,296	21,635	17,937	152,343	19.8	23.4	14.2	16.6	14.2	11.8	100.0

Note: DCR = Dhaka Central Region, NR = Northern Region, ER=Eastern Region, WR = Western Region, SR = Southern Region, SWR = South-western Region
Source: JICA Study Team worked based on RDP Survey Report (RAJUK, 2014)



Source: RDP Survey Report (RAJUK, 2014)

Figure 2.3.3 Land Use of RAJUK Area, 2013

2) Dhaka Central Region

A large portion of the Dhaka Central Region is already urbanized with 60% of the area as built-up. Majority of the built-up area is residential area with 43% followed by commercial area with 2.3%, mixed use with 2.0%, and industrial area with 1.8% (see Table 2.3.2). This region also covers Motijheel, Panthapath, and Gulshan, all of which are usually referred to as the central business district (CBD) of Dhaka. The land and property prices in this region increased incredibly between the period of 2000–2010.

About 13,000 ha of residential area is occupied mainly by middle- and high-income groups, and other residential areas developed spontaneously that are occupied by the low-income group. The spontaneous or unplanned development of residential areas in the region has increased urban problems.

There are 540 ha of industrial area, which are mainly in Pallabi, Mirpur, and Hazaribag Thanas, and 690 ha of commercial area in the southern side of DCC. Main commercial area is the old part of Dhaka City, such as Kotwali, Lalbag, and Sutrapur Thanas. Other commercial areas can also be found in Motijheel, Ramna, Tejgaon, and Khilgaon Thanas in the central part of DCC, and Gulshan, Mirpur, Badda and Uttara Thanas are in the northern part of DCC. All major commercial activities are situated along the major roads.

Besides the urbanized area, the agricultural land of 7,100 ha are spread in the peripheral area near the DMA boundary. Agricultural lands are mostly located in Uttar Khan, Beraid, Starkul, Badda, Demra, Sabujbag, and Khilgaon areas. Since the urban areas of the region are highly dense, these agricultural lands and water bodies have been converted for private housing projects.

This region also has 2,030 ha of restricted area occupied by military or government establishments. Important establishments include the President's Office and Residence at Banga Bhaban, Prime Minister's Office and Residence, National Parliament Building, Hazrat Shahjalal International Airport, Secretariat near Paltan, and Old Airport Area at Tejgaon. These restricted areas are located at a significant valuable land in an urban development aspect and became a constraint for the transport development. Besides the restricted area, large public facilities including government offices and universities also occupy prime land and cause congestions. Moreover, the share of recreational area and transport facilities are still insufficient to provide better living conditions for residents and to ensure sustainable development.

Table 2.3.2 Land Use Composition in Dhaka Central Region

Land Use Type	Ha	%
Agriculture	7,104.9	23.6
Industrial Area	541.4	1.8
Commercial	694.2	2.3
Mixed Use area	611.9	2.0
Residential Area	12,987.9	43.2
Purbachal RA	6.3	0.02
Public Facilities	1,293.6	4.3
Recreational Area	289.0	0.96
Restricted Area	2,030.0	6.8
Road/Railways	1,858.8	6.2
Waterbody	2,643.4	8.8
Total	3,0061.4	100.00

Source: RDP Survey Report (RAJUK, 2014)

3) Northern Region

Since most of the northern region is high land, the urbanization of Dhaka Central Region expanded to the north. The total 17,200 ha urbanized land is the second largest in RAJUK area. The Dhaka Central Region has 18,000 ha urbanized land. The agricultural area is still dominant in the region with 47% of the total area, but the residential area is also more than 40% (see Table 2.3.3).

About 14,000 ha of residential area is a mix of urbanized housing areas in Gazipur and Tongi Pourashava and rural homestead areas around the agricultural land. In general, urbanized housing areas have been developed for middle-income group, and the rural homestead areas are for low-income group. New planned residential areas are also being developed as private housing projects.

This region is known as one of the industrial cities of Bangladesh. Some industrial development can be seen along the Dhaka–Mymenshing Highway. In particular, Tongi is a major industrial area composed of many garment factories. The high land along this highway has increased in industrial development, but consequently caused disorder in residential and commercial developments that resulted with large slums. Another industrial zone is in the eastern side of the Upazila in Kashimpur Union and Konabari Union. Beximco Industrial park is situated near the Zirani Bazar. Small industrial areas are also scattered along the rivers and major roads where industrial establishments can have good accessibility for logistics.

Similarly, commercial areas were developed mainly along Dhaka–Mymenshing Highway. Gazipur and Tongi are the major commercial centers in this region. The latter, in particular, has the most commercial activity within the region.

Large part of the agricultural land is considered to be relatively of “high-value agricultural land.” In addition to the agricultural area, some seasonal crops also grow in the waterbody during dry season. The swampy areas used for agriculture are situated by the side of the Turag River in the south-eastern and eastern parts of the region.

Restricted land of 860 ha is mainly occupied by the Army Machine Tools Factory in the northern side of the region, Bangladesh Ordnance Factory (BOF), and Security Printing Press. Public facilities area has several research institute and universities.

Table 2.3.3 Land Use Composition in Northern Region

Land Use Type	Ha	%
Agriculture	16,560.0	46.6
Industrial Area	931.0	2.6
Commercial	291.5	0.8
Mixed Use area	127.7	0.4
Residential Area	14,247.8	40.1
Public Facilities	780.3	2.2
Recreational Area	4.1	0.01
Restricted Area	863.5	2.4
Road/Railways	552.8	1.6
Waterbody	1,203.1	3.4
Total	35,561.8	100.0

Source: RDP Survey Report (RAJUK, 2014)

4) Eastern Region

The eastern region is a predominantly agricultural area that occupies more than 45% of the entire region. The built-up area, which is mainly residential (see Table 2.3.4), occupies only 36%. The 9,800 ha of agricultural land is mostly the eastern fringe area with low-lying land. Part of the waterbody with 1,300 ha is also used for agriculture during the dry season.

The residential area is 7,000 ha or 33% of the total land. Since the eastern region is located at the peripheral area of DMA, sub-urban housing areas are situated on both sides of the roads within this area. Other residential areas are rural homestead area that is situated beside the agricultural land and occupied by the low-income group. Purbachal New Town, which is developed by RAJUK, is in this region as well (see Chapter 2.5). More urbanization would occur surrounding the peripheral semi-urban area of this zone being within the vicinity of the urbanized area.

Since the road network is not fully developed, the industrial development that covers less than 3% of the total area is concentrated by the river side of Balu, Shitalakhaya River, and Bhulta area. Along the national and regional highways and some important feeder roads are where the other industrial areas are. While the residential development increased, the commercial area occupied only 0.6% of the total area. Similar to the industrial area, commercial activities were developed mainly by the side of the national and regional highways and some important feeder roads. The industrial and commercial developments along the major roads also contributed to the additional unplanned development in those areas.

Table 2.3.4 Land Use Composition in Eastern Region

Land Use Type	Ha	%
Agriculture	9,813.5	45.6
Industrial Area	557.3	2.6
Commercial	134.3	0.6
Mixed Use area	3.9	0.02
Residential Area	7,022.3	32.6
Purbachal RA	2,391.5	11.1
Public Facilities	89.8	0.4
Restricted Area	30.2	0.1
Road/Railways	212.1	1.0
Waterbody	1,273.5	5.9
Total	21,528.5	100.0

Source: RDP Survey Report (RAJUK, 2014)

5) Western Region

The land use composition of the western region is similar to the eastern region (see Table 2.3.5). The main difference is that the western region has more public facilities and recreation areas, while the eastern region has a relatively large area for Purbachal New Town Development. More than 50% of the total land of the western region is agricultural land or waterbody that is considered as flood prone. In general, Keraniganj Upazila is low-lying and a flood prone area while Savar Municipality is relatively high land. Therefore, Savar Municipality has been developed as an urban center with residential, industrial, and commercial uses.

About 9,000 ha of residential area is mainly located along the roadside of Dhaka-Aricha Highway, Nabinagar-Tangail Road, Ashula Road, and Dhaka-Keraniganj Road. Urbanized residential area is generally developed for the middle-income group. The remaining rural homestead areas are for low income people.

About 700 ha of the industrial area includes the Savar Export Processing Zone located along the Nabinagar-Tangail Road. Some other industrial establishment is located along Dhaka-Aricha Highway, Hemayetpur-Singair Road, and Ashulia Road. The total area is small, but the western region has the third largest industrial area among six regions of RAJUK area.

Similarly, commercial land is also small at 140 ha. It has the smallest share of the land in the region (0.6%). The major commercial activity areas are the Hemayetpur, Savar Bazar, Nabinagar, Ganak Bari, and Zirani. There is also some commercial activity located along the river side of Buriganga and the Dhaka-Keraniganj Road.

Public facilities area includes Jahangir Nagar University, Savar Dairy Farm, Public Administration Training Center (PATC), City University, Daffodil University, BRAC Training Center, Bangladesh Atomic Energy Commission, Bangladesh Livestock Research Institute, etc. The area covers about 1,200 ha. There are also about 750 ha of restricted areas including Savar Cantonment which is a prime restricted area.

There is some high value agricultural land as well as some low-lying areas. Besides that, about 8% of the total area is waterbody, which can be used partially for growing some seasonal crops in dry season.

Table 2.3.5 Land Use Composition in Western Region

Land Use Type	Ha	%
Agriculture	11,156.2	44.1
Industrial Area	727.2	2.9
Commercial	138.8	0.6
Mixed Use area	82.4	0.3
Residential Area	8,852.0	35.0
Public Facilities	1,177.8	4.7
Recreational Area	87.3	0.4
Restricted Area	753.7	3.0
Road/Railways	418.4	1.7
Waterbody	1,901.8	7.5
Total	25,295.5	100.0

Source: RDP Survey Report (RAJUK, 2014)

6) Southern Region

Residential land use is central in the southern region as it occupies more than 40% of the total land (see Table 2.3.6). This is followed by agricultural land with 37%. Urbanized housing areas are located in Kadam Rasul, Sidhhirganj, and Narayanganj Pourashavas (NCC Area), Fatullah, Kanchpur, Madanpur, Islamia Bazar, Bandar Upazila head quarter, Mugrapara, etc. In addition, almost all are rural home stead areas for the low-income group that resulted from the lack of approved detailed plan.

The southern region has the largest industrial area of 910 ha in RAJUK, especially Narayanganj that is known as the industrial city of Bangladesh. Industrial activities have been mainly developed along the Shitalakhhaya River, Buriganga River, Old Brahmaputra River, Dhaka-Chittagong Highway, and Dhaka-Sylhet Highway. The Adamjee Export Processing Zone (EPZ), which was established in 2006, has 99.2 ha of the land and is located 15 km away from Dhaka City center. There are 61 companies with Bangladeshi main investors located in EPZ that generate more than 36,000 jobs. Other industries are located eastern side of Shitalokhhaya River in Bandar Upazila by the Brahmaputra River on Sonargaon Upazila and by the Buri Ganga River on Keraniganj Upazila.

The commercial area of 240 ha is all located in the City Corporation area along the Buriganga and Shitalakhhaya Rivers. Mugrapara, Islamia Bazar, Katchpur, Ekuria Bazar, Fatulla, Kutubpur, Shimulpara, Narayanganj, Kadam Rashul, and Siddhirganj are the main commercial activity centers in this zone.

About 8,800 ha of agricultural land and 2,400 ha of waterbody contribute to the agricultural activities of the region. The agricultural area is spread around the southern portion of Narayanganj Sadar Upazila, Bandar, and Sonargaon Upazila with low-lying parts.

Table 2.3.6 Land Use Composition in Southern Region

Land Use Type	Ha	%
Agriculture	8,094.6	37.4
Industrial Area	909.1	4.2
Commercial	242.1	1.1
Mixed Use area	123.7	0.6
Residential Area	8,758.8	40.5
Public Facilities	336.9	1.6
Recreational Area	9.4	0.04
Restricted Area	321.1	1.5
Road/Railways	423.1	2.0
Waterbody	2,416.5	11.2
Total	21,635.4	100.0

Source: RDP Survey Report (RAJUK, 2014)

7) South-Western Region

Although the south-western region is bounded by the urbanized area of the Dhaka Central Region, agriculture is its dominant land use. More than 60% of the total area is occupied by agricultural land and about 10% are waterbody. In addition, some parts of the region were converted into brick field.

Residential area shares the second highest with 23% of the total area. RAJUK's Jheelmil New Town and the urbanized residential area for the middle-income group has been developed by the roadside of Dhaka-Keraniganj and Dhaka-Mawa roads. The remaining area is the scattered and unplanned rural homestead for low-income group.

Other urban land uses in this region, such as industrial and commercial, are insignificant since they only occupy 0.8% (145 ha) and 0.4% (71 ha) of the total area, respectively. Moreover, commercial area is located along the side of Buriganga River and Shitalakhhaya Rivers.

Table 2.3.7 Land Use Composition in South-Western Region

Land Use Type	Area(ha)	%
Agriculture	10,996.9	61.3
Industrial Area	144.5	0.8
Commercial	71.4	0.4
Mixed Use area	21.2	0.1
Residential Area	4,153.8	23.2
Public Facilities	88.6	0.5
Recreational Area	0.0	0.0
Restricted Area	302.9	1.7
Road/Railways	192.4	1.1
Waterbody	1,965.6	11.0
Total	17,937.3	100.0

Source: RDP Survey Report (RAJUK, 2014)

2.3.2 Hazards

1) Flood and Inundation Characteristics

Basic inundation process that occur in Dhaka is when water levels rise in the three major rivers that cause back flows in the tributaries which, in turn, make it difficult to drain the surface water. Thus, this results in inundation in the wetlands and surrounding areas in the surroundings.

A major inundation (called *banna* in Bengali) that causes damages to human lives, properties, agriculture, etc. is when discharge from the three major rivers increase and river water of rising level flows into parts of the city with lower elevation; thus, inundating an extended area.

In recent years, major inundations occurred in 1988 and 1998 that brought about significant damages. During these inundations, water level of Buringanga River in the western part of Dhaka exceeded 7.0 m.

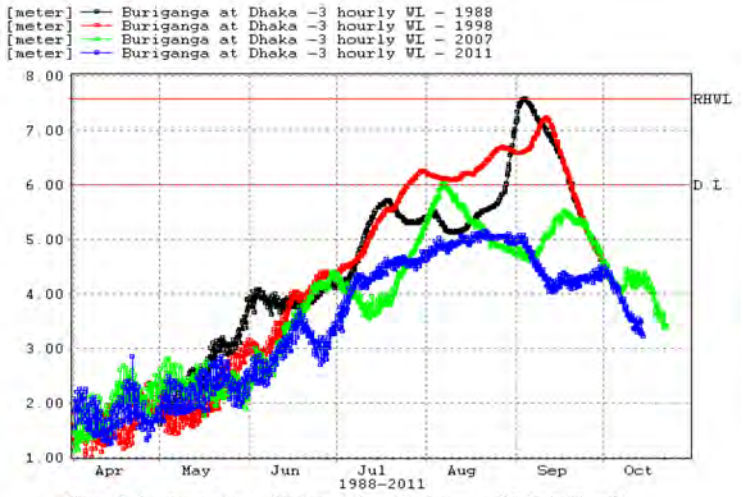


Figure 3. 6 : Comparison of Hydrograph on Buriganga at Dhaka(Milbarak)

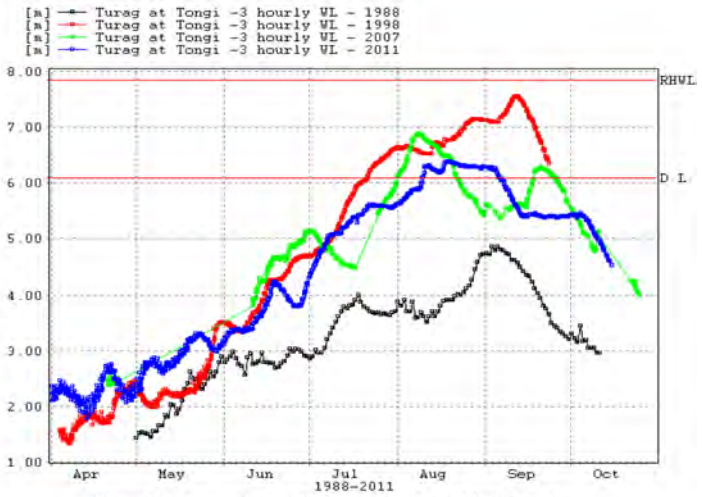


Figure 3. 7 : Comparison of Hydrograph on Tongi Khal at Tongi

Source: Annual Flood Report 2011, FFWC, BWDB

Figure 2.3.4 Water Levels in Rivers around Dhaka during Major Inundations in Recent Years

Dhaka City was built on a delta formed by rivers. Its ground is believed to be formed almost solely from silt and fine sand. As a result, river banks are subjected to erosion because of fluctuating water level and flowing river water.

Inundation by river water in Dhaka is characterized by a very slow process of flood water to recede, resulting in an elongated period of inundation. Typical duration of inundation in the last 50 years is from 15 to 45 days, during which the residents suffer directly and indirectly.

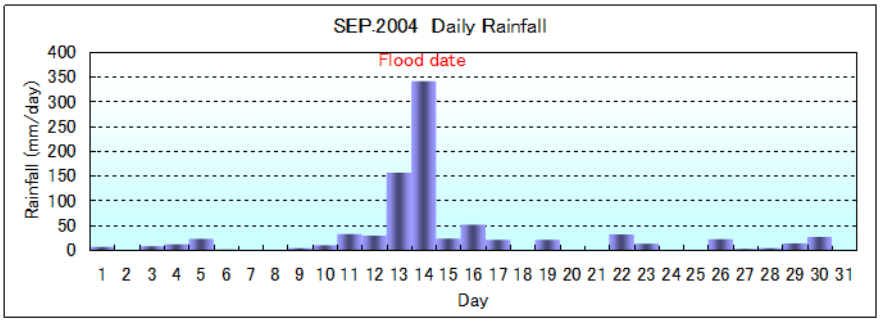
Another form of inundation that affects Dhaka is inundation by inside water. In case water levels in rivers rise when there has been a torrential rain, inundation damage by inside water occurs because the flood water cannot be drained into rivers. Flood caused by inside water is usually shallow and there is no risk of losing many lives. The 2006 Halcrow Report 2006 claims that an inundation due to drainage failure that causes damage to properties is brought about by a deluge having probability of occurrence once in ten years.

A recent case of inundation by inside water affected a large part of urban Dhaka in 2004.

This occurred when rising water levels in the rivers caused Balu River in the eastern Dhaka to overflow and then flooding the lowland areas of the city. In western Dhaka, overflow from Turag River flooded the inside land through culverts and opened regulators.

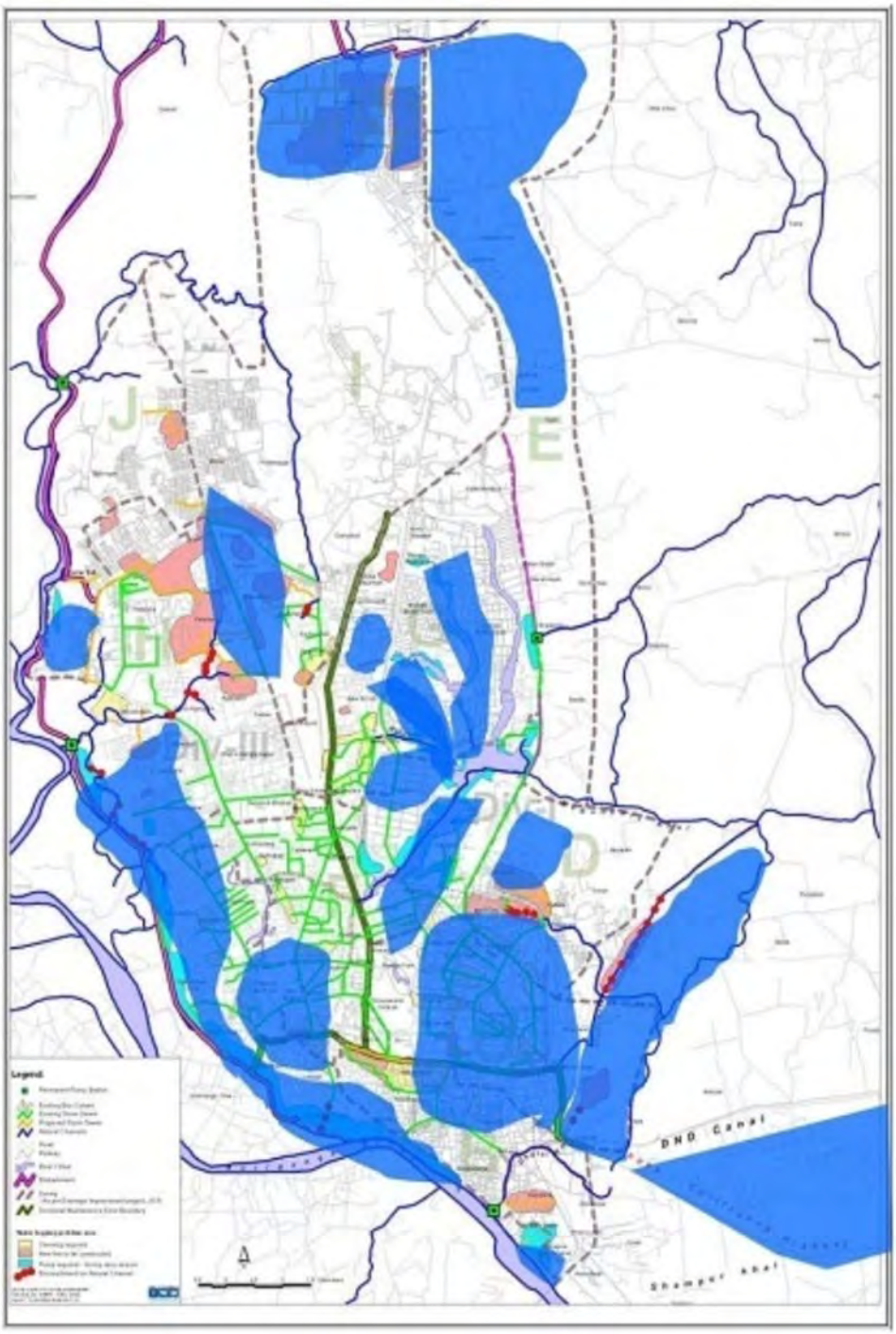
The inundation damage by inside water was caused by an intense rainfall in Dhaka when the regulator was closed so as to protect the urban Dhaka from the flooding river water.

Daily rainfall recorded in Dhaka in September 2004 when the inundation occurred was 341 mm. This means that such amount of rainfall occurred in one day exceeded the mean monthly precipitation of 284 mm recorded during rainy season (June to September) in the recent five years, and the large amount of rainwater remained in the urban area without being drained. An estimated 40% of the urbanized area in the western Dhaka was waterlogged by the inside water.



Source: Halcrow Report

Figure 2.3.5 Daily Rainfall in September 2004



Source: Survey Report (RAJUK 2014)

Figure 2.3.6 The Inundation map of Greater Dhaka, 2004

There were water channels, natural drainages, and lowland areas in and around Dhaka in the past that contributed to the retention and discharge of rain water. However, rapid sprawl of the urban district in recent years has decreased the water retention areas, leading to a loss of water-retaining capability of the urban district. In addition, haphazard urban development carried out in disregard of the topography coupled with the failure of timely building storm water drainages and negligence of maintenance services has been aggravating the problem of rainwater remaining in the urban district.

Rain water that remains over an extended period of time not only causes inconvenience to the residents' lives, traffic, and other activities, but also environmental and hygienic problems such as odor and health hazards.

Source: Survey Report (RAJUK 2014)

Figure 2.3.7 Water Logging Condition (Purba Jurain of Dhaka City)

Source: JICA Study Team

Figure 2.3.8 Street without Drainage (left) and Drainage Clogged with Garbage (right)

2) Flood control policy of Dhaka City

The flood control policy of Dhaka City was established as part of FAP in 1990s with the idea of preventing inundation by river water through building an embankment and draining rain water from the urban area by pumping. The flood control policy is intended to prepare for disasters with a probability of occurring once in one hundred years. Construction of the storm water drainage system in the city, on the other hand, was planned for disasters with a probability of occurring once in five years.

Under this policy, the western embankment (with a crown height from 7.5 to 10 m) and three pump stations (with a total discharge capacity 44.5 m^3/s) are now under construction. In the existing urban district, there are retarding basins, such as Gulshan Lake, and a new one was built in Tejgaon district to receive and retain drained rain water.

With regard to the embankment and the pump stations on the eastern edge, revision and F/S of the plan were completed, but the prospect to commence construction has not been obtained. Currently, DIT Road serves as a flood protection line and functions as an embankment that prevents overflows from rivers in the east from infiltrating the city (height of road surface is said to be around 8 m). For this reason, channels that cross the DIT Road are equipped with gates while two have pumping stations built alongside.

In the central part of the city, a project is now being implemented to construct a multipurpose waterfront that includes flood control.

3) Challenges facing the flood control policy in the eastern Dhaka development project

Dhaka is one of the most densely populated cities in the world. The trend toward nuclear families also makes it increasingly difficult to meet the demands for housing within the existing urban district. To tackle this problem, projects to develop housing lands have been carried out by the public and private sectors, making the urban district continue to sprawl. There has been a restriction on housing development in the eastern part of Dhaka because it is a lowland with elevation of 5 to 6 m. However, demands for housing development in this district have been growing because it is located near the urban district.

The most challenging about the housing development in the eastern part of Dhaka is the need for flood control measures. As described above, a project to construct embankment and reservoirs to keep inside water and pumping stations was put into place in the eastern Dhaka under the revised Eastern Bypass Study (2006). The following problems have been pointed out for this project.

(1) Setting the embankment crown height

In the past inundations, water levels in the three major rivers rose to 15 m or higher and Buriganga and Balu Rivers that surround Dhaka rose to almost 8 m. Since the ground height in eastern Dhaka is about 5 to 6 m, it was feared that building the embankment with a crown height of 8 m would lead to increased flooding energy in the event of dyke break, resulting in significant damages.

(2) Timing of embankment construction

Risk of inundation damage increases if building of an embankment lags the urban development works, If building of embankment in the downstream proceeds ahead of building in the upstream, overflow from the upstream would be prevented by the downstream embankment from returning to the river, so as to be retained in the inside over an extended period of time.

(3) Protection against bank erosion

The embankment should be protected with revetment installed over the height range of the varying water level. River sand will be used as embankment material when the actual conditions surrounding the project are considered. If this is the case, the surface behind the revetment must be installed with a soil draw-out prevention material to prevent the sand behind the revetment from being drawn out, giving rise to the danger of collapsing revetment and fragile embankment.

(4) Drainage of inside water

Building an embankment makes it difficult to drain the inside water. To drain the inside water, it is necessary to install pumps, sluice gates, and other facilities. Well-defined rules for operating these facilities and a reliable system must be put in place that can ensure correct operation and management of the facilities.

(5) Loss of wetlands

Eastern Dhaka has wetlands scattered that are valuable, not only for flood control as buffer and water retention in case of river overflow, but also for their contribution to the preservation of diversity in the natural environment. Water in the wetlands comes mainly from the overflow from rivers, ground water, and rain water. Construction of embankment would stop the harmless, ordinary flooding (barsha) from occurring; thus, causing wetlands to diminish and weaken their functions with the supply of water and fishes from rivers interrupted.

4) Development in eastern district by landfill

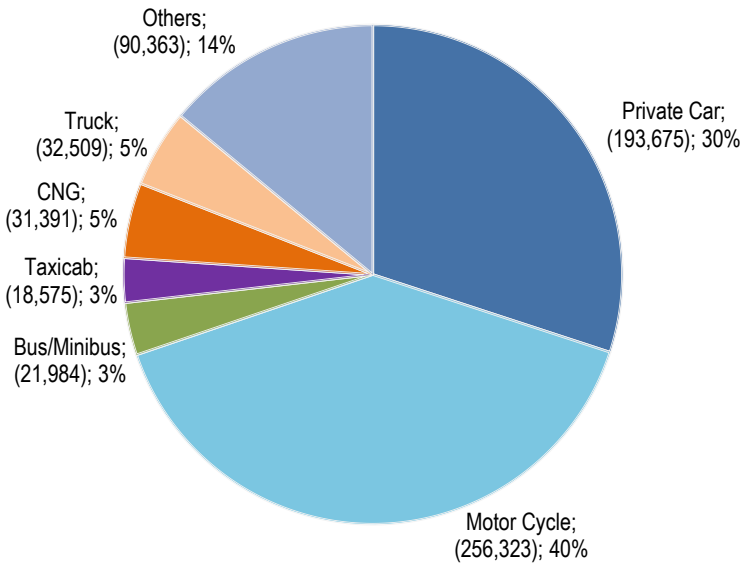
First Dhaka Eastern Bypass study was undertaken in 1998 under World Bank Technical Assistance. The study was updated in June 2006 with a new name “Updating/Upgrading the Feasibility Study of Dhaka Integrated Flood Control Embankment cum Eastern Bypass Road Multipurpose Project.”

Its main objective is to provide flood protection for the eastern part of Dhaka to mitigate damage and loss as a result of flooding by the Balu River and from internal flood water. The project will also deliver transport benefits, but they are secondary to flood defense. Total project cost in 2005 constant prices and excluding physical contingencies was estimated at BDT19 billion ($233 million) in the report.

2.4 CURRENT URBAN TRANSPORT SYSTEM

2.4.1 Introduction

At present, major modes of transport in GDA are motorcycles, private cars, microbuses, trucks, minibuses, and taxis. The number of registered public transport is quite less compared to private transport. In this section, various types of existing transports and performance as well as issues on public transport system in GDA are described.



Source: BRTA

Figure 2.4.1 Share of Total Newly Registered (2001–2013) Vehicles in GDA

2.4.2 Pedestrian & Non-Motorized Transports

1) Pedestrian

Walking is the common mode of transportation of the majority of people in Dhaka City. According to DHUTS in 2009, almost 20% of the people in the city walk. One of the reasons to some of the people is the financial incapability to use public transport. Also, quite a lot of garment workers commute to factories in the morning and by foot in the evening. Some people walk to access public transport like buses.

Even though a large share of people are pedestrians, facilities for pedestrians are not properly ensured. Convenience is not considered for the pedestrians whenever a road or an intersection is constructed or renovated in Dhaka City. There are around 66 pedestrian foot-over bridges and 4 underground pedestrian crossings in the city to ensure safe crossing of the users. In some locations, pedestrians attempt to cross the road with many motorized vehicles due to insufficient facilities for crossing. However, it has been also observed that some pedestrian foot-over bridges are not being used by pedestrians.

There are several on-going projects under DCC that focus on pedestrian walkway improvement. As a matter of fact, construction of footpath already start before construction works for drainage pipe installation, internet cable installation, etc. However, some of the re-constructed footpath are improperly done like unlevel construction with rough surface

where children and elderly people find difficult to walk on. In Bangladesh, there is hardly any consideration for the handicapped in their footpath designs. This calls for a development of barrier-free walkways or crossing facilities. Moreover, footpath's height practically varies from 15 to 60 cm as there is no predetermined height of the walkway. In March 2014, Dhaka North City Corporation (DNCC) inaugurated the construction of the first ever foot-over bridge with escalator (upward direction only) in Bangladesh located at the intersection of Banani Road Number 11 and Airport Road. DNCC has a plan of constructing seven more of this bridge type if they get a positive outcome.

2) Bicycle

Bicycle is a useful and environment-friendly transport, which plays an important role as access for commuting in developed countries. However, only 2% bicycle trips were found on arterial roads in Dhaka City. In the past, bicycle was used mostly in rural areas to commute to school and to office. Due to religious conservativeness, many women still do not use a bicycle.

Some problems of using bicycles in Dhaka City are:

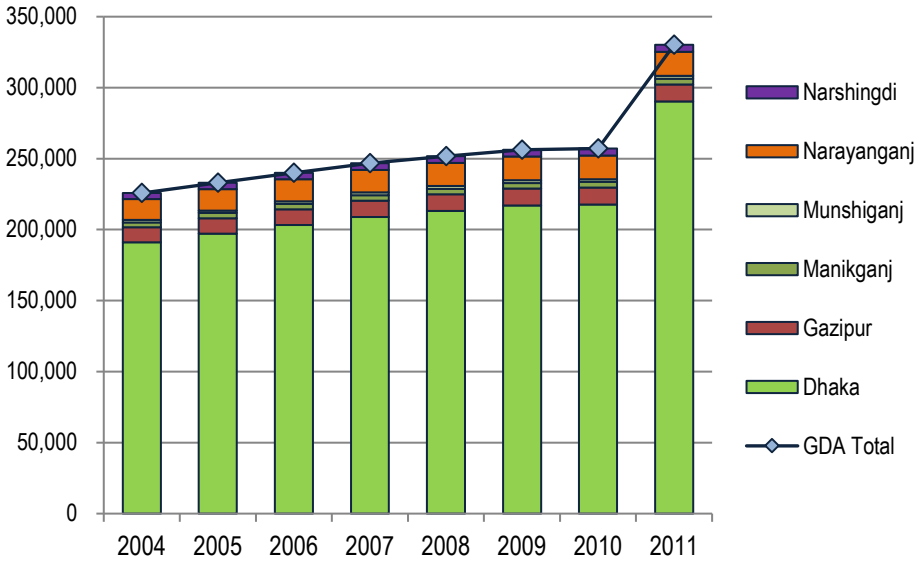
- Absence of dedicated bicycle lane that makes biking quite dangerous.
- No parking facilities for bicycle that makes it difficult to use even to access other modes of transport.
- Possibility of theft due to lack of parking facilities.
- Due to high initial cost of a good quality bicycle (approximately BDT15,000), it is an unaffordable to low-income people.

3) Rickshaw

Dhaka City is known to be a city of rickshaws. The registered number of rickshaws in the city, according to DNCC and Dhaka South City Corporation (DSCC), is around 100,000.[1] In many reports, it has been published that quite a number of unregistered rickshaws operate in Dhaka. Nobody actually knows the exact number of rickshaws that run in the city. The total number of registered rickshaws from 2004 to 2011 in the urban area of GDA is 330,143.[2] Out of all the districts of GDA, Dhaka holds 88% of the rickshaws while Narayanganj and Gazipur districts come in second and third, respectively.

[1] DHUTS.

[2] Statistical Yearbook of Bangladesh 2010 and 2012.



Source: Statistical Year Book of Bangladesh 2010 and 2012, BBS

Figure 2.4.2 Trend of Registered Rickshaws in the Urban GDA

People in Dhaka City mostly use rickshaw for travelling short distances of 1–3 km, and students and businessmen use more than 90% of these rickshaw trips.[3] The share of trips made by rickshaw was 38% in 2009.

4) Others (Rickshaw van, Thela etc.)

In GDA, many people use rickshaw van and *thela* to transport goods due to low fare charges. Rickshaw van or *thela* is a better option for people if they need to transport small amount of commodities; however, Dhaka Metropolitan Police restricted their use. According to DCC, there are around 8,000 registered rickshaw vans in Dhaka City.[4] The number of *thela* is not available as there is no registration system for this transport. It has also been observed that rickshaw vans were used as a temporary vendor shop for vegetables, chickens, etc.

2.4.3 Private Car, Motorcycle& Truck

1) Private Car

In GDA, private cars are mainly classified into three types: sedan car, four-wheeled jeep, and 6- to 10-seater microbus. Basically, private cars are used by middle- and high-income people with some families that own more than one vehicle. Although private cars were accounted for about 30% of vehicle share in Dhaka in 2010, the occupation rate of private cars has decreased by about 23% in 2016. However, the number of private cars has increased, and one of the increase is the low operating cost by using compressed natural gas (CNG). Since CNG is being produced locally, its cost is quite low compared to other types of fuel like octane that needs to be imported. According to Navana CNG, a renowned CNG conversion company in Bangladesh, 1 m^3 CNG is equivalent to 1.23 L of octane. Considering the over-all cost, (assuming yearly travelling distance of 60,000 km) a 1800 CC CNG driven-sedan car can save around BDT0.30 million every year.

[3] DHUTS

[4] Rickshaw Cycle Drivers in Dhaka: Assessing Working Conditions and Livelihoods.

Table 2.4.1 Number of Registered Motor Vehicles in Dhaka by Year

Type of Vehicles	Up to 2010	2011	2012	2013	2014	2015	2016	Grand Total
Ambulance	1,374	137	114	190	254	358	321	2,661
Auto Rickshaw	7,664	112	111	60	56	428	721	8,972
Auto Tempo	1,662	1	1	0	0	0	0	1,664
Bus	16,783	1,501	1,218	971	1,364	2,221	3597	26,756
Cargo van	3,231	477	278	676	603	398	908	6,344
Covered Van	4,277	1,910	1,170	1,850	2,352	1,855	2,485	15,278
Delivery Van	11,990	839	577	709	901	1,464	1,902	17,907
Human Hauler	2,718	569	145	115	109	502	870	4,811
Jeep(Hard/Soft)	19,520	1,698	1,241	1,107	1,582	3,109	4,457	31,600
Microbus	46,202	3,540	2,643	2,227	3,842	4,569	5,433	67,098
Minibus	9,490	136	103	83	135	103	153	10,165
Motor Cycle	210,081	34,708	32,810	26,331	32,894	46,764	52,178	422,722
Pick Up (double/single cabin)	20,481	7,258	5,149	4,908	7,295	7,916	8,176	59,139
Private Passenger Car	163,004	11,423	8,187	9,231	12,972	18,422	18,588	237,180
Special Purpose Vehicle	759	60	28	78	50	66	217	1,204
Tanker	817	152	90	136	163	146	173	1,634
Taxicab	36,011	52	43	4	302	54	1	36,467
Tractor	9,923	4,169	2,841	1,634	1,443	1,637	2,528	23,543
Truck	26,922	4,205	2,824	3,522	5,767	4,424	4,370	50,942
Others	168	0	0	660	967	1307	2233	47
TOTAL	**593,077**	**72,947**	**59,573**	**54,492**	**73,051**	**95,743**	**109,311**	**1,030,864**

Source: BRTA(2017)

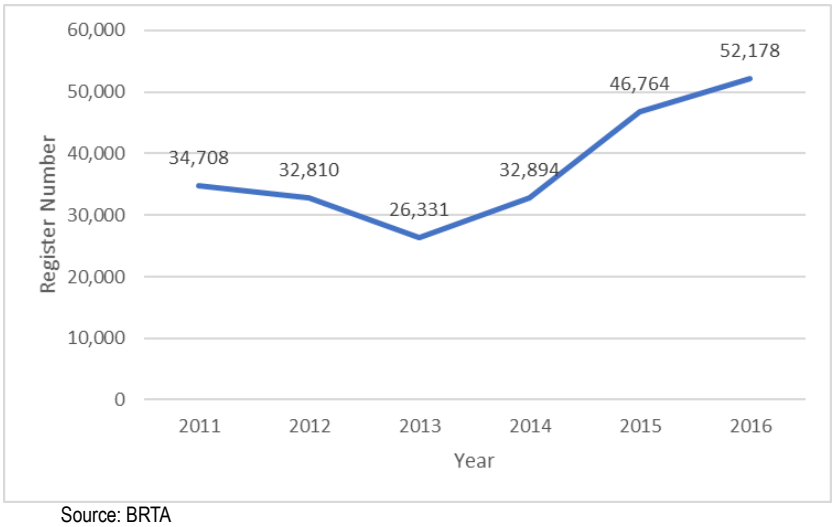
The government is trying to control the number of these types of vehicles by imposing different types of duties and taxes since 2009. There was a restriction on importing reconditioned cars of that are more than 5 years old. Importing reconditioned car duties are applicable depending on its age. To import a car in Bangladesh, several types of taxes are imposed such as import duty (5%), value added tax (15%), advance income tax (5%) and advance trade vat (3%). Aside from these, a supplementary duty is also applied that varies from 30% to 500% depending on vehicle type, engine capacity, etc. Therefore, over-all tax burden in importing a private car may vary from around 100% to 600% that is the reason of the sudden decline in the number of newly registered private cars since 2010.

2) Motorcycle

Motorcycle is becoming a popular mode of transport in Dhaka City as it can be driven through a narrow space and considered a useful transport to reach the destination in the midst of the city's traffic congestion. Its fuel consumption is quite low compared to other private vehicles.

The number of registered motorcycles has increased from 2013 to 2016 sharply. Bangladesh used to import motorcycles like Honda, Yamaha, etc. from Japan, but most of the motorcycles recently are imported from India and China. There are few local companies like Walton and Runner that assemble motorcycle parts and sell at lower price. In 2011, the government increased up to 45% the supplementary duty of importing a complete unit of motorcycle that resulted to a decreasing number of new motorcycles. The government initiated a policy to encourage motorcycle assembly industry, but most people prefer an

imported motorcycle.

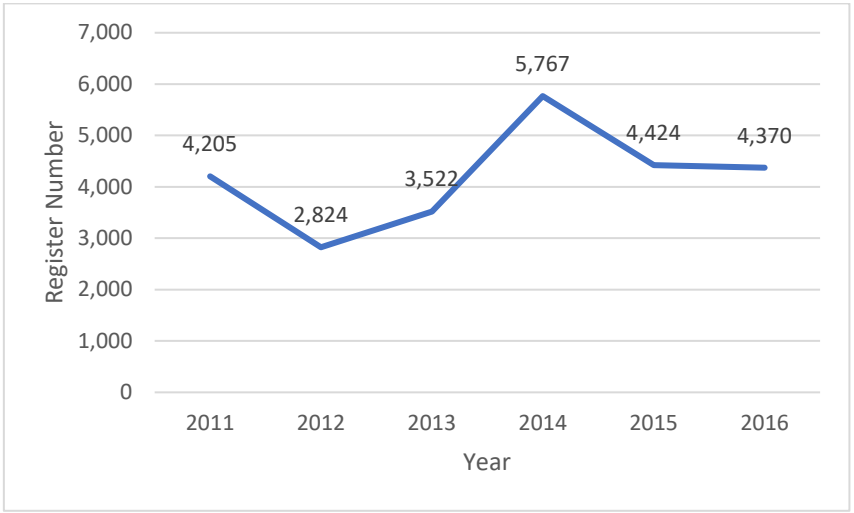


Source: BRTA

Figure 2.4.3 Trend of Yearly Newly Registered Motor Cycles in Dhaka

3) Truck

Truck is an important mode to transport goods within the districts of Bangladesh. In 2004–2005, modal split of freight transportation was around 90% by road whereas only 3.7% by rail and 6.5% by water between two most important districts of Bangladesh: Dhaka and Chittagong (Source: DHUTS). There are different types of trucks in Bangladesh depending on carrying capacity: 1.5 ton, 3 ton, 5 ton and 10 ton. Aside from these trucks there are also covered van and trailer truck which are used for carrying containers. These vehicles are operating within Dhaka, Chittagong and other major districts to transport goods.



Source: BRTA

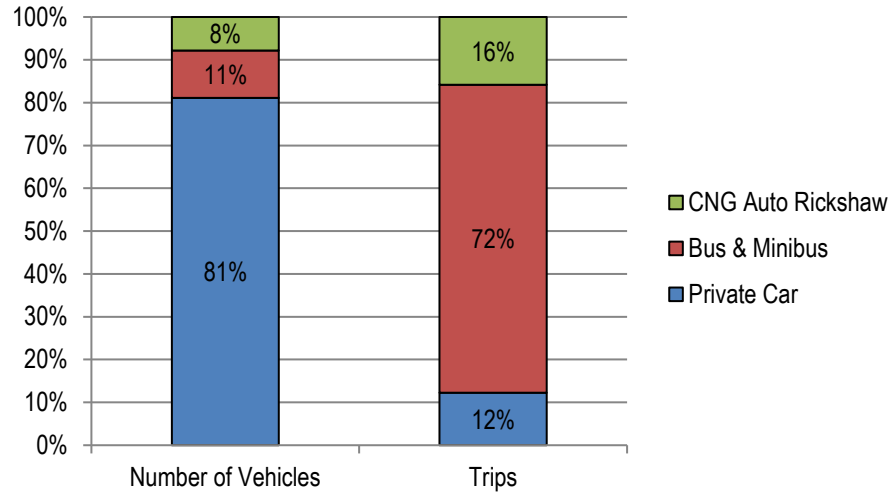
Figure 2.4.4 Trend of Yearly Newly Registered Tracks

The number of truck trips within Dhaka city is increasing every year. In 2009, a total of 28,706 trips were calculated within 24 hours (Source: DHUTS). Due to traffic congestion, Dhaka Metropolitan Police issued an order last July 2012, restricting trucks from entering

Dhaka city on a specified time table, thus trucks can only enter inside DMP area between 21:30 and 8:00. Meanwhile, DMP provides special permission to some trucks considering national importance like carrying government products. Trucks involved in construction work for government infrastructure projects are also allowed anytime inside the city. While trucks carrying export products can anytime use DIT road of Dhaka for going out and entering the city.

2.4.4 Public Transport

Main mode of public transport in GDA are bus, human hauler, train, water vessel, taxi cab, CNG and rickshaw. Recently, a new type of vehicle locally known as 'easy bike' which is basically battery operated rickshaw is also included to the public transport fleet in some areas.Trips by private cars, different types of buses and CNG in 2009 are shown with registered vehicles of each type. Buses and minibuses are generating 72% of person trips with only 11% of the share in registered vehicles.



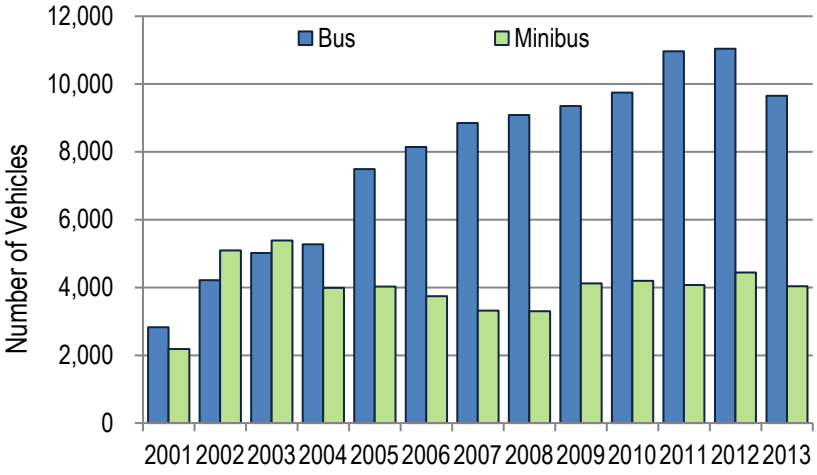
Source: DHUTS & BRTA

Figure 2.4.5 Modal Share and Generated Trips of Motorized Vehicles in 2009

1) Bus and Minibus

Currently, bus and minibus are the main mode of transport for dwellers of GDA. The number of bus routes is increasing every year to meet the travel demand of the people. However, the number of trips is still insufficient to meet the present demand. One of the reasons of low bus trips in GDA is inability to complete the planned daily trips due to traffic congestion.

According to Bangladesh law, 'Mini-bus' means any motor vehicle constructed or adapted or used to carry not more than 30 persons excluding the driver. If the number of passengers exceeds 30 persons excluding the driver then it is considered as bus. The number of registered buses is increasing than the mini-buses. In 2003, minibus has a bigger share compared with bus however the number has totally changed as the government encourages the introduction of large buses into the public transport system of Dhaka. In particular, importing of CNG driven buses has been encouraged in the national budget for the last few years.



Source: BRTA

Figure 2.4.6 Difference of Bus and Minibus

In Dhaka City, there are three inter-district bus terminals where buses depart towards different districts of Bangladesh: Sayedabad, Mohakhali, and Gabtoli. Aside from these, in Gulistan there is a bus stand where passengers can take buses towards south east direction from Dhaka. Some inter-district buses also start from Fakirapul, Kalabagan, Kallayanpur and Abdullahpur (near Uttara). Ten years ago, all inter-district buses were allowed to enter Dhaka city and take passengers from these locations. But presently bus companies provide mini-buses to carry passengers from here to main terminal. There is no designated bus terminal for city buses in Dhaka city which creates traffic hazards as most of the buses are parked along the road. Meanwhile, BRTC has five bus depots in different location of Dhaka city.

Table 2.4.2 Summary of the Inter-District Bus Terminals

Name	Area	Capacity	Daily Trips	Number of routes
Sayedabad	App. 40,500m^2	App. 500	App. 2000	87
Mohakhali	App. 36,400 m^2	App. 300	App. 800	60
Gabtoli	App. 123,400 m^2	App. 700	App. 2200	61

Source: DNCC, DSCC, & BRTA

2) Human Hauler

Human hauler, which is smaller than buses, is another type of public transport in Dhaka. Like for bus regulation, BRTA also issues route permission to human hauler services. As per BRTA records (March 2014), there are 106 planned routes for human haulers within Dhaka City and, out of these, only 34 routes currently operate with at least 1,733 human haulers on service. Different types of human haulers are Tempoo, Bondhuparibahan, Laguna, Champion, etc. Seating capacity of Tempoo and Laguna is around 10 to 12 persons while Bondhuparibahan and Champion have 14 to 20.

3) Train

Cost and safety are the two main reasons why Bangladeshi use train. Train's fare is cheaper than that of buses and it is considered as a safer mode of transport since the number of accidents and casualties is lower compared to buses. However, some people are hesitant to take the train due to sudden delay as most of the rail network in Bangladesh is single track. If any accident occurs, all train operations are affected.

Train service of Bangladesh is basically divided into categories intercity and mail. Commuter train is listed under mail train. These trains have several types of seating capacity depending on the route and train. Most exclusive one is the air-conditioned room which has sleeping arrangement and fare is almost 13 times higher than the cheapest class on the same route.

In GDA, people of Gazipur and Narayanganj use train quite often for commuting to Dhaka city. At present, a total 16 pair of commuter trains between Dhaka and Narayangonj and 4 pairs of commuter trains between Dhaka and Joydevpur are operating on weekdays. Between Dhaka and Joydevpur there are also other trains carrying passengers from Dhaka to Joydevpur. However, these trains do not stop at all the stations.

Table 2.4.3 Summary of Commuter Train Fare of RAJUK Area

Commuter Route: Dhaka (Kamalapur) –Joydevpur					
From	To	Distance	Regular Fare	Special Fare	Stations
Kamalapur	Airport	22 Km	10 Taka	BDT35; Intercity Train*	Tejgaon, Dhaka Cantonment
Kamalapur	Joydevpur	39 Km	15 Taka		Tejgaon, Dhaka Cantonment, Tongi, Dhirasram
Commuter Route: Dhaka (Kamalapur)–Narayanganj					
From	To	Distance	Regular Fare	Special Fare	Stations
Kamalapur	Cahra	14.5 Km	8 Taka	BDT15; Diesel Electric Multiple Unit (DEMU)Train	Gandaria, Fatullah
Kamalapur	Narayanganj	16.1 Km	10 Taka		Gandaria, Fatullah, Cahra

*Intercity trains do not stop at all the stoppages

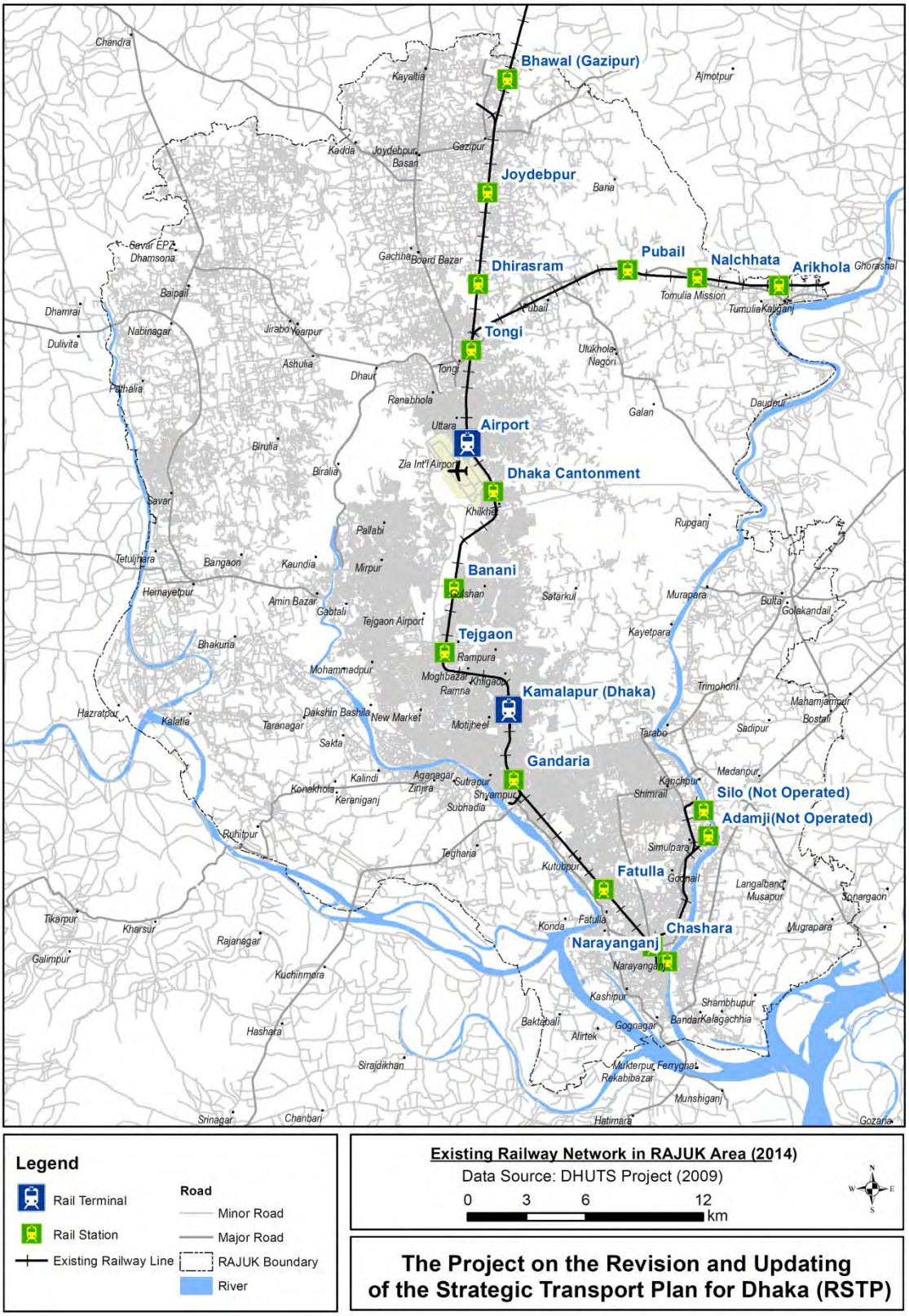


Figure 2.4.7 Existing Railway Network in RAJUK area

4) Water Transport

In Bangladesh, transport via water plays an important role, particularly for people from the southern district who uses different types of water transports like launch, ferry, steamer, etc. to come to Dhaka.

All long-distance water vessels towards Dhaka arrive at the main water terminal called Sadarghat. At present, there are 48 different long distance routes from Sadarghat to other districts in Bangladesh. Out of these 48 routes, 3 are for both private- and government-operated water vessels, 7 are only for government-operated vessels, and 38 are for private-operated water vessels. Bangladesh Island Water Transport Authority (BIWTA) is responsible for issuing the route permit and fare regulation, while Bangladesh Island Water Transport Corporation (BIWTC) is responsible for operating government-owned water vessels.

5) Taxi cab

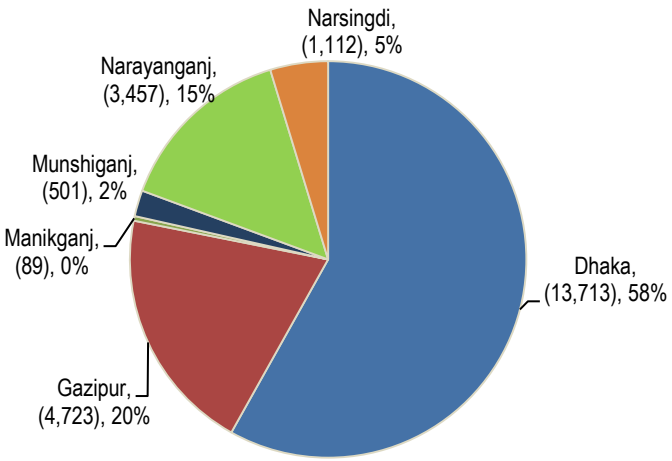
Taxi-cab service launched in Dhaka City almost 16 years ago. The two types of taxi cabs are airconditioned (A/C) and non A/C. All the A/C taxicabs are yellow-colored and the non-A/C cabs are black- or blue-colored. Most of the old taxicabs are in very poor condition, low service quality, and/or mostly are non A/C. Many of the old taxi cabs are now already off-road due to poor maintenance service. Some dilapidated cabs are still running in the roads with a pale gesture. As per BRTA, there were around 9000 taxi-cabs in Dhaka City in 2013.

In April 2014, a new taxi-cab service was introduced in Dhaka City under Trust Transport Services and Toma Group. These taxi-cabs have different types of modern features such as: A/C, radio communications, video recording, automatic vehicle tracking, on-call service, receipts, etc. However, the fare of this service is more expensive than any other public transport services in the past.

6) ”CNG” (Three-wheeler Auto-Rickshaw)

Three-wheeler auto-rickshaw plays a vital role in the public transportation system of Dhaka. Basically, the two major types of rickshaws are compressed natural gas-powered (CNG) rickshaws and Mishuk. Mishuk is a special type of three-wheeler made in Bangladesh and driven with petrol. Nowadays, Mishuk has become very rare. A maximum two persons can sit comfortably in Mishuk while three persons can in a CNG.

Before 2002, there were around 40,000 auto-rickshaws driven by two stroke petrol engines and was known as “baby-taxi.” Due to the huge air pollution emitted by a baby-taxi, the government decided to have it replaced. In 2002, the Government of Bangladesh introduced 12,000 three-wheelers in Dhaka City that will run using CNG. The three-wheeler auto-rickshaw is now known as “CNG.” It will also be used in this report to describe this type of vehicle, since it is driven using CNG. In 2013, there are around 23,500 CNGs that operate in GDA as per BRTA. Around 14,000 units are registered in Dhaka district, while Gazipur and Narayanganj also have significant numbers of CNG among the other districts of GDA.



Source: BRTA

Figure 2.4.8 Share in CNGs (2013) among GDA Districts

The life span of CNGs was predicted 8 years from the time of introduction. However, in 2011, the government extended the life span by another 3 years and was supposed to have ended in 2013. But due to some protests from the owners and drivers, the government decided to increase the life span to 15 years unless the vehicle meets the conditions set by Bangladesh University of Engineering and Technology (BUET). These conditions are full-overhauled engine, replacement of hood cover and seats, necessary repairs of body, and suspension and break transmission.

CNGs are basically owned by an individual unlike the taxicab. The owner leases his CNG to a driver for 8 hours and can officially charge 600 takas, but most drivers complain that they have been charged 800 to 1000 takas. Another common practice by CNG owners is to lease the CNG to two different drivers in a day for an 8-hour shift that will make him earn twice from the same CNG.

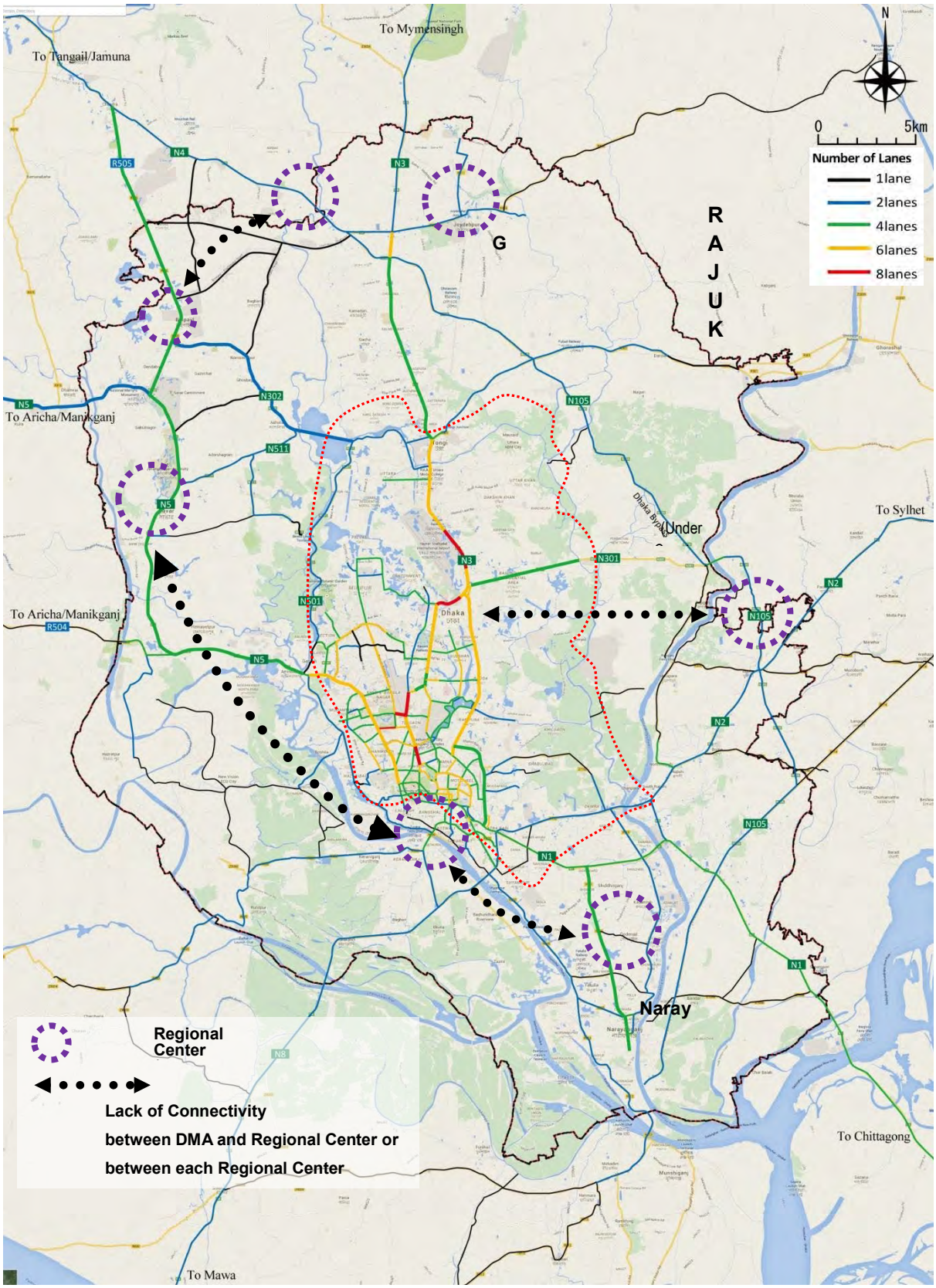
2.4.5 Urban Road Network

The road network system in the study area can be divided into two major areas as shown in Figure 2.4.10. One is the urban network that serves the traffic movement among the urban centers (DMA). The other is the regional network that serves regional traffic movement in the suburban area (RAJUK area out of DMA).

DMA is situated in the middle of RAJUK surrounded by Buriganga, Turag, and Balu Rivers. Although the major roads in DMA are multi-lane and the current pavement conditions are generally good as reported in DHUTS, there is still severe traffic congestion due to insufficiency of functional road classification, some missing links, and inadequate traffic management.

As for the road network in the suburban area, its road density is lower than in the urban area and connectivity to some adjacent regional centers is unavailable. Such situation is assumed to hamper regional partnership and to promote intense concentration of population and advanced urban functions to DMA.

Although Bangladesh governments formulated policies to resolve problems, such as exclude rickshaw from specific areas and restrict entry on cargo vehicles, the effect of policies is limited due to lack of implementation. Therefore, it is necessary to impose alternatives to road transportations.



Source: JICA Study Team

Figure 2.4.9 Major Road Network in RAJUK Area

2.4.6 MRT Line 6

1) Background

JICA conducted the Dhaka Urban Transportation Network Development Study (DHUTS) Phase 1 in March 2009 with the DTCA as its counterpart agency. The study's objectives were to conceptualize basic urban development scenarios for the DMA up to 2025 and to select priority projects that would be integrated into the scenarios. That study recommended the prioritization of constructing MRT Line 6. As a result, JICA conducted the feasibility study on MRT Line 6 under DHUTS Phase 2. Following this study, the GOB and JICA concluded in February 2013 the loan agreement on the Dhaka Mass Rapid Transit Development Project that was the blueprint for the construction of an MRT Line 6.

2) Existing Situation

Dhaka Mass Transit Company (DMTC) was established under the Ministry of Road Transport and Bridges as the MRT Company in 2013. Since September 2014, the General Consultant has been implementing the design works and has been preparing tender documents for MRT Line 6. At the same time, Institutional Development Consultant (IDC) for the Dhaka MRT Line 6 has started.

3) Progress of Construction Work (September, 2018)

There are eight kinds of bid, six packages for civil works, one package for system, and one package for locomotive.

CP-01: contract package CP-01 is for the land development of depot area which is completed and handing over to CP-02 contractor.

CP-02: contract package CP-02 is depot civil and buildings which are stabling yard, central store for maintenance and overhauled materials, space for overhaul and train maintenance, main workshop, operation control center, train inspection, generator and electrical building, train wash station, manual train washing, multi-storied building for DMTC head office, and green space. Presently, construction of retaining, sonic logging test at test pile, check boring, static load test on test pile, service pile, permanent pile and raft construction of building are going on.

CP-03 and 04: construction of viaducts and nine elevated stations between Uttara North and Agargaon and boring, construction of permanent pilling, pile cap, column and pier head, and precast segment are going on all along the corridor.

CP-05 and 06: package CP-05 is for the construction of viaducts and elevated stations from Agargaon to Karwan Bazar and package CP-06 is for the construction of viaducts and elevated stations from Karwan Bazar to Motijheel. The contractors have been taken access to and possession of the site and construction yards is under construction.

CP-07 and 08: package CP-07 is for electro-mechanical system and CP-08 is for rolling stock & depot equipment. Contractors are discussing about demarcation of communications system with PDCB, ESS dimensions and interface issues. The CP-08 contractors are discussing with CP-02 and CP-07 teams and reviewed the progress.

The periodic monitoring, reviewing, reporting of Environmental and Social Environment (WG-6) of CP-02, CP-03 & 04 is going on.

2.4.7 BRT Line 3

1) Background

The BRT Line 3 corridor project in Dhaka is under the Greater Dhaka Sustainable Urban Transport Project (GDSUTP). Asian Development Bank (ADB) sponsored the BRT route of the northern section that connects Gazipur and Uttara (international airport). World Bank sponsored the BRT route of southern section that connects Uttara (Airport)–Mohakhali–Ramna–Gulisthan–Keranigonj (Jhilmil). BRT Line 3 corridor in Dhaka has different sponsor, however. It is a single BRT route that connects the northern and southern areas. So, BRT Line 3 corridor must have a design with an equal service pattern for public transit users. The completion date should have been in 2016. Planning and joint implementation should be coordinated, and the northern and southern projects should become one BRT system upon completion.

Therefore, considering coordinated BRT system, this detail design work for BRT Line 3 corridor (Airport–Keraniganj) will have to be the service pattern with same bus fleets and same infrastructures such as bus-way, station, and etc. However, after preparation of detail design, the project was out of project list by the World Bank because of the proposed RAJUK Flyover Project. It made the BRT Line 3 Project impossible to be implemented at the same transport corridor.

2) DTCA Proposal

In this situation, DTCA made a proposal to World Bank to implement the project under phasing with the justifications. The proposed phases were as follows:

Phase 1:

Airport to Mohakhali section: Construction of 10-km BRT corridor from airport to Mohakhali including construction of five BRT stations, Mohakhali flyover, Mohakhali terminal, and Keraniganj Depot. Prepare and implement shuttle service plan from Mohakhali to Keranigaj (Jhilmil).

- Construct airport to Mohakhali.
- Construction of Mohakhali and Keraniganj Depot.
- Commence BRT service.
- Establish Shuttle service.

Phase 2:

Mohakhali to Gulistan section

- Construct Mohakhlai to Gulistan.
- Expand BRT service.

Phase 3:

Gulistan to Jhilmil section

- Construct final stage to Jhilmil.
- Operate full BRT service.

3) DTCA's Justifications

- It is a proactive measure to manage traffic and travel demand during BRT construction that demonstrates good planning and management initiative during the traffic chaos

due to BRT construction. Public opinion of the BRT project is likely to be improved.

- Provides an essential transport connection to Mohakhali and Farmgate should the ADB BRT northern section of the airport be completed earlier than the World Bank section.
- A traffic management measure during BRT construction is to offer motorists a good alternative than be stuck in traffic and introduce the use of the bus service prior to BRT.
- Allows restrictions to be placed on cars on the basis that good public transport alternatives are provided (with traffic priority for buses).
- The interim shuttlebus service will pilot key elements of the BRT such as establish system management (the BRT Co.), engage operators under contract, initiate fleet procurement, and commission the system.
- Triggers early engagement with affected bus operators and establishes the operations of the future BOC consortium of BRT Line 3, introducing them to a performance-based contract regime prior to start of BRT.
- Establishes the operations of the BRT company; giving them a trial run in bus operations, providing services and managing contractors.
- Facilitates an early introduction of e-ticketing system prior to BRT with revenue collected by the Dhaka BRT Co. (BOC is paid on km basis) giving the BRT Company time to familiarize and trial the system.

4) The Mission

In this context, a World Bank team carried out an Exploratory Mission for the proposed Dhaka BRT Line 3 on 23–27 April 2017. The main objectives were to assess the modified project proposal from the original proposal in 2013, namely on the line length and the arrangement for the implementing agencies, and to understand if the new proposal is technically sound and if an effective coordination mechanism is in place for the stakeholder agencies.

5) The Features of the Project

The mission identified the following features of the new proposed proposal:

- Corridor. The proposed project is for the Phase 1 section (10.5-km from airport to Mohakhali) of the BRT Line 3 corridor. The Line 3 Corridor was originally proposed in the Strategic Transport Plan (STP) that was developed with support through the WB-funded Dhaka Urban Transport Project (DUTP) and approved by the government in 2008. The corridor is also included in the Revised Strategic Transport Plan (RSTP), approved during the August 2016 Cabinet meeting as a part of 2 BRTs and 6 Mass Rapid Transit (MRT) networks.
- Connection with BRT Line 3 North. The Government of Bangladesh is in the implementation phase of GDSUTP that is funded by ADB, AFD, and GEF. The GDSUTP 'will contribute to developing a sustainable urban transport system in DNCC and Gazipur City Corporation (GCC) areas, which form part of north Greater Dhaka, through the delivery of a 20-km BRT corridor; BRT line 3-North will start from Gazipur BRT Line 3-North and Line 3-South is connected at the airport station. The plan is to have a single operation for the entire corridor with buses operating continuously across Airport Station, managed by the same Dhaka BRT Company.
- BRT Operation. The Line 3 Corridor will run articulated 18m-long buses on the dedicated lane by the median. The BRT lanes will have physical barrier (high-curb or

fencing) to prevent mixed traffic and pedestrians from coming in. There are seven stations (Airport, Khilkhet, Kuril, Cantonment, Kakoli, Amtali, Mohakhali Terminal), which will be on the median side and not the curve side. Stations will be accessible via foot-over-bridges or pedestrian subways with universal access or at-grade road crossing. BRT buses will run mainly at grade, but also on existing Banani Flyover (between Cantonment and Kakoli), and the proposed Mohakhali Flyover, which will be constructed in the North–South direction to the east side of the existing Mohakhali Flyover.

- Implementation Arrangement. Two project implementation units (PIUs) at RHD and DNCC were proposed and supported by project coordination unit (PCU) at DTCA. DMP will work closely with PIUs/PCU on traffic management matters and will have another PIU once its technical unit is established.
- Project Activities. Based on the request letter and preliminary discussions with the clients, the following activities were envisaged at this stage:
  - BRT Corridor Construction (implemented by RHD). At grade corridor, Mohakhali Flyover, and stations.
  - Feeder Road Construction (by DNCC). Feeder road, sidewalk, street lighting, drainage
  - Terminal and Depot Construction (by DNCC, RHD). Mohakhali Multi-story Terminal (by DNCC), Keraniganj feeder Bus Depot (by RHD)
  - Traffic Management (by DNCC for DMP, or Bangladesh Police HQ).
  - Regular Bus Restructuring (by DTCA/DNCC/RHD). Bus depot, bus stops, signs, fleet renewal -program, etc. This needs further clarification on activities and responsible agencies.
  - Studies and Technical Assistance (by DTCA).
- Project Cost: $250 million.

6) Technical Aspect

Overall, the mission found the proposed project to be technically sound and will have a significant impact in improving the traffic situation in Dhaka. While truncation into Phase 1 would pose operational challenges for the feeder bus service from Mohakhali to possible BRT passenger destinations like Farmgate and Gulistan, it is deemed feasible with the proposed number of buses and service plan. However, detailed observations of the mission on the technical aspects were as follows:

- Project Outline. The proposed construction of the RAJUK elevated road made it impossible to construct the BRT Line 3 Southern Section from airport to Keraniganj as originally planned. An alternative approach whereby the line is modified and completed in sections/phases was proposed by GOB. Funding for the first phase from airport to Mohakhali Bus Stations was requested and is the subject of this current assessment. This section is 10.5-km in length and is planned to form a single corridor with the ADB-funded Line 3 northern section that runs from Gazipur to the airport. Some of its aspects are now under construction. The original project envisaged three BRT services (S1–S3) that operate from the northern to the southern sections with two services that terminate at Gulistan and one service continue across the river to Keraniganj. A fourth service, S4, was also planned to operate between Uttara and Farmgate that joins the

BRT reserved lanes at House Building and leaving again from BG Press to travel in mixed traffic to Farmgate.

- Project Impact. The proposed project will benefit commuters that use this corridor and choose to switch to BRT. Travel time between the airport and Mohakhali by BRT is anticipated to be less than 30 minutes in contrast to the current travel time that is generally about one hour or can often be more. BRT Line 3 North and South is expected to carry about 300,000 daily passengers, most of which are likely to come from buses. As a result, bus traffic on the corridor will be greatly reduced, congestion will be reduced, and air quality will improve. The provision of safe, clean, and reliable public transport will also greatly benefit the tens of thousands of female workers at the garment factories along the corridor.
- BRT Route Truncation. As a result of the truncation of the BRT infrastructure at Mohakhali (which also has a BRT depot adjoining the BRT station at this point) all passengers on Services S1–S3 wishing to travel to Gulshan will be required to interchange to feeder buses at Mohakhali. Passengers on S4 to Farmgate will be unaffected by the truncation as the BRT ramp down from the Mohakhali elevated section will be constructed enabling the S4 to re-join the street system to travel to Farmgate. Passengers on S1–S3 who wish to go to Farmgate will interchange at Amtali to the S4 as was planned in the original design. All buses on S1–S3 will enter the Mohakhali Depot, make a turn in the depot, and re-join the BRT corridor starting again from Mohakhali Station. The S1–S3 service operates at 3-minute intervals with the S4 operating at 4-minute intervals. DCTA estimates this would require peak vehicle requirement of 66 buses on S1–S3 and 27 buses on S4. Assuming 10% spares, this suggests a fleet size for these services of 103 buses.
- Feeder Service Plan. The feeder service is expected to operate from Mohakhali, making use of the depot to turn around. Assuming separate feeder routes are used (rather than BRT buses simply continuing in mixed traffic), passengers from Gulshan would be dropped off at Mohakhali Station and the feeder buses would turn in the depot then return to Mohakhali Station to pick up southbound passengers. Current plans prepared by DTCA propose that the feeder route operates at 90 second intervals between Mohakhali and Keraniganj. That would require 106 buses in service plus 11 spares making a total of 117 buses. They are assuming the feeder buses are high-floor, 18-m long, and of140-capacity similar to the BRT buses with low-level doors on the left-hand side to enable boarding/alighting at regular bus stops.
- Importance of Phase 1 to BRT Line 3 North. If the southern section of Line 3 is not built and the northern section terminates at the airport, this will force all passengers to transfer to local buses with an estimated 10,000 passengers per hour at peak. This will not be attractive to passengers, will place huge transfer demands at the airport station, and will severely affect the viability of the northern section. Therefore, there are significant grounds to proceed with the southern section.

7) Next Steps of BRT Line3

- Operational risk assessment of Roads and Highways Department (RHD) by World Bank on 30 September 2017.
- Procurement and contract management capacity and risk assessments of DTCA, RHD, and Dhaka North City Corporation (DNCC) by World Bank on 30September 2017.
- Request WB for project preparation advance by DTCA, RHD, DNCC, and ERD on

31December 2017.

Source: BRT and Corridor Restructuring Implementation Study and Preliminary Design work for the Uttara–Mohakhali–Ramna–Sadar Ghat Corridor in Dhaka.

Figure 2.4.10 BRT Line 3 Network

8) Progress of BRT Line 3 (September, 2018)

(1) Southern Part – funded by the World Bank

As per present scope, a 10km BRT Line 3 (southern part) would be constructed along with seven stations from Airport to Mohakhali Bus Terminal rather than 22km from Airport to Keraniganj. The southern part of BRT will link with northern part BRT Line 3 at the airport. The southern BRT line will mix of at-grade and elevated. Airport to Kakoli is at-grade section and Kakoli to Mohakhali is elevated section and the bus terminal will also elevated at present Mohakhali Bus Terminal. The BRT Line 3 is renamed as “Dhaka Public Transport Improvement Project”. The project presently is preparing Technical Assistance Project Proposal (TAPP) for (i) revision of design, (ii) social safeguard and resettlement action plan, and (iii) environmental study to get the updated cost estimation. The project office will engage the TAPP consultants and will prepare Development Project Proposal (DPP) as per

the costs and review findings.

(2) Northern Part – funded by Asian Development Bank

The detail design and construction supervision of the project was started since October 2013 and construction was started since July 2016.The summary of progress is up to September 2018.

Table 2.4.4 Progress of Northern Part of BRT Line 3

Work	Contract 01		Contract 02		Contract 03	Contract 04
	Required	Achieved	Required	Achieved		
Sub-soil investigation (nos. of boreholes)	92	92	200	129	24 out of 74 roads to be constructed have been taken up for works.	Gazipur bus depot with parking are and maintenance facility. 82.21% work completed
Pile (nos.)	800	87	2000	5 9test piles)	8 kitchen markets need to be developed/ constructed. No work taken up yet	
Pile cap (nos.)	105	6	287	0		
Piers (nos.)	105	0	287	0		
Drainage (m)	23,680	4,480	6,400	0		
Pavement (m)	32,000	250 (up to sub-base)	9,000	0		
Stations (nos.)	19	1 (footbridge on going)	6	0		

2.4.8 Dhaka Elevated Expressway (DEE)

1) Objective

The purpose of the expressway is to increase traffic capacity within and around the city by improving connectivity between the northern part of Dhaka City with the central, south, and south-eastern parts. In addition to providing a much-needed increase in traffic capacity, the expressway will be designed to relieve existing overloaded roads. Access and distribution to the expressway will be designed to avoid adding congestion to existing facilities.

2) Project Scope

Design, construction, operation, and maintenance of the approximately 23-km elevated expressway including construction of culverts, toll plazas, underpass and overpass, lay byes, wayside amenities; installation of computerized toll collection system, providing adequate lights and development of service areas with all required facilities.

3) Main route

The route of the DEE shall commence at Shahjalal International Airport and go along the New Airport Road and the rail alignment through the Mohakhali, Tejgaon and Moghbazar to Kamalapur Rail Station. Then the expressway shall pass through Golapbag that is south of Kamalapur Stadium and east of Jatrabari, and then connect to Dhaka–Chittagong Highway near Kutubkhali. Elevated Link 1 is Manik Mia Avenue–Holy Cross College–Tejgaon Crossing. Elevated Link 2 is Palashi–Katabon–Hatirpul–Hotel Sonargaon (backside)–Moghbazar.

4) Progress of DEE PPP Project

Progress in Land Acquisition

The project would be needed 210 acres of land to be acquired along the expressway corridor. Of them, 180 acres are under government (120 acres are under Bangladesh Railway) and 30 acres are under private land. The BBA already acquired 25 acres of land from private owners and remaining 5 acres to be acquired. In addition, demolition of

structures and shifting of utilities are ongoing.

It is seen that the progress of a 7km of Tranche – 1 (Airport to Banani) is visualizing. The Trans-2 (Banani to MoghBazar, 7km) and Tranche-3 (MoghBazar to Kamlapur to Kutubkhali, 7km) are not visualizing.

Progress in Physical Works

The following table shows the major activities and program of First Dhaka Elevated Expressway up to 31st August 2018.

Table 2.4.5 General Features of Dhaka Elevated Expressway (DEE) Project

Items	Descriptions
Executing Agency	Bangladesh Bridge Authority (BBA)
Investor Agency	Italian Thai Development Public Company Limited
Signing of Agreement	15 December, 2013
Project Route	Shahjalal International Airport – Kuril – Banani – Mohakhali – Tejgaon – Mogbazar – Kamlapur – Sayedabad – Jatrabari – Dhaka Chittagong Highway (Kutubkhali).
Length	Mainline: 19.73 km Phasing of the Project: 1st Phase – Chain 0+000 m to 7+450 m 2nd Phase – Chain 7+450 m to 13+300 m 3rd Phase – Chain 13+300 m to 19+730 m
Ramp	31 number, length 27 km
Total length	46.73 km
Construction Costs	BDT 8940.18 Crore
Support to Dhaka Elevated Project Expenditure	BDT 3216 Crore.
Viability Gap Funding (VGF)	BDT 2413.84 Crore.
Concession Period	25 years (including 3.5 years construction period)

Source: Bangladesh Bridge Authority (BBA), June 2017

Table 2.4.6 Progress of Works by Items of Dhaka Elevated Expressway (DEE) Project

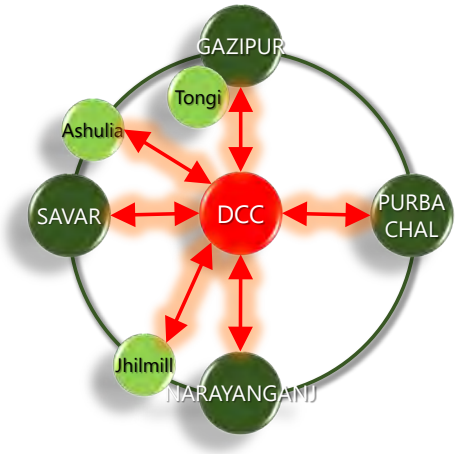
SL	Work Description	Unit	Est. Total Quantity (Tranche-1)	Total Work Done (Tranche-1)	% Work Progress (Tranche-1)
1	**Bored Pile Work**	**No.**	**1,514**	**1,127**	**74.44%**
1.1	Mainline (Dia. 1.00m & Dia. 1.2m)	No.	1,194	943	78.98%
1.2	Ramp (Dia.0.80m & Dia. 1.00m)	No.	320	184	57.50%
2	**Footing/Pile Cap Work**	**Pier**	**350**	**195**	**55.70%**
2.1	Mainline	Pier	225	169	75.11%
2.2	Ramp	Pier	125	26	20.80%
3	**Pier Column Work (Equivalent No.)**	**Pier**	**350**	**127.80**	**36.50%**
3.1	Mainline (Equivalent No.)	Pier	225	111.60	49.60%
3.2	Ramp (Equivalent No.)	Pier	125	16.20	13.00%
	- Pier Column Upper Part (Step-2) – Full Height	Pier		Mainline=84 Ramp=15	Full Height =100.2 Pier
	- Pier Column Lower Part (Step-1) – 40%	Pier		Ml. Stem-1=153 Pier	Balance Stem-1 =69 Pier
4	**Crosshead/Portal Beam**	**Pier**	**350**	**25**	**7.14%**
4.1	Mainline – Crosshead/Portal Bean	Pier	225	25	11.11%
4.2	Ramp – Pier Head for ramp	Pier	125	-	0.00%
5	**PC Yard Construction for I-Girder Production**	**LS**	**1**	**-**	**100%**
6	**PC –Girder Production**	**No.**	**3,179**	**150**	**4.53%**
6.1	PC I-Girder (Typ. Length 30m) – Mainline	No.	2,512	147	5.85%
6.2	PC Yard – (Type. Length 30m) – Ramp	No.	667	3	0.45%

Source: Bangladesh Bridge Authority (BBA), August 2018

3 Route Selection

3.1 Review of Previous Studies

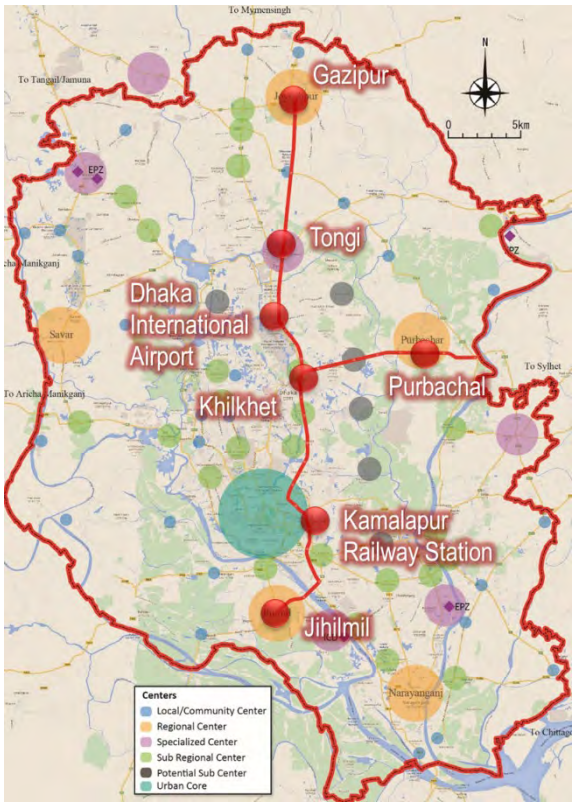
According to the Final Report of "The Project on The Revision and Updating of the Strategic Plan for Dhaka (RSTP) (2016 Nov.), Dhaka's MRT Line 1 originating from the Gazipur Region passes Tongi, then the International Airport, and when it reaches Kuril, it divides into a southern branch and an eastern branch. The southern line is aimed to go further to the Jhilmil Region, while the eastern line aims to serve the Purbachal development area. The total length of Line 1 is 52km. The said Line 1 is expected to have the highest passenger demand among the seven corridors that was proposed by RSTP. The number of passengers is estimated at 1.9 million per day by 2035.



Source: RSTP Final Report (2016, JICA)

Figure 3.1.1 Transport Corridor in RAJUK Area

The RSTP-proposed Mass Transit System Network is shown in Figure 3.1.1, connecting the central business district (CBD) and the Suburban Regional Centre.



Source: JICA Study Team

Figure 3.1.2 Proposed MRT Line 1

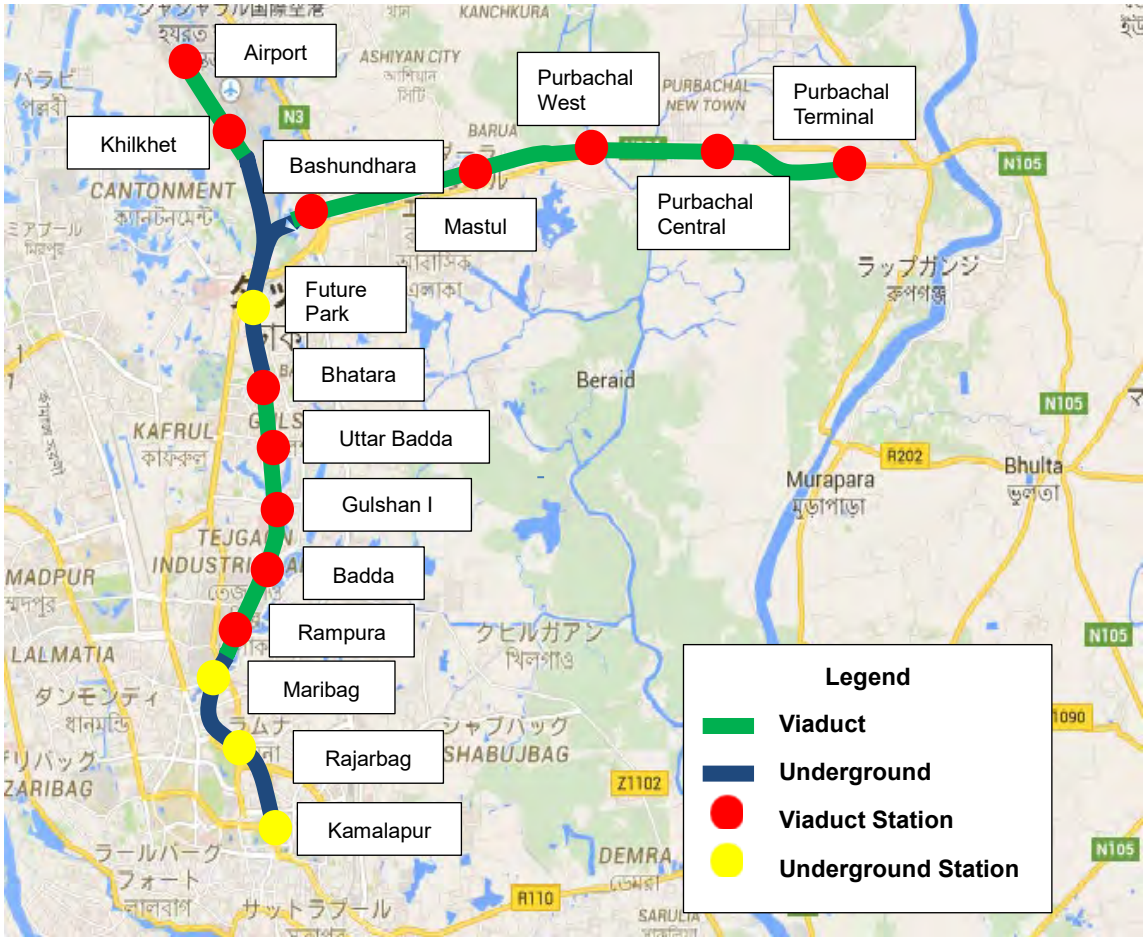
The proposed MRT Line 1 originates from the Gazipur Regional Centre and runs south toward the Tongi – International Airport and further into the CBD. While the route originating at the RAJUK Jhilmil development area in the southern part of MRT Line 1 crosses the Buriganga River and reaches the CBD via Kamalapur, the northern part of MRT Line 1 separates at the Kuril Area where it branches into the southern line and eastern line. The proposed MRT Line 1 is shown in Figure 3.1.2. MRT Line 1 Study Team assumed CBD area are comprised of Motijheel Center Ward (Thana) as commercial center, Shahbagh Ward as Educational center, Paltan Ward as Government Office.

The MRT Line 1 has the most potential among the proposed seven corridors, and early project implementation was proposed. It is desirable to operate MRT Line 1 following MRT

Line 6, which is presently under construction. RSTP proposed opening the MRT Line 1 in 2025

As one element of RSTP, a preliminary feasibility study (Pre-FS) was conducted, and it recommended as Phase 1 the MRT Line 1 between the International Airport and Kamalapur, and the Purbachal Line, in order to establish the Rolling Stock Depot. There are many opinions that MRT Line 1 Phase 1 should originate at UTTARA, where high demand is expected. But in the same corridor, the BRT Line 3 Project (Bus Rapid Transit System) is under way with financial assistance from the Asian Development Bank. It was decided that it will be at the International Airport terminate that MRT Line 1 terminates pending a detailed study about the movement of people after opening BRT Line 3.

Figure 3.1.3 shows the proposed alignment of MRT Line 1 by Pre-FS.

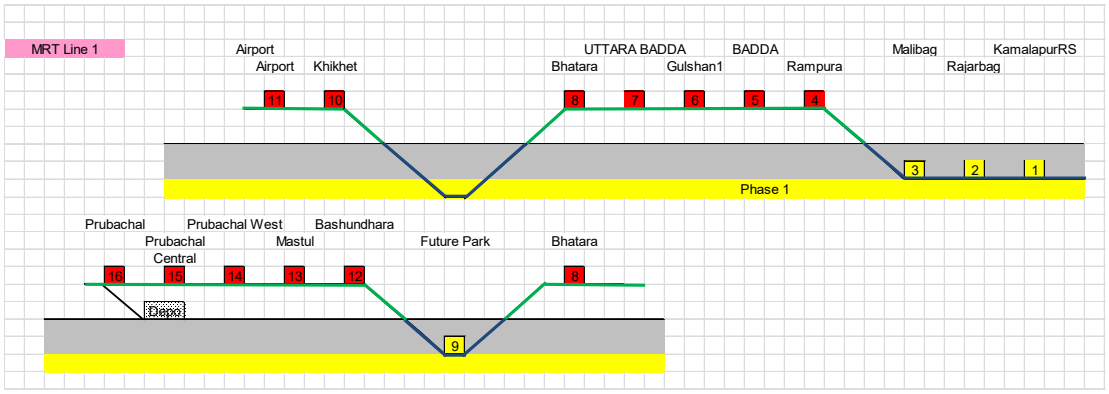


Source: JICA Study Team

Figure 3.1.3 The Proposed MRT Line 1 by Pre-FS

Though the main FS plan was supposed to be discussed more in detail based on the Pre-FS plan, the result of careful evaluation on current existing urban infrastructure showed that the space for introducing MRT needed drastic revision.

Figure 3.1.4 Shows the structures plan proposed in the Pre-FS and details are discussed in section 3.2.3.



Source: JICA Study Team

Note: Station name of Badda, Gulshan 1 and Vatara were replaced by Hatir Jheel, BADDA and Notun Bazar respectively in FS,

Figure 3.1.4 Elevated and Underground Mixed Track Proposed by Pre-FS

To construct this transferring structure, land acquisition of about 4m on both sides of the road is necessary to make room for the structure of 10m wide and the width of the original road.

In the Pre-FS plan, the underground and elevated parts have been combined, and at the transferring part from underground to ground section, a U-shaped retaining wall was planned between Malibagh and Rampura stations and between Notun Bazar and Future Park stations.

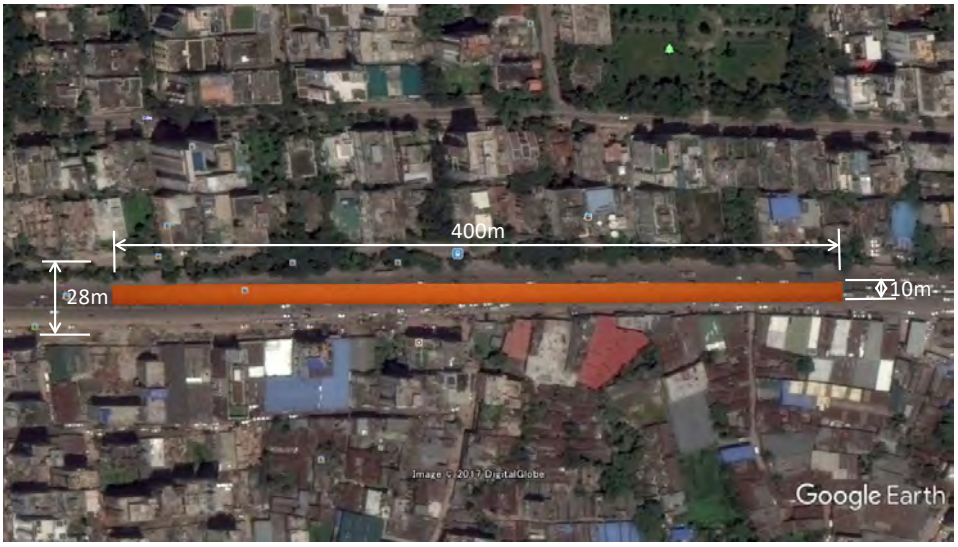
The structure plan of the “Transition” is discussed in Chapter 4, 5.2 (5) Between Stations

Between Rampura – Malibagh, for both side of the Transition Structure, a 4m wide and 50m long land is require, but there are many private houses on the land, and thus, it was concluded that this section of track should be built underground.

Source: JICA Study Team

Figure 3.1.5 The Area of Influence of the Transition Section (Between Malibagh and Rampura Stations)

On the other hand, the road width between Notun Bazar and Future Park is 29.6m including pedestrian space, and the median width is wide enough to construct the Transition Structure.



Source: JICA Study Team

Figure 3.1.6 The Area of the Transition Section (Between Notun Bazar and Future Park Stations)

Land acquisition is one of the critical issues to conduct smooth project implementation. In discussions with DTCA, there were many opinions that alignment shall avoid land acquisition as much as possible. In addition to this, since there is an elevated highway between Malibagh and Rampura stations, it is quite hard to accommodate an elevated MRT structure. JST concluded and recommended DTCA/DMTCL abundance of the Underground + Viaducts Mix Scenario and adaptation the whole Underground option. Accordingly, it is necessary to build Ventilation Towers and Cooling Towers those require some land acquisition. Detailed discussion of this issue can be found in section 4.2.3.

The Pre–FS does not present alternatives regarding route selection. Between the International Airport and CBD area there is no road which has enough width to construct the MRT System except DIT Road. If the condition not to acquire land were to be followed, the only candidate would be DIT Road.

The Pre-FS proposes the opening of MRT Line 1 in 2025. In order to realize this schedule, it is necessary to implement related works such as system designing, tendering, and construction on time. This target is quite tight. In order to meet this target, land acquirement shall be minimized as much as possible. Detailed discussion of this issue can be found in section 4.15.1.

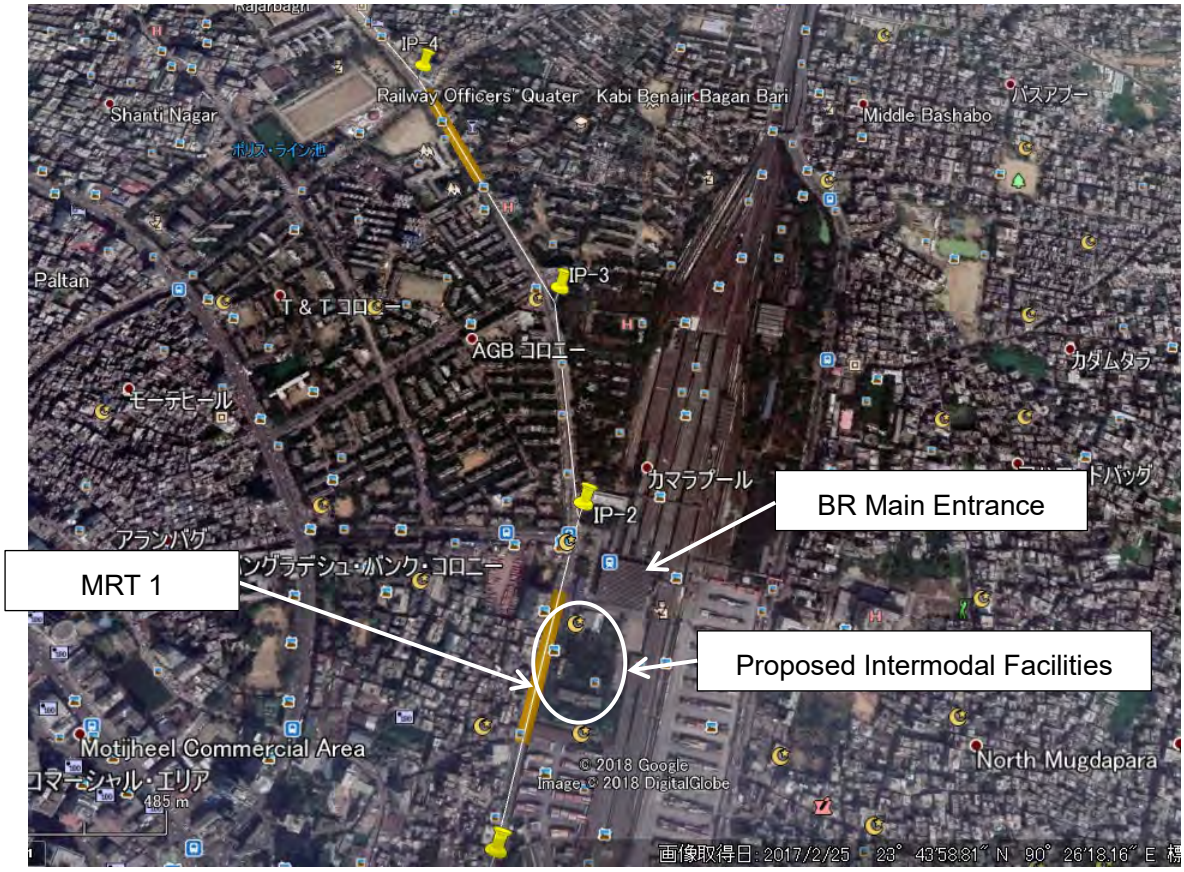
In the development of MRT, the location of the MRT has an impact on urban structure and economic activities. As discussed earlier, the MRT Line 1 connects the suburban areas such as Gazipur and the CBD. JST proposes Kamalapur BR Station as the starting point of MRT Line 1 because of the following reasons:

1. There are many passengers going to and coming from Bangladesh Railway.
2. There is the Sayedabad Bus terminal near Kamalapur

3. MRT Line 6 terminates at Motijiheel near Kamalapur.

At Present, the Dhaka Elevated Expressway Project is under construction, and the BR Kamalapur Station yard will be highly commercially developed. BR has a plan to re-arrange track layout and develop the area. At present there are many BR operations.

Now there is a big Inland Container Depot adjusted to BR; furthermore, there are several maintenance depots and material stockyards. These shall be re-arranged to make more space. The redevelopment potential of BR-owned land is very high, and MRT Line 1 cannot ignore this fact. JST studied three alternatives on the location of MRT Kamalapur Station (refer to section 3.2.5). Figure 3.1.7 shows the location of the Kamalapur Station of MRT Line 1 and of BR.

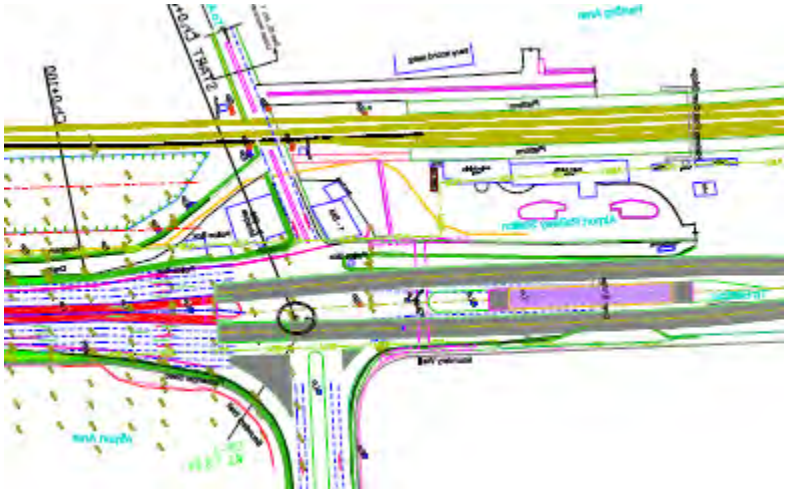


Source: JICA Study Team

Figure 3.1.7 Present BR Kamalapur Station and MRT Kamalapur Station

MRT Line 1 is planned aiming forward to Gazipur north of Dhaka Mega City, There is the BRT Line 3 project which is under implementation with the assistance of ADB. In addition, the southern part of BRT Line 3 is also scheduled to be implemented with World Bank assistance. From the north suburban area, passengers of BRT Line 3 have to leave the said system at the International Airport and change to other transportation modes. Therefore, MRT Line 1 has high potential.

Below is the location of BRT Line 3 Station and an image of transfer from BRT to MRT.



Source: DTCA Detailed Engineering Design Works for Bus Rapid Transit Line 3 Corridor in Dhaka

Figure 3.1.8 Image of Transferring between BRT and MRT at International Airport

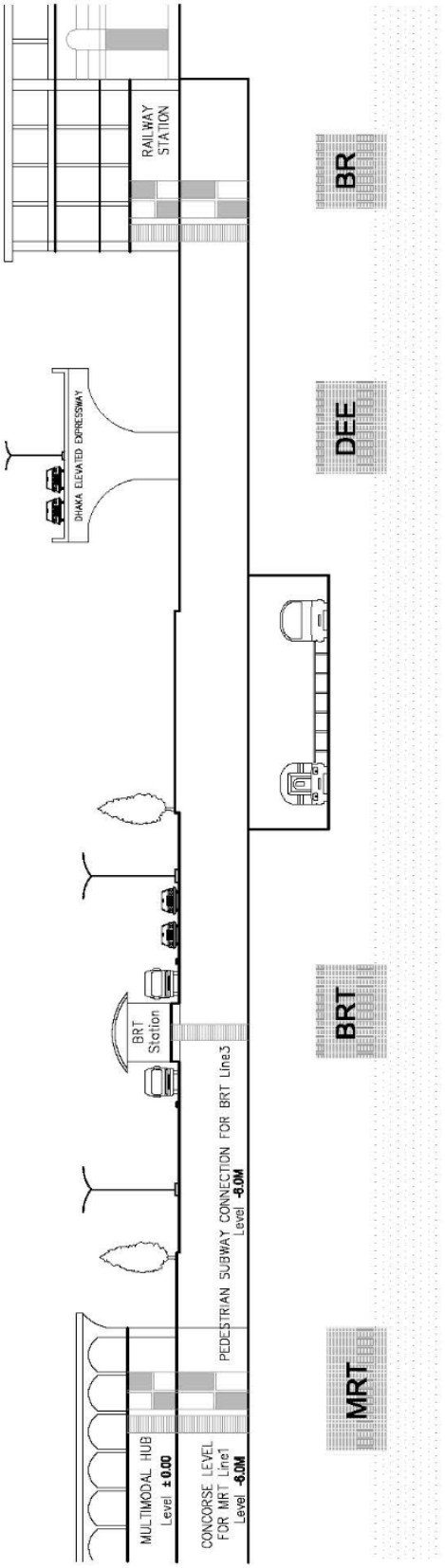


Figure 3.1.9 BRT Line 3 Station

Source: JICA Study Team

With regard to Purbachal Terminal, DTCA gave JST the available location of the depot at Purbachal some 22km from Kuril. Taking into account future development, the JST accepted the candidate location and MRT Line 1 is terminated at this location. In the selection of the location of the Purbachal Terminal Station, several things were taken into account such as approach to the Depot, Line 1 Extension to over the Kanchon Bridge and people from the east who wish to reach the CBD.

3.2 Study of Location of Stations and Alternatives

3.2.1 Concept of Location of Stations

The selection criteria for the station locations are focal city activities, traffic nodes, physical conditions (elevated road, geology, groundwater, etc.), accessibility protection from flooding and escape in an emergency. Purbachal Line is within the planned development area, and for that reason the plan of the passenger coverage area of the station shall be within an 800m radius and one station set every 1.5km.

JST studied the elevated station locations in considering the followings.

Bashundhara Station: Convenience for the peoples that use the Convention Center and sufficient distance between the station and transit structure, which shall be provided at the point where the track changes from underground to elevated.

Bashundhara Station～Purbachal West : JST couldn't find any future development projects, so a standard interval of 1.5 km was adopted.

Mastul Station: Near the station, Reliance is implementing a large scale housing project.

Purbachal Wes Station: Near the station a large-scale sorts complex is planned. Furthermore there is the Purbachal New Town Plan by RAJUK. From the technical point of view, sufficient distance between the Balu River and the station shall be kept.

Purbachal Central and Purbachal East: Take the RAJUK development plan into consideration.

Purbachal Terminal: As discussed above

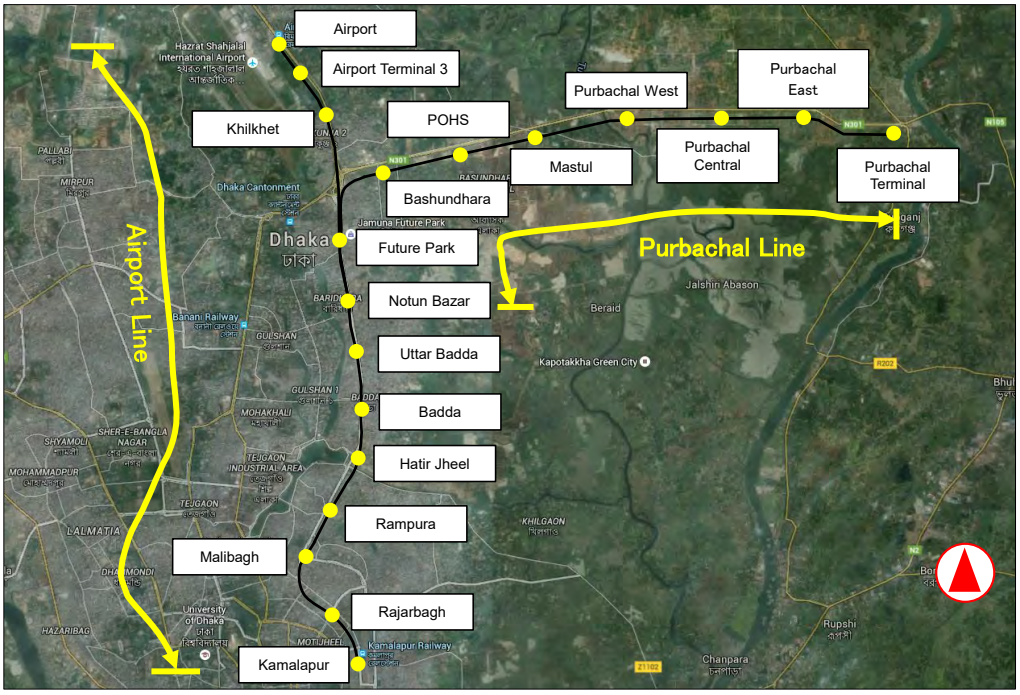
On the other hand, for the section underground, about 1km intervals between stations is the basic distance; however, according to existing condition, the distances are varied. According to suggestions of several experts, it is better to avoid locations near a river, pond or lake. In general, the MRT Line 1 runs in an area where high risk of flooding is not expected. The lowest station is provided at Hatir Jheel, where GL is some 11.0m, while as shown Table 4.4.1 the highest flooded record indicates 8.5m at Mirpur. But enough protection from flooding shall be provided. Details are discussed in section 4.5.

3.2.2 Station Location of Each Line

Figure 3.2.1 shows the location of Line 1 (Airport Line and Purbachal Line) and Table 3.2.1 shows the station list of Line 1.

With regard to the distance between Rajarbagh and Malibagh, it is some 2.1 km, which is

twice that of the basic idea. At the time of Pre-FS, the location of exit of the flyover was not clear. JST found through site survey that the location of Malibagh station of Pre FS was too close to the existing flyover. Thus, the location of Malibagh station was revised and shifted north by 360 m keeping the distance between the exit and construction site of Malibagh Station at around 500 m. Consequently, the location of Malibagh station is moved to the east by 16m and required private land acquisition. In order to avoid land acquisition, a 2.1 km distance between Rajarbagh and Malibagh was adopted.



Source: JICA Study Team

Figure 3.2.1 Route Map of Line 1

Table 3.2.1 Station List of Line 1

No.	Line	Station Name	Kiropost（km）	Distance（km）
1	Airport Line	Kamalapur	0.125	1.12
2		Rajarbagh	1.249	2.11
3		Malibagh	3.355	0.95
4		Rampura	4.307	1.18
5		Hatir Jheel	5.490	1.06
6		Badda	6.551	1.03
7		Uttar Badda	7.583	0.98
8		Notun Bazar	8.568	1.58
9		Future Park	10.152	2.47
10		Khilkhet	12.617	1.43
11		Airport Terminal 3	14.044	0.85
12		Airport	14.890	
9	Purbachal Line	Future Park	10.152	2.73
13		Bashundhara	12.884	1.68
14		POHS	14.567	1.68
15		Mastul	16.521	1.67
16		Purbachal West	17.918	1.54
17		Purbachal Central	19.461	1.96
18		Purbachal East	21.418	2.18
19		Purbachal Terminal	23.594	

Source: JICA Study Team

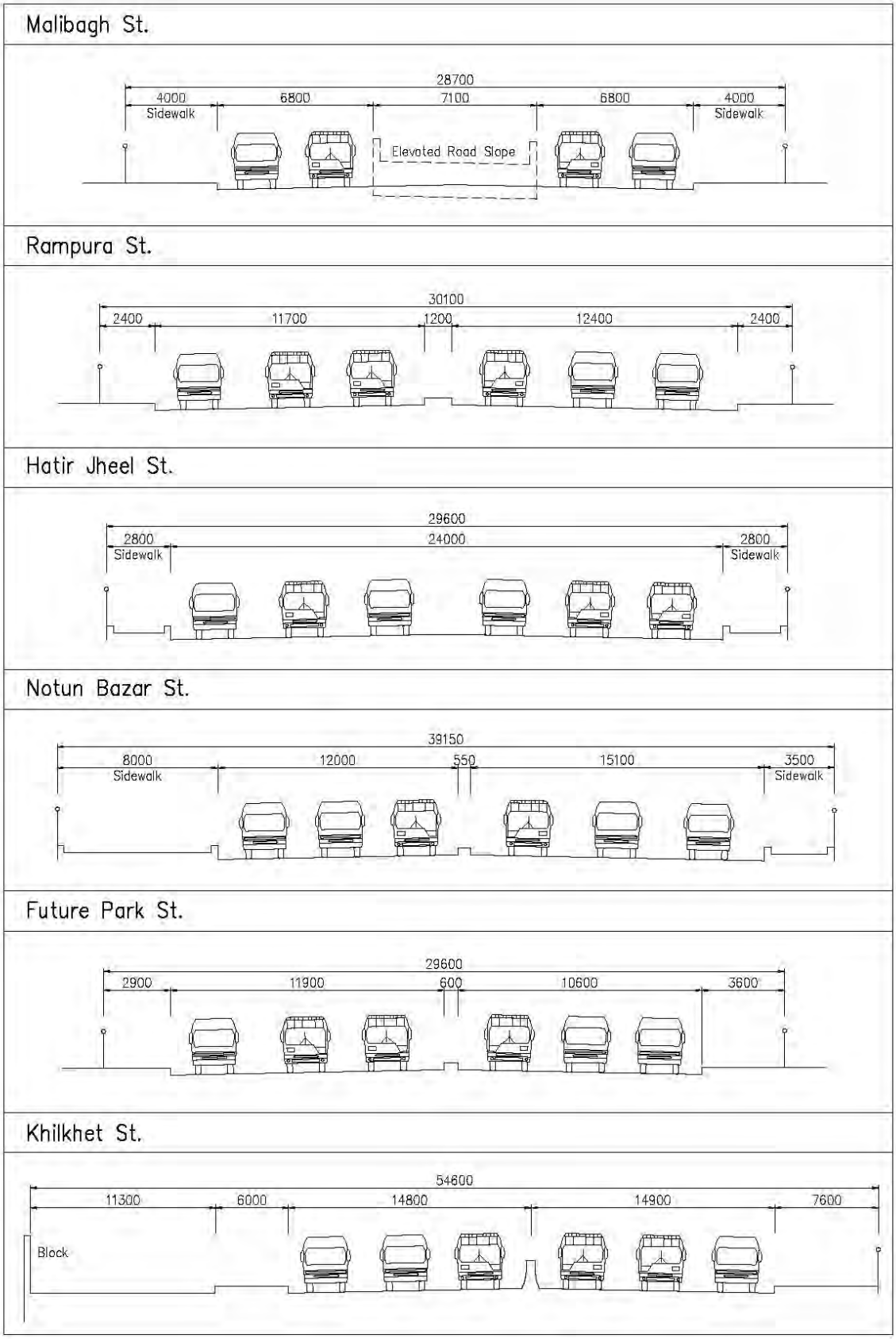
Table 3.2.2 gives a list of the station names which correspond to their locations and the type of platform to be constructed at each station.

Table 3.2.2 Location of Stations and Type of Platform

Proposed Station Location and Type of Platform				
No	**Tentative Station Name**	**Distance from Kamalapur**	**Proposed Location/Land Mark**	**Type of Station Platform**
1	Kamalapur (Origin)	0.125 km	BR Kamalapur Station West South. Within Outer Circle Road. Coordination with DEE Structure is needed	1 island platform contains SC with draw up track
2	Rajarbagh	1.249 km	South of the Rajarbagh Police Line Outer Circle Rd.	1 Island platform 2 tracks
3	Malibagh	3.355 km	North of Level Crossing East side of Existing Flyover	Stack Platform
4	Rampura	4.307 km	Rampura Bazar South Cross Ulon Rd. & DIT Rd.	1 Island platform 2 tracks
5	Hatir Jheel	5.490 km	North of Rampura Khel Bridge	1 Island platform 2 tracks
6	BADDA	6.551 km	Cross Bir Uttam AK Khandakar Rd. & DIT Rd.	1 Island platform 2 tracks
7	UTTARA BADDA	7.583 km	Dakshin Shahzacipur Cross Mashritola Rd.	1 Island platform 2 tracks
8	Notun Bazar	8.568 km	North Cross Madani Ave. & DIT Rd.	2 Island platforms 4 tracks
9	Future Park	10.152 km	In front of Jamuna Future Park	2 layers island platform
9	Khilket	12.617 km	Cross Point Airport Rd & Khilkhet Rd. Between Rd. 13 & 19	1 Island platform 2 tracks for two levels
10	Airport 3rd Terminal	14.044 km	In front of Airport Terminal 3 Building	1 Island platform 2 tracks
10	Airport	14.890 km	BR Airport Sta. In front of BR Airport Station	1 Island platform 2 tracks
11	Future Park	10.152 km	In front of the Future Park Amusement	2 Layor Island Platforms
12	Bashundhara	12.884 km	Bashundhara Residential Development Housing Block G	Lateral Platforms
	POHS	14.567km		Lateral Platforms
13	Mastul	16.251 km	Dumni (Reliance Model Town)	Lateral Platforms
14	Purbachal West	17.918 km	Sector 13 Balu River (East side of Bridge)	Lateral Platforms
15	Purbachal Center	19.461 km	Sector 9	Lateral Platforms
	Purbachal East	21.418 km	Sector 7	Lateral Platforms
16	Purbachal Terminal	23.594 km	Sector 5	2 island platforms 4 tracks

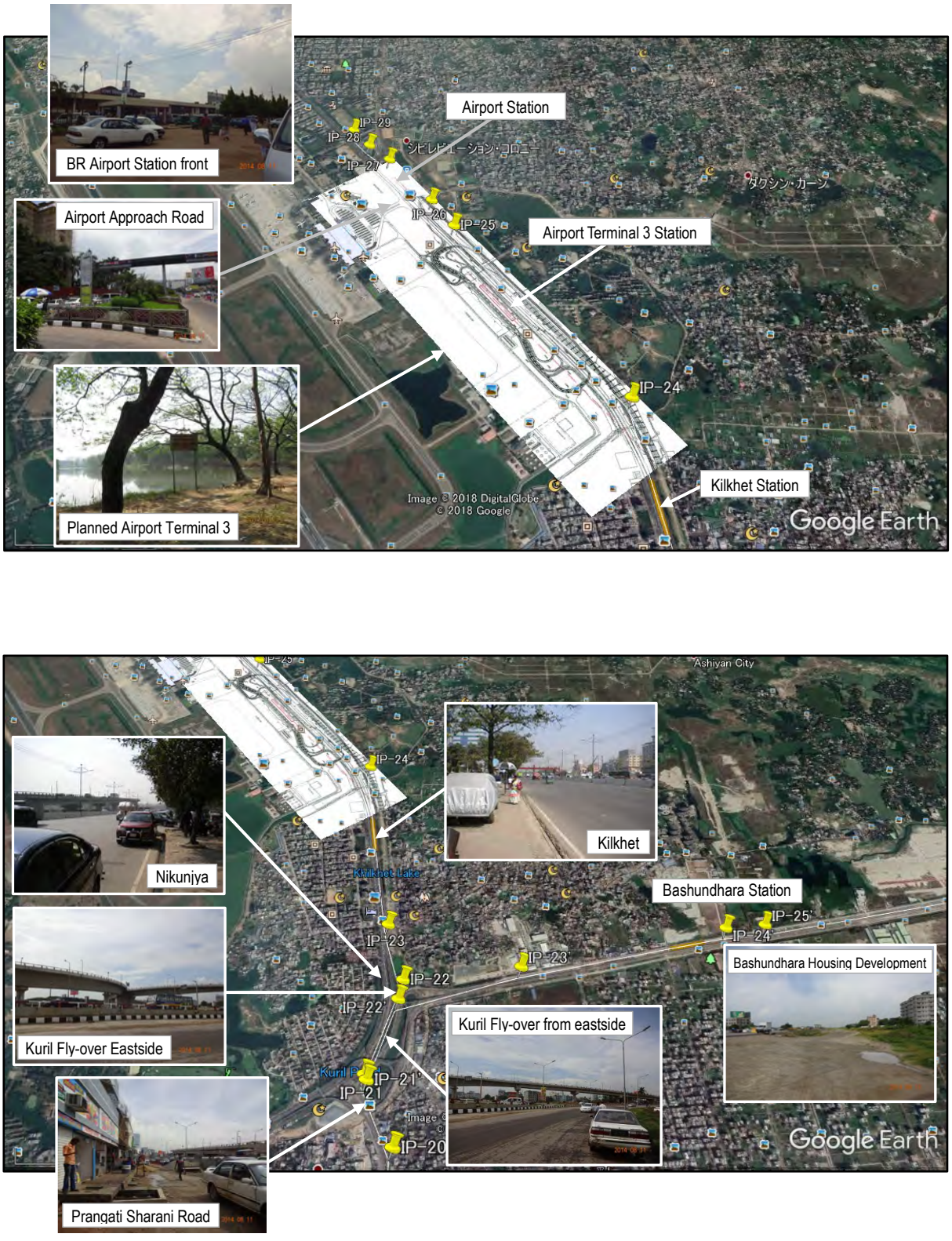
Source: JICA Study Team

The road width of on Major points of MRT Line 1 are shown in Figure 3.2.2.



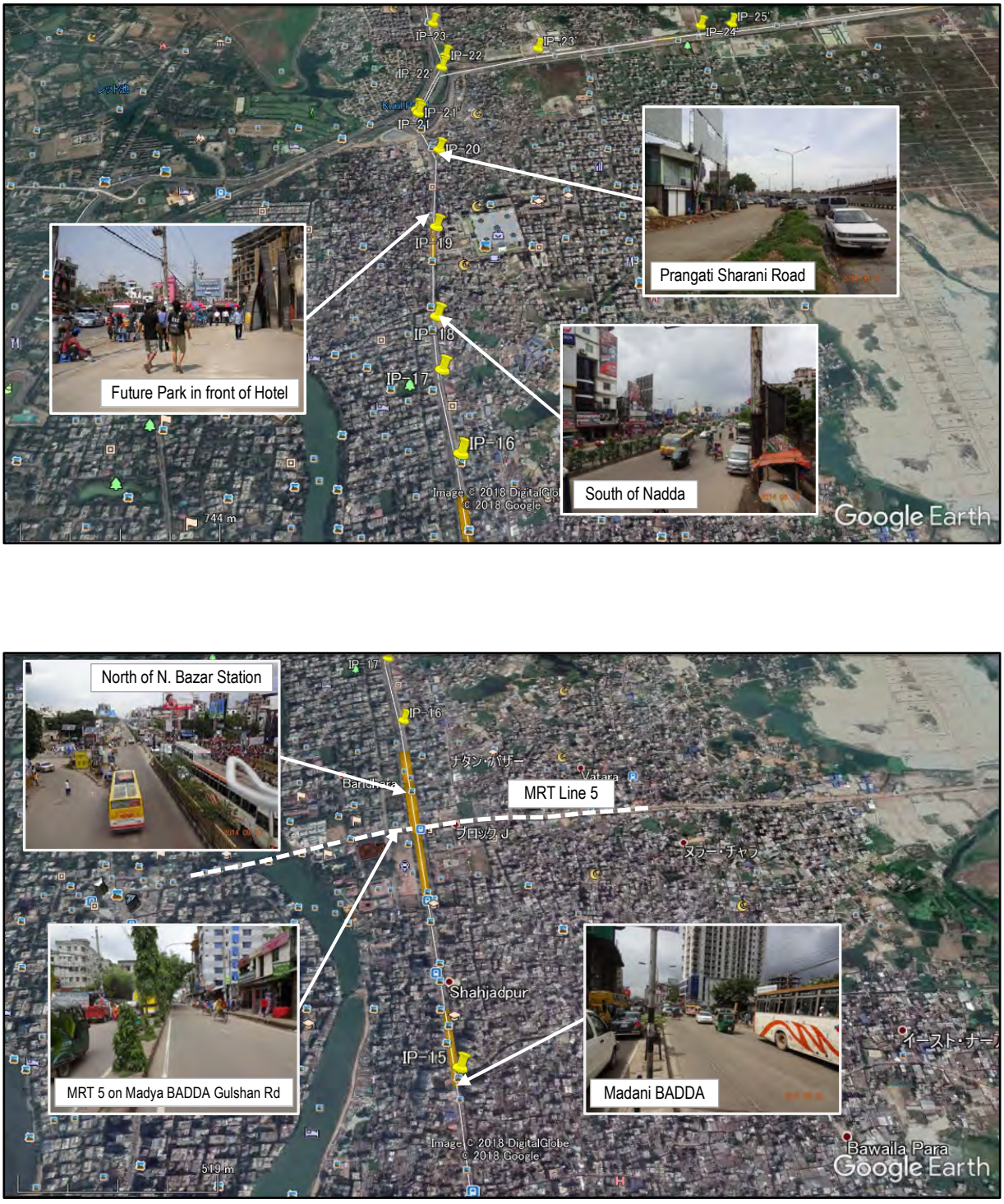
Source: JICA Study Team

Figure 3.2.2 The road width on major points of MRT Line 1



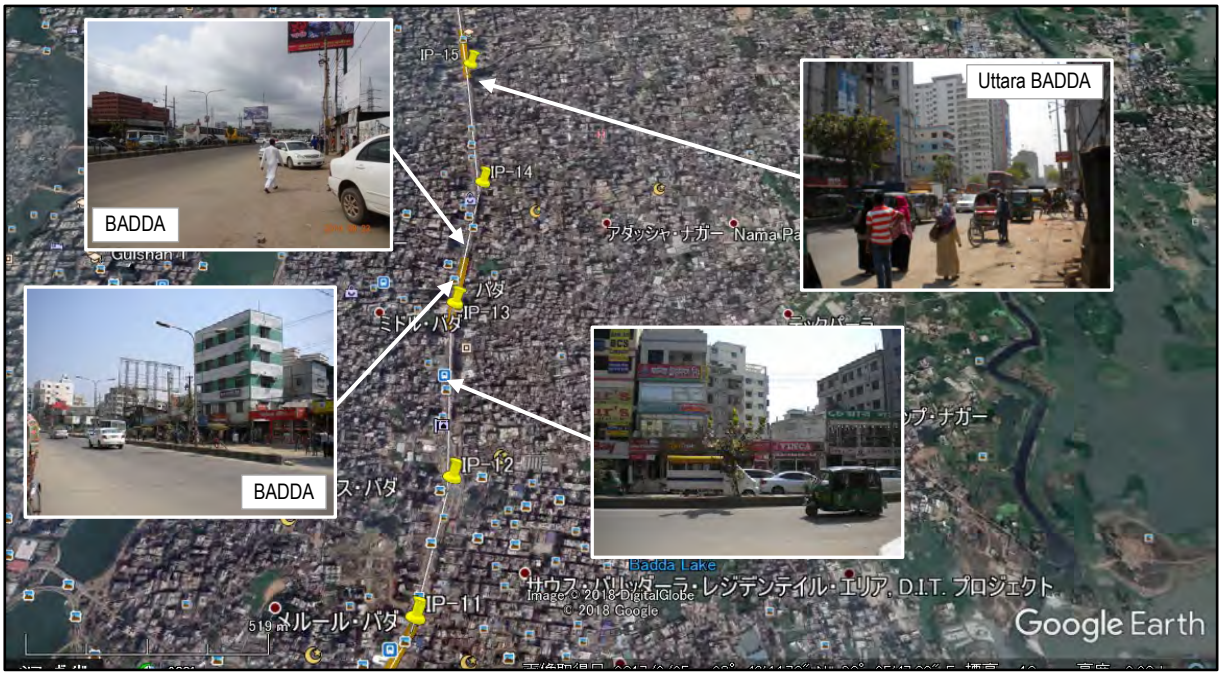
Source: JICA Study Team

Figure 3.2.3 Present Scenery of Sites for Stations (1)



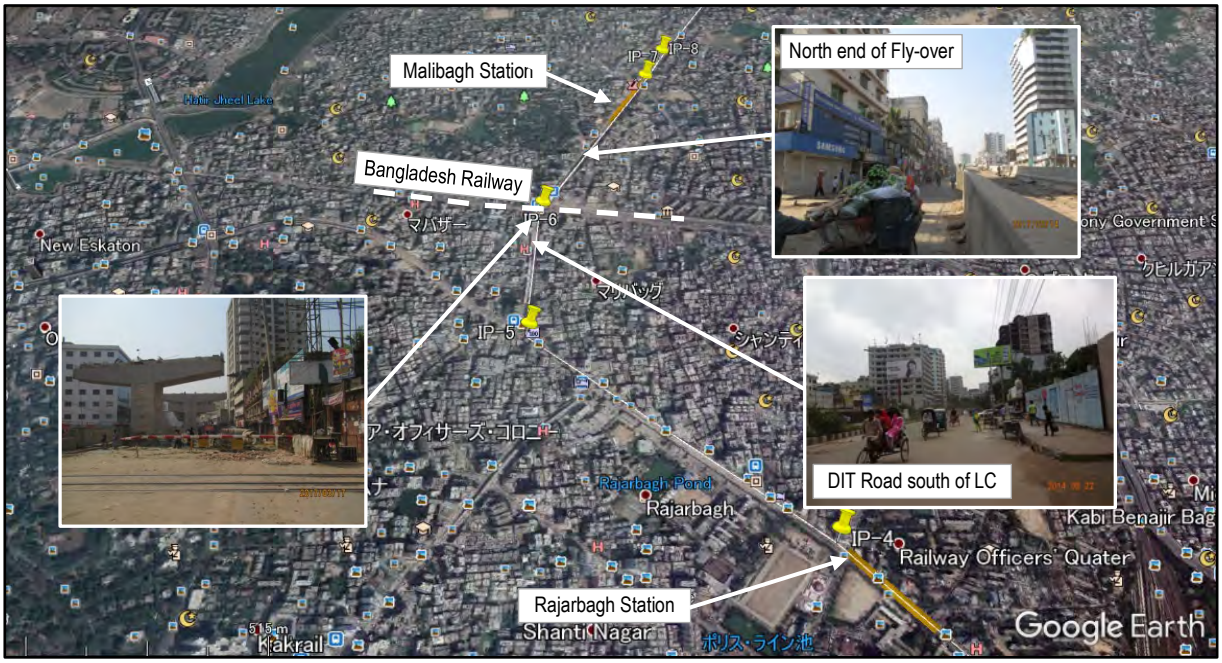
Source: JICA Study Team

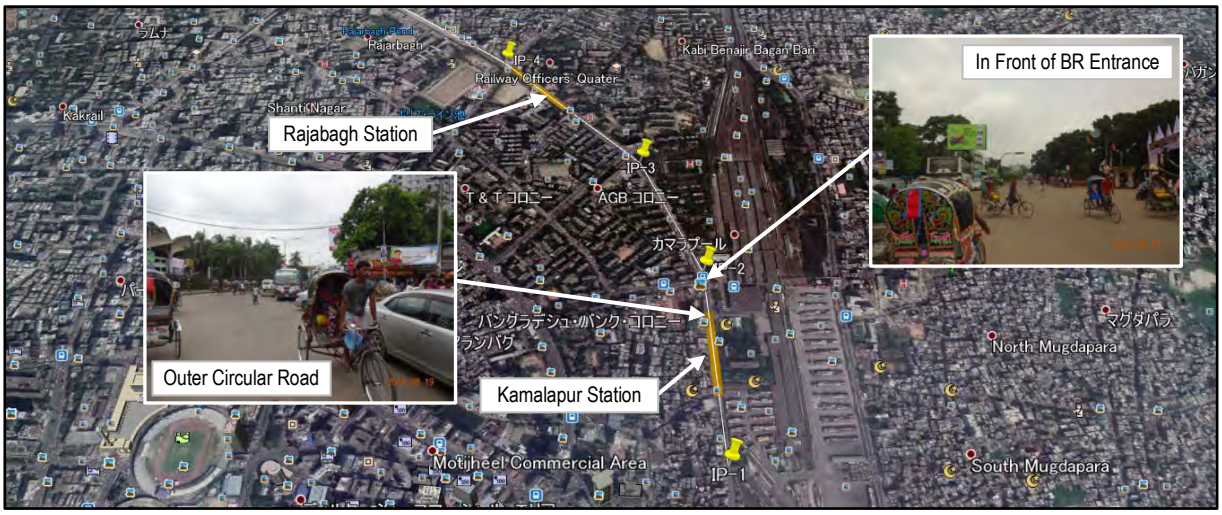
Figure 3.2.3 Present Scenery of Sites for Stations (2)



Source: JICA Study Team

Figure 3.2.3 Present Scenery of Sites for Stations (3)





Source: JICA Study Team

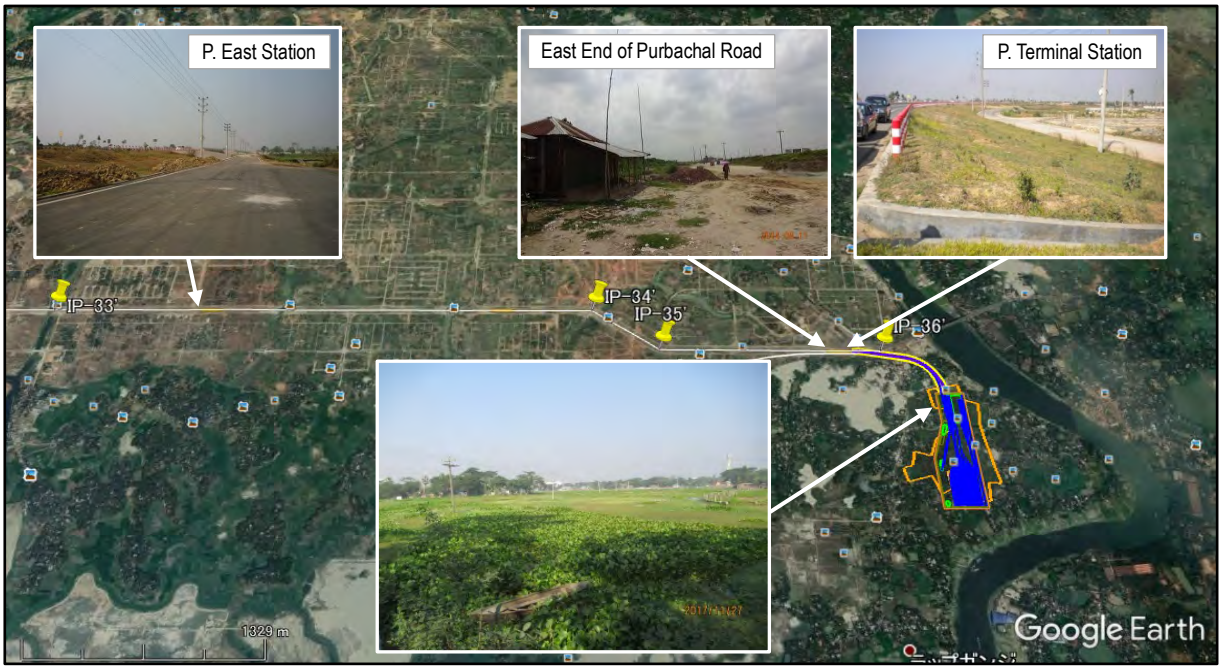
Figure 3.2.3 Present Scenery of Sites for Stations (4)

Source: JICA Study Team

Figure 3.2.3 Present Scenery of Sites for Stations (5)

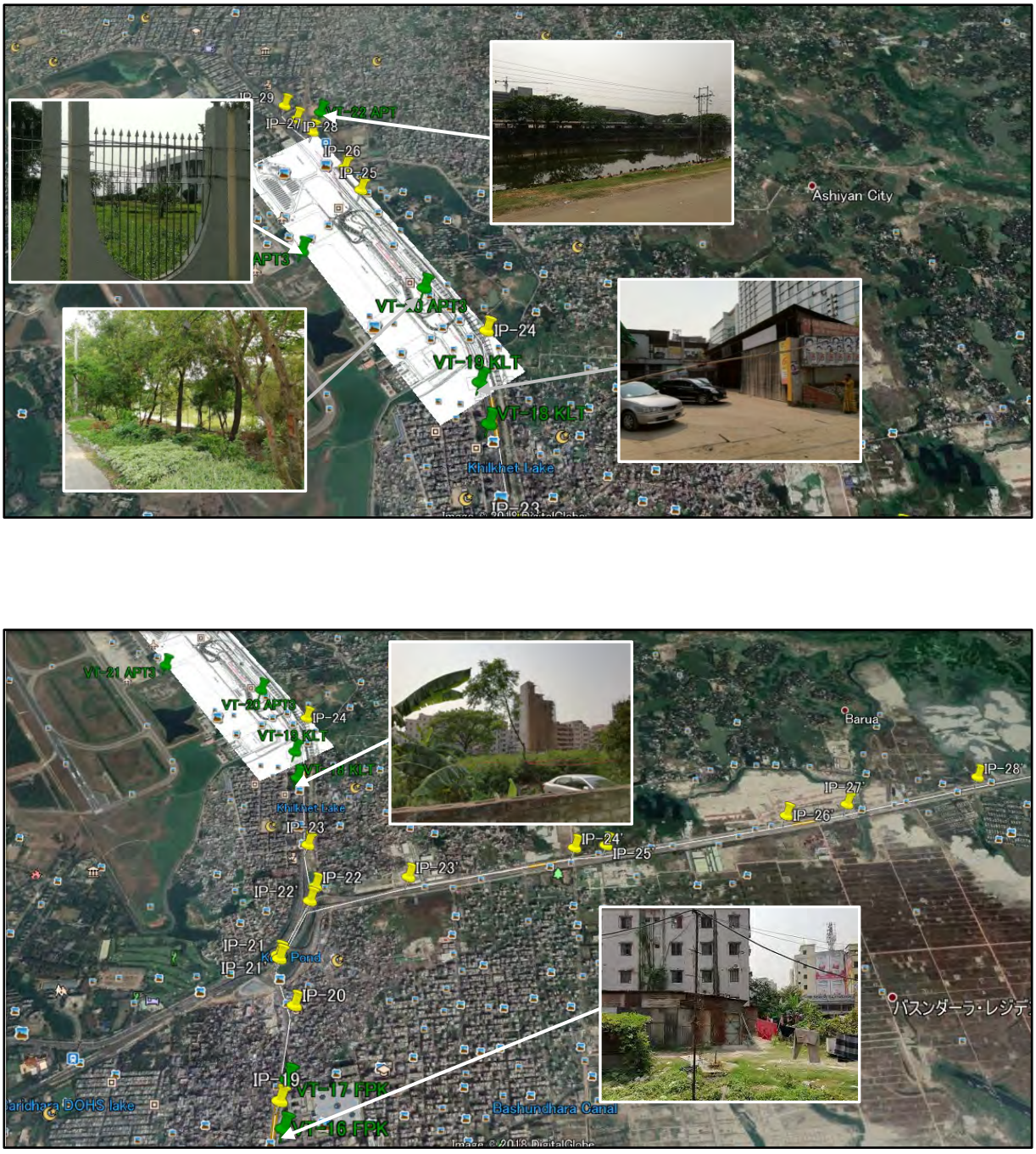
Source: JICA Study Team

Figure 3.2.3 Present Scenery of Sites for Stations (6)



Source: JICA Study Team

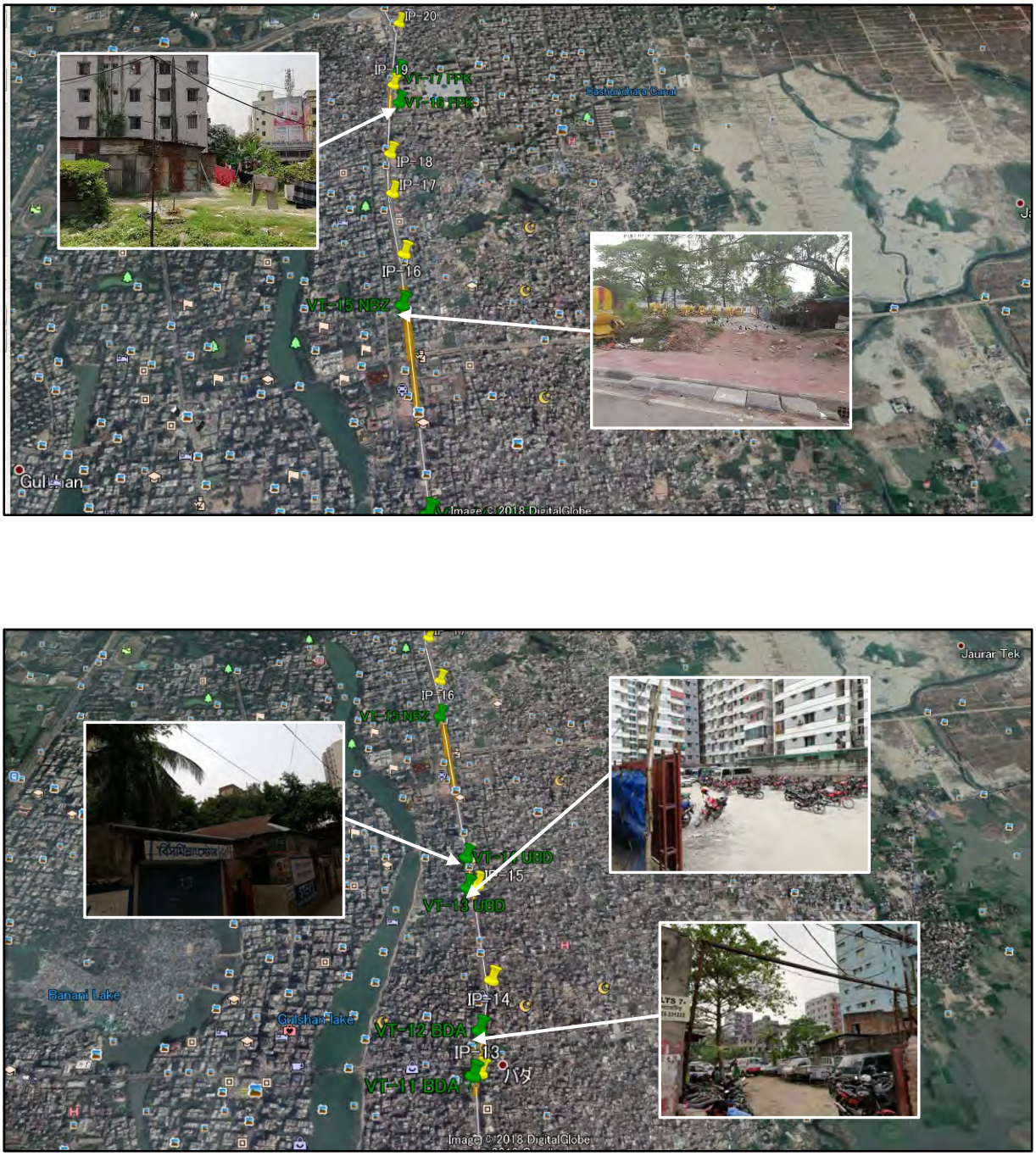
Figure 3.2.3 Present Scenery of Sites for Stations (7)



: Ventilation

Source: JICA Study Team

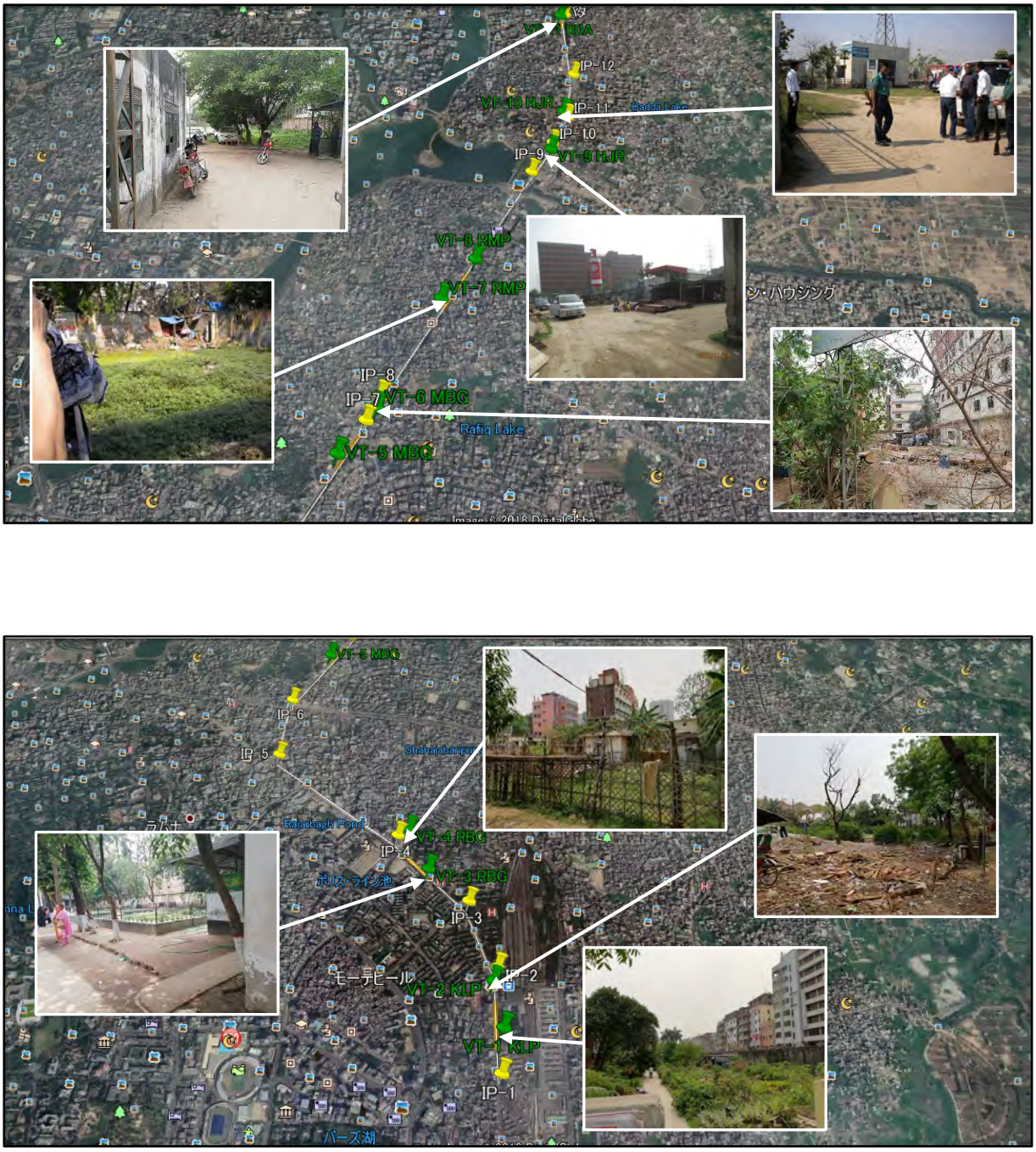
Figure 3.2.4 Proposed Location of Ventilation (1)



: Ventilation

Source: JICA Study Team

Figure 3.2.4 Proposed Location of Ventilation (2)



: Ventilation

Source: JICA Study Team

Figure 3.2.4 Proposed Location of Ventilation (3)

3.2.3 Infrastructure Facility Alternative Study

As for the type of structure for an urban railway, there are three kinds of structures, namely, elevated structure, underground structure and at-grade structure, but an at-grade structure is undesirable in respect of the installation of level crossings and splitting of communities. Thus, an at-grade structure is not an alternative. As for Purbachal Line, the planned road is wide enough to construct elevated structures. An underground structure, which is costly, shall not be adopted, but an elevated structure shall be adopted. As for the Airport Line, the following three alternatives were compared with the combination of underground structures and elevated structures.

Plan A: The section between Kamalapur Station and Malibagh Station, underground structure; the section between Rampura Station and Notun Bazar Station, elevated structure; the section between Future Park Station and Kuril flyover, underground structure; and the remaining section, elevated structure.

Plan B: The section between Kamalapur Station and Malibagh Station, underground structure; other sections, elevated structures.

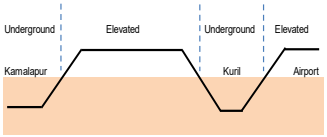
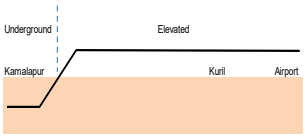
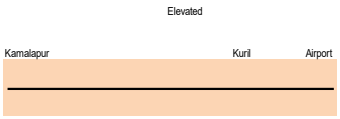
Plan C: All sections will have underground structures.

The above plans were compared in terms of the following aspects and the results are shown in Table 3.2.3:

- Social Environment: Land Acquisition, Affected Households
- Natural Environment: Protected Area, Biological Diversity (Marsh), Flood Risk, Landscape
- Pollution Prevention: Noise/Vibration, Air Pollution, Water Pollution, Ground Settlement
- Technical Aspect: Construction Cost, Road Traffic, Construction Difficulty, Convenience for Passengers

The comparison results confirmed that Plan C is inferior to other plans in respect of water pollution, ground settlement and construction cost, but Plan C is superior to the other plans in respect of other items. Therefore, Plan C shall be adopted. The main reasons why Plan C is adopted are less land acquisition, less affected households and less effect to road traffic.

Table 3.2.3 Comparison of Alternative Proposals for the Airport Line Structure

	Plan A (Starting Point and Kuril Area Underground)	Plan B (Starting Point Underground)	Plan C (All Lines Underground)
Concept			
Social Environment			
Land Acquisition	× There are three transition sections and land acquisition is required especially at the transition section between Malibagh Station and Rampura Station and the transition section between Notun Bazar Statin and Future Park Station.	△ Land acquisition is required at the transition section between Malibagh Station and Rampura Station.	○ The lowest land acquisition is required as compared with other plans because there is no transition section.
Affected Households	× 145	△ 135	○ 115
Natural Environment			
Protected Area	○ There is no protected area along the proposed route.	○ There is no protected area along the proposed route.	○ There is no protected area along the proposed route.
Biological Diversity (Marsh)	○ Since the route is proposed in the centre of Dhaka City, there is no place of biological diversity such as marshes.	○ Since the route is proposed in the centre of Dhaka City, there is no place of biological diversity such as marshes.	○ Since the route is proposed in the centre of Dhaka City, there is no place of biological diversity such as marshes.
Flood Risk	△ There is a risk of flooding around Kamlapur Station. Appropriate flood countermeasures are necessary because of the underground structure.	△ There is a risk of flooding around Kamlapur Station. Appropriate flood countermeasures are necessary because of the underground structure.	△ There is a risk of flooding around Kamlapur Station. Appropriate flood countermeasures are necessary because of the underground structure.
Landscape	× Not desirable in respect of landscape because there are a lot of elevated sections.	× Not desirable in respect of landscape because there is the longest elevated section.	○ Most desirable in respect of landscape because all sections are underground.
Pollution Prevention			
Noise/ Vibration	○ It is expected that noise and vibration are caused by the operation of construction machines during the construction of stations and viaducts. A higher effect than the plan of all sections underground. Noise is caused by train operation at elevated sections.	○ It is expected that noise and vibration are caused by the operation of construction machines during the construction of stations and viaducts, but there is less of an effect than the elevated plan at Kuril. Noise is caused by train operation at elevated sections.	◎ It is expected that noise and vibration are caused by the operation of construction machines during the construction of stations and viaducts, but causes the least effect among the three plans.
Air Pollution	○ A higher effect than the plan of all underground, but less effect than Plan B.	○ A higher effect than the plan of all underground because elevated section is longer than other plans.	◎ It is expected that air pollution is caused by the operation of construction machines at stations, but causes the least effect among the three plans.
Water Pollution	◎ Least effect among the three plans because the underground section is shortest among three plans.	○ It is expected there will be less effect than Plan C.	△ It is expected to have the most effect among the three plans because the underground section is the longest.

	Plan A (Starting Point and Kuril Area Underground)	Plan B (Starting Point Underground)	Plan C (All Lines Underground)
Ground Settlement	◎ It is expected that limited ground settlement may be caused because the underground section is shortest among three plans.	○ It is expected that ground settlement may be caused, but the effect is less than Plan C.	△ It is expected that ground settlement may be caused because all sections are underground.
Technical Aspect			
Construction Cost	△ Approximately 80% of Plan C	○ Slightly lower than Plan A	× Highest
Road Traffic	× Effect to road traffic even during construction is huge because the road alignment is changed at the section of transitions.	× Structure north of Malibagh Station is a viaduct and there is no transition between Notun Bazar Station and Future Park Station, but the effect to road traffic during construction is huge.	○ Effect to road traffic is least for both the construction period and completion.
Construction Difficulty	△ It is necessary to construct transitions in narrow roads. It is required to take into consideration road traffic and traffic accident prevention because the elevated structure is constructed at a median strip. General-purpose construction method is adopted, but a skilled engineer is required. Since it is the first time for Bangladesh to construct underground structures, training for labourers is also required. High quality materials for segments etc. are required and plans for them must be built from zero base in this country.	○ The same as Plan A	○ It is necessary to construct transitions in narrow roads. It is required to take into consideration road traffic and traffic accident prevention because elevated structure is constructed at a median strip. General-purpose construction method is adopted, but a skilled engineer is required. Since it is first time for Bangladesh to construct underground structures, training for laborers is also required. High quality materials for segments etc. are required and plants for them must be built from zero base in this country. Highly skilled operation is required to construct a tunnel through Kuril flyover and DEE.
Convenience for Passengers	○ There is no special inconvenience for passengers.	× Platform is constructed at the same level as 6th floor of the buildings around Kuril area. Therefore, it is expected that there are effects of driving rain and strong wind. Evacuation is needed in case of an emergency.	○ There is no special inconvenience for passengers.

※The transition section is switching point on the elevated bridge and underground, especially the section which cannot secure the construction gauge under the beam from the opening part in the existing road part shall indicate the section influencing the road traffic

Source: JICA Study team

3.2.4 Design Criteria for MRT Line 1

Dhaka MRT Line 1 consists of the Airport Line, which goes through highly developed commercial areas or the district where garment factories or wood processing plants exist randomly, and the Purbachal Line is expected in future development.

The Airport Line intersects twice with the original BR Line, and there are passengers transferring at the Airport and Kamalapur stations. To make the transferring smooth, it should be considered that both lines shall be as close together as possible. The Multiple Transport Hub concept has currently been promoted for the Airport Line. The MRT Line 1 stations shall consider the transfer between BR or other BRT lines or the convenience of passengers of the Airport Terminal 3.

The specifications for MRT Line 1 are basically the same as that of MRT Line 6 and this enables the trains to operate on both systems. Though mutual transferring between Line 1 and Line 6 is difficult in reality, the electric system, track, and spare parts of rolling stock shall be used together. The table below is the construction specification of Line 6, which shows that there is no difference of items between Line 1 and Line 6.

Table 3.2.4 MRT Line 6 Specifications

No.	MRT Line 6 Specifications	
1	Gauge	1435mm
2	Train Operation	
	Train Frequency at peak hour	4 min 30 sec (2020), 4 min (2025)
	Train Frequency at off peak hour	7 min
3	Congestion Rate	180%
4	Operation Hour	6:00 - 23:30, 5:30 - 0:00 (in summer season)
5	Design Life	
	Facility	Until 2051
	Civil Structure	100 years
6	Design Speed	110 km/hr (for Rolling Stock Design),
	Viaduct Design	100 km/hr
7	Standard Voltage	DC 1500V
8	Rolling Stock	
	Formation	4M2T
	Propulsion	VVVF Inverter
	Traction Motor	140-200 kw
	Braking	Mechanical & Electrical (regenerative)
	Body	Aluminium alloy or Stainless Steel
	Window	400mm opening
	Seat Arrange	Longitudinal seating with wheelchair space
	Operation Speed	Max. 100km/hr
	Acceleration	3.3 km/h/s (0,92 m/s2)
	Deceleration	Service 3.5km/h/s Emergency 4.5km/h/s
	Adhesion	Less than 20%
	Axle Load	Max 16t
	Vehicle Dimensions	Width 3000mm
		Gauge Length 20,300mm (End car)
		Gauge Length 20,000mm (Middle car)
	Floor height	1,150 mm
	Bogie Wheel Base	2,100 mm and 13,800 mm centre distance
	Wheel Diameter	860 mm
	Door	W: 1,300 mm, H: 1,850mm 4 door/car each side
	Ventilation	Forced air ventilation13m^3/h per person
	Air Conditioning	Outside: 40 C, 90% RH
		Inside: 24 C 60% RH with 200% Congestion
	Carrying Capacity	1,738 pax. At 180% Congestion
	Number of Train	24 sets in 2026
9	Power Supply	
	OHC	Simple Catenary
	Number of Receiving Substations	2 Receiving Substations (132kV/33kV) in 2051
	Number of Traction Substations	7 Traction Substations (33kV/1,500 VDC)
	SCADA	Equipped
	Voltage of Distribution Line	33 kV
10	Number of distribution line circuits	Ring main

No.	MRT Line 6 Specifications	
11	Escalator & Lift	Install (Number to fix)
12	Signal	
	Block system	CBTC Moving Block
	Signal appearance	Cab Signal
	ATP	CBTC, ATP, Speed Restriction Control, Possession Control, ATO
13	Running	Left side
14	Interlocking	CIL to CBTC & CTC
15	Train operation Control	CTC from OCC
16	Depot Control	Shunting Signal (Test track CBTC)
17	Telecommunications	
	BTN	MPLS
	Master Clock	GPS base
	Communication for Safety	
	Radio communication	LTE (instead TETRA)
	Telephone	DLT and PABX
	PA and PIS	Peak SPL 70dB(A) - 96dB(A), Display LCD
18	CCTV	PTZ Camera
19	AFC	
	Ticket	Contactless IC ticket
	Data Transmission	ISO/IEC 18092 (Type C) or ISO/IEC 14443
	Security Level	EAL 4 of ISO/IEC 15408
	IC Ticket Media	Single Journey, Day Ticket, Stored Value, Commuter
	Capacity	60 persons/min
	TVM	Provided
	Ticket Office machine	Provided
	Fare Adjustment	Provided
	Type of AG	Horizontally swing flap door
20	Civil Structure	
	Viaduct Superstructure	30 m Segment Box Type
	Sub-structure	Independent Pier and Portal Frame
	Foundation	Cast-in pile, steel pipes, mono pile or group pile
	Bridge	Cast-in balanced cantilever right type PC Bridge
	Station	Track and Station are independent
21	Track	Main Line: Non-Ballasted track Plinth Type, Depot: Ballasted Track
22	Distance between two tracks	Rolling Stock Gauge + 800mm = 3.8m
23	Clearance for outer structure	2.5 m
24	Platform	
	Length	170m
	Width	Lateral: 7m, Island 10 m
	Height	1100mm above rail top
	Edge Clearance	70mm
25	PSD	Half Height
26	Horizontal Curve	
	Between Stations	Min. 180 m
	Station	Min. 400 m (Main), 120 m (Depot)
	Vertical Curve	3000 m (2000 m in absolute min.)
		4000 m (3000 m in absolute min.) less 600m curve
27	Maintenance Facility	
	Car Shed for	39 eight-car trains
		5 inspection lines, 5 heavy lifting line
	Stabling	36 eight-car trains
28	Facility SCADA	Equipped

No.	MRT Line 6 Specifications	
29	OCC	OCC in Depot
30	Emergency Crossover	Install
31	Evacuation Method	Evacuate from both ends. In case of fire, train runs until nearest station
32	Rescue Operation	Emergency Crossover
33	Noise & Vibration	To Be study
34	One-man Operation	With ATO

Source: MRT Line 6 Design Report

Since it is the first time to construct a metro in Bangladesh, it is necessary to establish a construction standard for underground structures or systems. In particular, a structure plan of the underground stations shall be assumed considering disaster prevention or emergency situations. The Technical Standards for the Metrorail in Bangladesh (December 2014) was established with financial and technical assistance from JICA. Chapter 13 presents qualitative performance specification of underground structures while detailed design requires the tailor made quantitate specification, design criteria or manuals which reflect character of Dhaka such as climate, culture, religion, national geopolitics etc.

Furthermore, the regulations on development activities regarding working over the top of underground structures will be amended in the future, so that legislation must consider the compensation standard in these cases. Special attention shall be paid to land development such as construction of high stories buildings over the tunnels. In the Hanoi Line 2 development, the Ministry of Transportation made the Circulation which prohibits any action within the Protection Zone and requests permission from the Authorities regarding development activity within the Restriction Zone. The Government of Dhaka also shall create such Circulation.

It is essential to carry out topography surveys to implement the main construction design since the current design was done based only on the existing data because of a shortage of resources to do the site survey and measurements. At this time, the elevation is measured by Google Earth, and this causes several tens of centimetres of differences between the real and measured values.

During the documentation of this draft final report 2, no boring survey on the Airport line will be carried out. The construction method for the tunnels and structure size of underground stations need to be inspected during the engineering section.

3.2.5 Connecting with Other MRT Lines

1) Connection with MRT Line 6

MRT Line 6, which is currently ongoing, runs north to south in Dhaka, some 5km west from MRT Line 1. At Uttara 3, rolling stock maintenance depot is provided. Line 6 originates at UTTRA 3 development area and runs in the southern direction to Mirpur via Pallabi. From Mirpur the line runs along Begun Rokeya Road, west of Tejigaon Airport, comes to Farm Gate then enters Airport Road. At Shahbag, it turns east then forward to Bangladesh Bank in Motijiheel, the terminal of Line 6. It is important to connect Lines 1 and 6 to increase passengers for both MRT Systems. JST studied several ways to connect them, but the following barriers were found:

1. MRT Line 6 is an elevated system, while MRT Line 1 is built underground.
2. Connection between Line 6 and Line 1 by elevated structure is difficult due to space availability.
3. There is a high building - Bangladesh Bank.

Then JST proposed an underground box culvert which connects between Line 6 Motijiheel and Line 1 Kamalapur under Kamalapur Road (refer to section 4.5.2 which discusses how to make a box culvert).

A detailed study regarding fares for the customers who use two lines shall be done at the Design Stage.

2) Connection with Line 5

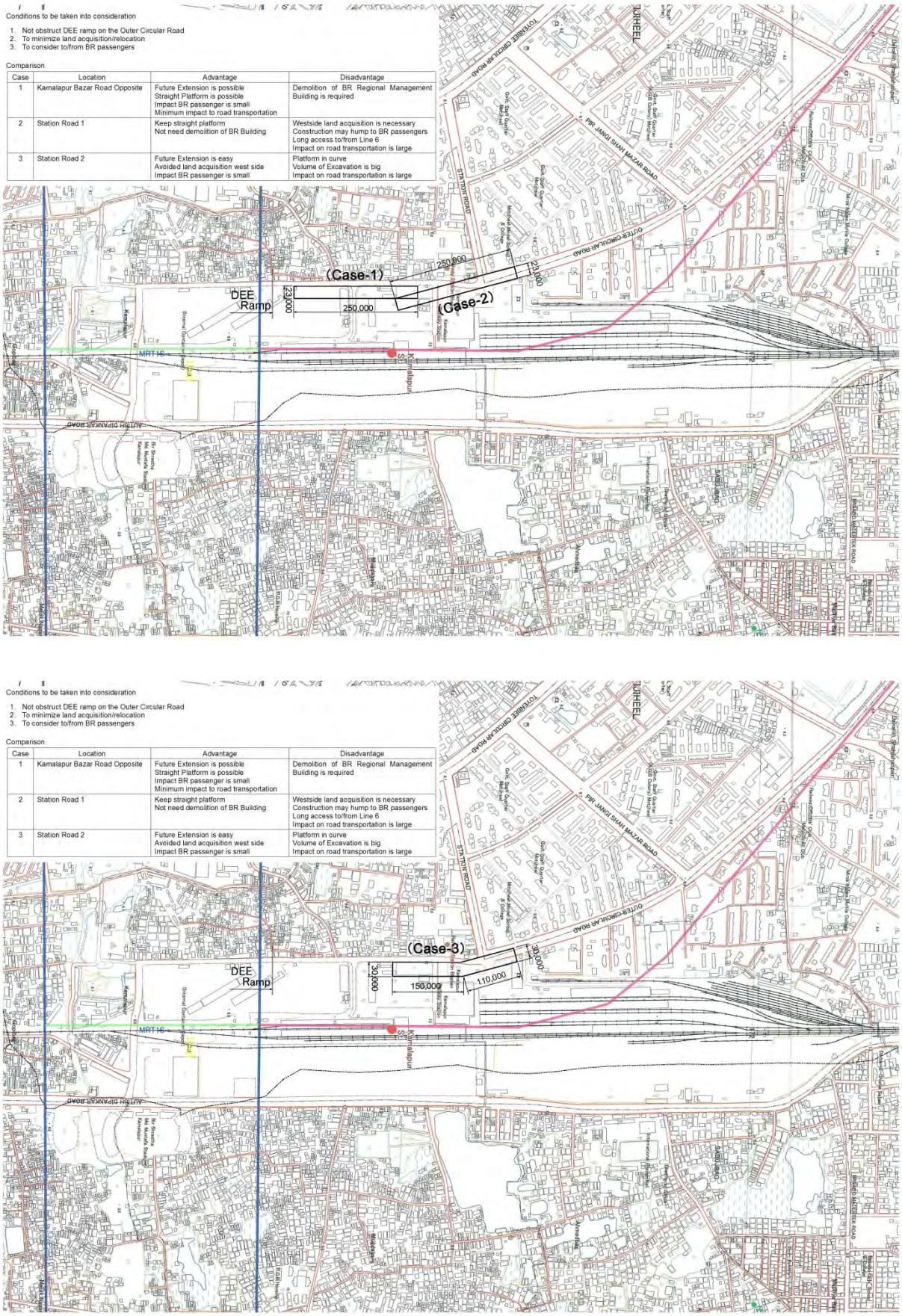
It is expected that traffic conditions in Dhaka City will drastically improve by the establishment of the MRT Line 6 and Line 1, especially incoming traffic to the city from north to south, and create the backbone of city transportation. In order to increase passengers for those lines, the line which runs west to east plays an important role. MRT Line 5 originates west of Dhaka, Gabtori, then runs to Mirpur where the line crosses with MRT Line 6. As the line goes further east, it crosses with Line 1 at Notun Bazar. A passageway by which passengers of Line 1/5 can transfer to Line 5/1 will be provided underground (for details, please refer to section 4.5.2, Underground Structure, (9) Connection with MRT Line 5).

3) Connection with Bangladesh Railways (BR)

(1) Kamalapur Station

As discussed in 3.1, the Kamalapur Station is the project stating point of Phase 1. In the Feasibility Study, the Study Team tried to arrange the entrance of MRT Line 1 to be close to the BR entrance in order to effectively use the BR networks. At present, BR has a very wide land in front of Regional Management Building. JST proposes DTCA/DMTCL at the seminar held on 17 September, 2017 at JICA Training Center that utilize this area for Temporary Working Depot for the Contractor, and after completion of Underground Station Construction, this area will be the Transfer Park where passengers can be picked up by a taxi, CNG or bus.

With regard to the location of the MRT Kamalapur Station, JST studied three alternatives and proposed Case 1. The following figures show advantage and disadvantage of three alternatives.



Source: JICA Study Team

Figure 3.2.5 Kamalapur Station-Case 1, 2, 3

(2) Connection with BR Airport Station

Refer to Figure 3.1.9. The Line 1 Airport Station will be built between DEE and BR. Line Considering the entrance of MRT Line 1 will be built in front of the BR Airport Station to make smooth passenger transfer between MRT and BR Line. But now Bangladesh Railway has a plan to develop the Airport Station. In Detailed Design, both organizations shall discuss the situation in detail.

(3) Connection with BRT Line 3

As discussed in section 3.1, the stations of three transport modes, i.e., BR Airport Station and BRT Line 3 Airport Station together with MRT Line 1, are in front of the Hazrat Shahjalal International Airport. An image of arrangement of these three modes is shown in Figure 3.1.9.

At present, with financial assistant from ADB, the Bus Rapid Transit (BRT) System Line 3 Project is ongoing. This project connects Northern Suburban with CBD. But as Phase 1, BRT Line 3 north part until the International Airport will be built.

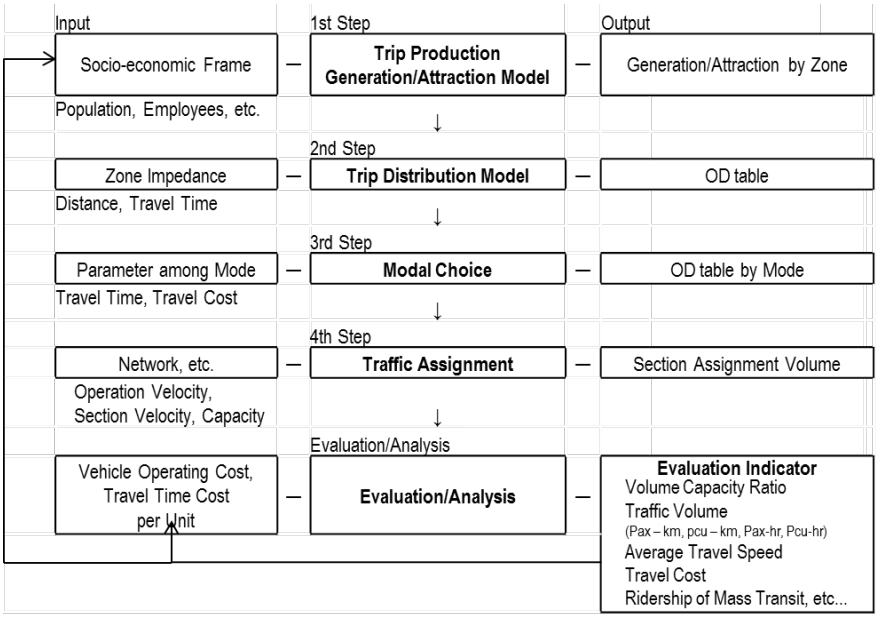
(4) Airport Terminal 3

The BRT Line 3, as the first phase, terminates at International Airport. Passengers coming from UTTRA end can transfer to MRT Line 1 and go to the CBD, while air passengers and airport workers have no transport mode except automobiles. At present, the Bangladesh Government is implementing the Airport Terminal 3 Building Construction project. The JST studied how to connect MRT Line 1 to Terminal 3 and concluded to provide the Airport Terminal 3 Underground Station. And the Terminal 3 Building Construction Project shall build an underground passageway 9m wide and 6m high within Navigation Authority's right of way (ROW) while the MRT Line 1 Project will build the same road ROW.

3.3 Passenger Demand Forecast for MRT Line 5

3.3.1 Framework of Demand Forecast

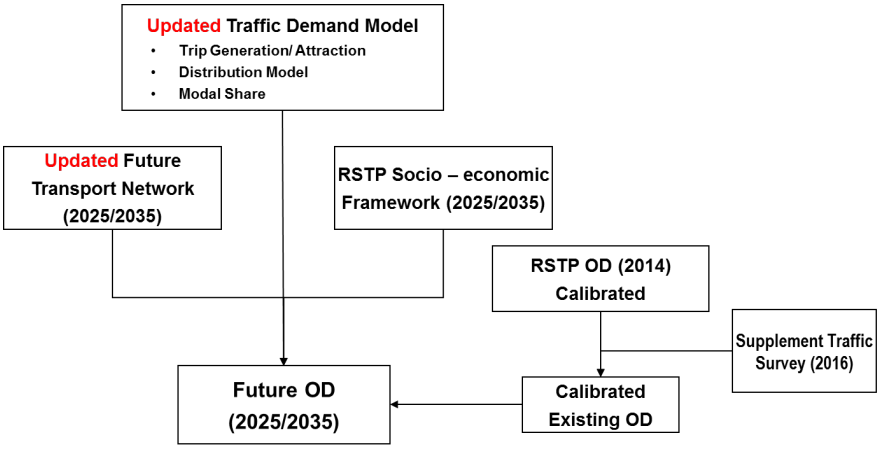
Demand forecast was carried out by 4 step models as shown in Figure 3.3.1. Database used in the study was based on RSTP which is the basis of target MRT routes of the Study.



Source: JICA Study Team

Figure 3.3.1 Flowchart of 4 Step Traffic Demand Forecast Model

Updating OD tables was carried out by the method as shown in Figure 3.3.2. The OD table developed in RSTP was updated through supplemental traffic survey along MRT corridors. The outline of the supplemental traffic survey is described in following section.



Source: JICA Study Team

Figure 3.3.2 Flowchart of Updating OD Table

3.3.2 Update of RSTP Traffic Demand

1) Supplemental Traffic Survey

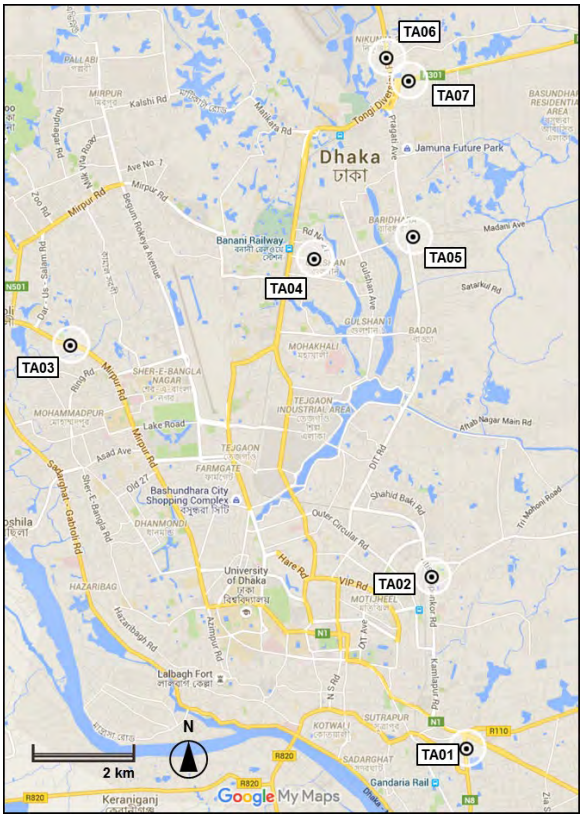
Supplemental Traffic Survey is to provide vehicular traffic and passenger information to update the current distributed traffic volume along the planned UMRT corridors. The survey location is shown in Table 3.3.1 and Figure 3.3.3.

Table 3.3.1 Traffic Count Survey Stations

Code	Survey Station	Survey Period (no. of hours) 1)		Survey Date
		Vehicle Count	Vehicle Occupancy	
TA 01	Dhaka–Mawa Highway	24	16	11 May 2016 (Wed)
TA 02	Kamlapur Road	16	16	16 May 2016 (Mon)
TA 03	Mirpur Road	16	16	17 May 2016 (Tue)
TA 04	Kemal Ataturk Avenue	16	16	18 May 2016 (Wed)
TA 05	Madani Avenue	24	16	10 May 2016 (Tue)
TA 06	Dhaka–Mymensingh Highway	24	16	23 May 2016 (Mon)
TA 07	Purbachal Express Highway	16	16	04 May 2016 (Wed)

1) 24: conducted for 24 hours from 6 a.m. to 6 a.m of the following day.
16: conducted for 16 hours from 6 a.m. to 10.p.m. of the same day.

Source: JICA Study Team



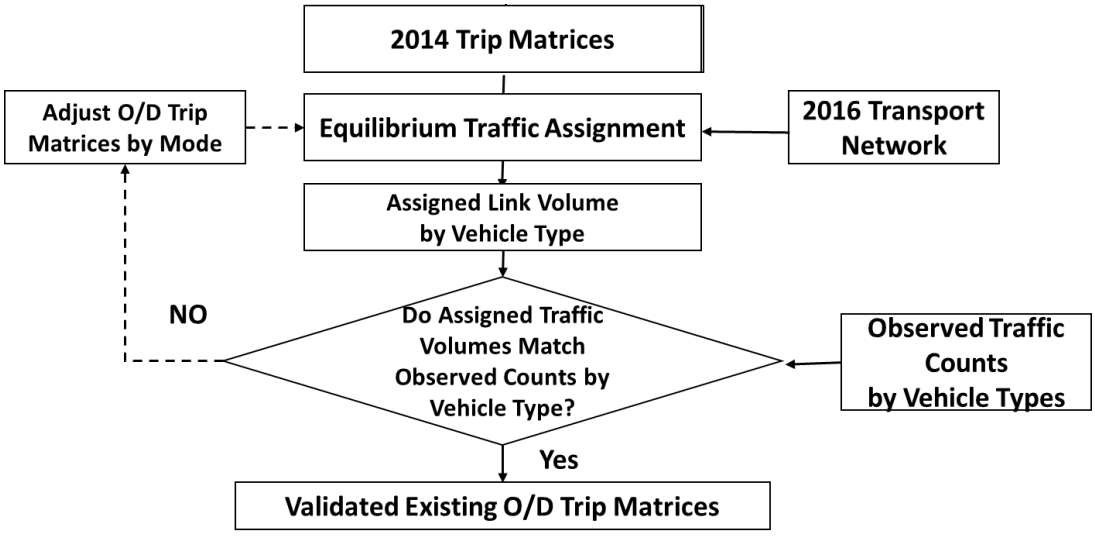
Source: Worked out by JICA Study Team, based on Google

Figure 3.3.3 Location of Supplemental Traffic Survey

2) Carburation of O-D Table

The base year model validation was carried out by comparing the assigned traffic volume against the result of supplemental traffic survey. The initial OD trip tables for each mode were assigned to the updated network using the traffic assignment model. The modelled results, i.e., the assigned traffic volumes were compared with the observed traffic counts across the survey location.

The OD table adjustment and traffic assignment were repeated until the assigned traffic volumes were within +/- 10% of the observed counts, at which stage the model was then considered valid. The final iteration of the OD trip matrices was deemed as the validated 2016 travel demand. This process is illustrated in Figure 3.3.4.



Source: Worked out by JICA Study Team, based on Google

Figure 3.3.4 Update of Current O/D Table

Based on the validated current O/D table, the future O/D table also will be updated. The socio-economic indicators such as population, employment and student by traffic analysis zone is of RSTP study. MRT Line 5 is planned to open in 2028 and OD table in 2028 has not been created, therefore the OD table in 2028 is estimated by interpolating between 2025 and 2035 and assigned on 2025 transport network. Passenger demand in 2055/ 2058 is also necessary because the economic project life of MRT Line 1 and Line 5 is 30 years. Therefore, it is assumed that annual growth rate is 1 % from 2035 to 2058.

3) Hourly Passenger Demand Forecast

(1) Policy of Data Utilization

Hourly demand forecast is required to formulate the train operation during peak time and off-peak time. There is no current MRT in operation. In addition, BR is functioned as an intercity railway, so it is not suitable to refer the BR operation statistics for MRT hourly demand forecast. Thus, hourly trip ratio of current bus operation is applied for MRT hourly demand forecast because bus passengers' behaviour is similar to MRT passenger even though bus is the road transport.

The latest traffic count survey was conducted by RSTP supplement study in May 2016 at 7 sites. There are four count sites along the MRT Line 1, and 2 of the survey stations are in existing city centre as shown in Figure 3.3.5 and cross section traffic of north-south direction was observed at the sites.

Source : Edited by JICA Study Team based on RSTP Supplement Study

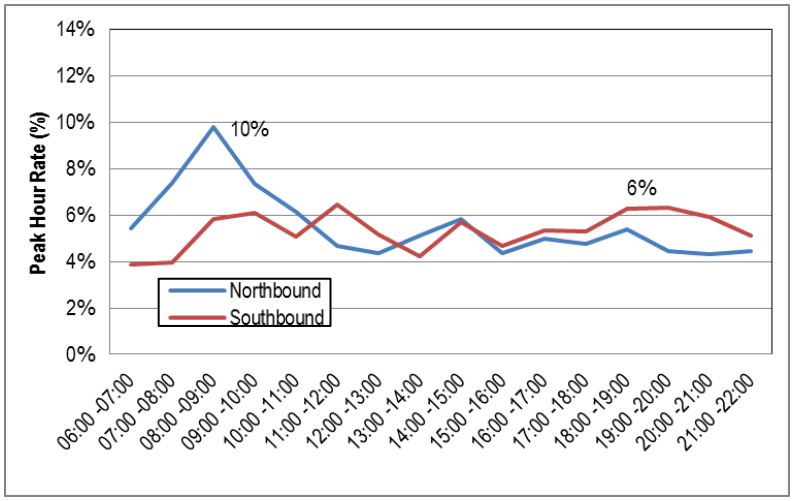
Figure 3.3.5 Location Map of Traffic Count Survey by RSTP Supplement Study

(2) Calculation Method and Its Result

Calculation method is as follows;

- Target transport modes are “Micro Bus/ Mini Bus”, “Standard Bus” and “Large Bus”.
- The hourly number of person trips for each direction.

Hourly trip ratio is shown in Figure 3.3.6 as calculated by above procedure. Peak ratio is 10 % at 8:00-9:00 for eastbound. After this peak time, there is no clear peak or off-peak and it looks similar pattern between eastbound and westbound. Peak time for westbound is 6 % at 18:00 – 19:00.



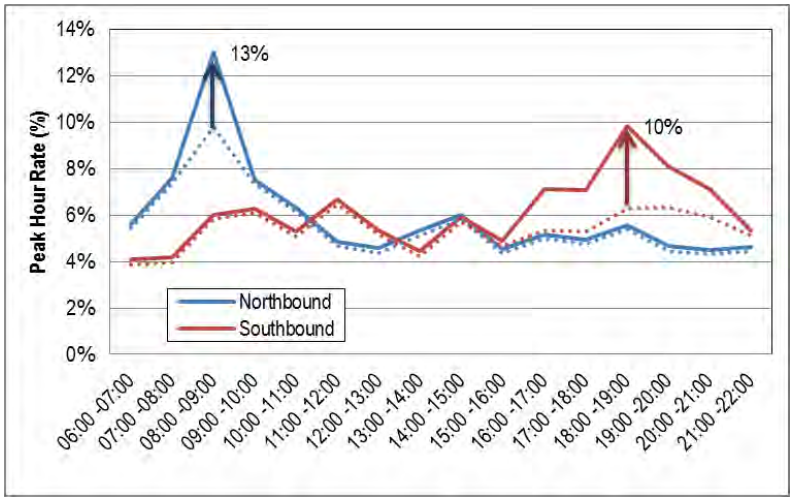
Source: JICA Study Team

Figure 3.3.6 Hourly Trip Ratio (Present)

(3) Hourly Trip Ratio for Train Operation Plan

Current trip ratio as shown in Figure 3.3.6 is applied because MRT will start to operate from 2028. After 2035, several MRTs will be operated. In general, peak ratio increases with the development of urban railway. The peak ratio of MRT Line 6 is set as 13%, therefore the future peak ratio of MRT Line 1 in 2025 and 2035 is assumed as 13% coordinated with MRT Line 6.

Other time of passenger ratio is distributed by increased equally. Regarding southbound, although clear peak time and off-peak time are not shown, symmetry pattern will be seen between northbound and southbound normally. Peak time is 6.3% between 18:00 and 19:00 at present, so this time, it is assumed to be 10%. Figure 3.3.7 shows the adjusted hourly trip ratio.



Source : JICA Study Team

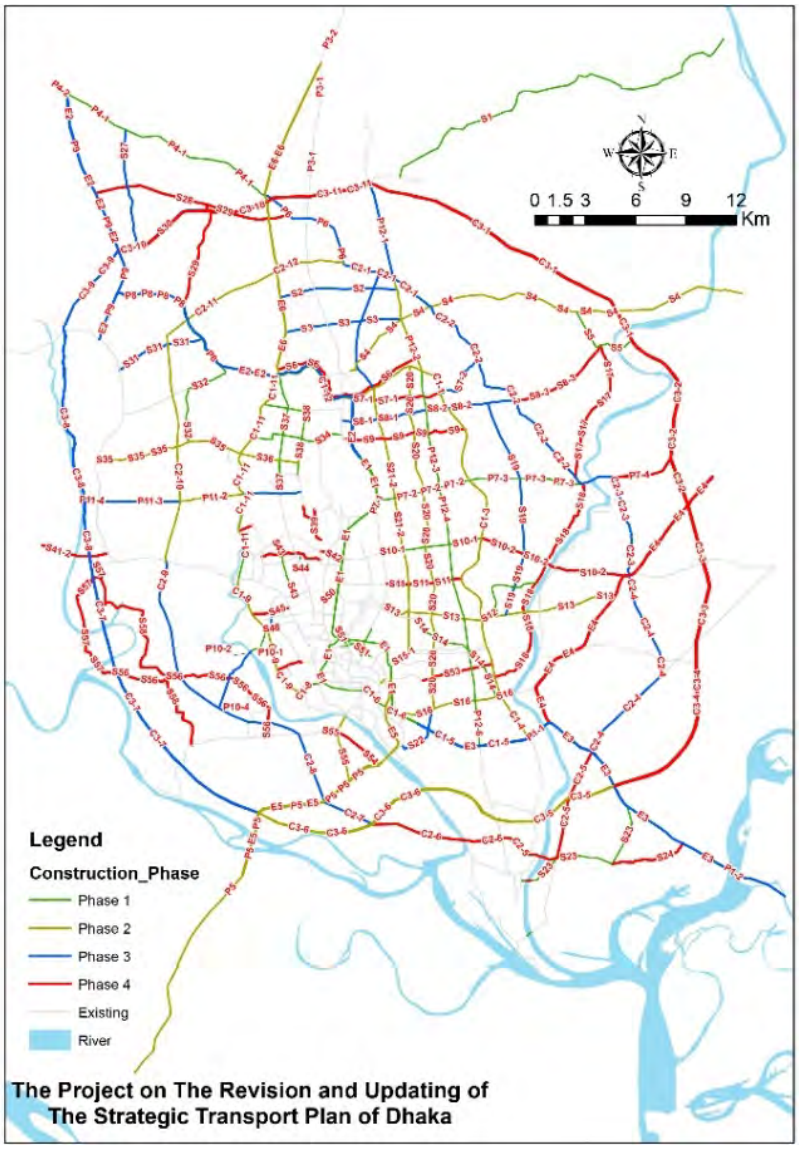
Figure 3.3.7 Hourly Trip Ratio (After 2035)

3.3.3 Network Settings

1) Updating Transport Network

(1) Road Network

In demand forecast, the road network is based on the road development plan proposed in RSTP study. The proposed road network by phase is shown in Figure 3.3.8.



1) Phase 1:2016 – 2020, Phase 2: 2021-2025, Phase 3: 2026-2030, Phase 4: 2031-2035
Source: RSTP Study (2016)

Figure 3.3.8 Road Development by Phase Proposed in RSTP

(2) MRT/BRT Network

Although the mass transit network assumed in the study is consistent with RSTP study, the development roadmap was updated from RSTP. The parts of Route 2 and Route 5 are proposed to be integrated into route 5 and proactively developed as east – west urban transit backbone. The mass transit network proposed in the study is shown in Table 3.3.2 and Figure 3.3.9.