Final Feasibility Study Report (Updated)

Transaction Advisory Services for Upgrading of Gabtoli – Savar- Nabinagar - Bipile into 6-Lane Expressway on PPP Basis

Submitted to: *Public Private Partnership Authority (PPPA) and Roads and Highways Department (RHD), Bangladesh*

Submitted by: *Deloitte Touche Tohmatsu India LLP, BCL Associates Limited and Watermark Incorporation*

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List of Abbreviations

Abbreviation	Full Form
AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ADP	Annual Development Plan
AVL	Automatic vehicle location
AVLS	Automatic Vehicle Location System
BAFO	Best and Final Offer
BBA	Bangladesh Bridge Authority
BC	Binder course
BDT	Bangladeshi Taka
BECA	Bangladesh Environment Conservation Act
BIDA	Bangladesh Investment Development Authority
BIWTA	Bangladesh Inland Water Transport Authority
BLT	Build–Lease–Transfer
BNBC	Bangladesh National Building Code
BOO	Build–Own–Operate
BOOT	Build–Own–Operate–Transfer
BOT	Build–Operate–Transfer
BSEC	Bangladesh Securities and Exchange Commission
BUET	Bangladesh University of Engineering and Technology
CBD	central business district
CBS	Cost Based Selection
CCEA	Cabinet Committee on Economic Affairs
CCEA	Cabinet Committee on Economic Affairs
CIT	Corprate Income Tax
COD	Commercial Operation Date
CP	Check Points
CPI	Consumer price index
CRRI	Central Road Research Institute
DBFO	Design–Build–Finance–Operate
DBFOT	Design-Built-Finance-Operate-Transfer
DoE	Department of Environment
DRT	Demand Responsive Transport
DSCR	Debt Service coverage ratio
DSV	Design Service Volume

Abbreviation	Full Form
DTCA	Dhaka Transport Coordination Authority
DTTILLP	Deloitte Touche Tohmatsu India LLP
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EIRR	Economic internal rate of return
EPC	Engineering-Procurement-Construction
ERP	Electronic Road Pricing
ETC	Electronic Toll Collection
FERA	Foreign Exchange Regulation Act
FPIPP	Foreign Private Investment Promotion and Protection Act
G2G	Government to Government
GDP	Gross Domestic Product
GIS	geographical information systems
GoB	Government of Bangladesh
GPS	global positioning system
HAM	Hybrid Annuity model
IAS	International Accounting Standards
IDC	Interest during Construction
IEE	Initial Environmental Examination
IFB	issuance of Interest for Bids
IFRS	International Financial Reporting Standards
IHMCL	Indian Highways Management Company Limited
IRC	Indian Roads Congress
IRDA	Insurance Development and Regulatory Authority
IRR	Internal rate of return
ISA	Intelligent Speed Adaptation
ITS	Intelligent Transportation Systems
LAD	least available depth
LOS	Level of Service
LRFD	Load and Resistance Factor Design
MoRTH	Ministry of Roads, Transport and Bridges
Mpa	Mega Pascal
NBR	National Board of Revenue
NH	National Highways
NHAI	National Highways Authority of India
NoC	No Objection Certificate

Abbreviation	Full Form
NPCI	National Payments Corporation of India
NPP	National Priority Projects
NPV	Net Present Value
NRTA	Non – Resident Taka Account
OBU	On-board unit
OD	Origin- Destination
OFC	Optical fiber cable
PCU	Passenger Car Unit
PDT	Project Delivery Team
PFI	Project Finance Initiative
PPP	Public Private Partnership
PPPA	Public Private Partnership Authority
PPPO	Public-Private Partnership Office
PPPTAF	Public-Private Partnership Technical Assistance Financing
PSC	Public Sector Comparator
PSI	Pound per square inch
PV	Present Value
QCBS	Quality and Cost Based Selection
RFID	Radio – Frequency Identification
RfP	Request for Proposal
RfQ	Request for Qualification
RHD	Road and Highways Department
RMG	Readymade garments
RoI	Request for Interest
RoW	Right of Way
RTPI	real time information to public transport
RUC	Road user charging
SASEC	South Asia Subregional Economic Cooperation
SCF	Standard conversion factor
SHW	Standard High Water
SHWL	Standard High-water level
SIA	Social Impact Assessment
SLW	Standard Low Water
SMVT	Slow Moving Vehicular Traffic
SPV	Special Purpose Vehicle
SROs	Statutory Regulatory Orders

Abbreviation	Full Form
Tk	Taka
TPC	Total Project Cost
TRRL	Transport and Road Research Laboratory
TTC	Travel time costs
TVC	Traffic Volume Count
UN-ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
VAT	Value Added Tax
VfM	Value for Money
VG	Viscosity Grade
VGF	Viability Gap Financing
VMS	Variable message signing
VOC	Vehicle Operating Costs
VOT	Value of time
VUPs	Vehicular Under Passes
WB	World Bank
WDV	Written down value
WTO	World Trade Organisation
WtP	Willingness to Pay
YoY	Year on year

1. Executive Summary

Dhaka is the center of major economic and industrial activities in addition to being a perspective spot for tourism and cargo transit for Asia. The upgrading of Gabtoli-Nabinagar-Bipile expressway (24.445 km) is a key project that facilitates the intercity movement of cargo and passengers entering the Dhaka city. It is an integral part of National Highway N-5, which plays a strategic and critical role in the transportation network of Bangladesh connecting 28 districts of northern and north-western part of the country with Dhaka City.

The key proponents that have a bearing on the feasibility of the project involved technical planning, costing, revenue predictions and economic returns from the project. Expressway is envisaged to be developed in PPP mode. For project viability analysis, various funding and financing options and mechanisms such as toll, viability gap financing, availability payments and capital grant etc. were analyzed in conjunction with various prevalent models of PPP across the globe and in Bangladesh.

The next few sections bring to the forefront, summary of the study and analysis below:

Project Corridor

The Gabtoli-Savar-Nabinagar-Bipile stretch (24.445 Km, part of NH-5) starts from Gabtoli Bus Terminal on the mid-west boundary of the city area and passes through Aminbazar, Hemayetpur intersection and Savar Bazar and then passes Nabinagar intersection at National Monument Site followed by passing Nabinagar-Chandra R505 (a link between N5 and N4) and ends at Bipile intersection with Abdullahpur-Ashulia-EPZ Road. The road crosses a major river Buriganga at Aminbazar (Gabtoli) and river Bangshi, a distributor of river the Dhaleswari river at Genda, Savar.

It is one of the major urban corridors in the country like the Dhaka-Kanchpur-Chittagong road corridor around the capital region. It serves the entire Dhaka bound traffic from the north and northwest, west and southwest of the country connected with N5 and N7 through Paturia –Daulatdia Ferry and with N4 and N6 through the Bnagabandhu Jamuna Bridge. The proposed gateway is strategically positioned to be connected to the major ports of Bangladesh, Chittagong and Mongla, via the Western Bypass (under planning stage) which leads to N1 (Dhaka Chittagong Highway). Thus, it is poised to provide seamless connectivity between major economic centres of the country.

Traffic Estimations

The estimated traffic on the proposed road (considered as 6 sections) with expected Level of Service (LOS) is enlisted below. These projections are made on the basis of three-pronged approach of Traffic Volume Count (TVC) Survey, Origin–Destination (O-D) Survey and Willingness to Pay (WTP) Survey. Diversions and additions due to competing and complementing projects were also included to arrive at the realistic scenario of traffic over the project duration.

- Section 1 – 50,964 (2022) – 82,863 (2045) with LOS changing from B to C in 2040
- Section 2 – 54,460 (2022) – 87,773 (2045) with LOS changing from B to C in 2040
- Section 3 – 49,113 (2022) – 80,384 (2045) with LOS changing from B to C in 2045
- Section 4 – 36,925 (2022) – 62,259 (2045) with LOS stable at B till 2045
- Section 5 – 53,364 (2022) – 86,223 (2045) with LOS changing from B to C in 2040
- Section 6 – 43,790 (2022) – 71,653 (2045) with LOS stable at B till 2045

Proposed Upgradations

The project is for development of an international standard expressway by ensuring un-interrupted traffic flow with best possible Level-Of-Service (LOS). The following measures are considered for achieving the desired LOS by making a very well analysed balance between the project development cost and the achieving the intended high-grade transport facility without compromising with essential improvements.

S.N.	Present Facility	Proposed Upgrading
1.	Four-lane 'At grade' highway	Six-Lane expressway with 'At-grade' construction in Non-urban stretches and 'Grade Separated' elevated Flyovers in urban and congestion prone stretches.
2	'At-grade' crossings with intersecting roads. This are the causes for interruption in traffic flow, slow travel speed, increased travel time and cost, increasing accident occurrences.	Proposing Vehicular Overpasses at all intersecting roads, for saving travel time by un-interrupted traffic flow and reducing accident possibilities.
3.	No service roads for the local traffic, slow moving traffic and agricultural tractors. Hence there is mixed traffic in the main highway causing slow travel speed, congestion, long waiting by jams, occurrences of accidents.	Continuous service roads on either side of the main expressway by providing height bars restricting plying of commercial vehicles. The service roads shall be 'At-grade' throughout the length and never on elevated structure. Also there shall be separate bridges on the rivers for the service road traffic. At elevated stretches of the expressway, the service roads shall be the existing highway under the elevated flyovers to minimize the construction cost.
4.	There is significant congestion and long traffic signal waiting at Nabinagar Junction.	(i) 4-Lane Tunnel is proposed for traffic coming from and going to the city of Dhaka. (ii) 4-Lane Box-Girder Flyover is proposed for Bipile bound traffic.
5.	The bridges are of 4-Lane configuration on canal at Ch. Km 1+180, on river Bongshi at Ch. Km 9+714, and river Buriganga at Ch. Km 10+248. These bridges have mixed traffic composed of slow moving local traffic and main highway through traffic, causing slow speed, congestion and high damage to the bridge structures.	The proposed bridges are of 6-Lane configuration on canal at Ch. Km 1+180, on river Bongshi at Ch. Km 9+714, and river Buriganga at Ch. Km 10+248, along with separate bridges for service roads separated by crash barriers from the main expressway.

S.N.	Present Facility	Proposed Upgrading
6.	The traffic signs are significantly inadequate.	Traffic signs are to be provided as per Bangladesh and international standards, throughout the entire route.
7.	The road markings are significantly inadequate.	Road markings are to be provided as per Bangladesh and international standards, throughout the entire route.
8.	The pavement structure and surface needs overall re-construction and re-surfacing, otherwise results increased cost by regular maintenance.	The proper design for proposed pavement structure shall reduce maintenance cost and also reduce hazards by causing traffic interruption during frequent maintenance.
9.	For the existing highway the proposed LOS is D or below.	For the up-graded expressway the proposed LOS is B (with slippage to LOS C in the year 2040 at some sections).
10.	For the natural characteristics of Flat Terrain, the drainage, especially during monsoon is not adequate.	In the proposed highway, the drainage and culverts are adequately proposed for ensuring effective drainage during heavy rainfall and flood situations.
11.	Tolling mechanism	The proposed Expressway shall have two toll-plazas throughout its alignment as part of the open tolling mechanism. For tolling mechanism, two options were deliberated upon: • Full Electronic Toll Collection with gantry but no barricading • Full Electronic Toll Collection with barricading (Mix of Tag and Cash Lanes i.e. Hybrid Model) In Bangladesh Tolling technologies are underway. Accordingly, electronic tolling with barricading (mix of tag and cash lanes) is recommended for this project. The technological interventions shall not only provide greater transparency in toll collection but will also cater to both cash and non-cash modes of payment.

The above interventions are expected to improve the traffic speed and travel time as below:

Present Facility	Proposed Upgrading
Present Average Traffic Speed: 30 kmph in Peak Hours and 40 kmph at other times	Expected Average Traffic Speed: 80 kmph during normal hours with 60 kmph during Peak Hours
Present Average Travel Time from Gabtoli to Nabinagar: 120 minutes in Peak Hours and 60 minutes at other times	Improved Average Travel Time from Gabtoli to Nabinagar: 30 minutes during normal hours and upto 45 minutes during Peak Hours

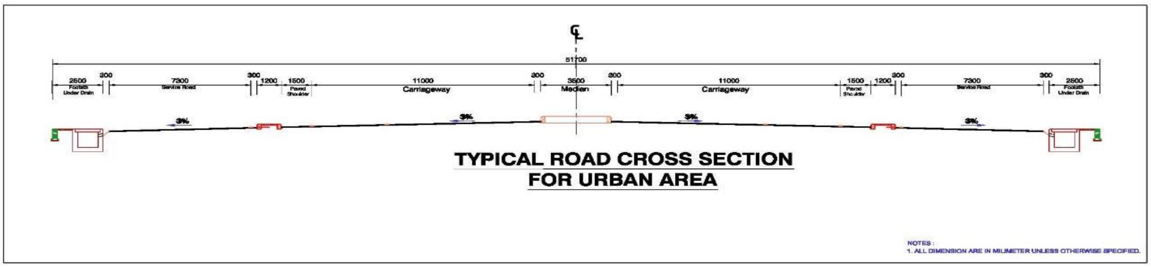
Design Considerations

Principally RHD Geometric Design Standards Manual (Revised) 2005 was followed for design parameters. Besides this, the following reference recommendations and standards have been consulted for references:

- AASHTO "A policy on Geometric Design of Highway and Streets" 2011
- Asian Highway Classification and Design Standards, UN- ESCAP
- Overseas Road Note 6 "A Guide to Geometric Design" published by TRRL 1988.

For traffic signs and road markings, Traffic Signs Manuel 2004, Bangladesh Road Transport Authority (BRTA), was followed.

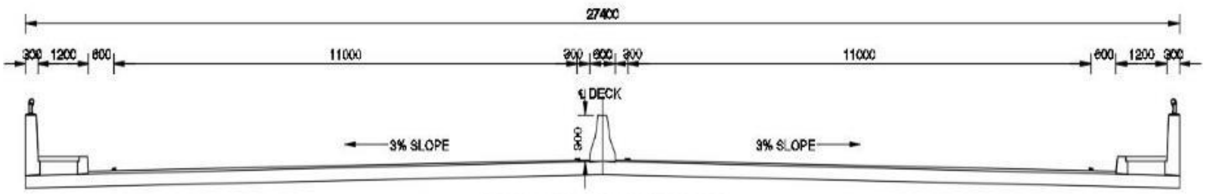
Present Facility	Proposed Upgrading
Median Width	3.5 m (for 6 lanes) throughout for At grade sections
Carriageway Width	11 m for each direction
Breakdown Lane (Paved Shoulder)	1.5 m throughout, all along the carriageway (at at-grade stretched)
Service Road (SMVT)	7.3m for 2 lanes each direction (to facilitate localized traffic
Footpath/ Side drain	2.5m at the end of the SMVT lane, to facilitate pedestrians with covered drains under the footpath
Other Facilities	Crash Barrier throughout (to make access controlled), median fencing



Similarly, below are the design proposed for the bridges:

Type D Flyover system: Considered for three new 6-Lane elevated Flyovers for main expressway:

Elements of Cross Section and dimension on each side of proposed Flyover Centre line	
Half of Central Divider	0.3 m
Shy distance	0.3 m
3-Lane Main Carriageway	11.0 m
Shy distance	0.6 m
Side walk	1.2 m.
Parapet/ railing	0.3 m
Width on each side	**= 13.70 m**
Total width	**= 2 x 13.7m = 27.4 m**

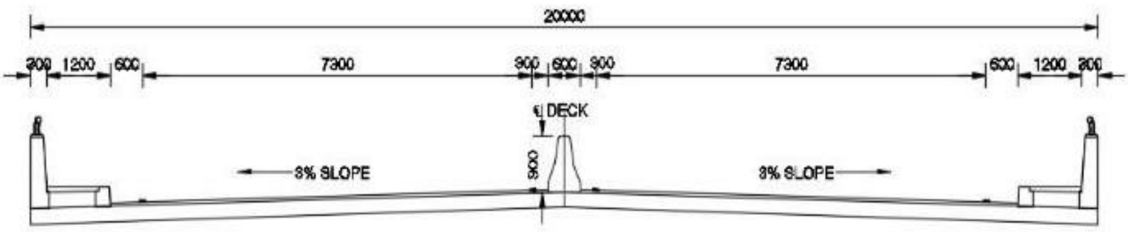


DECK TYPE-D (6 LANE ONLY)
NEW FLYOVER

Type E Flyover system: Considered for one new 4-Lane elevated Flyovers at Nabinagar Junction

Elements of Cross Section and dimension on each side of proposed Flyover Centre line	
Half of Central Divider	0.3 m
Shy distance	0.3 m
2-Lane Main Carriageway	7.3 m
Shy distance	0.6 m
Side walk	1.2 m.
Parapet/ railing	0.3 m

Elements of Cross Section and dimension on each side of proposed Flyover Centre line	
Width on each side	**= 10.00 m**
Total width	**= 2 x 10.0m = 20.0 m**



DECK TYPE-E (4 LANE ONLY)
NEW FLYOVER

Project costs

Basis the above estimated traffic, the project development has been envisaged to accommodate for the growth in PCU numbers over time. The business potential of the developed facility is apparently lucrative in terms of traffic volume/ no. of users, but at the same time the development cost is higher in Bangladesh for developing a similar project in other developing economies.

There are three main components for the expenditures in developing the facility, these are, cost of civil construction, cost land acquisition and cost of utilities relocations along with environment protection. Amongst these three components the cost of civil construction is the major component. The construction costs have been estimated basis the "Schedule of Rates 2019" and the cost of construction of similar projects in Bangladesh. Local availability of materials seem to be a major challenge, which makes import imperative for project development thus increasing development costs.

The Estimated Civil Cost for above configuration is estimated at BDT 4,398.98 Crores at present (year 2019) costs. The operation and maintenance expenses for the operational period of 22 years (2026-2042) including the effect of inflation (considered 5.5%) are estimated to be BDT 3,487.28 Crores (including toll plaza expenses). It should be noted here that for the purpose of financial analysis as a PPP project from the private sector perspective, the Land Acquisition and Resettlement Costs have not been considered as this cost will be borne by GoB/RHD.

Source of Revenues

The project is expected to garner revenues from the user/toll charges that would be levied on the vehicles using the expressway. The vehicles that are expected to use the expressway have been segregated into 8 types depending on the size and axle of the vehicles. These 8 types of vehicles have been considered to be charged different toll rates. These toll rates are essentially a function of the vehicle weight and the pavement damaging potential they have. Toll revenue has been computed for the Operations period of 22 years considering the base Toll Rate of BDT 6 per km. (rounded off to the nearest BDT 5) for a car for the first year of operation with an annual increment of 5.5% annually. Open toll system of tariff is considered in which vehicles have to pay for the entire distance between the two tolls proposed irrespective of their exit points. As per these assumptions, the toll revenue sums up to BDT 7,556.29 Crores and BDT 6,460.99 Crores for toll plaza 1 and 2 respectively. The total tolling revenue is estimated to be around BDT 14,017.28 crores.

Apart from the toll revenues, revenue from advertisement and sign boards has been considered for the project. These revenues have been considered in principle to be adding to the profitability of the project and have thus been included as positive cash inflows for the developer.

Financial Assessment

Financial viability assessment has been undertaken under two business scenarios, one from the self-sustainable model to check the returns from this project on BOT (Toll) basis and others from the perspective of providing reasonable return to the investor/ developer. These scenarios have been defined as below:

- Base Case –The base case has been formulated to assess the financial viability of the project to be undertaken in the BOT – Toll mode (Option 1) and has been assessed from its self-sustainability perspective.
- Additional Cases – Investor perspective: To provide optimum returns to the investors and the concessionaire, multiple PPP options such as:
  - Annuity/availability funding only – Option 2
  - Toll plus Availability – Option 3
  - Toll plus VGF – Option 4
  - Hybrid Annuity – Option 5
  - Hybrid Annuity plus Toll – Option 6

The key financial indicators for the above options are illustrated below:

Particulars	Option 1 – Toll	Option 3 – Toll Plus Availability/ Annuity	Option 4 – Toll Plus VGF
Total Capex	BDT 6,718.65 Crores	BDT 6,718.65 Crores	BDT 6,474.42 Crores
Total Opex	BDT 3,487.28 Crores	BDT 3,487.28 Crores	BDT 3,487.28 Crores
GoB initial Capital Contribution/VGF	Nil	Nil	VGF – 39.73% During Construction - BDT 2,572.29 Crores VGF during O&M – BDT 4,123.82 Crores
Availability Payments	Nil	BDT 16,296.69 Crores	Nil
Equity IRR	0.34%	15%	15%
Project NPV	-2,760.64	1,428.63	2,349.88
Project IRR	3.46%	11.93%	11.81%
Min. DSCR	0.19	1.12	1.18
Avg. DSCR	0.55	1.44	1.43

Particulars	Option 1 – Toll	Option 3 – Toll Plus Availability/ Annuity	Option 4 – Toll Plus VGF
Toll ownership	Private	Private	Private
Total Funding required from GoB/RHD in terms of VGF + Availability	-	BDT 16,296.69 Crores	BDT 6,696.11 Crores
Toll earned by GoB	-	-	-
Net outgo for GoB	-	BDT 16,296.69 Crores	BDT 6,696.11 Crores
Net Outgo of GoB (in NPV terms discounted @7%)	-	BDT 5,794.35 Crores	BDT 3,901.23 crore
Net Outgo of GoB (in NPV terms discounted @8%)	-	BDT 5,098.80 crores	BDT 3,685.06 crore
Net Outgo of GoB (in NPV terms discounted @12%)	-	BDT 3,195.00 crores	BDT 3,029.00 crore

The above comparison lists the differentiating levels of project returns and GoB contribution for options involving toll ownership by private player (option 1), together with toll plus annuity (option 3) and toll plus VGF (option 4). An equity returns of 15% is achievable in option 4 for an VGF contribution of 39.73% during construction and O&M period in accordance with the "Rules for VGF for PPP Projects, 2018", which is even less than the 40% capping allowed by the GoB. The outcomes of some other potential PPP options wherein the toll ownership remains with RHD are illustrated below:

Table 1: Financial Option Analysis-2

Particulars	Option 2 – Availability/ Annuity only	Option 5 – Hybrid Annuity	Option 6 – Hybrid Annuity plus Toll
Total Capex	BDT 6,718.65 Crores	BDT 6,472.81 Crores	BDT 6,472.81 Crores
Total Opex	BDT 3,277.02 Crores (excl. Toll Plaza maintenance)	BDT 3,277.02 Crores (excl. Toll Plaza maintenance)	BDT 3,487.28 Crores
GoB initial Capital Contribution/VGF	Nil	BDT 2,589.12 Crores	BDT 2,589.12 Crores
Availability Payments	BDT 29,021.83 Crores	BDT 18,098.80 Crores	BDT 5,369.57 Crores

Particulars	Option 2 – Availability/ Annuity only	Option 5 – Hybrid Annuity	Option 6 – Hybrid Annuity plus Toll
Equity IRR	15%	15%	15%
Project NPV	1,338.43	2,793.58	3,033.76
Project IRR	11.85%	11.85%	11.98%
Min. DSCR	1.15	0.95	0.90
Avg. DSCR	1.45	1.45	1.45
Toll ownership	RHD	RHD	Private
Total Funding required from GoB/RHD (VGF + Availability)	BDT 29,021.83 Crores	BDT 20,687.93 Crores	BDT 7,958.69 Crores
Toll earned by GoB	BDT 14,017.28 Crores	BDT 14,017.28 Crores	-
Toll Expenses by GoB	BDT 210.26 Crores	BDT 210.26 Crores	-
Net outgo for GoB	BDT 15,214.81 Crores	BDT 6,880.91 Crores	BDT 7,958.69 Crores
Net Outgo of GoB (in NPV terms discounted @7%)	BDT 5,587.05 crore	BDT 3,951.54 crore	BDT 4,157.38 Crores
Net Outgo of GoB (in NPV terms discounted @8%)	BDT 4,938.14 crore	BDT 3,726.12 crore	BDT 3,885.50 Crores
Net Outgo of GoB (in NPV terms discounted @12%)	BDT 3,139.22 crore	BDT 3,045.03 crore	BDT 3,100.01 crore

The above analysis clearly indicates that options 2 i.e. Availability Only and 3 i.e. Toll plus Availability require similar levels of contribution from the GoB in terms of annuity payments i.e. more than BDT 15,000 crores (more than BDT 5,500 crores in NPV terms) in each case. These payments are quite substantial and would cost the exchequer a substantial outflow. Thus, these modes of development are not suggested for a potential PPP structure.

The other options of toll plus VGF, HAM and HAM plus toll, entail a smaller contribution from the GoB than the above options. However, it can be noted that the contribution required in Option 6 is relatively more than the other Option 4 and 5. Whereas the contribution required in Option 4 and 5 are in the similar levels (around BDT 3900 crores in NPV terms).

Hence, the above tables demonstrate that Toll plus VGF and HAM model are both potential options for the PPP project and the authority can consider either of these two options in the implementation phase.

Economic Assessment

The Economic feasibility was also conducted for life cycle costs of project infrastructure between different alternatives: 1) routine maintenance to keep the asset at current LOS and 2) improvement alternative of 6-lane expressway along with 2-lane service lane on both sides and hard shoulders.

The results of sensitivity tests are also robust for all three tests except for combined impacts of Savar-Nabinnagar-Bipile section. The results show that the project will generate sufficient economic returns to stand viable even the capital and construction cost goes up to 15% and traffic benefits reduce by 15%. In those cases, EIRRs are above 12% return on investment. In case of combined joint adverse effects, most of the EIRRs are above 12% except Savar-Nabnagar-Bipile section. The EIRR comes at 11.3% slight below usual cut off rate but above the infrastructure cut off rate of 10% (ADB). This is because of high construction cost per km due to construction of long elevated section along PATC, Jahangir Nagar University, Savar Cantonment, Golf Club and National Monument with a proposed tunnel at Nabinagar. But when we consider over all corridor results of sensitivity tests are found combined EIRR at 16.7% robust and positive. Therefore, even the cost for one section is higher still the project is satisfactorily viable.

Value for Money Assessment

According to a comprehensive VFM analysis, the PPP-Toll+VGF model is the most preferred mode of procurement from the value for money point of view from the government perspective with a VFM net positive benefit of 9.02% of the PSC in comparison to the PPP-HAM model with a VFM net positive benefit of a 8.85% of PSC. While, the Toll+VGF model is the recommended option in terms of its financial returns and commercial viability to the developer amongst other PPP models, the final decision for implementing this project either under Toll+VGF or HAM model would still be taken by the RHD.

Environmental and Social Impact Findings

This IEE study finds that the Project development would cause adverse impacts on the local environment. However, most of them are minor to moderate severity, short term duration, the physical extent within the confined area of protect. Residual impact found to be none, except land acquisition impact and resettlement issues and the permanent alteration of surface water movement during construction of bridges. Again, all of the negative impacts can be reduced, avoided and/ or offset by undertaking mitigation measures defined in the EMP for the project.

The EMP and its mitigation and monitoring programs will be included in the bidding/tender documents as environmental specifications and implementation of which will be binding to the Concessioner through developing and implementing Concessioner's ' Construction Environmental Management Work Plan (CEMWP) or Site Specific Environmental Management Plan (SSEMP) based on the Project's EMP.

This IEE reveals the requirement of EIA study for this project is obligatory to comply the Environmental Conservation Rules, 1997. The EIA will address all relevant likely impacts identified in IEE and proposes a full set of time-bounded mitigation and monitoring actions, including the assignment of responsibilities for the implementation of the Project. The DoE under MoEFCC will grant an Environmental Clearance Certificate for the Project commencement after their approval of EIA report.

Social assessment helps to explain social diversity, reflect relevant gender and ethnic factors and recognize vulnerable groups and identify the structural reasons for their vulnerability. Social impact study involved analysis of the demographics of the influence region specifically their populace, literacy, households, economy and poverty profile among others. The effect of the project on the local populace was studied, the details of which are mentioned in this report.

Way forward

Based on RHD and stakeholder approval, the key considerations of the feasibility assessment report shall be translated in the project bidding documents for approval and roll out for selection of concessionaire.

2. Introduction

Realizing the importance of Infrastructure development as a catalyst in unlocking the development potential of the country, the Government of the People's Republic of Bangladesh (GoB) has been making relentless efforts to enhance transport connectivity and infrastructure development in the country. The GoB has identified and prioritised the Public Private Partnership (PPP) as one of the key initiatives to meet this investment priority. To achieve this, the government has been undertaking a series of measures to create an enabling environment for attracting private investments to deliver high valued projects of national importance. The establishment of PPP Authority (PPPA) has been imperative for accelerating and envisaged pace of PPP development in the country.

Over the years, the GoB has introduced various initiatives for enhancing the transportation network of the country. The road transport has turned out to be the crucial mode in carriage of freight and passenger traffic. While there has been steady expansion of road network, the development of the sector has been under the priority thrust area of the Government to measure up to the demand fuelled by urbanization and increase of vehicular traffic in the country.

In the last few decades, the GoB has focused on building the road infrastructure with the support of various Development Partners (Donors) and has achieved a significant growth in the road transport sector. The Roads and Highways Department (RHD) as a leading infrastructure network development agency catering to over 21,000 kms in the country, has been successful in establishing a corridor-based road network across the country.

The GoB's priority is now on increasing the sectoral efficiency with a special emphasis on leveraging private sector expertise. As a part of a series of initiatives, the upgradation of the Gabtoli-Savar-Nabinagar-Bipile expressway project has been identified as one of the key projects which is expected to contribute directly to the region's socio-economic growth and connect major economic regions by enhancing connectivity to the capital city.

2.1. About the Project

Figure 1 : Images of the stretch

The GoB envisioned the upgradation of of the National Highways (NH) 1 to 8 of Bangladesh to expressways in the coming years. The Perspective Plan of 2010-2021 developed by the Planning Commission states that the priority is now being given to upgradation and maintenance of the existing roads relative to new road construction along with removing the maintenance backlogs and strengthening capabilities in all the aspects of road maintenance.

As part of this strategy, GoB through PPPA has identified the Gabtoli-Savar-Nabinagar stretch (24.445 Km, part of NH-5) for upgradation into expressway on PPP basis.

Dhaka loses approximately 3.2 million business hours daily owing to a slow vehicular traffic speed of 7 kmph, which acts as a major constraint to the economic growth of the region.

In the light of addressing this issue in line with the GoB's strategy of creating an efficient road network, the current project aims to establish a congestion- free, access controlled expressway that enhances connectivity, strengthens trans-regional traffic, and promotes socio-economic development in Dhaka and its adjoining areas.

The key features of the project stretch are as follows:

Table 2 : Key features of the project

Parameter	Description
Alignment	Brownfield – upgradation of existing highway
Project stretch length	22 Km + Extension = Estd 24.445 Kms
Major interchanges	Amin Bazar, Hemayetpur, Savar and Nabinagar
Existing highway dimensions	Expressway having 7.3m width on both sides with 1.2 m median with hard shoulders on both sides and without service roads
Proposed modality of operation	PPP

2.2. Our Role and Current Status of the Progress

PPPA, Govt. of Bangladesh has appointed Deloitte Touche Tohmatsu India LLP (DTTILLP), in association with BCL Associates Limited and Watermark Incorporation, Bangladesh as Transaction Advisors for the Project. The objective of this Engagement is to provide PPP transaction advisory services for upgradation of Gabtoli-Savar-Nabinagar-Bipile stretch into Expressway through undertaking the due diligence of the project section to assess the viability for undertaking this project under the PPP mode by undertaking the following activities:

a) Assessing the technical, commercial, financial, environmental and social viability for the project development

b) Assisting the Government in delivering, designing and implementing the project on a PPP structure

c) Structuring the project, developing a commercial model, assisting in the bidding process and award of the project

The envisaged outcome of the project delivery in meeting the GoB's priorities shall be the successful award of the project in PPP mode to a private player demonstrating an optimal level of technical proficiency, commercial soundness and competitiveness required to implement the project.

The project commenced with the signing of the Contract between PPPA, Bangladesh and Deloitte on 25 June 2019. The services were commenced with a project kick-off meeting with PPPA and the RHD on 11 July 2019.

During the inception stage, a preliminary reconnaissance survey was undertaken to map the key project features, identify project constraints and visually appraise the project stretch. The key observations along with the detailed methodology for delivering this engagement was captured in the Inception Report and submitted to the client on 18, July, 2019.

The next stage of preliminary assessment for arriving at the key considerations and rationale for the project was undertaken which was captured in the preliminary findings report submitted on 22nd August, 2019. It provided the strategic analysis for the project along with an initial assessment of institutional, legal and regulatory framework as well as the mechanisms for undertaking the project in PPP mode. The report also captured an assessment of best practices of similar projects along with an initial site and traffic assessment of the project stretch.

In order assess and arrive at the viability of the project stretch to analyse the business case for undertaking the development on PPP, the detailed feasibility assessment was undertaken by conducting the enabling framework due diligence followed by a detailed traffic, financial and economic analysis for arriving at the PPP structuring option as well as a technical feasibility assessment was conducted for arriving at the design and technical solution for construction, operation and maintenance of the project. The findings and the outcomes of the assessment have been captured in this report. The progress so far is as follows:

The draft feasibility report was submitted and a discussion was held on 9th July, 2020 to appraise and discuss on the findings of draft feasibility report with various stakeholders from RHD. The comments and suggestions provided by the stakeholders during this meeting have been incorporated in this report. The response to the queries raised by the stakeholders has been enclosed with the report as Enclosure-1.

2.3. Coverage and Structure of the Report

The feasibility report is prepared with an objective of conducting the technical, economic and financial analysis for assessing the viability of developing this project in PPP mode. The report assimilates the findings of the assessment. The report is divided into sixteen chapters with the following coverage pertaining to the assessment of the key considerations for the project:

- **Executive Summary:** This chapter provides an overall summary of the key findings to capture the highlights of each chapter of the report.
- **Introduction:** This chapter provides an overview of the project and its objectives, current status of the engagement and a snapshot of the coverage of this study
- **Enabling Framework Due Diligence**: This chapter covers the overview of the legal and institutional framework for PPPs in Bangladesh followed by capturing the key considerations that will facilitate the development of this project which have been divided into:
    - **Legal and Regulatory Analysis:** Provides the key features and considerations of relevant laws, policies and regulations governing PPPs and project development in the country.
    - **Institutional Framework**: Covering the established institutional mechanism that facilitates development and implementation of PPP projects in the country.
- **Project Corridor:** This chapter highlights the key features of the project stretch including the corridor characteristics, influence zones and strategic importance of the corridor.

- **Traffic Analysis and Tolling Mechanism:** This chapter covers the traffic assessment for arriving at the future traffic projections by analyzing various traffic scenarios with traffic survey results and also for assessing the revenue potential along for the project stretch with an analysis of the tolling mechanisms that can be adopted for its operations.

- **Highway Engineering- Preliminary Design:** This chapter captures the technical surveys and engineering assessment for geometric, pavement and structure design considerations to arrive at a technical solution for the development of the project stretch.

- **Source of Materials for Pavement and Structure:** This chapter lists out the source of materials for construction followed in Bangladesh with reference to similar practices prevailing in the country which have further been taken into consideration for arriving at the preliminary project cost for development.

- **Environmental Impact Assessment:** This chapters covers the key aspects, findings and recommendations of the Initial Environmental Examination (IEE) undertaken during the study for the project stretch.

- **Social Impact Assessment:** This chapters covers the key aspects of sociological parameters of the project influence zones undertaken during the study

- **Preliminary Project Cost:** This chapter covers the assumptions and the estimation of quantities of arriving the preliminary project cost.

- **Financial Analysis:** This chapter covers the financial viability assessment and sensitivity analysis for different PPP modes to arrive at the most financially viable option.

- **VFM Analysis:** This chapter captures the VFM analysis for determining its feasibility and value for development with the expected returns to the Authority in the long run in comparison to the public procurement mode.

- **Economic Analysis:** This chapter captures the key findings of the economic analysis to arrive at the economic costs and benefits as well as the improvement options for the project development.

- **PPP Project Structuring:** This chapter covers the assessment of different PPP models to arrive at the key features of the finalized model for development along with appropriate risk allocation between the authority and the private developer.

- **Market Sounding:** This chapter covers the overall framework and approach for undertaking market sounding exercise.

- **Way Forward:** Details out our key considerations, critical success factors and way forward for undertaking the project to the next stage.

3. Enabling Framework Due Diligence

3.1. Scope of Review

A review of the legal and regulatory framework, along with the associated institutional framework for PPPs in Bangladesh was undertaken to arrive at the guiding principles for the implementation and successful delivery of the project by:

- Identifying the prevailing PPP enabling as well as project development framework within the country and analysing their strengths and improvement areas
- Assessing current laws, acts, regulations and policies that ascertain the validity and viability for the project
- Identifying specific areas of concerns that might impede the implementation process and analysing legal regulations pertaining to them
- Identifying potential approvals, permits and licensing requirements
- Assessing the policy framework guiding the project rationale including land acquisition, environment and social frameworks
- Assessing the guidelines and legislations pertaining to the project implementation such as tolling policy
- Assessing and evaluating the appropriate institutional framework in the country taking into consideration of the roles and responsibilities applicable to undertake this project

3.2. Legal and Regulatory Framework

This section details out the legal and regulatory provisions that are relevant to this project. For ease of understanding, the regulations have been classified under various heads including PPP, Procurement, Financing, Taxation & Incentives etc. The laws studied in the respective heads are classified as below:

Table 3 : Legislations and guiding documents

Group	Legislations and guiding documents	Issuing Authority	Project Implications
Public-Private Partnership	The Bangladesh Public-Private Partnership Act, 2015 (The PPP Act)	Parliament of Bangladesh	• Provides overall PPP framework • Classification of projects for PPP execution • Guidelines for project execution • Defines right to levy User Charges
Procurement	Procurement Guidelines for PPP Projects, 2018	Public Private Partnership Authority	• PPP Procurement process, including preparation and execution steps

Group	Legislations and guiding documents	Issuing Authority	Project Implications
			• Guides on project approval and monitoring processes
Financing, Taxation and Incentives	Rules for Viability Gap Financing (VGF) for PPP Projects, 2018	Ministry of Finance, Finance Division	• Guides on financial assumptions including analysis on the means of finance (based on VGF/ Annuity) • Guides on project structuring based on incentives • Guides on financial and regulatory aspects for PPP projects
	Foreign Exchange Regulation Act (FERA), 1947	Parliament of Bangladesh	
	Bangladesh Accounting Standards	Institute of Chartered Accountants of Bangladesh	
	Statutory Regulatory Orders (SROs)	National Board of Revenue	
	Income Tax Ordinance, 1984	Parliament of Bangladesh	
	The Value Added Tax (VAT) Act, 2012	Parliament of Bangladesh	
	Laws on Repatriation for PPPs	Bangladesh Bank	
Banking and Investment regulations	Bangladesh Bank guidelines for Foreign Exchange Transactions	Bangladesh Bank	• Guides on providing inputs for financial, economic and Value for Money (VFM) analysis • Guides on overall project structuring
	Insurance Act 2010 Insurance Corporations Act 2019	Parliament of Bangladesh	
Land Acquisition, Environmental	The Acquisition and Requisition of Immovable Property Act, 2017	Parliament of Bangladesh	• Procedures for land acquisition • Timelines, compensation, roles & responsibilities for land acquisition • Granting of land to concessionaire for
	Land Management Policies of RHD, 2015	Roads and Highways Department	

Group	Legislations and guiding documents	Issuing Authority	Project Implications
and Social Regulations	Bangladesh Environmental Conservation Act, 1995	Parliament of Bangladesh	project development and conditions thereof • Classification of project for environmental assessment and pertaining regulations
	Bangladesh Environmental Conservation Rules, 1997	Department of Environment	• Guidelines for securing Environmental Clearance Certificate
Construction, Operation and Maintenance	RHD Geometric Design Standards Manual (Revised) 2005	Roads and Highways Department	• Guidelines for defining parameters and structure for geometric design
	AASHTO "A policy on Geometric Design of Highway and Streets" 2011	American Association of State Highway and Transportation (AASHTO)	• Guidelines for defining parameters for design of the pavement
	Asian Highway Classification and Design Standards, UN-ESCAP	United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP)	• Guidelines for defining operational and maintenance specifications
	Overseas Road Note 6 "A Guide to Geometric Design" published by TRRL 1988.	Transport and Road Research Laboratory (TRRL)	
	AASHTO Guide for Design of Pavement Structures 1993	American Association of State Highway and Transportation (AASHTO)	
	IRC 37-2018: Guidelines for design of Flexible Pavements	Indian Roads Congress (IRC)	

Group	Legislations and guiding documents	Issuing Authority	Project Implications
Traffic and Tolling	Manual Classified Traffic Counts Instruction Guide, RHD (October 2001)	Roads and Highways Department	• Guidelines for Classified Traffic Volume count (TVC) surveys • Passenger Car Unit (PCU) conversion factors • Estimation of Design Service Volume and Maximum Capacity for Project sections • Socio-economic indicators for Traffic Forecasting exercise • Estimation of Level of Service for the Project sections • Establishment of tolling mechanism and revenue projections
	Geometric Design Standards for RHD, October 2000	Roads and Highways Department	
	Statistical Year-Book Bangladesh 2018	Bangladesh Bureau of Statistics	
	National Toll Policy, 2014	Roads and Highways Department	
	The PPP Act, 2015	Parliament of Bangladesh	
Company Regulation	Companies Act, 1994	Ministry of Commerce, Government of Bangladesh	Outlines the regulations for incorporation of a project company

3.2.1. Public-Private Partnership Laws and Regulations

This section details out the laws, regulations, policies and guidelines that govern the PPP framework and environment in Bangladesh. Primarily, the Public-Private Partnership Act (PPP Act) enacted in 2015 governs PPPs across sectors and forms the basis for executing the projects in PPP mode. It also defines the powers and responsibilities of the PPPA, sources for funds, and the mechanism for taking up and approving projects. Further, the PPPA has also issued procurement guidelines as well as financing and taxation guidelines applicable for PPP projects detailed out below.

3.2.1.1. The Bangladesh Public-Private Partnership Act, 2015 (The PPP Act)

The Bangladesh PPP Act, 2015 was enacted and gazetted on 16 September, 2015 and acts as the guidance document for undertaking projects under the PPP framework across the country.

The PPP Act has been defined as "An Act to provide for the legal framework for creation of public-private partnerships by involving private sector

participation along with public sector and attracting local and foreign investment upon connecting Bangladesh with the global economy to ensure extensive investment in infrastructure in different sectors in order to fulfil the basic needs of the people of Bangladesh and to expedite socio-economic development in the interest of improvement of their living standard, and for establishment of a reliable Authority in this behalf and the matters ancillary thereto".

- **Eligible Sectors under the Policy framework:** While the initial framework developed in the Policy and Strategy for PPP, 2010 defined the specific sectors eligible for PPP, the PPP Act, 2015 defines a prescriptive approach which entitles the relevant contracting authority to enter into a PPP contract for the construction or reconstruction of Infrastructure. Further, it defines **"Infrastructure"** as any new or existing physical or non-physical infrastructure in the public sector through which public goods or public services or both are created or provided.

  Under this definition, the Gabtoli-Savar-Nabinagar-Bipile project stretch can be classified as an Infrastructure project facility and regulations applicable for such projects shall be applicable to our project stretch.

- **PPP Models under the policy frameworks:** Although no specific types of PPP contracts are explicitly defined under the PPP Act and relevant regulations, as per the document "Your Guide to PPP in Bangladesh" published by PPPA, the different contractual models for PPPs in Bangladesh have been defined as below:

  - Joint Venture and partial Divestiture;
  - Concessions, Build–Operate–Transfer (BOT), Build–Own–Operate–Transfer (BOOT), Build–Own–Operate (BOO), Project Finance Initiative (PFI), Build–Lease–Transfer (BLT) , Design–Build–Finance–Operate (DBFO);
  - Leases and Affermages; and
  - Management and Operating Contracts

- **Project Size for a PPP Project :** While the initial framework developed during the Policy and Strategy for PPP in 2010 classified PPP projects by investment size into small, medium and large projects, the current PPP Act and procurement guidelines do not specify any differentiation of project sizes based on any defined threshold limits of capital / investment requirements.

- **Contracting Authority:** The PPP Act defines **"Contracting Authority"** as (a) any Ministry or Division, or any office or directorate or department under the Ministry of Division, or corporation or statutory body, local government, or any similar organization; or (b) the PPPA. Hence, in accordance with Section 23 of this Act and the definition as provided above, the RHD, being a Department under the Ministry of Road Transport and Bridges (MoRTB), is authorised to enter into a Contract/ Concession Agreement with the selected Preferred Bidder/ Concessionaire.

- **Incorporation of an SPV for a PPP Project:** Section 22 of the PPP Act states the need for incorporation of a project company to execute the PPP project. It provides flexibility to the Preferred Bidder to incorporate such project company generally referred to as a Special Purpose Vehicle (SPV), limited by shares in accordance with provisions of the existing laws related to company formation, either prior to or after execution of the PPP Contract.

It also states that all the rights and obligations of the private partner shall be assigned to the project company after signing of the PPP Contract. The PPP Act, however, does not state any defined procedures to transfer all rights and obligations to the project company if such a company is incorporated post signing of the PPP Contract. In general, if the Project Company is not incorporated by the time of signing of the PPP Contract, the Preferred Bidder (being each Consortium Member in the case where the Preferred Bidder is a Consortium) will enter into the PPP Contract and the Project Company will execute and accede to the PPP Contract upon incorporation. This may be done by executing a substitution agreement with the Contracting Authority. However, as a best practice the SPV should be incorporated before signing of contract.

- **Right to levy user charges**: Section 29 of the Act provides the right to the private partner/ Concessionaire to impose a levy in accordance with the PPP partnership contract (the contract executed between the Contracting Authority and the project company) in exchange of the supply of public goods and services. It shall include tariff, toll, fee or charge and the mechanism for fixation and adjustment shall be specified in the PPP Contract executed.

- **Risk Allocation**: As stipulated under Section 26 of the PPP Law, it has been stated that the PPP contract that shall be entered into by the Contracting Authority and the Concessionaire shall also include the optimal allocation of risks between both the parties determined for that particular PPP project.

  Furthermore, during the PPP screening process, it is also assessed whether the risk matrix has been completed to show the indicative appropriate risk allocation for undertaking any project under PPP. The PPP Screening Manual (2013) issued by PPPA also includes a "typical risk allocation matrix" which acts as a guiding rationale for developing the risk allocation for PPP projects.

- **Dispute Resolution and Enforcement Mechanism:** Section 30 of the PPP Act stipulates a dispute resolution procedure in order to enhance investor protection which includes amicable settlement, mediation and arbitration.

  The PPP Act expressly provides that disputes arising from the application or interpretation of the provision of the PPP agreement would be settled through mutual agreement between the parties; or, if the dispute is not settled, intervention of a neutral expert mediator would be resorted to and, if the dispute is not resolved by the neutral expert mediator, it would have to be referred to arbitration.

  Furthermore, disputes may only be settled as described above irrespective of other acts or enactments and the venue for arbitration would be in Dhaka. However, in special circumstances through mutual agreement, the venue may be in other countries as well. At the same time, remedy from national or international courts cannot be sought before an attempt to resolve the dispute under the dispute resolution process as set out in the PPP Act, as it takes precedence over any acts or enactments. Bangladesh has also signed and is a part of the New York Convention on the Recognition and Enforcement of Foreign Arbitral Award.

- **Termination and Compensation:** The PPP framework of Bangladesh does not expressly regulate material adverse government action, force majeure, or change in law. Furthermore, Chapter 6 of the PPP Act on terms and conditions of partnership contract does not specifically state that the contract shall contain provisions for grounds for termination. However, the coverage under this chapter of the Act is not exhaustive, and compensation for such events can be negotiated within the contractual terms agreed between the parties in the PPP Contract on mutual agreement basis.

Project Considerations
The PPP Act forms the outline of the PPP framework applicable for undertaking PPP projects in the country. The Act, however, does not specify the list of PPP models and related guidelines for execution of projects in the country in comparison to sector specific and PPP model specific guidelines prevalent in countries like India. This implies that a project specific approach has to be adopted pertaining to the sector and nature of infrastructure development to be undertaken on PPP. We shall undertake this through conducting a best practices assessment during the development of the PPP agreement. However, there needs to be an integration and streamlining of the approach amongst various executing agencies in order to avoid any conflict amongst various government organizations.

3.2.2. Procurement

3.2.2.1. Procurement Guidelines for PPP Projects, 2018

The procurement of the Concessionaire/ Project Company is regulated by the Procurement Guidelines for PPP Projects, 2018 issued by the PPPA . The procurement guidelines define processes, timescales and institutional roles and responsibilities, and an overall mechanism to select and award the PPP project to the preferred bidder. In concurrence with the project preparation and bidding life-cycle, the guidelines have been divided into four phases i.e. Identification, Development, Bidding and Approval & Award. The guidelines for each of the phases as mentioned above, along with the observations and project implications have been detailed under the following sections.

It is pertinent to note that these guidelines are not applicable to projects classified as National Priority Projects (NPP) and those being implemented under Government to Government (G2G) partnership. Additionally, in cases where the project is funded (50% of the financing to undertake the PPP project) by a donor agency or other international agency/ government/ fund, these guidelines shall not apply.

- **Consortium for Bidding**: As defined in the guidelines, a Consortium shall include a lead member and up to four non-lead members unless any exemption is provided by the PPPA. It also defines a lead member as a member who has at least 26% equity shareholding in the consortium and will be the largest shareholder who is authorised by all consortium members to be responsible for the bidding process on behalf of the consortium. The guidelines also define a non-lead member as a member who has entered into an agreement with the remaining Consortium Members to subscribe to at least 10% of the equity in the project company.
- **Identification Phase**: This phase essentially involves the project identification stage wherein the project to be executed under the PPP model is identified from the Government's Annual Development Plan (ADP) or otherwise, by the Contracting Authority/ PPPA. The project so identified by the Contracting Authority is appraised to the Applicable Line Ministry, who on finding the project suitable based on detailed analysis sends it to PPPA for project screening. After PPPA endorsement, the project is sent to the Cabinet Committee on Economic Affairs (CCEA) for In-Principle Approval. In addition to project identification, the Contracting Authority/ PPPA may also

undertake a pre-feasibility study of the project prior to appraising the project before the CCEA.

- **Development Phase**: During the development phase, the Contracting Authority with the support of PPPA, shall determine the feasibility of the project by testing the overall viability of the project in order to finalize the scope and commercial structure of the project to be implemented on PPP Basis. As per Section 13 of the guidelines, the feasibility study shall, at minimum, cover the following aspects:

  a) Technical issues;

  b) Commercial and financial considerations;

  c) Environmental factors;

  d) Social issues;

  e) Linked projects; and

  f) Any other issues which may be deemed relevant by the PPPA or the Contracting Authority

  To undertake the Feasibility Study, as per Section 14 of the guidelines, the Contracting Authority may appoint a transaction advisor/ consultant, or any other internal/ external expert. In doing so, the Contracting Authority/ PPPA shall follow the Public Procurement Act 2006 and Public Procurement Rules 2008.

  In order to facilitate and fast-track the project progress, a Project Delivery Team (PDT) and a Project Assessment Committee (PAC) is constituted. While the PDT is constituted by the Contracting Authority, the PAC is constituted by the PPPA and contain at least five members.

  The feasibility study is approved by the Contracting Authority post receipt of feedback from PPPA, who review the same through PAC.

  Additionally, in order to solicit feedback from the market in relation to the project, the Contracting Authority may instruct for a Request for Interest (ROI) process, subject to concurrence of the PPPA.

- **Bidding Phase**: During this phase, the Contracting Authority process and approve the applications, proposal or bids submitted in response to the bid documents

  Bidding Process: The Contracting Authority choose the type of bidding process based on the instructions of the PPPA or any other Acts, Rules, Policies, Guidelines or Notifications issued by the PPPA pursuant to the PPP Act. The bidding process can either be a single stage bidding or a two stage bidding. They are detailed as under:

  - Single Stage Bidding: The single stage bidding comprises of issuance of Interest for Bids (IFB) only. As a part of this, the bidders are required to register and become a registered entity in order to submit bid. The bidder is then required to submit the technical and financial bid in two separate envelopes. Based on the evaluation of the technical bid, the financial bid of technically qualified bidder is opened. Based on the evaluation of the financial bid, the preferred bidder is then selected.

  - Two Stage Bidding: The two-stage bidding comprises of issuance of both the Request for Qualification (RFQ) and the Request for Proposal (RFP). The RFQ is issued to shortlist the bidder that meet the basic qualification criteria (which may include the technical and financial criteria). In accordance with these guidelines, a maximum of five bidders are then shortlisted. The RFP is issued only to the shortlisted bidders to submit their technical and financial proposals.

Bidding Documents : The bidding documents (including the draft PPP Contract) is prepared by the Contracting Authority based on the outcomes of the feasibility study, market feedback and on the model documentation issued by the PPPA (where available), and as amended from time to time. These draft bidding documents shall be submitted to PPPA for its concurrence prior to issue. The PPPA shall review the draft bidding documents through the PAC, who shall provide feedback that may be taken into consideration by the Contracting Authority. Upon obtaining concurrence from the PPPA, the Contracting Authority shall finalise and issue the document, after taking into account the observations of PPPA. The Contracting Authority may use an online data room in order to share documents and communicate with applicant or bidders.

Evaluation Process: The Contracting Authority, after obtaining concurrence from the PPPA, follows either a Quality and Cost Based Selection (QCBS), or a Cost Based Selection (CBS) method. While the QCBS method considers both the technical and financial scores of the pre-qualified bidders for evaluation, a CBS method considers only the financial score of the technically qualified bidder who is shortlisted on the basis of pass/fail criteria in conformance to the technical criteria specified in the RFP or in some instances only the financial bid invited from the pre-qualified bidders shortlisted during the RFQ stage. In case of tie bids, the method of Best and Final Offer (BAFO) shall be used to select the preferred bidder. As a part of BAFO, the bidders shall be asked to re-submit their bid (technical or financial or both) and based on the outcome of evaluation of revised bids, the preferred bidder shall be selected. Moreover, the Contracting Authority may, subject to concurrence of the PPA, indicate a minimum and maximum ceiling within which the financial bids must be placed.

The guidelines also set out the minimum timelines that shall apply in relation to the bidding and processes, which are as below:

- IFB: The bids submitted shall be received within a minimum of 42 (forty-two) Days from issue of the IFB document.
- RFQ: The applications submitted shall be received within a minimum of 28 (twenty-eight) Days from the issue of the RFQ document.
- RFP: The proposals submitted shall be received within a minimum of 42 (forty-two) Days from the issue of the RFP document

The Contracting Authority, in order to secure maximum participation, shall appropriately advertise the RFQ or IFB in accordance with the guidelines.

The guidelines further list down the procedures that shall be followed for bid process including eligibility, treatment of tie bids, bid security, pre-bid meetings, bid opening, evaluation committees, negotiation including terms and conditions pertaining to confidentiality, conflict of interest and grievance redressal mechanism.

- **Approval and Award Phase**: This is the final stage upon achievement of which, the project shall be awarded to the preferred bidder. During this phase, the legally vetted PPP Contract shall be sent to the CCEA for final approval and the Contracting Authority with the support of the PPPA shall issue the Letter of Award (LoA) to the Preferred Bidder. The legal vetting may have been carried out by the Legislative and Parliamentary Affairs Division of the Ministry of Law, Justice and Parliamentary Affairs in relation to the specific PPP Project or the PPP Project may have been based on previously legally vetted model documentation in which case no further legal vetting will be required.

The LoA shall be issued within four weeks following receipt of CCEA approval. However, this timeline may be extended upon concurrence of the PPPA.

Project Considerations
The procurement guidelines outline the framework for selection of the Concessionaire/ project company that shall execute the project. In terms of the current engagement, the upgradation of Gabtoli-Nabinagar-Bipile has been identified by RHD for which the PPP pre-feasibility study was undertaken by the PPP Cell of RHD which proposed the development with the support of Government ADP and VGF on BOT Toll model. For the way forward, the procurement guidelines however throw limited light on the constitution of the bidder (partnership, limited by shares/ guarantees, JVs etc.). In case of two stage bidding, the guidelines state shortlisting of a maximum of five bidders for the second stage, which limits competition and may lead to increased procurement costs for the Contracting Authority. Additionally, in case of tie-bids, the BAFO methods have been proposed. The guidelines throw limited light in case of re-tie at the BAFO stage. These guidelines will be customized and agreed upon with PPP and RHD in order to design the procurement process for this project. In the case of the ongoing Transaction Advisory engagement for Improvement of Hatirjheel [Rampura Bridge]–Shekherjaiga– Amulia–Demra Road on PPP, a two stage bidding process has been proposed by RHD. It includes RFQ stage shortlisting based on technical and financial capacity of the bidders followed by the RFP stage which includes submission of technical proposal and financial proposal. The technical evaluation is based on technical completeness and mandatory conformance to the RFP requirements on pass/fail criteria and in meeting those requirements, the financial evaluation is defined by opening and scoring of the financial bid for the selection of the final bidder. The Technical Proposal includes: Commercial Structure- Equity and shareholder agreements, Contracting Structure and Subcontracting arrangements Project Control Plans – Approach and methodology including Traffic Management Plan, Project Safety Plan, Construction Management Plan, Quality Control Plan, Highway Maintenance Plan, Highway Operations Plan and Toll Collection & Management Plan Concept Designs : Roadway Design and Structural Design The Financial Proposal includes : • Quoted Based Availability Payment • Financial Model • Funding Commitment Based on the assessment of the existing practices of the PPP projects being undertaken in Bangladesh across sectors and on the basis of best practices assessment, the approach will be customized to best suit the requirements for this engagement.

3.2.3. Finance and Taxation

3.2.3.1. Rules for VGF for PPP Projects, 2018

The rules for Viability Gap Financing for PPP Projects have been published by the PPP Unit, Ministry of Finance on 17 October 2018. These rules have been enacted to implement PPP projects with high economic and social viability but limited financial viability or to maximize the Value for Money (VFM). The rules state certain key definitions that shall have significant impact on PPP projects, and are as under:

"Equity Contribution" means the share capital contributed by the shareholders of the Project Company or other forms of funding provided by the shareholders to the Project Company including shareholder loans

"Total Estimated Capital Cost" means the total cost of designing, constructing and commissioning a project including capital expenditures, consultancies, capitalized interests, contingencies, margins, overheads, applicable government charges and taxes as determined through a Detailed Feasibility Study

"Total Estimated Project Cost" means the aggregate of the Total Estimated Capital Cost and the cost of operation including maintenance, management, consultancies, interest, contingencies, margins, overheads, applicable government charges and taxes

"Viability Gap Financing" or **"VGF"**, means a direct subsidy by way of capital grant and/ or annuity payment provided under these rules.

In accordance with Clause 3 and Clause 5, the VGF can be provided in the form of either a grant or annuity, or both.

- VGF in the form of capital grant shall be disbursed during the construction phase on a pro rata basis with the Equity Contribution subscribed and expended by the private sector company for each agreed project construction milestone. The VGF in this form only shall not exceed forty percent (40%) of the Total Estimated Capital Cost
- VGF in the form of annuity shall be disbursed on a periodic basis during the period when the Project Company provides service after the commencement of operations (after achieving COD). The VGF in this form only shall not exceed forty percent (40%) of the Total Estimated Project Cost.
- The total VGF in both forms (capital grant and annuity) shall not exceed forty percent (40%) of the Total Estimated Project Cost.

Additionally, as per clause 8 of the rules, the Contracting Authority shall submit the VGF proposal to the PPPA in the prescribed format (along with Form A, B and C), certifying with reasons that:

- Tariff or user charge cannot be reasonably increased to eliminate or reduce the viability gap or enhance project viability
- Project term cannot be reasonably increased for reducing the viability gap or enhancing project viability
- Total Estimated Capital Cost and Total Estimated Project Cost are reasonable and are based on the standards and specifications and they shall not be further restricted for reducing the viability gap

In case the project is approved for VGF, the PPP Unit of Finance Division, the Lead Financial Institution and the Project Company shall enter into a tripartite agreement for the purposes for disbursement of the VGF.

In case the PPP model of Hybrid Annuity Mode (HAM) is envisaged for this project, the Contracting Authority will not be able to source funding under the VGF scheme.

3.2.3.2. Government's support in terms of guarantees and payment mechanism

Government Guarantees: The PPP regulations are silent on the provision of government guarantees. As per Asian Development Bank's (ADB) report on PPPs in Bangladesh, in practice, a number of energy generation projects received payment guarantees under Power Purchasing Agreements (PPAs). There is a need to further explore this for development of priority sectors.

Availability based payments: PPP regulations are silent on the possibility of an availability-based payment method. In practice, most of the energy generation projects have been implemented on an availability payment basis under PPA in Bangladesh

In terms of road sector, a road PPP project (Improvement of Hatirjheel [Rampura Bridge]–Shekherjaiga– Amulia–Demra Road) is proposed to be developed on an availability-based payment mechanism. Its significance and impact in terms of applicability of its provision for the development of a particular project needs to be evaluated.

As on date, no PPP project has been undertaken under HAM model in Bangladesh. With the emerging scope for PPPs in the country, this model can be explored for development of economically important projects in Bangladesh.

3.2.3.3. Insurance Laws

In accordance with Section 16 of the Insurance Corporations Act 2019, this project shall be designated as a public property and Fifty percent (50%) of the insurance shall be placed with the Sadharan Bima Corporation and the remaining fifty percent (50%) of such business shall be placed with the private insurers. Additionally, in accordance with the Insurance Act 2010, no person shall insure outside Bangladesh any risk in respect of property or interests in Bangladesh unless a certificate has been issued by Insurance Development and Regulatory Authority (IRDA) either granting an exemption or certifying that the risk in question cannot be insured in Bangladesh.

We understand that the PPPA has been liaising with IDRA in order to obtain an exemption from the local insurance market applicable to all PPP projects. This shall aid the foreign companies in securing their assets and debt in line with policies of foreign investors. However, as informed, this exemption may take some time and is unlikely to be obtained in near future.

3.2.3.4. Guidelines for foreign investments

In order to boost private sector investment and draw foreign investments into PPP projects, the GoB has liberalised policies and guidelines for investors. The Foreign Private Investment Promotion and Protection Act (FPIPP ACT), 1980 is the key law which enables the government to regulate foreign investments, and provides a fair and equitable treatment for foreign investors which covers the provisions in relation to expropriation and foreign exchange. The GoB allows for full ownership (100%) of the Project Company in order to execute projects under PPP, except for certain reserved sectors. Additionally, Bangladesh Bank in Chapter 9 of the Foreign Exchange Guidelines has issued guidelines for foreign investments in Bangladesh. An entity carrying out a project in a non-reserved sector may therefore be set up in collaboration with local investors or may be wholly owned by the foreign investors. Therefore, the selected private partner can be a local entity, an entity with 100% foreign ownership, or partially foreign-owned local entity.

The foreign investors are free to make investments in Bangladesh, expect for few reserved sectors, and they do not require permission from the Bangladesh Bank to set up such ventures provided they use their own funds to do so.

However, in order to avail facilities and institutional support provided by the Government, they may secure registration with Bangladesh Investment Development Authority (BIDA). Additionally, prior permission of the Bangladesh Bank is not required for issue of shares in favour of non-residents against foreign investment in Bangladesh; general permission is accorded in this behalf subject to the following conditions:

- The venture will have permission from the Registrar of the Joint Stock Companies and Firms (RJSCF)/ The Bangladesh Securities and Exchange Commission (BSEC) about its capital issue.
- Shares may be issued either against freely convertible foreign exchange brought in from abroad through banking channel or against import of capital machinery.

Clause 3 of this chapter of the Foreign Exchange Guidelines also lays down the guidelines for remittance of sale proceeds of non-residents' investment in Bangladesh. These can be by sale of shares of public limited companies listed with stock exchange, shares of the public limited companies not listed with stock exchange and private limited companies. The guidelines are as follows:

- **Public listed companies**
  Prior approval of Bangladesh Bank is not necessary. In such cases, the repatriable amount must not exceed the market price of securities prevailing in the stock exchange on the date of sales.
- **Public limited companies not listed and private limited companies**
  Prior approval of Bangladesh Bank is required for repatriation of sale proceeds. There being no established market price for such investment, Bangladesh Bank will accept fair value of the shares as on date of sale based on appropriate combination of the three valuation approaches (viz. net asset value approach, market value approach and discounted cash flow approach) depending on the nature of the company. If the Bangladesh Bank does not conceive the submitted value as fair, it may undergo re-valuation to arrive at a fair value.

Project Implications
The valuation of shares during the sale of equity is imperative to secure investor interest. In a case where the investor may look to sell its' share in the Project Company upon finding successful buyer during the operations phase, the stake sale shall be a function of the demand and supply, and valuation as perceived by the market. Appropriate clauses shall be inducted in the Concession Agreement to cover these aspects.

3.2.3.5. Guidelines for general banking

In accordance with the guidelines issued by the Bangladesh Bank, the Authorized Dealers (AD) can open the Non – Resident Taka Account (NRTA) in the name of the proposed company of foreign investors that shall invest in Bangladesh, without prior approval of Bangladesh Bank for the purpose of inward remittances received from abroad only. Upon registration/ commencement of the business, a new account in the name of the company may be opened following usual procedures. However account opened previously should be closed immediately and balances lying therein shall be transferred to the new account.

The ADs may further open convertible Taka accounts in the name of foreign organizations, foreign contractors and consultants engaged for specific projects under the Government/ Semi-Government agencies.

These convertible Taka accounts may be credited with foreign currency brought in or remitted from abroad or transferred from a foreign currency account or another convertible account. No money emanating from a business originating in Bangladesh and otherwise repatriable to Bangladesh can be credited to these accounts. A convertible Taka account may be debited for payments in foreign currency abroad, for local expenses, for transfers to foreign currency accounts or other convertible Taka accounts or for credits to a non-convertible Taka account.

For the purposes of this project, Non-convertible Taka accounts are not recommended as they bear restrictions on foreign remittance.

Project Implications
As per the guidelines issued by Bangladesh Bank, money earned from business in Bangladesh (the road asset in our case) cannot be credited in the convertible taka account. In such a case, the project company, being a locally incorporated will be able to operate and maintain bank accounts in Bangladesh. It shall open an account in which the revenue from the project, in terms of either toll receipts or annuity, can be credited. **Additionally, according to Foreign Exchange Regulation Act (FERA), 1947 and guidelines issues by Bangladesh Bank, in order to remit funds outside Bangladesh, permission from the Bangladesh Bank shall be required. These approvals may take time and hamper the project progress. As an alternative, the PPPA may liaison with the Bangladesh Bank to provide exemption to the projects being executed under PPP in this regard.**

3.2.3.6. Guidelines for loans, overdrafts and guarantees

The guidelines for loans, overdrafts and guarantees is governed by Chapter 16, Section 1 of the Foreign Exchange Guidelines. For the purpose of these guidelines, a company is deemed to be controlled directly or indirectly by persons resident outside Bangladesh:

1. if it is a branch office of a company incorporated outside Bangladesh;
2. in the case of partnership, if
    a. 50% or more of the capital of the partnership is owned by foreign nationals or,
    b. the majority of the partners are foreign nationals; and
3. in case of companies incorporated in Bangladesh, if
    a. 50% of the shares or more are owned by foreign nationals or,
    b. 50% or more of the directors in the Board of company are foreign nationals. In the case of equal share holding or equal representation on the Board of

Directors, a company is deemed to be foreign controlled if its Chairman is a foreign national.

Grant of credit facilities in Taka to non-residents, to companies (other than banking companies) controlled directly or indirectly by persons resident outside Bangladesh and to residents against guarantees or collateral lodged outside Bangladesh, are all regulated under sections 3, 4, 5, 18 and 20 of the FERA Act.

In accordance with Chapter 9 of the Foreign Exchange Guidelines and guidelines of BIDA for foreign loans, prior approval from the Bangladesh Bank shall be required for Public Limited companies not listed and Private Limited companies.

The ADs are not allowed to grant Taka loan against overseas guarantees or collateral outside Bangladesh without prior approval of the Bangladesh Bank.

ADs may issue Taka guarantees on behalf of foreign or foreign controlled companies/firms operating in Bangladesh in favour of residents in Bangladesh: (i) against 100% cash deposit and/or where the guarantee is required to be submitted with tender documents in lieu of earnest money deposit, subject to the condition that validity of the guarantee issued in lieu of earnest money will be limited to the period within which the decision regarding acceptance or rejection of the tender is taken, (ii) against adjustment of the amount from the overdraft limit, if any, allowed to the company/firm concerned.

ADs may without prior approval of Bangladesh Bank, issue guarantee, bid bond or performance bond in foreign currency on behalf of a non-resident firm/company favouring residents in Bangladesh provided a back to back guarantee covering the guaranteed amount from an overseas correspondent or other bank abroad is held by the AD. In all other cases, ADs shall require prior approval from Bangladesh Bank for issuing such guarantees.

All proposals for borrowing from abroad by private sector industrial enterprises in Bangladesh (including supplier's credits, financial loans from institutions or individuals and debt issues in capital markets abroad) shall require prior authorisation of BIDA (Chapter 15, Paragraph 1 of the Forex Guidelines).However, short term credit accommodations of up to one year duration from suppliers/buyers abroad are, however, subject to the guidelines/instructions issued by Bangladesh Bank in regard to settlements for current commercial transactions.

Pursuant to Existing Procedure and Guidelines for Approval of Foreign Private Borrowings (Foreign Private Borrowings Guidelines), industrial enterprises in the private sector incorporated under the Companies Act 1994 and registered with BIDA are eligible for obtaining foreign borrowing from recognized lenders subject to approval of Foreign Borrowing Scrutiny Committee. Foreign borrowings refer to commercial loans including financial loans, bank loans, buyer’s credit, supplier’s credit from institutions or individuals and debt issues in the capital market abroad, etc. The Foreign Private Borrowings Guidelines provide that the borrowers can raise the foreign borrowings from internationally recognized sources such as:

i. International banks, international capital markets, multilateral financial institutions (such as The World Bank-WB, ADB etc.);

ii. Export credit agencies; and

iii. Suppliers of equipment; and

iv. apart from these, approval of borrowing from foreign equity holders and their concerned interests will be accorded sparingly, only by way of short term bridging arrangements.

It is further provided that the interest rate and other charges related to the foreign borrowing should be reasonable compared to the prevailing lending rates at the international markets in the concerned currencies for the relevant tenure. Such foreign borrowing will be allowed only for investment (such as import of capital goods for new project, modernization/expansion of existing production units) in industrial sector including small and medium enterprises as well as infrastructure and priority sector announced from time to time.

Project Implications
The issuance of loans and guarantees by ADs and other banks to foreign companies is imperative considering the nature of the project. For construction projects, bank guarantees typically ranging from 1-5% are required to act as securities against performance and cover the risk of the Contracting Authority in case of adverse events. **The provisions of issuance of counter-guarantees by ADs based on foreign guarantees promotes international competition, and aids in overall sectoral development. Detailed clauses w.r.t guarantees in local and foreign currencies shall be covered as a part of the bid documents and the contract agreement to provide clarity to the bidders and avoid disputes.**

3.2.3.7. Laws on Repatriation

The FERA Act defines the roles and responsibilities of Authorised Dealers to remit and receive foreign payments from resident/ non-resident in and outside Bangladesh. Under the provisions of Section 5 of the FERA Act, only in accordance with any general or special exemption from the relevant provisions which may be granted conditionally or unconditionally by the Central Bank of Bangladesh, any person in or resident of Bangladesh make any payment to any person resident outside Bangladesh or on behalf of any person resident outside Bangladesh. If no general exemption is available for any payment to or for the credit of any person resident outside Bangladesh, then the AD through which the payment is to be made applies for special permission to Central Bank of Bangladesh.

According to the incentives provided to the investments in PPP projects, full repatriation of the capital invested from foreign sources will be allowed. Similarly, profits and dividend accruing to foreign investment may be transferred in full. If foreign investors reinvest their dividends and/ or retained earnings, those will be treated as new investment.

3.2.3.8. Bangladesh Accounting Standards

Bangladesh has adopted the International Accounting Standards (IAS) and International Financial Reporting Standards (IFRS) across the country for accounting and financial reporting purposes. In order to undertake financial analysis and economic assessment, the same have been used.

3.2.3.9. Statutory Regulatory Orders (SROs)

The GoB is offering fiscal incentives to PPP investors with the aim of reducing the cost of implementing the project and enhancing the viability of the project. The GoB has issued SRO - 208, 209 and 210 that outline the income tax incentives applicable to multiple project stakeholders involved in undertaking a PPP Project. The SROs along with incentives are as follows:

1. **S.R.O 208 Law/Income Tax/2017**: The project organization shall receive 100% exemption on income tax for the 10 years from the start of its Commercial activities (operation)
2. **S.R.O 209- Law/Income Tax/2017**: The project organization will get 100% exemption on income tax for the 10 years from the start of its commercial activities (operation) for the following :
    a. Income tax raised on capital gains of capital share transfer
    b. Income tax on paid royalty and technical knowhow or technical assistance fee to manage the particular PPP project, for the 10 years from the start of its commercial activities
3. **S.R.O No 210- Law/Income Tax/2017**: The appointed foreign technicians of the project organization will get 50% exemption on income tax for three years from the appointment date.

These incentives shall act as a catalyst to draw investment from the private sector in executing PPP projects.

3.2.3.10. Income Tax Ordinance, 1984

According to the Income Tax Ordinance published in 1984, the Government of Bangladesh has been mandated to enter into Double Taxation Treaties and hence, prevent fiscal evasion with respect to taxes on taxable income as computed under this ordinance and under the corresponding law in force in that country. Bangladesh has double taxation avoidance agreement with 33 counties, including South Asian nations. Entering into these agreements is a signal to the international community a spirit of openness and willingness to adopt internationally accepted tax standards.

The corporate tax rates as applicable to foreign owned locally incorporated is 35% of the taxable income, post allowable deductions in accordance with relevant laws and accounting standards. As the concessionaire shall be subject to income tax exemption in accordance with the SROs No 208, 209 and 210 (as detailed above), the tax shall be levied only after 10th year of operation. However, the computation of tax shall also be done by appropriately reviewing Section 82C of this Act, which details the minimum tax applicable.

3.2.3.11. The VAT Law, 2019

The relevant law in Bangladesh in relation to Value Added Tax is the Value Added Tax and Supplementary Duty Act, 2012 (“VAT Act 2012”). Although the VAT Act 2012 was passed in the year 2012, all the provisions of VAT Act 2012 have been enacted from 01 July 2019. As a result, the previous Value Added Tax Act 1991 (“VAT Act 1991”) has become ineffective. Moreover, through issuance of SRO No. 170- Law/2019/27-VAT dated 13 June 2019 (“SRO No. 170”) all the rules, orders, notifications and notices under VAT Act 1991 and VAT Rules 1991 have been repealed.

As per VAT Act 2012, value added tax shall be imposed and payable on the taxable import and taxable supply and unless otherwise provided, the rate of VAT is fifteen percent (15%). The VAT Act 2012 defines "taxable import" as any import, other than an exempt import and "taxable supply" as a supply other than an exempted supply, which is made in Bangladesh by any person registered or required to be registered through the process of economic activities. Moreover, “supply" has been defined as any supply including supply of goods, supply of immoveable property, supply of services or a combination of the three types of supplies.

Recently, pursuant to Special Order No: 11/MUSHOK/2019 dated 13 June 2019, the National Board of Revenue ("NBR") has exempted VAT for private investment in PPP projects in relation to the services of 1. Construction Firm (Service code S004.00); 2. Consultancy firm and supervisory firm (S032.00); 3. Procurement Provider (Except petroleum) (S037.00); and 4. Lawyer (S045.00) under the following conditions:

a. PPPA have to take certification from an appropriate person in Prime Minister's office.

b. In the certificate, the investors' name, address, VAT registration number, approved PPP project name, project details, project duration and if the aforementioned service is related to the PPP project, that should also be clearly mentioned.

c. A copy of the certificate should be sent to NBR by PPPA

Under the recently published Special Order for exemption, the project proponent shall be liable for VAT exemption.

Project Implications
The VAT incentives shall act as a mechanism to attract private sector investments to undertake infrastructure projects under PPP. Imposition of VAT on the project and its components could have increased the cost of the project and made it less viable in terms of margins sought by the private sector. Clarifications in this regard in the Concession Agreement shall be provided to extend maximum benefits of the VAT incentives to the Concessionaire, its applicability in terms of retrospection.

3.2.4. Land Acquisition, Environmental and Social Assessment

3.2.4.1. The Acquisition and Requisition of Immovable Property Act, 2017

The Ministry of Land has been entrusted with the responsibility for acquisition and requisition of land that shall be acquired for government organization or private person. The Acquisition and Requisition of Immovable Property Act 2017 governs the land acquisition for government purposes. For the purposes of the Act, the following terms have been defined:

- Acquisition means acquiring the ownership and possession of any immovable property for any requiring person or organization in exchange for compensation or rehabilitation or both
- Owner means and includes the owner or a person who is legally in possession of the immovable property
- Immovable Property means any land and any permanent thing affixed therein

The Acquisition process shall be initiated by the Deputy Commissioner when it appears that any property in any locality is needed for any public interest, and shall cause a notice to be published at convenient places on or near the property. Generally, religious places, graves or crematoriums can be taken into acquisition.

Under the relevant section of the Act, the Government shall act and take final decision based on the report of the Deputy Commissioner. It is pertinent to note that a clear evidence shall be produced at all stages that the land being acquired shall be for public purposes only.

Provision for Compensation under the Act

Based on the decision to acquire the property, the Deputy Commissioner shall, within seven days from the date of making award of compensation-

- Give notice of his award to the person interested (land owner) ;
- Send the estimate of the award of compensation to the requiring persons or organizations.

The Requiring persons or organization shall pay the estimated amount within 120 working days after receiving the estimation. In determining the amount of compensation to be awarded for any property to be acquired, the Deputy Commissioner shall take into consideration:

- the market value of the property at the date of publication of the preliminary notice of acquisition shall be determined by the average value of the properties of similar description and with similar advantages in the vicinity during the twelve months preceding the date of publication calculated in the prescribed manner;
- the damage that may be sustained by the person interested, by reason of the taking of any standing crops or trees which may be on the property at the time of making of the joint list;
- the damage that may be sustained by the person interested, at the time of taking possession of the property by the Deputy Commissioner by reason of severing such property from his other property;
- the damage that may be sustained by the person interested, at the time of taking possession of the property by the Deputy Commissioner, by reason of the acquisition injuriously affecting his other properties, movable or immovable, in any other manner, or his earnings;
- if in consequence of the acquisition of the property, the person interested is likely to be compelled to change his residence or place of business, the reasonable expenses, if any, incidental to such change;

While the government is acquiring land, it shall provide the persons interested with compensation of 200 per centum of the market price. Provided that if the government acquires the land for any non-government person then the amount of compensation shall be 300 per centum. In cases of injuries made under relevant sub-sections of the Act, additional 100 per centum compensation shall be provided.

On making of an award, before taking possession of the property, after the submission of the estimated amount of compensation by the requiring persons, the Deputy Commissioner shall pay the aforesaid compensation within not exceeding 60 days from the date of deposit by the requiring persons.

When the compensation mentioned in the award has been paid or is deemed to have been paid in pursuance of the Act, the property shall stand acquired and vest absolutely in the Government free from all encumbrances, and the Deputy Commissioner shall thereupon take possession of the property. Immediately after the acquisition of the property, a declaration by the Deputy Commissioner to that effect shall be published in the official Gazette.

It is also pertinent to mention that no award made under this Act shall be chargeable with stamp duty, and no person claiming any interest under any such award shall be liable to pay any fee for a copy of the same.

Project Implications
Land acquisition is considered one of the major hurdles while executing an infrastructure project. As the road project is executed along the length in technically feasible zones, the requirement of land is large, and forms one of the major money outflow stream for the government. The huge amount of land acquisition often leads to public protests, environmental concerns and has massive cost implications on government resources. **In order to secure the interest of investors (especially the financial institutions), it is imperative to acquire substantial part of the land before the project is brought to the market for execution. As a best practice, it is advised to acquire around 95% of the project land pre-tendering, securing risks of the investors and thus increasing project competition and viability. Additionally, effective design shall be put in place to minimize land acquisition. The design should also focus on effective solutions for tolling (in case of tolled roads) as the Right of Way required to build the toll plazas (in case of barrier base tolling) is generally more than the overall Right of Way.**

3.2.4.2. Land Management Policies of RHD, 2015

The Land Management Policies of RHD 2015 have been reviewed with respect to the right to lease the land to the project company to build infrastructure, and terms and conditions thereof. The Policy primarily covers the management aspects of the RHD owned land. The policy talks about issues such as -

- The Right of Way (RoW) of the existing highways can be used for the installation of water/gas/optical fibre/electricity/telephone lines.
- The RHD owned land may be used for development works such as the installation of passenger sheds/sculpture.
- The RHD owned land may be leased on a temporary basis for providing entry to commercial institutions, residential plots or for building pit-stop, fish farming, agricultural purposes, billboards etc. and the rates of lease rental applicable.

However, the PPP arrangements, whereby the Private Party will be responsible for constructing roads on government owned land, have not been covered in the Land Management Policy.

Project Considerations
For the purpose of defining the PPP arrangement, the issue of grant of Right of Way and the conditions thereof shall be appropriately addressed in the PPP Contract. Additionally, in order to meet the terms and conditions of the lenders, the stand on and terms & conditions for creation of charge on the revenues generated from assets shall also be addressed in the PPP Contract.

Government’ support to Land acquisition and resettlement for PPP Projects:

According to ADB Report on PPPs- 2019, the GoB’s support for PPP projects may also take the form of acquisition or requisition of land, resettlement of populations, or the provision of utilities. Examples where the government was responsible for land acquisition are the Bibiyana 300–450 MW Gas-Fired Combined Cycle Power Project and the Dhaka Elevated Expressway PPP Project.

According to The World Bank's Benchmarking of PPP Procurement in Bangladesh 2018, the procuring authority spends an average number of approximately 270 calendar days obtaining permits, land, and/or right-of-way required under the regulatory framework. Addressing and fast-tracking this process is crucial for accelerating the development of PPP projects in the country.

3.2.4.3. Bangladesh Environment Conservation Act (BECA), 1995

The Bangladesh Environment Conservation Act 1995 is the act governing environmental protection. The main objectives of Act are conservation of the natural environment, improvement of environmental standards and control as well as mitigation of environmental pollution. Section 5 of the Act empowers the Government to declare an area as ecologically critical if it is satisfied that an area is in an environmentally critical situation or is threatened to be in such a situation. Additionally, Section 12 of the Act states that no industrial unit or project shall be established or undertaken without obtaining, in the manner prescribed by rules, an Environmental Clearance Certificate (ECC) from the Director General. This Act lays down the foundation for the Bangladesh Environment Conservation rules which define the procedures to obtain such ECC.

3.2.4.4. Bangladesh Environment Conservation Rules, 1997

The Bangladesh Environment Conservation Rules 1997 consists of a set of rules that have been formulated to implement and enact the BECA 1995 across the country. It details out the environmental approvals and processes for various project types and provides allowable limits for environmental disturbance or pollution discharge / emissions.

The rules classify projects based on the nature of the establishment, site and their impact on the environment. Based on the above, the projects can be classified into the following categories:

- Green
- Orange – A
- Orange – B
- Red

The exhaustive list of the projects for each category have been provided in the rules. For the purpose of our analysis, we shall detail out the categories relevant to our project. In accordance with Schedule – 1 of the rules, our project components can be classified as below:

Table 4 : Classification of project components in environment categories

S.No.	Project Component	Category
1	Stone grinding, cutting and polishing	Orange – B
2	Construction, re-construction and extension of road (feeder road, local road)	

S.No.	Project Component	Category
3	Construction, re-construction and extension of bridge (length below 100m)	
4	Public toilet	
5	Engineering works, capital above 10 (ten) hundred thousand Taka	Red
6	Exploration/ extraction/ distribution of mineral resources	
7	Construction/ re-construction/ expansion of road (regional, national & international)	
8	Construction/ re-construction/ expansion of bridge (length 100m and above)	

In accordance with the rules, for projects falling under Orange – B and Red categories, firstly a Location Clearance Certificate and thereafter an Environmental Clearance Certificate (ECC) shall be issued. Exception in this regard can be granted by the Director General who, if he deems fit, may directly issue Environmental Clearance Certificate for the project.

The validity period of the Environmental Clearance Certificate shall be one year from the date of its issuance for Orange – B and Red category projects. Each ECC shall have to be renewed at least thirty days before the expiry of its validity period.

Project Implications
The project stretch is an urban stretch having densely populated areas neighbouring the project stretch. In such a scenario, it becomes imperative to put in place a comprehensive system to minimise the harmful effect of construction on public health. **It is pertinent to state that at the terminal point at Nabinagar, there is the National Martyr's Monument, which is a monument of national significance. In order to protect the monument, the authorities may require the concessionaire to follow specific guidelines that may be applicable to ecologically critical/ sensitive areas. Stringent measures may have time and cost implication on the project.**

3.2.5. Construction, Operation and Maintenance

The framework for technical design and development standards that have been studied are as follows which have been detailed out in the Technical Assessment chapters under geometric design and pavement design sections:

1. RHD Geometric Design Standards Manual (Revised) 2005: The manual published by RHD acted as a guide for understanding and analysing road design aspects to arrive at the technical solution for the project.
2. American Association of State Highway and Transportation Officials (AASHTO) "A policy on Geometric Design of Highway and Streets" 2011 and AASHTO Guide for Design of Pavement Structures 1993: These international guidance documents provided technical considerations of international standards for designing and incorporating the key aspects into our technical analysis for finalizing the geometric and pavement designs.
3. Asian Highway Classification and Design Standards, UN- ESCAP: This international guidance document provided technical design considerations of Asia pacific highways for arriving at our highway design parameters.
4. Overseas Road Note 6 "A Guide to Geometric Design" published by TRRL 1988: The note acted as a guide for understanding and analysing geometric design aspects for our project.
5. IRC 37-2018 - Guidelines for design of Flexible Pavements: This document published by IRC, India describes the guidelines for design of flexible pavements which has been adopted for arriving at the technical design considerations for the project.

3.2.6. Traffic and Tolling

3.2.6.1. Traffic

The framework for traffic analysis have been arrived by considering the following guiding documents which have further been detailed out in the traffic analysis and tolling mechanism chapter:

1. Manual Classified Traffic Counts Instruction Guide, RHD (October 2001) : Mandated by the RHD as a reference document to plan, design, and conduct a manual classified traffic volume count on urban and rural roads of Bangladesh. It specifies the format of the questionnaire, description of the data to be collected, survey methodology, and associated tasks.
2. Geometric Design Standards for Roads & Highways Department, October 2000: This document acts as a guide for understanding and analysing road design aspects. In relation to this report, the standards have been consulted to calculate PCU values for the vehicle categories provided in National Toll Policy, 2014.
3. Indo-Highway Capacity Manual (2018), CSIR-CRRI, New Delhi: This document has been published by CRRI, India and describes the capacity of roads under various conditions similar to Bangladesh. In context of this report, the standards published in this report have been taken as reference material to estimate the capacity of the proposed Expressway under various scenarios of traffic and project design.
4. Statistical Year Book Bangladesh 2018: This report is published by the Government of Bangladesh as a compendium of all major economic indicators for the year 2018.

Various indicators presented in this publication have been considered for analysis to project the economic strength and its forbearing on transportation, and ultimately to project vehicular traffic on the proposed Expressway for multiple scenarios.

3.2.6.2. Tolling

The tolling framework in Bangladesh is governed by the National Toll Policy 2014 and the PPP Act 2015. Both of these define the toll regime that shall apply to the PPP projects.

According to Clause 7.7 of the National Toll Policy 2014, the process of imposition and collection of tolls and the rate of tolls to be imposed on an infrastructure which is constructed on a PPP basis, shall be fixed as per the agreement executed between the Government and the investor.

The relevant toll provision from the PPP Act 2015 has been detailed in section 3.2.2.1 of this report. Reiterating, Section 29 of the Act provides the right to the private partner/ Concessionaire to impose a levy in accordance with the partnership contract (the contract executed between the Contracting Authority and the project company) in consideration of the supply of public goods and services. It shall include tariff, toll, fee or charge and the mechanism for fixation and adjustment shall be specified in the PPP Contract executed.

Project Considerations
Drawing from the relevant regulations, based on the outcomes of traffic surveys (including WTP) and similar projects being undertaken, the toll rates shall be decided and levied, and the same shall be made a part of the Contract Agreement. In addition, the detailed mechanism to collect, formula for computation and provisions for increase shall be explicitly detailed in the Contract Agreement.

The basis for tolling mechanisms and relevant implications have further been detailed out in the traffic analysis and tolling mechanism chapter.

3.2.7. Company Regulation

3.2.7.1. Company Law, 1994

The constitution/ incorporation of a company in Bangladesh is governed by the Companies Act, 1994.

An incorporated company can either be a public company (having minimum 7 members) or a private company (having minimum 2 members), with the following constitutions:

- A company limited by shares: A company having the liability of its member limited by the memorandum to the amount, if any, unpaid on the shares respectively held by them; or
- A company limited by guarantee: A company having the liability of its members limited by the memorandum to such amount as the members may respectively thereby undertake to contribute to the assets of the company on the event of its being wound up; or
- An unlimited company: A company having no limit on the liability of its members

In accordance with Section 22 of the PPP Act, the preferred bidder shall incorporate a project company limited by shares in accordance with provisions of the existing laws related to company formation. The PPP Act, however, provides flexibility to the preferred bidder to incorporate either a public or a private company. The key features of constitution are tabulated below:

Table 5 : Key features of constitution for an entity

Type of entity	Max allowed foreign ownership	Minimum Paid up Capital	Minimum no. of Shareholders	Max no. of Shareholders
Private Limited	100%	$1	2	50
Public Limited	100%	$1	7	N/A

3.3. Institutional Framework for PPPs

The institutional framework with the designated specialized roles in the process of development & implementation of PPP projects in Bangladesh explained below is crucial for determining the success of the project. The integration of the roles for ensuring effective implementation of the project is possible through enhanced coordination and streamlined efforts of the institutions.

Overview of the current institutional framework – Our guiding rationale for the project

The overall current institutional framework for PPPs which shall act as a guiding mechanism for our project has been illustrated in the figure below:

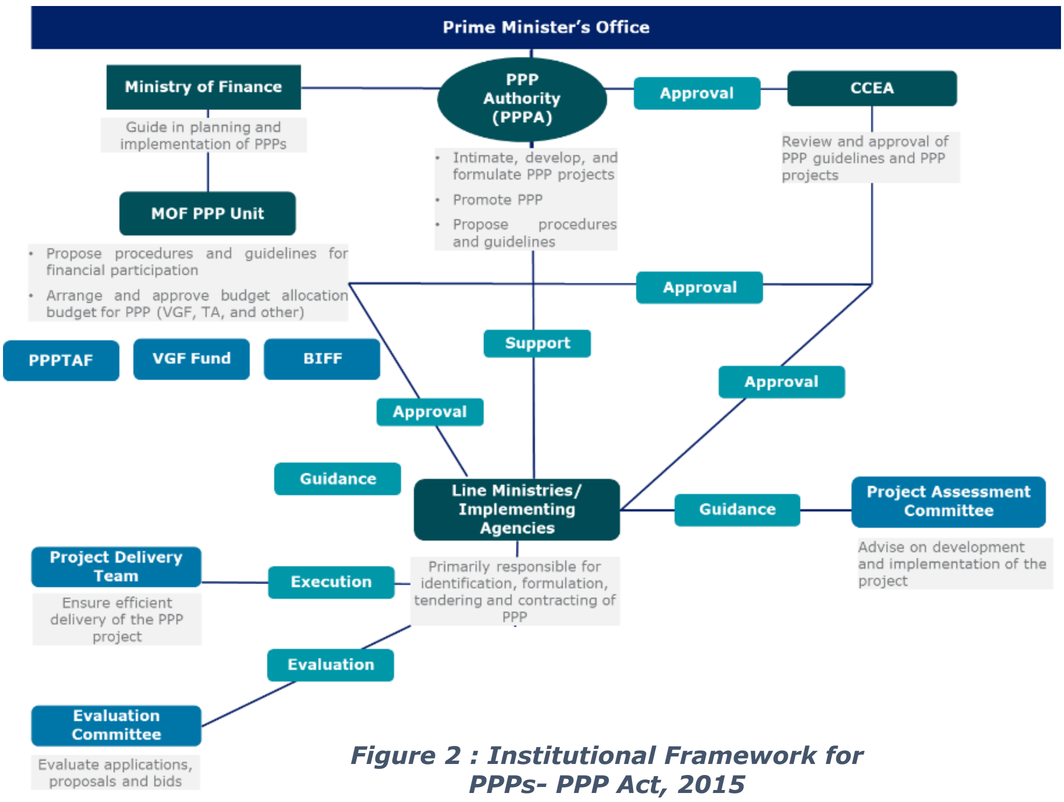


Figure 2 : Institutional Framework for PPPs- PPP Act, 2015

Governing and approving authorities: For facilitating PPPs in the country, the institutional mechanism has the following key governing and approving institutions:

- **CCEA:** Providing approvals and guidance for undertaking PPP program in the country
- **Planning Commission :** For planning and approving PPP allocation through Annual Development Program
- **PPP Unit- Finance Division :** For facilitating financing of PPP projects

The CCEA is the apex approving authority for undertaking any PPP development in the country, by providing the in-principal and final approval for a PPP project to contracting authority. This approval allows the authority to enter into a contract with the preferred bidder and/or the project company. CCEA approvals for approving the feasibility and contractual documents for going forward to the procurement stage will be the decision-making factor for this project.

Whereas, the PPP unit under the Finance Division will play a key role in terms of finalization and approval of the financing mechanism for the project. Its role involves overseeing the fiscal viability of PPP projects and sanctioning funding/financing support for their development including managing three key funds under GoB: the Public-Private Partnership Technical Assistance Financing (PPPTAF), viability gap fund and Bangladesh Infrastructure Finance Fund.

PPPA: For facilitating PPPs in the country, a Public-Private Partnership Office (PPPO) that was established under the PPP Policy, 2010 has been institutionalized as a statutory authority named PPPA in 2015.

The key objectives of the authority are to facilitate development of sustainable public service infrastructure projects and promoting increased flow of private investment by creating a legal and regulatory framework for building confidence among private investors.

Governing and Management Structure of PPPA: The overall management and administration of the PPPA is vested in the Board of Governors with the following organization structure:

Table 6 : Management Structure of PPPA

Chairperson – Prime Minister
Vice Chairperson- Finance Minister, Ministry of Finance
Members
• **A Minister nominated by the Prime Minister** • **The Minister or State Minister of the Ministries concerned with the Project** • **Principal Secretary to the Prime Minister and Chairman – Member Secretary**

The PPPA had also developed a network of focal points at all relevant Line Ministries in order to support the processing of PPP projects and has now also started the process of establishing PPP cells at selected Agencies who were developing multiple PPP projects in the country.

It is of paramount importance that the role of PPPA shall be pivotal for delivering this project on PPP. The role of the Project Delivery Team and Project Assessment Team created through PPPA will be significant for undertaking and implementing this project successfully.

Powers and functions of the Authority: For the successful progress and implementation of this project to be developed on PPP, the role of the authority defined under Section 9 of the PPP act is as follows:

- Promulgating, approving, publishing PPP related policies, regulations, directions, and guidelines;
- Providing decisions on the financial participation and provision of incentives for PPP projects by Government;
- Providing necessary direction to the contracting authority;
- Resolving any constraints and providing opinion on matters relating to PPP Projects;
- Framing and approving technical and best practice requirements, pre-qualification and bid documents;
- Approving the selected bidder for PPP projects and executing and signing PPP contract;
- Reviewing and monitoring the progress of the PPP project; etc.

With the PPP framework evolving in the country over the last few years, there is a need to customize project specific guidelines for undertaking PPPs in the country. Any suggestions on the policy framework or procurement guidelines to be considered for this engagement based on best practices, shall be approved by the PPPA for incorporation. It shall also act as a guiding framework for future projects in this sector.

In addition to the institutionalization of the PPPA, the following committees are established for any particular project as per the Guidelines for PPPs, 2018:

PDT: As per Guideline 11, on receipt of in-principal approval for a project, the PPPA shall communicate with the Contracting Authority to form a Project Delivery Team (PDT) led by a Project Director to ensure smooth development and delivery of the PPP Project. The PDT shall ensure timely development, administration, management, coordination, execution, monitoring and reporting on the progress to the Authority.

PAC: As per Guideline 13, the PAC is established by the PPPA for each project on the receipt of the in-principal approval from CCEA. It shall include members from PPPA, Line Ministries and the Contracting Authority for conducting a review and providing recommendation on the development and implementation of the project including feasibility study, Draft IFB document/PPP Contract, Draft tender documents and other relevant procedures during tender process.

A PDT under Mr. Zikrul Hassan as the Project Director along with RHD officials – Md. Tanvir Hossain, Sahana Firdaus, M Roknuzzaman and Meraj Rubayat Kamal supported by PPPA officials has been formed for ensuring the development and implementation of this project.

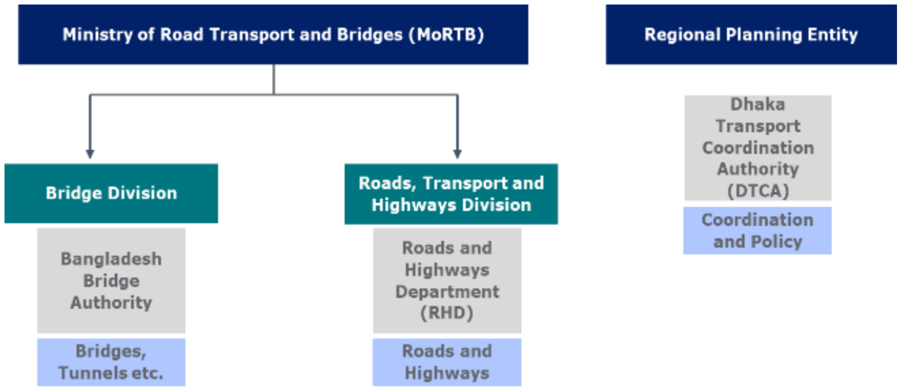
Evaluation Committee: As per Guideline 38, an evaluation committee shall be formed after the issue of the RFQ/IFB for the purpose of examination and evaluation of applications, bids or proposals.

As the value for developing this project is more than **Bangladeshi Taka (BDT) 800 (Eight Hundred) crore,** A 7 member committee with members from applicable line ministry- MoRTB, contracting authority- RHD, PPPA and external members shall be formed during the tender evaluation stage to ensure effective evaluation of the bids for the selection of a competitive bidder. The final approval by CCEA on the finalization of the bidder will be critical to completion of the PPP process for this project.

3.4. Institutional framework for Project Implementation

Line Ministries and Implementing Agencies[1]: Given the scale and importance of our Project, the role of line ministry and the relevant implementing agencies are crucial for ensuring successful development and implementation of this project. The institutional framework governing the development of the road sector includes the following:

Figure 3 : Institutional Framework for Project Implementation



Line Ministry - MoRTB: The MoRTB is persistently working towards building an efficient road system and an integrated modern public transport system for the country which shall play an important role in planning and implementation of the project. The Ministry 2 Divisions i.e. "Bridge Division" and "Roads, Transport and Highways Division (RTHD)", as specialized implementation agencies with distinct roles to facilitate developments. The role of RTHD to augment the growth in the roads transport has been elaborated below:

Division - RTHD: This Division is primarily responsible for:

- Building sustainable highway infrastructure through maintenance, improvement and expansion;
- Establishing integrated urban public transport system; and
- Ensuring safe road transport system through improving of transport services and management standards.
- Encourage PPP in road transport sector.

Implementing Agency - RHD: RHD under the RTHD Division, is responsible for the construction as well as the maintenance of the major roads and bridge network of Bangladesh. The departmental objective of RHD is to provide safe, cost effective and well-maintained road network in the country.

The department is divided into the management, technical, bridge management, planning, maintenance and mechanical wings with designated mandate and responsibilities for undertaking road sector development. With the collaboration and integration of the above wings, the road sector development in the country is planned, developed and implemented through the RHD department.

[1] MoRTB , RTHD, RHD , BBA and DTCA websites

The Line Ministry- MoRTB and implementing agency - RHD play a pivotal role in approving and finalizing a framework with key considerations for the development of the project in terms of applicable standards and guidelines.

RHD shall be the contracting authority for the Project and shall therefore grant the concession to selected private partner by entering into a PPP agreement.

The Detailed Project Proposal comprising of the key terms for undertaking the project development on PPP will be prepared for this project, which shall be processed for obtaining requisite approvals before going ahead with the transaction.

Dhaka Transport Coordination Authority (DTCA): DTCA was established to prepare strategic Transport Plan and provide regular supervision and co-ordination for all possible planning for transportation infrastructure development works within Dhaka city and adjacent districts.

DTCA shall act as an advising authority for planning of the project in terms of arriving at the project modalities and to understand the integration of the project with other complementing projects and strategic transport plan under the purview of these authorities. It shall also be responsible for providing approval of the final design prior to obtaining the CCEA in-principle approval.

This chapter on enabling framework due diligence set outs the key considerations, guidelines and mechanisms for undertaking the project on PPP in Bangladesh. The following chapters detail out the feasibility assessment for the project stretch in terms of assessing its traffic, technical and financial viability followed by developing a implementation structure for the project.

4. Project Corridor

The Gabtoli-Savar-Nabinagar-Bipile stretch (24.445 Km, part of NH-5) starts from Gabtoli Bus Terminal on the mid-west boundary of the city area and passes through Aminbazar, Hemayetpur intersection and Savar Bazar and then passes Nabinagar intersection at National Monument Site followed by passing Nabinagar-Chandra R505 (a link between N5 and N4) and ends at Bipile intersection with Abdullahpur-Ashulia-EPZ Road. The road crosses a major river Buriganga at Aminbazar (Gabtoli) and river Bangshi, a distributor of river the Dhaleswari river at Genda, Savar.

The road passes through brown field development area for most of the alignment except urbanized agglomeration of Hemayetpur and Savar commercial, residential and cantonment areas.

4.1. Influence Zone

The project road stretch can be called the Gateway Corridor as it serves the entire Dhaka bound traffic from the north and northwest, west and southwest of the country connected with N5 and N7 through Paturia –Daulatdia Ferry and with N4 and N6 through the Bnagabandhu Jamuna Bridge. All of them are important national and regional highways being improved to 4-lane highways under funding from ADB and other donors serving national, sub-regional and international traffic via major land ports along the India-Bangladesh border. The major ports served are Mongla, Bhomra, Benapole, Darsana, Sona Masjid, Hili, Banglabandh and Burimari. The corridor is part of Dhaka urban transport network and serves the city and its western agglomeration providing local, regional and sub-regional traffic.

The project stretch is one of the important urban corridors in the country like the Dhaka-Kanchpur-Chittagong road corridor around the capital region. The immediate zone of influence is the entire western half of the Dhaka City stretching from Sadarghat in the south to Ashulia and Tongi on the north in the eastern bank of the Buriganga served by the Gabtoli Bus Terminal. The adjoining areas of Dhanmondi, Newmarket, Farmgate, Mohammadpur, Mirpur, Uttara, Darus-salam, Shymoli, Kllayanpur, Shere-Bnagla Nargar use this corridor to travel to west and northwest of the Country. On the western side of the Buriganga, the corridor supports the development of Amin bazar as the transport hub and truck point, Hemayetpur as an urban agglomeration and the modern Leather Industrial City. Further, it supports the sub-urban development of Savar as the satellite to Dhaka for higher education and administrative training, commercial and industrial growth, cantonment and defence city, national monument, and setting up first Export Processing Zones in the country which inspired sprawling growth of export processing by the private sector stretching to northern Savar, Zamgarh, Ashulia, Tongi, Kashimpur, joydebpur, Gazipur, Mauchak, Chandra and Kalikoir.

4.2. Corridor Characteristics

At present the road corridor is an ordinary 4-lane standard highway improved over a period of time from a single lane road before the independence in 1971. Later on, it was improved to 2-lanes during 1980s under the World Bank finance and was later upgraded to a 4-lane road in 2005. The latest overlay over the road stretch was conducted in 2014-15. The highway does not have hard shoulders on the edge all along. The traffic on the road has grown tremendously during the last 3 decades, particularly after the opening of the Bangabandhu Setu in 1998. As the road passes through low lying flood planes in the first section and with the presence of urban areas, markets and commercial places, the subsequent section service quality of a 2-lane road is limited due to congestion and severe delays. The first section is subject to inundation during high floods in monsoon and is prone to road accidents. Urban sections are crowded with parked vehicles and local traffic causing further congestion. To avoid peak time congestion, freight traffic has been shifted to night hours but during peaks hours, the situation gets worst even during the nighttime. Due to these prevailing circumstances, the GoB has planned the upgradation of the corridor stretch to access controlled 6-lane expressway in addition to the existing 4-lanes as service lanes on PPP basis.

4.3. Strategic Importance of Gateway Corridor

The gateway corridor is very important to maintain both radial connection to expanded city and expressway connection to the planned Western Bypass starting at Hemayetpur linking Dhaka-Mawa N8 at Keraniganj (near Central Jail) and proceed further to Sonargaon on Dhaka-Chittagong Highway, N1. The proposed bypass has also been allocated for PPP development. Thus, the gateway will be directly connected to the Padma Bridge, Mongla Sea Port, Paira Sea Port and Chittagong Port to avoid the congestion of the Metropolitan area. The stretch also serves the middle ring road proposed by the Revised Strategic Transport Plan, Dhaka. Another important strategic aspect of the expressway is to serve Nabinagar point, important for the National Monument and Heritage and which also shall be the future transport hub in relation to the development of the second Padma Bridge at Paturia–Daulatdia crossing. This will serve the Benapole (India) traffic directly to Chittagong, Tamabil and Agartala ports as well as to the south and southeastern part of the country channelling through the Dhaka Eastern Bypasss which is being developed by a Chinese investor under the PPP mode. Therefore, modelling the intersection for the project stretch is very important in the long run. RHD wishes to extend the expressway up to Chandra on Dhaka-Tangail highway in the future when the project is matured.

On the northern section, the expressway will be connected to the Ashulia-EPZ Elevated Expressway to get access to Mass Transit System such as Dhaka elevated expressway, BRT Route-3, MRT- line1 and MRT-line6, etc and then to the Dhaka Eastern Bypass. On the western side, the expressway will be connected to the Hemayetpur- Singair – Manikganj-Aricha road, R502 supporting urban development in Manikganj and traffic diversion from Paturia. The strategic importance of gateway corridor is depicted in the figure 4 and 5 below which showcases the connectivity of the stretch to significant locations in the country. The corridor planning is aimed at national and sub-regional integration for promotion of sub-regional trade and transit for economic development suggested by different studies in the last few years.

Figure 4: Alignment of Outer-1 Ring Road & Inner Ring Road with Radial Connection

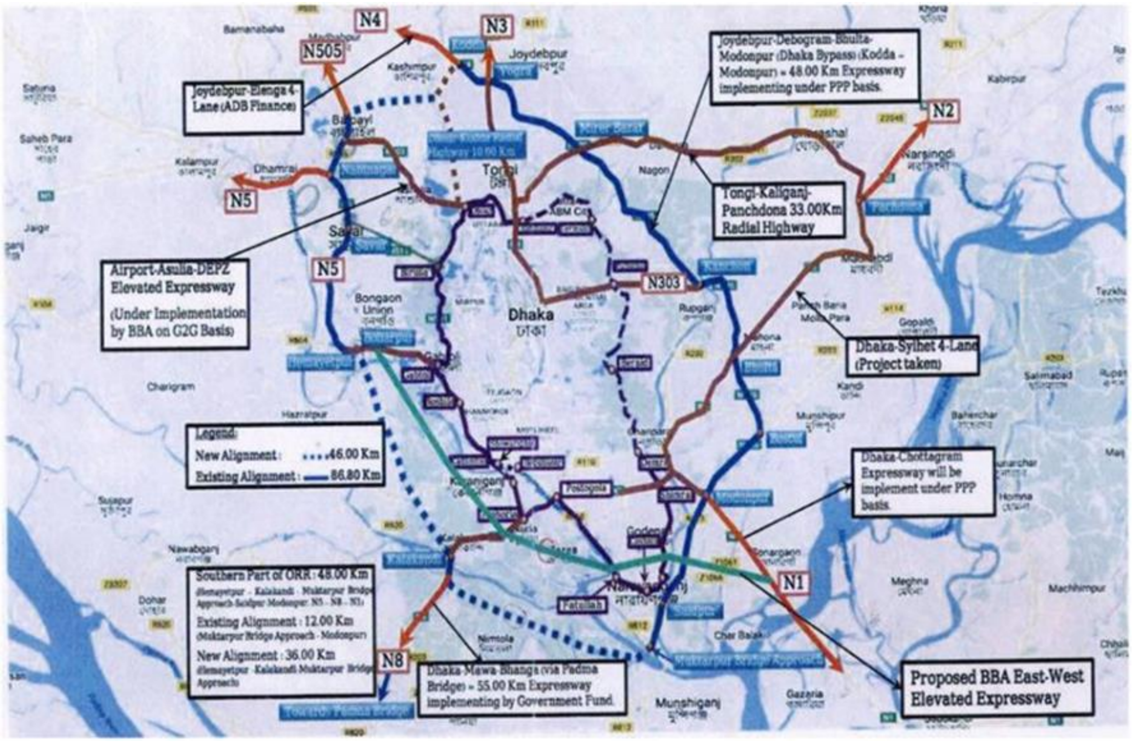
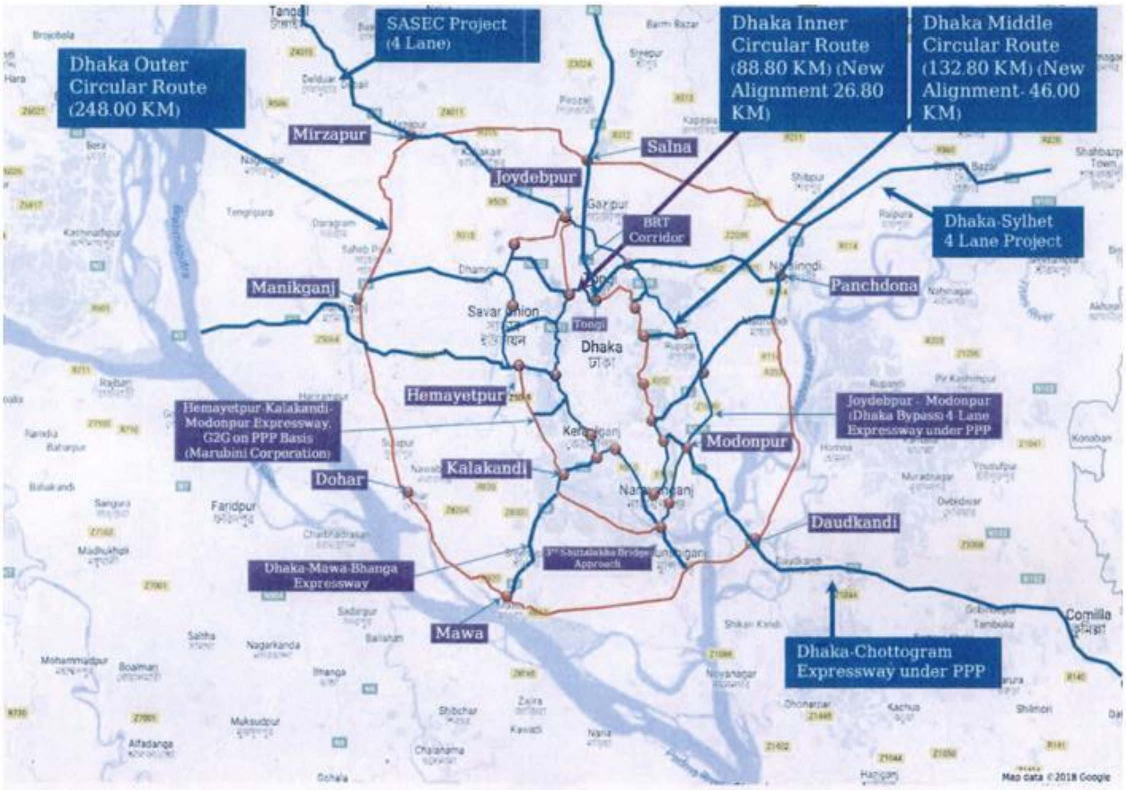


Figure 5: Radial Connection between Dhaka Inner, Middle & Outer Circular Route



4.4. Need for Road sector development in Bangladesh

Bangladesh witnessed rapid growth in transport sector since independence. The relative roles of transport modes are evolving with the expansion of the road transport. Despite the observed growth, the overall performance of the road sector has been weak and has been considered as a constraint for expansion of exports and for promoting economic growth. Trade logistic performance indicators suggest that the country has performed at the lower end as compared to similar developing countries due to higher transportation costs.

SAARC Multimodal Transport Study, 2003 observed that the landlocked and semi-isolated hinterland of Bangladesh can be integrated by sub-regional connectivity improvement. Due to the fragmented transport system caused by political and historical reasons, the potential of the transport system to act as an engine for driving economic growth at the sub-regional level remained largely unutilized. Restoring sub-regional connectivity through the projects envisaged for development will facilitate in realizing the sub-regional trade and transit in Bangladesh through road sector development.

Government recognizes the importance of substantially upgrading the transport infrastructure and services for efficient and cheaper transport. The existing transport system, especially in Dhaka, Chittagong and other big cities has been outdated due to lack of infrastructure as well as weak transport system management. Considering the increasing volume of domestic traffic as well as future traffic from Asian highways, the main objective of the development plans of GoB is to develop a balanced and integrated road transport network and infrastructure through adoption of strategic programs for for facilitating passenger and cargo movements. Given the importance of the capital city of the Dhaka, the GoB's priority in the recent years has been on the increasing focus to break the traffic gridlock in Dhaka.

In order achieve the envisaged regional connectivity in Dhaka and for reduction in congestion, the underlying investment needs to achieve this for efficient road sector development through the annual budgets has not been sufficient to cater to these requirements due to low initial resource base and other competing claims on the budget. International experience of developing countries in meeting these requirements through bringing in and mobilizing private sector investment has been increasing in the road sector. The experiences from India and Indonesia are of especial relevance in this regard. The GoB has also been focussing on developing PPPs in the country in the last few years for infrastructure development.

4.5. PPP in Infrastructure

As part of its strategy to allow the private sector a greater role in Bangladesh, the GoB's developmental plan underscores the importance of PPPs in infrastructure projects and other areas. Under the new PPP initiative and the associated investment guidelines, the procedures for PPP investment has been streamlined and a new PPP Office has been established to promote PPP projects in Bangladesh based on a transparent investment and approval criteria. The GoB envisages a progressive increase in the infrastructure investment under the PPP initiative in the following years by gaining momentum and reaching its full potential in the long run. As part of these initiatives, our current engagement is focussed on developing one the most important projects of the capital region of Bangladesh on PPP basis.

5. Traffic Analysis and Tolling Mechanism

In order to arrive at the traffic potential of the projects stretch, it is imperative to understand the traffic dynamics in the current state of the project corridor and analyse various traffic scenarios which shall predict the future viability and impact for undertaking the development for the proposed expressway. Based on the traffic analysis, the assessment of the revenue potential along the project corridor establishes a business case for development.

5.1. Traffic Survey Implementation

A traffic survey exercise has been carried out along the project stretch to gauge the quantum and pattern of present traffic movement along the project corridor. As part of this exercise, the following type of traffic surveys have been carried out:

1) Traffic Volume Count (TVC) Survey;
2) Origin–Destination (O-D) Survey; and
3) Willingness to Pay (WTP) Survey.

The surveys have been carried out at strategically selected Check Points (CP) on the Gabtoli-Savar-Nabinagar-Bipile section of the NH-5 and a few locations on the nearby road network, in order to capture the maximum potential traffic for the proposed Expressway. The locations, duration and starting dates of the traffic surveys were worked out based on review of the project region and the Site Visit undertaken on 9 July 2019.

Our approach for conducting the traffic survey initiated with the identification of survey locations / CPs that would capture the right quantum of traffic, followed by preparation of traffic survey through obtaining local police support/ permissions, identifying instruments and enumerators for mobilization. Our traffic survey team was then mobilized at the respective locations and the traffic surveys were conducted with a phased manner to arrive at a pattern of traffic for assessment.

Figure 6 : Approach for Traffic Survey

5.1.1. Location of Traffic Surveys

The locations of the traffic surveys were selected based on the O-D patterns of the traffic between the key areas of the region as well as appropriate focal points for capturing the vehicle counts. The CPs that have been identified include the following locations:

- CP-01 N5 - Amin Bazar Bridge
- CP-02 Hemayetpur Intersection
- CP-03 Nabinagar Intersection

Further, the locations points for O-D Surveys along with WTP Surveys and TVC surveys, have been are illustrated in figure 7 below:

Figure 7 : Location of Traffic Surveys

Map source: Google Earth

5.1.2. Duration and Dates

As per the local prescribed guidelines[2] , the TVC survey needs to be carried out for three consecutive days, excluding school holidays, public holidays, and Fridays.

In view of this, periods from 27 July 2019 to 29 July 2019 and 31 July 2019 to 2 August 2019 were selected for conducting these surveys at the respective locations.

The duration of time slots included 16 hour during the first day, followed by 24 hour count the second consecutive day and 16 hour for the third day for TVC Survey for both the periods. Whereas, WTP and OD Survey recorded a 24 hour count for the second day during both the periods.

5.1.3. Implementation Plan for Classified Traffic Volume and Origin–Destination Survey

The snapshot of the implementation plan for the surveys conducted have been detailed out below:

[2] Manual Classified Traffic Counts Instruction Guide, Roads and Highway Department, Government of the People's Republic of Bangladesh (October 2001)

Table 7 : Traffic Survey Location and Schedules

Survey Type	Survey Point	Traffic Survey Location	Duration	Date
Traffic Volume Count Survey	CP-01	N5 - Amin Bazar Bridge	Day 1: 06:00–22:00 hr Day 2: 24 hours (from 06:00 to 06:00 hrs) Day 3: 06:00–22:00 hr	27-29 July, 2019
	CP-02	Hemayetpur Intersection		27-29 July, 2019
	CP-03	Nabinagar Intersection		31 July-2 August, 2019
Origin Destination Survey + Willingness to Pay Survey	CP-01	N5 - Amin Bazar Bridge	Day 2: 24 hours (from 06:00 hrs)	27-29 July, 2019
	CP-02	Hemayetpur Intersection		27-29 July, 2019
	CP-03	Nabinagar Intersection		31 July-2 August, 2019

A snapshot of the traffic survey in progress is portrayed in figure 8 below:

Figure 8 : Snapshot of Traffic Survey

5.2. Traffic Survey Results

The results of the traffic surveys conducted have been elaborated below under various categories:

5.2.1. Traffic Volume Count:

The methodology for conducting the TVC survey has been defined below:

5.2.1.1. Traffic Volume Count Data Collection Format

The traffic volume count survey aims to capture the total number of vehicles, comprising all categories as defined in the survey format (refer Annexure), over a defined period of time. The survey format requires the coordinates of the survey location, direction of traffic movement, date and time of the survey, details of the enumerator and supervisor. The count is carried out manually for continuous 15-minute intervals. A team of three or more enumerators is assigned for counting the vehicles moving in a particular direction. Each enumerator is tasked with counting certain categories of vehicles in order to increase efficiency and reduce the risk of mistakes.

5.2.1.2. Traffic Volume Count Output Format

The survey formats are collated according to their time and locations and the data is consolidated into hourly intervals for different categories across different locations.

5.2.1.3. Traffic Volume Count (Vehicles)

The base output of the traffic volume count is in the form of number of vehicle units passing through a particular point in a specified period, in this case, 24 hours. The summary of vehicle counts as well as the number of toll-able vehicle across the three count locations viz. Gabtoli, Hemayatpur, and Nabinagar has been presented in table 7. Further, a detailed mode-wise vehicular count output has been presented in Annexure.

Table 8 : Traffic Volume Count and Toll-able vehicles

Count Location	Total		Grand Total	Toll-able Vehicles
Amin Bazaar	**To**	**From**		
24 hour	20,361	20,671	**41,032**	**34,985**
Hemayatpur (Alom Nogor)	**To**	**From**		
24 hour	26,277	22,742	**49,019**	**36,502**
Hemayatpur (Gam Factory)	**To**	**From**		
24 hour	18,466	20,625	**39,091**	**32,459**
Manikganj	**To**	**From**		
24 hour	15,472	13,472	**28,944**	**22,906**
Savar	**To**	**From**		

Count Location	Total		Grand Total	Toll-able Vehicles
Amin Bazaar	**To**	**From**		
24 hour	21,101	21,854	**42,955**	**34,820**
Baipile	**To**	**From**		
24 hour	16,850	18,097	**34,947**	**27,996**

5.2.1.4. Traffic Volume Count (PCU)

The vehicular count has been converted into Passenger Car Units (PCUs) in order to obtain insights into the road capacity utilized by the captured traffic. The PCU conversion factors have been sourced from the Geometric Design Standards published by the RHD[3] and from international practices and are presented in the table 8 below:

Table 9 : PCU Conversion factors

Heavy Truck (2-3 & 3+ axles)	Medium Truck	Small Truck	Large Bus	Mini Bus	Microbus	Utility	Car	Auto Rickshaw	M. Cycle	Bicycle	Cycle Rickshaw	Animal Cart/ Push Cart
4.5	3.5	2.5	3.5	2.5	2	1.5	1	1	0.5	0.5	1.5	4

The PCU values have been appropriately applied to the traffic volume counts. The summary of the PCU-based traffic volume count for the three count locations is presented in table 9. A detailed mode-wise PCU count output has further been presented in Annexure. In order to account for the higher pavement damage factor of multi-axle vehicles (greater than 3 axles), the heavy truck counts have been bifurcated in 2 to 3 axles and 3+ axles.

Table 10 : PCU-based traffic volume count

Count Location	Total		Grand Total
Amin Bazaar	**To**	**From**	
24 hour	42,794	47,955	**90,748**
Hemayatpur (Alom Nogor)	**To**	**From**	
24 hour	51,493	45,534	**97,027**
Hemayatpur (Gam Factory)	**To**	**From**	
24 hour	42,074	46,196	**88,270**

[3] Geometric Design Standards for Roads & Highways Department, October 2000

Count Location	Total		Grand Total
Amin Bazaar	**To**	**From**	
Manikganj	**To**	**From**	
24 hour	34,011	31,572	**65,583**
Savar	**To**	**From**	
24 hour	46,599	47,659	**94,258**
Baipayl	**To**	**From**	
24 hour	38,622	40,001	**78,623**

5.2.2. Origin Destination

The methodology for conducting the OD survey has been defined below:

5.2.2.1. Origin Destination Data Collection Format

The OD survey is aimed at collecting information regarding the travel patterns of the vehicles passing through the project corridor. The primary information collected is the origin and the destination of the vehicle, which provides insights into the traffic linkages of the region and the distribution of traffic to and from various regions surrounding the project corridor. Secondary data such as the purpose and frequency of the trip, the level of occupancy in the passenger vehicle, and the type and weight of commodity carried by freight vehicles are also captured to provide a picture of the traffic composition. The OD survey questionnaire format is presented in Annexure.

In order to facilitate data analysis, the Project Influence Area (PIA) is divided into Traffic Analysis Zones (TAZs) and each zone is given a notation. The TAZs have been demarcated based on a preliminary understanding of the area, demographic, and road network characteristics of the PIA. The properties of the TAZs have been described in table 10.

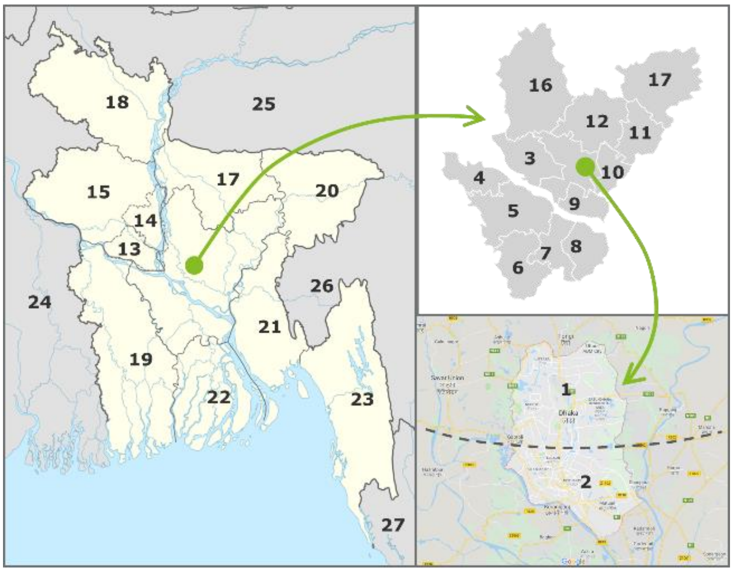
Table 11 : Properties of TAZ

Country	Division	District	City	Sub-city	Zone Description	Zone Code
Bangladesh	Dhaka	Dhaka	Dhaka	North Dhaka	All areas in Dhaka city north of Gabtoli	**1**
				South Dhaka	All areas in Dhaka city south of Gabtoli	**2**
		Manikganj	All cities/towns within the district			**3**
		Rajbari				**4**
		Faridpur				**5**
		Gopalganj				**6**

Country	Division	District	City	Sub-city	Zone Description	Zone Code
		Madaripur				**7**
		Shariyatpur				**8**
		Munshiganj				**9**
		Narayanganj				**10**
		Narsingdi				**11**
		Gazipur				**12**
	Rajshahi	Pabna	All cities/towns within the district			**13**
		Sirajganj				**14**
		All other districts				**15**
	Mymensingh	Tangail	All cities/towns within the district			**16**
		All other districts				**17**
	Rangpur	All districts within the division				**18**
	Khulna					**19**
	Sylhet					**20**
	Comilla					**21**
	Barishal					**22**
	Chittagong					**23**
India	West Bengal	All regions				**24**
	Assam & Meghalaya					**25**
	Tripura & Mizoram					**26**
Myanmar	All regions					**27**

To understand the boundaries of the regions encompassed by the zone codes, they have been represented in a set of maps presented in the figure below:

Figure 9 : Zone codes



5.2.2.2. OD Survey Output Format

The filled OD survey forms are collated and the data is transferred to a tabular form. A pivot table is formulated with this data with the origin zones and destination zones forming the 'x' and 'y' axes respectively. This is referred to as the OD Matrix. The base data presented in the OD Matrix is the quantity of trips captured between zone X to zone Y in the OD survey. With the aid of filters, certain limiting condition can be imposed on the matrix, which results in targeted outputs which are then analysed to gather critical observations related to the travel patterns. The consolidated OD matrix has been presented in Annexure.

5.2.3. Willingness to Pay

The WTP survey is carried out along with the OD survey, primarily to gauge the elasticity of the travellers to pay the prescribed toll. The respondents are asked regarding their preference to pay the prescribed toll, a lower toll, or no toll. Views are then solicited from them regarding their expectation of the toll amounts for their vehicle category and other feedback. The output is presented along with the OD data set and analysed through the pivot table.

5.3. Traffic Survey Data Analysis

5.3.1. Traffic Volume Count

A comprehensive analysis of the TVC survey has been presented in the Preliminary Findings Report. A summary of the critical observations is presented here:

5.3.1.1. Inferences from Traffic Volume Count (vehicles)

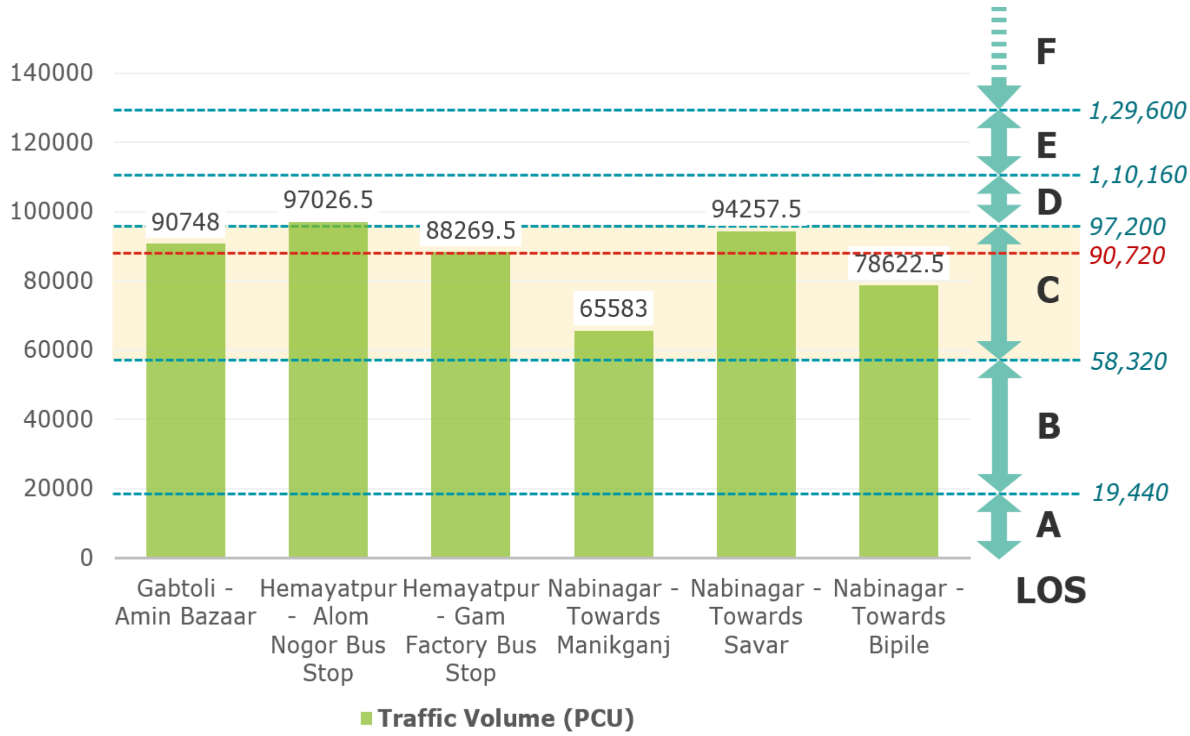
- The traffic volume is fairly similar for both directions over a period of 24 hours/16 hours.
- During the morning period, it is observed that more private vehicles are heading towards Savar and Nabinagar as compared to Dhaka. This trend reverses in the evening period, indicating that Savar and Nabinagar areas are employment centers and draws daily commuters from Dhaka.
- During the night period from 22:00 to 05:00, unidirectional freight traffic is observed towards Dhaka, and the reverse trend is observed during the early morning period. This indicates heavy cargo movement into Dhaka during the night, where the consumption and industrial goods are unloaded and reloaded, and outbound movement during early morning period, when the city traffic is relatively lighter.
- The heaviest traffic volume is observed at the CP at Alom Nogor bus stand in Hemayatpur. The traffic volume at Gam Factory bus stop is 20% lesser than at Alom Nogor, which indicates considerable traffic movement from Dhaka towards Manikganj. This establishes Hemayatpur as a three-arm junction with considerable traffic movement on all three arms.

5.3.1.2. Capacity Utilization

The relevant design standards state that the capacity of a 4-lane divided carriageway in an urban area is 1,29,600 PCU per day (5,400 PCU per hour). Whereas, the DSV of the road is 90,720 PCU per day (3,780 PCU per hour).

The figure below presents the traffic volume in PCU captured at all the CPs along the project corridor, along with the Level of Service (LOS) and their associated range of traffic volume in PCU.

Figure 10 : Traffic volume



The standards recommend that urban roads should be designed to handle traffic volume defined under LOS C category, with the Design Service Volume (DSV) being 90,720 PCU. It may be noted that the traffic volume captured on all the CPs is within the range of LOS C i.e. 58,320 to 97,200 PCU, with three of the six CPs breaching the DSV value. This indicates that the project corridor has stable traffic flow but the vehicle speeds are increasingly affected by speeds of surrounding vehicles. The general level of driving comfort begins declining at this level and maneuvering through the traffic requires higher vigilance.

It is recommended that the planning for capacity augmentation should be initiated when the traffic volume equals the lower end of the LOS C spectrum, and implementation carried out before it breaches the upper limit of the LOS C spectrum. Hence, the project corridor is ideally placed for capacity augmentation along with corridor improvement in order to increase the LOS of the corridor.

5.3.1.3. Traffic Composition

- In a 24 hour period, it is observed that approximately one-third of all traffic comprise freight vehicles. Buses comprise approximately one-fourth of the traffic, while the rest consists of four-wheel, three-wheel, two-wheel, and non-motorized vehicles.
- During the period from 06:00 to 22:00, it is observed that the share of freight traffic drops as compared to the 24 hour traffic composition, especially at CPs near Dhaka city. This is attributed to the restrictions placed on the entry of heavy vehicles within Dhaka city area during the daytime hours. Subsequently, the traffic composition is dominated by buses followed by private cars.
- During the night traffic count from 22:00 to 06:00, freight vehicles majorly dominate the traffic composition, because of removal of restrictions to enter Dhaka city. Around two-thirds of the night traffic comprise freight vehicle, followed by buses plying on overnight routes.

5.3.2. Origin Destination Patterns

The pivot table (OD Matrix) formulated from the data collected through the OD survey has been analysed by applying various filters to extract travel patterns and travel characteristics in the project region. The inferences have been presented in the following sections.

5.3.2.1. Travel Patterns

The trips captured in the survey, across all three locations, have been classified into internal trips, internal to external trips, and through trips. This classification has been captured in the table below:

Table 12 : Classification of Trips

Location	Vehicle	Internal to Internal (%)	Internal to External (%)	External to External (%)	Total (%)
Amin Bazaar	All	40	53	7	100
	Freight	33	54	13	100
	Bus	25	70	5	100
	Car	77	22	0	100
Hemayatpur	All	60	35	5	100
	Freight	67	31	2	100
	Bus	43	47	10	100
	Car	72	28	0	100
Nabinagar	All	31	62	8	100
	Freight	23	65	12	100
	Bus	23	71	6	100
	Car	57	43	0	100
Average Across all 3 locations	All	44	50	6	100
	Freight	41	50	9	100
	Bus	30	63	7	100
	Car	69	31	0	100

The following observations may be drawn from the above table:

- 44% of the traffic is local traffic with origin and destination both within the Dhaka metropolitan region, which covers Dhaka city as well as towns along the project stretch such as Hemayatpur, Genda, Savar Bazaar, and Nabinagar.
- 69% of the private cars are part of the local traffic, which suggests that cars are being used mainly for daily commuting to nearby towns from Dhaka city.
- A considerable proportion of buses (30%) and trucks (41%) are classified as local traffic, which points to heavy passenger and cargo movement within the Dhaka metropolitan region.
- 63% of the bus traffic is categorized as internal to external traffic, indicating that buses are a popular mode for inter-city trips from Dhaka.

- Only 6% of all traffic captured on the project stretch had origin and destination points outside of Dhaka metropolitan region, cementing Dhaka's position as a magnet for traffic passing through the region. Of this, the share of cars in through traffic is almost negligible

5.3.2.2. Prominent OD Pairs

The trip patterns have been further analysed to understand the major origin-destination pairs in terms of their share of the total traffic captured during the OD survey. This exercise has been carried out to establish the travel linkages between various destinations across the project stretch region and beyond. The major OD pairs, classified by internal, internal to external, and through traffic, have been presented in the table below:

Table 13 : O-D Pairs

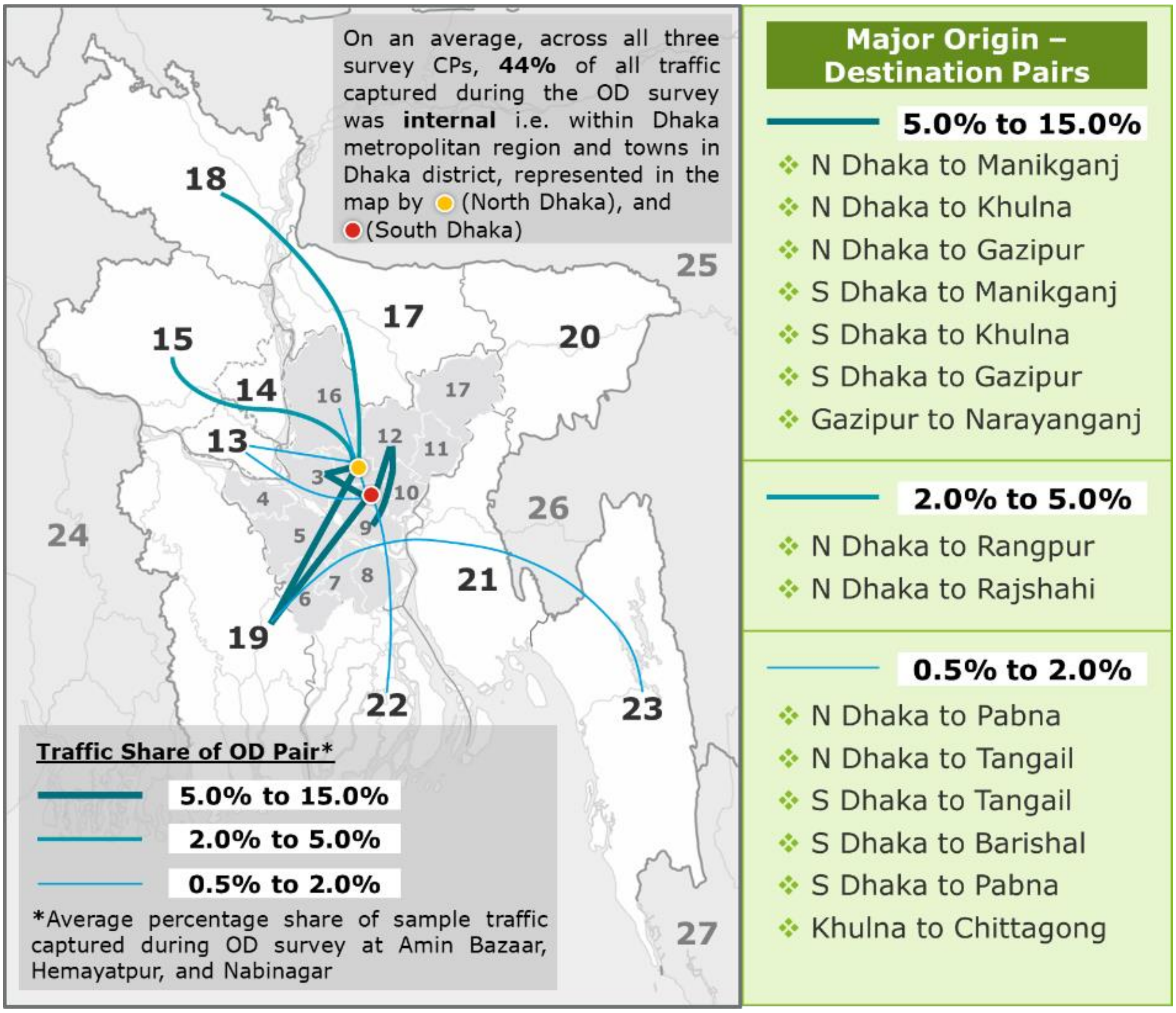
Type of Traffic	Origin - Destination	% of Total Traffic
Internal Traffic	N Dhaka - S Dhaka	38.4
	N Dhaka - N Dhaka	11.5
Internal to External Traffic	Dhaka - Manikganj	13.9
	Dhaka - Khulna	13.4
	Dhaka - Gazipur	9.4
	Dhaka - Rajshahi	4.1
	Dhaka - Rangpur	2.9
	Dhaka - Narayanganj	1.8
	Dhaka - Tangail	1.8
	Dhaka - Barishal	1.4
	Dhaka - Pabna	1.0
Through Traffic	Khulna - Chittagong	0.4

Apart from the local traffic, the most frequented destinations from Dhaka are Manikganj, Khulna, and Gazipur. Due to connectivity constraints in the south of Bangladesh owing to the Ganges delta basin, traffic from Khulna to Chittagong passes through Dhaka.

Desire Line Diagram: The prominent OD pairs and their share of the total traffic has been captured graphically in Figure 1.

Owing to the location of the project stretch to the west of Dhaka city, it follows that most of the major destinations from Dhaka lie on the western half of Bangladesh, such as Khulna, Rangpur, and Rajshahi.

Figure 11 : O-D Pairs and traffic share



5.3.2.3. Trip Characteristics

The OD survey provides insights into various trip characteristics, such as the purpose for which trips are made, the frequency of trips, the average travel time, and the perceived cost of the journey. These traits aid in reinforcing the understanding of travel patterns of the respondents.

Trip Purpose: The majority of trips have been made for business purposes, which cements Dhaka's position as the major trading and commerce centre of Bangladesh. Personal trips are at second position comprising 7% of the total trips.

Table 14 : Trip Purpose

Location	Vehicle	Trip Purpose			
		Business (%)	Tourist (%)	Personal Visit (%)	Other (%)
Amin Bazaar	All	86	2	8	4
Hemayatpur		89	1	7	4
Nabinagar		89	1	7	2
Average		88	1	7	3

Trip Frequency: The trips which are made on a daily basis account for 63% of the total trips, which when clubbed with the fact that 88% of the overall trips are made for business purposes, establishes that the project stretch caters to a large number of daily work trips. 92% of the bus traffic plies on a daily basis as compared to 48% of the freight traffic. The Gabtoli bus terminal, which is the starting point of the project, is the major contributor to the daily bus traffic plying on the project stretch. Freight traffic moves slower across the country and is more demand driven, and hence has a significant share of weekly frequency. Private cars cater to all types of trips, and are not usually bound to strict schedules, and hence their trip frequencies are spread across all four timescales. The trip frequency details have been presented in the table below:

Table 15 : Trip Frequency

Location	Vehicle	Trip Frequency			
		Daily (%)	Weekly (%)	Monthly (%)	Occasionally (%)
Amin Bazaar	*All*	61	21	11	6
	Freight	43	39	14	4
	Bus	92	2	3	2
	Car	33	27	22	19
Hemayatpur	*All*	67	17	8	9
	Freight	53	32	7	8
	Bus	94	0	3	2
	Car	45	21	15	19
Nabinagar	*All*	62	28	10	5
	Freight	50	39	10	1
	Bus	89	5	3	2
	Car	44	22	18	16
Average	*All*	63	22	10	7
	Freight	48	37	11	4
	Bus	92	3	3	2
	Car	40	24	18	18

Average Travel Time: The average travel time provides insight into the average distances travelled by each mode and the delays faced by them. The average travel time across all modes is 242 minutes (4 hours). However, since trucks and buses have a larger proportion of internal to external movement, their respective travel times are 286 minutes (close to 5 hours) and 285 minutes (close to 5 hours), while the travel time for cars is significantly lower at 105 minutes (less than 2 hours). The reason attributed to the lower travel time for cars is that cars travel at faster speeds, face lesser delays and inspections, and travel shorter distances. The average travel times for each mode across all three survey points are presented in the table below:

Table 16 : Average Travel Time

Location	Average Travel Time (minutes)			
	All	Freight	Bus	Car
Amin Bazaar	288	362	326	109

Location	Average Travel Time (minutes)			
	All	Freight	Bus	Car
Hemayatpur	149	133	204	97
Nabinagar	288	362	326	109
Average	242	286	285	105

Average Journey Cost: The average journey cost of all modes is BDT 3260. The cost for buses and trucks is higher as they tend to travel longer distances, consume higher amount of fuel, and pay higher tolls than other vehicles. The average cost of cars is considerably lower at BDT 560 since they travel shorter distances and are more economical. In addition, cars pay two to five times lower tolls than buses and trucks. The average journey cost of all modes across all survey locations is presented in the table below:

Table 17 : Average Journey Cost

Location	Average Journey Cost (BDT)			
	All	Freight	Bus	Car
Amin Bazaar	4195	5245	5326	526
Hemayatpur	1377	1137	2309	448
Nabinagar	4209	5421	4705	707
Average	3260	3934	4113	560

5.3.3. Willingness to Pay

The willingness to pay survey, carried along with the OD survey, presents data on the willingness of the survey respondents to pay toll in order to avail better road facilities.

5.3.3.1. Willingness to pay across Three Survey Locations

It may be noted that, on average, 33% of the respondents are willing to pay the proposed toll rates for their particular mode (presented in table). 63% of the respondents are inclined to pay a toll, but have found the proposed toll rates unfeasible, and have stated their preference for the toll rates. Only 2% of the respondents have declined to pay the toll, and 1% are unsure about their decision at this juncture. The summary of the willingness to pay toll is presented in the table below:

Table 18 : Summary of WTP Toll

Location	1. Yes	2. Lower rate	3. No	4. Can't say	Total
Amin Bazaar	37%	58%	3%	2%	100%
Hemayatpur	39%	57%	3%	2%	100%
Nabinagar	24%	73%	2%	1%	100%
Average	*33%*	*63%*	*2%*	*1%*	*100%*

5.3.3.2. Willingness to pay by Mode

A significant difference has been noted regarding the willingness to pay toll when various modes are analysed separately. Buses are found to be the most willing to pay the proposed toll, whereas trucks are found to be the least willing. However, 73% of the truck traffic are willing to pay a lower toll. Thus, around 95% of all modes are willing to pay toll, albeit different toll rates. The mode-wise responses have been presented in table below:

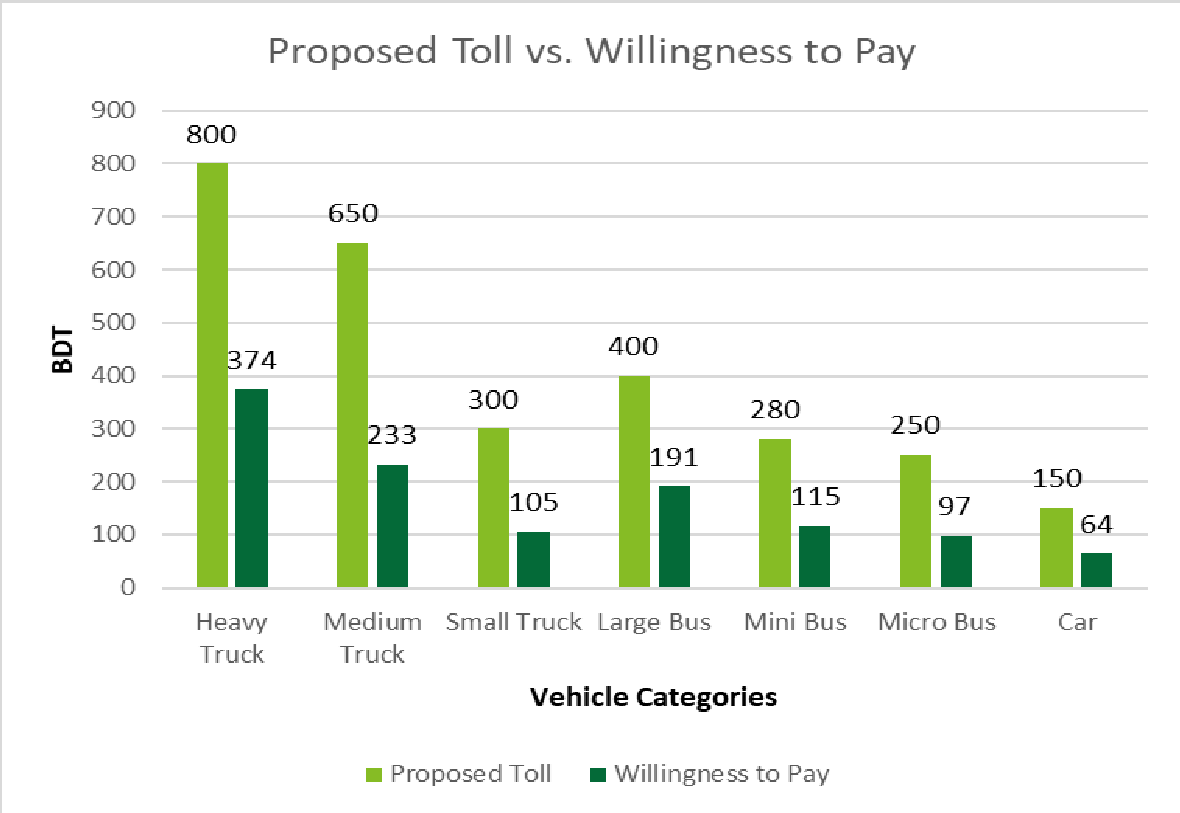
Table 19 : WTP by mode responses

Mode	1. Yes	2. Lower rate	3. No	4. Can't say	Total
Freight	23%	73%	3%	2%	100%
Bus	40%	57%	2%	1%	100%
Car	36%	59%	3%	2%	100%
Average	*33%*	*63%*	*3%*	*1%*	*100%*

5.3.3.3. Willingness to pay Lower Tolls

A comparison between proposed toll and willingness to pay toll, across different modes, has been presented in the figure below. It is noted that respondents are willing to pay 35% to 50% of the proposed toll.

Figure 12 : Comparison between proposed toll and WTP Toll



The above sections capture the analysis of the surveys conducted on the project corridor to arrive at the current scenario assessment. Further, in order to project the future traffic potential based on evaluation of various parameters, the following section defines the assessment undertaken for various scenarios.

5.4. Transport Demand Indicators

In this chapter, an extensive study of relevant economic and transportation sector growth indicators has been carried out. The patterns observed and inferences noted have been analysed and presented in conclusion. These indicators shall lay the foundation for traffic growth rate assumptions and traffic forecast scenarios. The indicators will evaluate the level of buoyancy in the economy and the way the transport sector, especially road-based transport, has grown over a period. A correlation will be established between various economic and transport sector growth trends through single or multi-variate regression. This correlation will be used to project future traffic volumes in the succeeding chapters.

5.4.1. Economic Profile of Bangladesh

A macroscopic review of pertinent economic indicators of Bangladesh and their year-on-year growth rates have been presented in table. The GDP of Bangladesh at constant prices of 2005-06 has been recording solid growth of 7% on an average over the last decade. The GDP grew at 8% in the year 2017-18. The GDP per capita has also posted a strong growth rate of 5% on an average and 7% in the previous financial year.

Table 20 : Economic Indicators of Bangladesh

Indicators	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average Growth
GDP at constant* market prices (billion Tk.)	5751	6071	6463	6885	7299	7741	8249	8835	9479	10224	
Growth Rate		*6%*	*6%*	*7%*	*6%*	*6%*	*7%*	*7%*	*7%*	*8%*	***7%***
Per capita GDP at constant* market prices (Tk.)	39441	41076	43190	45421	47491	49701	52243	55259	58603	62477	
Growth Rate		*4%*	*5%*	*5%*	*5%*	*5%*	*5%*	*6%*	*6%*	*7%*	***5%***

In table 20, the growth rates of the three broad sectors of the economy have been presented. The low growth rate of the agriculture sector and the higher growth rates of the industry and service sectors points to a transition economy, with expanding secondary and tertiary sectors.

Table 21 : Sectoral growth rates

Sectoral growth rate of GDP constant* market prices (%)	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average Growth

Agriculture	3.5	6.2	4.5	3.0	2.5	4.4	3.3	2.8	3.0	4.2	***3.7***
Industry	6.9	7.0	9.0	9.4	9.6	8.2	9.7	11.1	10.2	12.1	***9.3***
Services	5.1	5.5	6.2	6.6	5.5	5.6	5.8	6.3	6.7	6.4	***6.0***

The table below presents the evolution of total investment in Bangladesh over the years, along with a break-up of private sector investment and government investment. It may be noted that the rate of growth of private investment is twice that of GDP growth rate, whereas that of public investment is thrice that of GDP growth rate. These data point towards a dynamic economy and strong faith of investors, both public and private.

Table 22 : Investment Indicators of Bangladesh

Indicators	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average Growth
Investment at current prices (billion Tk.)	1848	2093	2511	2982	3404	3840	4379	5138	6028	7029	
Growth Rate		*13%*	*20%*	*19%*	*14%*	*13%*	*14%*	*17%*	*17%*	*17%*	***16%***
Private investment (billion Tk.)	1543	1721	2030	2374	2607	2960	3345	3983	4564	5235	
Growth Rate		*12%*	*18%*	*17%*	*10%*	*14%*	*13%*	*19%*	*15%*	*15%*	***15%***
Public investment (billion Tk.)	304	373	482	608	796	880	1034	1155	1465	1794	
Growth Rate		*23%*	*29%*	*26%*	*31%*	*11%*	*18%*	*12%*	*27%*	*22%*	***22%***

In continuation to the above data, table 22 shows the increasing share of investments in the overall GDP figures. This portrays a strong push from the government and private players to invest more in the economy. Also noteworthy is the fact that private investment exceeds public investment by up to three times.

Table 23 : Investment share of GDP

Indicators	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Investment as % of GDP	26.2	26.3	27.4	28.3	28.4	28.6	28.9	29.7	30.5	31.2
Private investment	21.9	21.6	22.2	22.5	21.8	22.0	22.1	23.0	23.1	23.3

Public investment	4.3	4.7	5.3	5.8	6.6	6.6	6.8	6.7	7.4	8.0

5.4.2. Area and Demography Profile

This section presents the general statistics related to area and demography of the project region, which has been considered as Dhaka district, within the Dhaka division, which includes Dhaka city, as well as towns such as Hemayatpur, Savar Bazaar, and Bipile. The table below describes the total area of Dhaka district, as well as the number of its sub-constituents such as Upazilas, Unions, Villages, and Municipalities.

Table 24 : Area of Dhaka District

Division and Zilla	Total Area (Sq. km.)	Upazilas / Thanas	Unions	Villages	Municipalities
Dhaka	1463.6	46	79	2001	4

The table below describes the demographic statistics of Dhaka district including population, households, sex ratio, and literacy.

Table 25 : Demographic Staistics of Dhaka district

Division and Zilla	No. of household				Population			Sex Ratio (M/F)	Literacy Rate
	Total	General	Institutional	Others	Both Sex	Male	Female		
Dhaka	27,86,133	26,39,630	5,578	1,40,925	1,20,43,977	65,55,792	54,88,185	1.19	70.54

5.4.3. Transport Systems in Bangladesh

This section studies the growth trends of all major transport systems of Bangladesh. The transport systems have been broadly classified into three sectors, viz. Land transport, water transport, and air transport. The table below showcases the total value added in million BDT at constant prices for various transport systems for the previous seven financial years. Land transport is the fastest growing sector at 6%, whereas water and air transport are growing at 4% on an average. Within land transport, mechanized road transport is the fastest growing transport system at 7%, which includes motorized vehicles plying on urban roads and highways. The Bangladesh Road Transport

Corporation, which is a government agency chiefly responsible for bus transport, grew at 3% on an average. Whereas the non-motorized transport and railways have stagnated or are posting negative growth. Biman Bangladesh, the state carrier, has posted the highest growth rate of 8% among all the transport systems.

Table 26 : Growth Trends in Transport systems of Bangladesh

Items	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average
Land transport	511722	540184	573608	609662	652751	696614	
Growth Rate		*6%*	*6%*	*6%*	*7%*	*7%*	***6%***
Bangladesh Railway	7549	6655	6955	6742	6825	6924	
Growth Rate		*-12%*	*5%*	*-3%*	*1%*	*1%*	***-2%***
Bangladesh Road Transport Corporation	1037	732	762	869	1055	1095	
Growth Rate		*-29%*	*4%*	*14%*	*21%*	*4%*	***3%***
Mechanized Road Transport	433875	462934	495870	531868	574661	618356	
Growth Rate		*7%*	*7%*	*7%*	*8%*	*8%*	***7%***
Non-Mechanized Road Transport	69261	69863	70021	70182	70210	70240	
Growth Rate		*1%*	*0%*	*0%*	*0%*	*0%*	***0%***
Water Transport	58937	60797	63035	65089	67789	70196	
Growth Rate		*3%*	*4%*	*3%*	*4%*	*4%*	***4%***
Bangladesh Shipping Corporation	529	379	409	310	349	362	
Growth Rate		*-28%*	*8%*	*-24%*	*13%*	*4%*	***-6%***
Bangladesh Inland Water Transport Corp	838	782	811	812	903	947	
Growth Rate		*-7%*	*4%*	*0%*	*11%*	*5%*	***3%***
Mechanized Water Transport	50283	52497	54824	57268	59838	62332	
Growth Rate		*4%*	*4%*	*4%*	*4%*	*4%*	***4%***
Non-Mechanized Water Transport	7287	7139	6991	6699	6699	6555	

Items	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average
Growth Rate		*-2%*	*-2%*	*-4%*	*0%*	*-2%*	***-2%***
Air Transport	9419	9494	10343	10560	10905	11257	
Growth Rate		*1%*	*9%*	*2%*	*3%*	*3%*	***4%***
Bangladesh Biman Corporation	7087	6848	8457	8942	9896	10162	
Growth Rate		*-3%*	*23%*	*6%*	*11%*	*3%*	***8%***
Private airlines	2332	2645	1887	1618	1009	1095	
Growth Rate		*13%*	*-29%*	*-14%*	*-38%*	*9%*	***-12%***

5.4.3.1. Modal Share of Transport Systems

The table below describes the proportional shares of various transport systems operating in Bangladesh over a period of seven years. The biggest share among the three transport sectors is that of land transport, and over the past seven years, it has increased its share from 88.2% to 89.5%. The biggest share among the individual transport systems is mechanized road transport, which stands at 79.5% in 2017-18, having grown from 74.8% in 2012-13. Non-motorized transport and mechanized water transport contribute, respectively, 9.0% and 8.0% of the overall share of transport systems.

Table 27 : Share of various transportation systems in Bangladesh

Items	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Land transport	88.2%	88.5%	88.7%	89.0%	89.2%	89.5%
Bangladesh Railway	1.3%	1.1%	1.1%	1.0%	0.9%	0.9%
Bangladesh Road Transport Corporation	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Mechanized Road Transport	74.8%	75.8%	76.6%	77.6%	78.6%	79.5%
Non-Mechanized Road Transport	11.9%	11.4%	10.8%	10.2%	9.6%	9.0%
Water Transport	10.2%	10.0%	9.7%	9.5%	9.3%	9.0%
Bangladesh Shipping Corporation	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%
Bangladesh Inland Water Transport Corpo.	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Mechanized Water Transport	8.7%	8.6%	8.5%	8.4%	8.2%	8.0%

Items	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Non-Mechanized Water Transport	1.3%	1.2%	1.1%	1.0%	0.9%	0.8%
Air Transport	1.6%	1.6%	1.6%	1.5%	1.5%	1.4%
Bangladesh Biman Corporation	1.2%	1.1%	1.3%	1.3%	1.4%	1.3%
Private airlines	0.4%	0.4%	0.3%	0.2%	0.1%	0.1%

The following sections presents growth statistics and trends for the major transport sectors, viz. railways, aviation, and waterways.

Railway: The railways sector shows a robust growth in passengers carried and cargo carried over the previous few years. However, the overall value added in the railways sector, as presented in the table below, has been showing a negative trend. This indicates that the revenues generated are not enough to cover the maintenance costs of the aging railway network.

Table 28 : Growth rates of Bangladesh Railway

Railway traffic	Unit	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average Growth Rate
Tonne carried	"000s"	2011	2524	2555	2555	3870	4550	19.2%
Tonne kilometre	Million	525	677	694	694	1053	1237	20.1%
Passenger carried	Million	63	65	67	67	78	99	9.9%
Passenger kilometre	Million	8253	8135	8711	8711	10040	12994	10.1%

Aviation: Aviation sector is growing at a robust pace since the last eight years, especially domestic passenger sector and freight movement. The national carrier, Biman Bangladesh, is growing much faster than private airlines, some of which have shown a negative growth trend over the past few years.

Table 29: Growth Rates of Aviation traffic

Item	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average Growth Rate
Passenger carried ("000s")									
Domestic	120	184	224	233	113	322	379	447	35.5%
International	1264	1590	1349	1338	1907	1997	1966	2164	9.4%

Total	1384	1774	1573	1571	2020	2319	2345	2611	10.4%
Passenger kilometers									
(RPK Million)	5051	5564	5292	5207	6645	6937	6937	7072	5.4%
Cargo and mail uplifted									
(Million lbs.)	60	52	74	73	97	90	75	73	4.8%
Freight									
Tonne Kilometre (Million)	106	684	144	150	199	183	183	914	127.8%

Waterways: The inland waterways services have seen a steady increase in passenger services as well as cargo handled. Over the past eight years, ferry services have witnessed the highest growth, since many major highways are dependent on ferry services for connectivity.

Table 30 : Growth rates of Waterways indicators

Year		2010-11	2011-12	2012-13	2013-14	2014-15	2016-17	2017-18	Average Growth Rate
Navigable waterways in km	Monsoon	6000	6000	6000	6000	6000	6000	6000	0.0%
	Dry season	3824	3824	3800	3800	3800	4347	4347	1.1%
No. of passengers (in million)	By Motor Launch	231.52	333.09	232.75	139.27	152.4	195.12	283.58	17.5%
	By Steamer	1	0.8	0.75	0.6	0.6	0.39	0.33	-4.8%
	By Ferry Service	17.9	17.09	16.75	16.16	16.16	22.5	21.9	36.6%
	Total	250.42	350.98	250.25	156.03	169.16	211.88	305.81	15.0%
Volume of Cargo handled (million tons)		32.6	35.86	18.77	22.02	22.71	19.25	23.03	10.4%

Road Transport Demand: The indicators of road transport demand under various considerations have been defined below:

Length of Road Network: The table below presents the growth of the national road network in Bangladesh. While the overall road network has remained constant, the national highway length has increased. This may be attributed to the upgradation of certain regional and feeder roads to national highway status.

Table 31 : Growth of road network in Bangladesh

Survey Year	2011	2012	2013	2014	2015	2016	2017	2018
National (km)	3538	3580	3580	3580	3791	3813	3813	3791
Regional (km)	4276	4276	4276	4276	4328	4247	4247	4207
Feeder Type A (km)	13470	13509	13509	13509	13245	13262	13262	13130
Total (km)	21284	21365	21365	21365	21365	21322	21322	21128

Length of Road Network: The table below presents the current distribution of various categories of highways in Dhaka district.

Table 32: Length of Road network in Dhaka district

Name of District	National Highways	Regional Highways	Zilla Road	Total Length	Paved Road	Unpaved	Length of not Survey	Total Length
Dhaka	77.33	81.33	119.1	**277.76**	230.8	15.3	31.66	**277.76**

Estimated Number of Mechanized Vehicles in Bangladesh on Road by Type: The following table presents data on the growth of motorized vehicles plying on the roads of Bangladesh classified by type. Among the major vehicle types, motorcycle has seen the highest increase over the past six years at 17.1%. Private cars, buses, and trucks have registered growth between 7 to 8%.

Table 33: Growth rates of motorized vehicles

Sl. No.	Type of Vehicles	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average Growth Rate
1	Ambulance	2797	3036	3371	3744	4105	4549	*10.2%*
2	Auto Rickshaw	141608	155509	171460	184635	192945	204289	*7.6%*
3	Auto Tempo	12180	12530	13120	14069	15213	16172	*5.9%*
4	Bus	26708	27778	29350	31873	35106	37961	*7.3%*
5	Cargo Van	3883	4440	4885	5435	6432	7586	*14.4%*
6	Covered Van	8790	10924	13187	15524	18983	23565	*21.8%*
7	Delivery Van	16319	17175	18359	19977	21906	23846	*7.9%*

Sl. No.	Type of Vehicles	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average Growth Rate
8	Human Hauler	6833	7090	7563	9227	11990	14079	*16.0%*
9	Jeep (Hard/Soft)	29212	30441	32491	35785	39866	44244	*8.7%*
10	Microbus	63315	66076	70052	74689	79545	83795	*5.8%*
11	Minibus	22294	22456	22697	23022	23429	23823	*1.3%*
12	Motor Cycle	858317	932912	1060887	1296365	1576417	1876978	*17.1%*
13	Pick Up	42357	48560	56428	64990	74767	85437	*15.1%*
14	Private Passenger Car	209264	219602	234260	251905	269722	287112	*6.5%*
15	Special Purpose Vehicle	6021	6195	6384	6746	7398	8358	*6.9%*
16	Tanker	2812	3050	9345	3644	3954	4296	*34.2%*
17	Taxicab	35718	35862	36070	36126	36152	36211	*0.3%*
18	Tractor	24038	25430	26704	28344	30469	32939	*6.5%*
19	Truck	82097	87479	93781	99482	107043	117125	*7.4%*
20	Other	4106	2434	3863	6097	9554	13865	*35.5%*
Total		**1595967**	**1718979**	**1908252**	**2211678**	**2564998**	**2946233**	***13.1%***

Road Traffic Composition in Bangladesh: The table below presents the change in traffic composition in Bangladesh over a period. Motorcycles made up over half of all vehicles in 2012-13 and since then, they have increased their share to 63.7%. Private cars make up around 10% of the share, whereas buses make up around 5%. Every major vehicle type has seen a reduction in the share of traffic composition in favour of motorcycles over the study period

Table 34 : Road traffic composition

Sl. No.	Type of Vehicles	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Ambulance	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
2	Auto Rickshaw	8.9%	9.0%	9.0%	8.3%	7.5%	6.9%
3	Auto Tempo	0.8%	0.7%	0.7%	0.6%	0.6%	0.5%
4	Bus	1.7%	1.6%	1.5%	1.4%	1.4%	1.3%

Sl. No.	Type of Vehicles	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
5	Cargo Van	0.2%	0.3%	0.3%	0.2%	0.3%	0.3%
6	Covered Van	0.6%	0.6%	0.7%	0.7%	0.7%	0.8%
7	Delivery Van	1.0%	1.0%	1.0%	0.9%	0.9%	0.8%
8	Human Hauler	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%
9	Jeep (Hard/Soft)	1.8%	1.8%	1.7%	1.6%	1.6%	1.5%
10	Microbus	4.0%	3.8%	3.7%	3.4%	3.1%	2.8%
11	Minibus	1.4%	1.3%	1.2%	1.0%	0.9%	0.8%
12	Motor Cycle	53.8%	54.3%	55.6%	58.6%	61.5%	63.7%
13	Pick Up (Double/Single Cabin)	2.7%	2.8%	3.0%	2.9%	2.9%	2.9%
14	Private Passenger Car	13.1%	12.8%	12.3%	11.4%	10.5%	9.7%
15	Special Purpose Vehicle	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%
16	Tanker	0.2%	0.2%	0.5%	0.2%	0.2%	0.1%
17	Taxicab	2.2%	2.1%	1.9%	1.6%	1.4%	1.2%
18	Tractor	1.5%	1.5%	1.4%	1.3%	1.2%	1.1%
19	Truck	5.1%	5.1%	4.9%	4.5%	4.2%	4.0%
20	Other	0.3%	0.1%	0.2%	0.3%	0.4%	0.5%
Total		100%	100%	100%	100%	100%	100%

Number of Motor Vehicles in Bangladesh Registered by Type: The table below presents data on the number of vehicles registered by type in Bangladesh in the period from 2012 to 2018. Among the major vehicle types, motor cycles are growing the fastest whereas private cars, buses, and trucks are growing at a rate of 6 to 7% per annum.

Table 35: Number of registered motor vehicles in Bangladesh

Sl. No	2012	2013	2014	2015	2016	2017	2018	Average Growth Rate
Ambulance	3193	3436	3774	4254	4632	5126	5690	*10.1%*
Auto Rickshaw	170731	186428	206325	226325	237498	246708	260346	*7.3%*

Sl. No	2012	2013	2014	2015	2016	2017	2018	Average Growth Rate
Auto Tempo	15067	15462	15962	17057	18379	19971	20580	*5.4%*
Bus	30978	32085	33573	35964	39797	43558	46313	*7.0%*
Cargo Van	4293	4980	5588	5987	7004	8413	9693	*14.6%*
Covered Van	9433	11704	14573	16927	20267	25432	31161	*22.1%*
Delivery Van	18841	19735	20911	22630	24811	27214	29314	*7.7%*
Human Hauler	8387	8772	8997	10139	13626	17030	18453	*14.6%*
Jeep(Hard/Soft)	35989	37303	39173	42774	47666	53083	58638	*8.5%*
Microbus	73474	76011	80324	85548	91352	96927	101064	*5.5%*
Minibus	26169	26317	26573	26896	27368	27858	28294	*1.3%*
Motor Cycle	975461	1061269	1151954	1392312	1724369	2049968	2445571	*16.7%*
Pick Up	50325	56878	66432	76689	88060	101557	114654	*14.7%*
Private Passenger Car	242004	252476	267175	288237	308541	330488	348715	*6.3%*
Special Purpose Vehicle	6993	7220	7392	7688	8308	9297	10336	*6.8%*
Tanker	3218	3444	3806	4130	4524	4842	5371	*8.9%*
Taxicab	44627	44678	45052	45140	45184	45199	45360	*0.3%*
Tractor	29294	31179	32701	34400	36976	39753	43306	*6.7%*
Truck	94533	99662	107798	114128	121403	132729	145392	*7.5%*
Others	1325	2405	4000	6073	9943	14941	20917	*58.9%*
Total	**1844335**	**1981444**	**2142083**	**2463298**	**2879708**	**3300094**	**3353265**	***10.6%***

Number of Motor Vehicles Registered in Dhaka by Type: The table below represents the growth of registered vehicles in Dhaka from 2012 to 2018. The growth rate for most vehicle categories is lower than the national average owing to a larger vehicle base which has attained a degree of saturation.

Table 36 : Number of registered motor vehicles in Dhaka

Sl.No	2012	2013	2014	2015	2016	2017	2018	Average Growth Rate
Ambulance	2943	3133	3387	3745	4032	4432	4888	*8.8%*
Auto Rickshaw	108711	108771	108827	109255	109837	109879	115516	*1.0%*
Auto Tempo	13982	13982	13982	13982	13982	13982	13982	*0.0%*
Bus	29966	30937	32301	34522	38001	41295	43617	*6.5%*
Cargo Van	4256	4932	5535	5933	6934	8219	9443	*14.3%*
Covered Van	8247	10097	12449	14304	16917	20940	25321	*20.6%*
Delivery Van	18182	18891	19792	21256	23154	25352	27234	*7.0%*
Human Hauler	6803	6918	7027	7529	8316	8533	8744	*4.3%*
Jeep(Hard/Soft)	34361	35468	37050	40159	44376	49088	53952	*7.9%*
Microbus	71286	73513	77355	81924	87093	92021	95606	*5.0%*
Minibus	25137	25220	25355	25458	25622	25781	25966	*0.5%*
Motor Cycle	748363	774694	807588	854352	908090	983342	1087406	*6.5%*
Pick Up	41903	46811	54106	62022	70504	80810	90425	*13.7%*
Private Passenger Car	236095	245326	258298	276720	294730	314302	330621	*5.8%*
Special Purpose Vehicle	6047	6125	6175	6241	6465	6698	7200	*3.0%*
Tanker	2719	2855	3018	3164	3373	3562	3888	*6.2%*
Taxicab	44456	44460	44762	44816	44846	44850	44944	*0.2%*
Tractor	26637	28271	29714	31351	33861	36615	39974	*7.0%*
Truck	84988	88510	94277	98701	103254	110523	119254	*5.8%*
Others	989	1649	2616	3923	6490	9635	13227	*54.4%*
Total	**1516071**	**1570563**	**1643614**	**1739357**	**1849877**	**1989859**	**2161208**	***6.1%***

5.4.4. Summary of Indicators

The table below presents a summary of select indicators which provide insight into the growth trends of the transport sector.

Table 37: Indicators of growth trends in the transport sector

Select Indicators	Period of Growth	Average Annual Growth Rate
GDP at constant* market prices (billion Tk.)	2008-18	7%
Per capita GDP at constant* market prices (Tk.)	2008-18	5%
Industry sector	2008-18	9.3%
Services sector	2008-18	6.0%
Public investment	2008-18	22%
Value added by Land Transport (all modes)	2012-18	6%
Value added by Mechanized Road Transport	2012-18	7%
Share of Mechanized Road Transport among all transport modes	2012-18	79.5%
Growth of Mechanized Vehicles in Bangladesh on Road	2012-18	13.1%
Private Car Growth Rate	2012-18	6.5%
Bus Growth Rate	2012-18	7.3%
Truck Growth Rate	2012-18	7.4%
Growth of Registered Motor Vehicles in Bangladesh	2012-18	10.6%
Growth of Registered Motor Vehicles in Dhaka	2012-18	6.1%

5.5. Traffic Forecast and Growth Rates

This chapter presents the outcome of the analysis of various socio-economic and transport sector indicators presented in the previous chapter. The growth trend analysis has been studied and the growth rates for the traffic projections have been estimated accordingly taking various considerations into account elaborated below:

5.5.1. Traffic Growth Rates

Proceeding with the above objective, the table below presents the growth trends of the GDP of Bangladesh over the past five years. The trend shows steady growth every year, with the average growth for the past five years being around 7%, and 6.45% for the past eight years. The value added by the motorized road transport sector, under which the proposed Expressway shall be categorized, is growing at a slightly higher pace than the GDP. The registered and on-road vehicles in Bangladesh also present stellar growth of over 10% on an average. These indicators establish that the economy of Bangladesh is growing at a steady pace, and its transport sector is outpacing its economy.

Table 38: GDP and road sector growth indicators

Parameter	2013-14	2014-15	2015-16	2016-17	2017-18	Average Growth
GDP at constant[4] market prices	*6.1%*	*6.6%*	*7.1%*	*7.3%*	*7.9%*	***7.0%***
Value Added by Mechanized Road Transport	*6.7%*	*7.1%*	*7.3%*	*8.0%*	*7.6%*	***7.3%***
Motor Vehicles on Road in Bangladesh	*7.7%*	*11.0%*	*15.9%*	*16.0%*	*14.9%*	***13.1%***
Registered Motor Vehicles Bangladesh	*8.1%*	*15.0%*	*16.9%*	*14.6%*	*1.6%*	***10.6%***

The table below presents the average growth rate of the GDP compared with the average growth rates of the classified vehicle types as defined in the Statistical Yearbook 2018. The average GDP growth from 2011-12 to 2017-18 has been considered for this exercise. The elasticity value for each vehicle type has been calculated and presented. These elasticity values present the relationship between the growth of GDP and the growth in number of vehicles. The elasticity values have been used to project future traffic volume based on projected GDP growth rates.

Table 39 : GDP growth rate comparison with classified vehicle types

Parameter	Average Growth Rate	Elasticity
GDP	6.45	
Truck	7.7	***1.19***
Big Bus	9	***1.40***
Mini Bus	1.6	***0.25***
Micro Bus	6.2	***0.96***

[4] 2012-13 base year

Parameter	Average Growth Rate	Elasticity
Agriculture Vehicle	11.0	***1.71***
Car	8.9	***1.38***
3-wheeler	6	***0.93***
Motorcycle	21	***3.26***
NMT	10	***1.55***

5.5.1.1. Growth Scenarios

Economic forecasts[5] have projected Bangladesh's economy to grow at 8% in the immediate timeframe and at 7% on an average up to 2030. Post 2030, as the economy enters middle-income status, the growth rate is expected to stabilize at 5%. In order to account for fluctuations in the economic projections, the Consultant has considered three growth scenarios as listed below:

- **Conservative Growth**: This scenario assumes that the GDP shall grow by 7.5% by 2022 and fall to 5% growth by 2045.
- **Realistic Growth**: This scenario takes into account the current growth rate of 7.9% and assumes the GDP will follow similar growth trend and shall grow by 8% in 2022. It is projected to stabilize at 5.5% in 2045.
- **Optimistic Growth**: This presents the best-case scenario with GDP growth rate of 8.5% in 2022 and up to 6% in 2045.

5.5.1.2. Decision to augment capacity of the proposed Expressway

The proposal of a 4-lane Expressway was upgraded to a 6-lane Expressway in order to cater to the estimated traffic demand. Transport infrastructure supply does not influence the demand initially, however, after a period the infrastructure project establishes itself and begins to attract higher traffic. In case of the proposed Expressway, a certain period after it begins operations, the 6-lane Expressway shall be more preferred than its peer projects to travel along the designated route. This has been reflected in the growth rates for the traffic projected on the Expressway.

The three growth scenarios have been presented in the table below. As per the elasticity values of the vehicle types, the corresponding growth rates across all three scenarios for the defined period up to the horizon year have been calculated and presented.

Table 40 : Traffic growth rate scenarios

Year	Particular	Elasticity	Growth Rate		
			Conservative	Realistic	Optimistic
2022	**GDP GR p.a.**		**7.5%**	**8.0%**	**8.5%**
	Truck	1.19	9.0%	9.6%	10.2%
	Big Bus	1.40	10.5%	11.2%	11.9%
	Mini Bus	0.25	1.9%	2.0%	2.1%

[5] Economic outlook 2030: Bangladesh on a stable course (RSM Global)

Year	Particular	Elasticity	Growth Rate		
			Conservative	Realistic	Optimistic
	Micro Bus	0.96	7.2%	7.7%	8.2%
	Agriculture Vehicle	1.71	12.8%	13.6%	14.5%
	Car	1.38	10.4%	11.0%	11.7%
	3-wheeler	0.93	7.0%	7.4%	7.9%
	Motorcycle	3.26	24.4%	26.1%	27.7%
	NMT	1.55	11.6%	12.4%	13.2%
2025	**GDP GR p.a.**		**7.5%**	**8.0%**	**8.5%**
	Truck	1.19	9.0%	9.6%	10.2%
	Big Bus	1.40	10.5%	11.2%	11.9%
	Mini Bus	0.25	1.9%	2.0%	2.1%
	Micro Bus	0.96	7.2%	7.7%	8.2%
	Agriculture Vehicle	1.71	12.8%	13.6%	14.5%
	Car	1.38	10.4%	11.0%	11.7%
	3-wheeler	0.93	7.0%	7.4%	7.9%
	Motorcycle	3.26	24.4%	26.1%	27.7%
	NMT	1.55	11.6%	12.4%	13.2%
2030	**GDP GR p.a.**		**7.0%**	**7.5%**	**8.0%**
	Truck	1.19	8.4%	9.0%	9.6%
	Big Bus	1.40	9.8%	10.5%	11.2%
	Mini Bus	0.25	1.7%	1.9%	2.0%
	Micro Bus	0.96	6.7%	7.2%	7.7%
	Agriculture Vehicle	1.71	11.9%	12.8%	13.6%
	Car	1.38	9.7%	10.4%	11.0%
	3-wheeler	0.93	6.5%	7.0%	7.4%
	Motorcycle	3.26	22.8%	24.4%	26.1%
	NMT	1.55	10.9%	11.6%	12.4%
2035	**GDP GR p.a.**		**6.5%**	**7.0%**	**7.5%**
	Truck	1.19	7.8%	8.4%	9.0%
	Big Bus	1.40	9.1%	9.8%	10.5%
	Mini Bus	0.25	1.6%	1.7%	1.9%
	Micro Bus	0.96	6.3%	6.7%	7.2%
	Agriculture Vehicle	1.71	11.1%	11.9%	12.8%
	Car	1.38	9.0%	9.7%	10.4%
	3-wheeler	0.93	6.0%	6.5%	7.0%
	Motorcycle	3.26	21.2%	22.8%	24.4%

Year	Particular	Elasticity	Growth Rate		
			Conservative	Realistic	Optimistic
	NMT	1.55	10.1%	10.9%	11.6%
2040	**GDP GR p.a.**		**6.0%**	**6.5%**	**7.0%**
	Truck	1.19	7.2%	7.8%	8.4%
	Big Bus	1.40	8.4%	9.1%	9.8%
	Mini Bus	0.25	1.5%	1.6%	1.7%
	Micro Bus	0.96	5.8%	6.3%	6.7%
	Agriculture Vehicle	1.71	10.2%	11.1%	11.9%
	Car	1.38	8.3%	9.0%	9.7%
	3-wheeler	0.93	5.6%	6.0%	6.5%
	Motorcycle	3.26	19.5%	21.2%	22.8%
	NMT	1.55	9.3%	10.1%	10.9%
2045	**GDP GR p.a.**		**5.5%**	**6.0%**	**6.5%**
	Truck	1.19	6.6%	7.2%	7.8%
	Big Bus	1.40	7.7%	8.4%	9.1%
	Mini Bus	0.25	1.4%	1.5%	1.6%
	Micro Bus	0.96	5.3%	5.8%	6.3%
	Agriculture Vehicle	1.71	9.4%	10.2%	11.1%
	Car	1.38	7.6%	8.3%	9.0%
	3-wheeler	0.93	5.1%	5.6%	6.0%
	Motorcycle	3.26	17.9%	19.5%	21.2%
	NMT	1.55	8.5%	9.3%	10.1%

5.5.1.3. Seasonal Adjustment Factor

The Consultant had carried out the traffic surveys in the month of July in 2019. In order to nullify the effects of monthly variations in traffic, a seasonal correction factor for July has been applied to the vehicle counts. The seasonal correction factors for cargo and passenger vehicles have been applied. The original vehicle counts consolidated under car, bus, and truck categories have been presented in the table below along with the revised counts after application of the seasonal correction factors.

Table 41 : Vehicle Count in 2019

No	Project Section	Car	Bus	Truck	Total
1	Gabtoli - Baliarpur	9990	10923	13340	34253
2	Baliarpur - Hemayatpur	10579	11767	13054	35400
3	Hemayatpur - Savar	6971	10657	13828	31456
4	Savar - Nabinagar	3891	7821	10551	22263
5	Nabinagar - Dhamrai	7649	12423	14158	34230

No	Project Section	Car	Bus	Truck	Total
6	Nabinagar - Bipile	5356	9672	12467	27495
Seasonal Correction Factor		***0.99***	***0.99***	***1.10***	
1	Gabtoli - Baliarpur	9890	10814	14674	35378
2	Baliarpur - Hemayatpur	10473	11649	14359	36482
3	Hemayatpur - Savar	6901	10550	15211	32663
4	Savar - Nabinagar	3852	7742.8	11606	23201
5	Nabinagar - Dhamrai	7573	12299	15574	35445
6	Nabinagar - Bipile	5302	9575.3	13714	28591

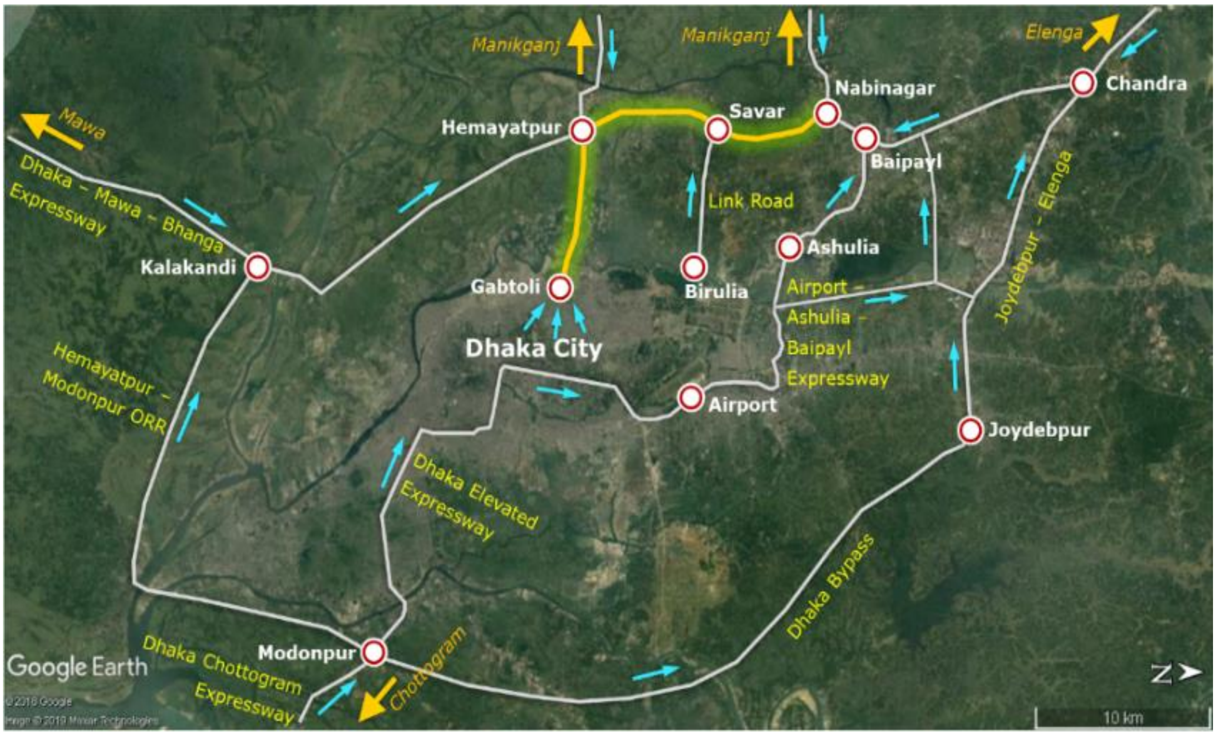
5.5.1.4. Related Projects in Influence Area

Following is a list of road projects under different stages of implementation, with the purpose of improving the regional connectivity of Dhaka:

- Dhaka Elevated Expressway: Connects Dhaka International Airport to the south-east of the city and is also the starting point for the Dhaka-Chottogram (also known as Chittagong) Expressway, which aims to boost connectivity between Dhaka and the second largest city of Bangladesh.
- Airport – Ashulia – DEPZ Elevated Expressway: This project is envisioned to be the northern extension of Dhaka Elevated Expressway and will connect the Airport to Dhaka Export Processing Zone (DEPZ) located in Bipile, north-west of Dhaka.
- Dhaka East West Elevated Expressway: This project aims to connect Modonpur to Boliarpur through an elevated expressway following a green-field alignment.
- Dhaka Bypass: This project will connect Joydebpur to Modonpur via Debogram and Bhulta, thus acting as a bypass road to the east of Dhaka.
- Southern Section of ORR: This section will connect Modonpur to Hemayatpur via Kalakandi, acting as the southern bypass road of Dhaka.
- Dhaka – Mawa – Bhanga Expressway: This road is proposed to commence at Kalakandi and connect Dhaka with major centres in Khulna and Barishal divisions. The project includes a major bridge over the river Padma.
- Second Padma Bridge: Roads from Hemayatpur and Nabinagar merge at Manikganj and proceed towards Paturia. A second bridge over the river Padma shall connect Dhaka directly with Jessore and reduce the travel time to Kolkata.
- Joydebpur – Elenga: This project aims to expand the present road to 4 lanes and boost connectivity of Dhaka with Rajshahi and Rangpur divisions.
- Birulia – Savar Link Road: This road connects the area of Birulia in Dhaka with Savar Bazaar through a new link road.

  These projects have been portrayed in the adjacent figure. These projects have been analysed on the basis of their primary function, their role in the regional connectivity of Dhaka, and the impact they are likely to have on the proposed Expressway corridor

Figure 13 : Related project in Influence Area



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5.6. Transport Demand Model

5.6.1. Travel Demand on Project stretch

The table below presents the existing traffic plying on Gabtoli – Savar – Nabinagar-Bipile corridor, as captured during the traffic counts carried out by the Consultant. The vehicle counts have been presented based on the classification of vehicles defined in the National Toll Policy, 2014.

Table 42 : Existing traffic on the project Corridor

Project Section	Present Vehicles											
	Heavy Truck	Medium Truck	Mini Truck	Big Bus	Mini Bus	Microbus	Agriculture Vehicle	Car	3 wheel vehicle	Motor Cycle	NMT	Total
1	678	10130	3867	3952	5025	1836	725	9890	411	4264	1312	42089
2	659	7798	5903	3553	5581	2516	1091	10473	4590	5359	2443	49965
3	182	10321	4708	3378	5053	2120	993	6901	403	4296	1867	40221
4	472	7503	3631	2345	3602	1796	637	3852	2669	2548	760	29815
5	312	9596	5665	4126	5274	2899	584	7573	2721	4138	1195	44083
6	472	8764	4478	2266	5284	2026	496	5302	2356	3344	1181	35969

The table below presents the existing traffic demand on Gabtoli – Savar – Nabinagar-Bipile corridor in terms of PCU.

Table 43 : Existing traffic demand - PCU Count

Project Section	PCU Count											
	Heavy Truck	Medium Truck	Mini Truck	Big Bus	Mini Bus	Microbus	Agriculture Vehicle	Car	3 wheel vehicle	Motor Cycle	NMT	Total
1	3049	30390	9666	13832	12563	3673	1087	9890	411	2132	945	87638
2	2965	23394	14757	12436	13952	5031	1636	10473	4590	2679	1760	93673
3	817	30964	11770	11823	12632	4239	1489	6901	403	2148	1345	84531
4	2124	22509	9078	8209	9004	3592	955	3852	2669	1274	548	63813
5	1406	28789	14163	14442	13184	5797	876	7573	2721	2069	861	91880

Project Section	PCU Count											
	Heavy Truck	Medium Truck	Mini Truck	Big Bus	Mini Bus	Microbus	Agriculture Vehicle	Car	3 wheel vehicle	Motor Cycle	NMT	Total
6	2124	26291	11195	7931	13209	4051	744	5302	2356	1672	851	75727

5.6.1.1. Diverted Traffic

In addition to the existing traffic plying on the Gabtoli – Savar – Nabinagar-Bipile corridor, traffic from other roads is also expected to shift to this road once it is upgraded to Expressway standards. Conversely, other upcoming road projects may compete with this Expressway and some of the traffic may shift to these roads. Such road projects which may impact the traffic on the proposed Expressway have been broadly classified into competing projects and complementing projects.

a) **Competing Projects :** These projects are expected to offer shorter travel time, lower or no toll, or other advantages for specific travellers as compared to the proposed Expressway. These projects are likely to attract some of the traffic which might otherwise have used the proposed Expressway. These projects have been listed below:

- <u>Airport – Ashulia – Bipile Elevated Expressway:</u> This project shall act as a viable alternative for the residents of Dhaka, especially the northern part of the city, to travel from the Airport to Bipile and onwards to Chandra. Since this project is an elevated corridor, it is expected to offer a seamless and uninterrupted ride to the travellers and hence shall compete with the proposed Expressway, which also terminates at Bipile.

- <u>Dhaka Bypass:</u> This bypass corridor shall provide a viable alternative to the residents of Dhaka to travel from the city to Chandra via Joydebpur. This project shall also attract traffic from Chittagong, Comilla, and Sylhet by providing them the access to Chandra, Elenga, and Rajshahi. The proposed Expressway shall also target to attract the traffic from Chittagong heading towards Chandra, and in this respect the Dhaka Bypass shall compete with the proposed Expressway.

b) **Complementing Projects:** These projects shall act as feeders to the proposed Expressway, or shall change the regional traffic movement in such a manner so that the Expressway is in a position to attract extra traffic. Such projects have been listed below:

- <u>Dhaka East West Elevated Expressway:</u> This project shall consist of an elevated corridor initiating from Modonpur and terminating at Boliarpur, which lies between Gabtoli and Hemayatpur, intersecting the proposed Expressway. Thus, it shall attract traffic from Chittagong, Narayanganj, and Barishal and deposit them to the proposed Expressway. In this manner, it is expected to complement the proposed Expressway by feeding traffic to it.

- <u>Southern Outer Ring Road:</u> This project shall follow a parallel alignment as compared to the Dhaka East West Elevated Expressway and shall terminate at Hemayatpur. Thus, it is expected to feed traffic to the proposed Expressway from the same sources as mentioned above.

- <u>Birulia – Savar Link Road:</u> This proposed greenfield alignment shall connect Birulia area in North Dhaka to Savar town on the alignment of the proposed Expressway. It will facilitate quick movement from North Dhaka to Savar, Bipile, Chandra, and onwards. It will also enable easy access from North Dhaka to Hemayatpur and Manikganj. Thus, it is expected to feed traffic to the proposed Expressway from Dhaka.

Table 43 presents the traffic diversion model for the proposed Expressway. Each of the projects listed above are expected to feed or attract traffic from the proposed Expressway. Thus, based on the impact of the projects they have been assigned a value which states the extent of diversion to or from the proposed Expressway.

The value is in the form of the percentage of the projected traffic expected to be diverted to or from the proposed Expressway. The diverted traffic volume has been subjected to the growth rates identified for the existing traffic and the future diverted traffic has been arrived at.

Table 44 : Expected diverted traffic volume

Projects	Notation	Length	Present Status	Upgradation Proposal	Expected Year of Operations	Competing Project	Complementing Project	Diverted Traffic to/from Project (%)	Diverted to/from Project Section	Diverted Traffic to/from Project - Average Annual Daily Traffic (AADT)					
										2022	*2025*	*2030*	*2035*	*2040*	*2045*
Gabtoli - Savar - Nabinagar-Bipile Expressway	N-5	22	4 lane	6 lane AC + 4 lane SR	2022						*1.11*	*1.10*	*1.09*	*1.08*	*1.08*
Dhaka East West Elevated Expressway	Green-field	39	N/A	4 lane AC viaduct	2025			10%	1 and 2		4603	5055	5516	5942	6400
Airport - Ashulia - Bipile Expressway	N-302	23	2 lane	4 lane AC viaduct	2025			10%	6		3597	3950	4310	4643	5001
Dhaka Bypass (Joydebpur - Modonpur)	N-105	48	2 lane	4 lane AC	2022			5%	6	1798	1988	2183	2382	2566	2764
Southern ORR (Modonpur - Hemayatpur)	N/A	57	N/A	4 lane AC	2025			10%	1 and 2		4603	5055	5516	5942	6400
Birulia - Savar Link Road	N/A	10	N/A	4 lane	2022			5%	4	1491	1648	1810	1975	2127	2291
Total traffic diverted from/on the proposed Expressway										**-308**	**5268**	**5787**	**6315**	**6802**	**7326**

5.6.1.2. Metro Shift

As part of the urban transport development plan of Dhaka, a metro line has been planned from Gabtoli to Hemayatpur, and up to Nabinagar in future. Since this metro corridor shall follow the same alignment as that of the proposed Expressway, it is expected to directly compete with the Expressway for local traffic. As per the OD survey, 44% of the traffic captured was local in nature, i.e. the traffic originated and terminated within Dhaka metro region. The metro line is expected to become operational in another 5 years, and it is primarily going to attract the private vehicles owners, majorly cars and motor cycles, who would have otherwise used the proposed Expressway or the service roads to reach their local destination.

The table presents the assumptions regarding the expected shift to metro and its distribution among the private vehicles. It has been assumed that in the initial year of its operation, the metro will attract 10% of the internal and private vehicle traffic. Over the years as the metro becomes more popular as a quick and seamless mode of transport, and as its network expands across Dhaka region, the shift from private vehicles is expected to increase to up to 30% by 2045.

As per the traffic survey count, the ratio of cars vs motor cycles in the traffic mix is 3:2. Accordingly, the diverted traffic has been distributed among cars and motor cycles in the same ratio. This traffic has been deducted from the projected traffic for the proposed Expressway.

Table 45 : Expected traffic shift to metro

Year	2025	2030	2035	2040	2045
Shift from Private Vehicles to Metro	10%	15%	20%	25%	30%
Share of Private Passenger Cars	6%	9%	12%	15%	18%
Share of Two-wheelers	4%	6%	8%	10%	12%

5.6.1.3. Induced Traffic

The proposed Expressway is expected to improve the driving conditions on the Gabtoli – Savar – Nabinagar-Bipile corridor by offering higher speed, better road quality, advanced safety features, and a comfortable journey. This intervention is expected to further increase the strategic importance of this corridor as a critical commercial and industrial suburb of Dhaka. Thus, the proposed Expressway is likely to induce further development of commercial and industrial clusters along the catchment area of the project corridor. This development shall in turn generate more traffic for the Expressway. Since this is a brown-field project with the alignment having a semi-urban character, there is considerable development already on this corridor and hence this project is not expected to induce the level of traffic as compared to a green-field project. Considering these factors, the proposed Expressway is expected to induce 10% extra traffic in the project corridor.

5.6.1.4. Expressway and Service Road Traffic Distribution

The total projected traffic for the project corridor will ply on the proposed four–lane Expressway as well as the service roads running along the sides. In order to estimate the traffic split between the two components, the Consultant had carried out the willingness to pay exercise along with the OD survey. This survey provides an insight into the likelihood of the projected traffic to use the Expressway.

The table below presents the willingness to pay toll analysis. The responses for willingness to pay have been analysed separately for internal and external traffic. The respondents from the internal traffic category who are willing to pay the prescribed toll are highly likely (75%) to use the Expressway, whereas those who are willing to pay a lower toll are less likely (25%) to use the Expressway and are expected to use the service road. Respondents who have stated their unwillingness to pay toll or were unsure have not been considered for the Expressway traffic. It is inferred from the OD survey that 44% of the traffic is internal and hence the likelihood of internal traffic using the Expressway is a proportion of this internal traffic.

A similar analysis has been presented for the external traffic. Respondents willing to pay the prescribed toll are highly likely (75%) to use the Expressway, whereas those willing to pay a lower toll are half as likely (50%) to use the Expressway. The external traffic has a greater incentive to use the Expressway as compared to the internal traffic since the former will travel a longer distance and benefits more from the expected time and cost savings offered by the proposed Expressway.

Table 46 : WTP Toll Analysis

<table>
<tr><th colspan="2">Willingness to Pay</th><th>Total</th><th>Yes</th><th>Yes, but at lower rate</th><th>No</th><th>Can't Say</th></tr>
<tr><td rowspan="3">Internal</td><td colspan="2">Percentage</td><td>31%</td><td>64%</td><td>4%</td><td>2%</td></tr>
<tr><td colspan="2">Likelihood of using Expressway</td><td>75%</td><td>25%</td><td rowspan="2" colspan="2"></td></tr>
<tr><td>Contribution from Internal Traffic</td><td>44%</td><td>10%</td><td>7%</td></tr>
<tr><td rowspan="3">External</td><td colspan="2">Percentage</td><td>33%</td><td>63%</td><td>2%</td><td>1%</td></tr>
<tr><td colspan="2">Likelihood of using Expressway</td><td>75%</td><td>50%</td><td rowspan="2" colspan="2"></td></tr>
<tr><td>Contribution from External Traffic</td><td>56%</td><td>14%</td><td>18%</td></tr>
<tr><td rowspan="2"></td><td>Traffic on Expressway</td><td colspan="5">10% + 7% + 14% + 18% = 48.7%</td></tr>
<tr><td>Traffic on Service Roads</td><td colspan="5">51.3%</td></tr>
</table>

5.6.1.5. Traffic Assignment Model

The table below summarizes the traffic demand model and presents the traffic assignment model for the traffic projection exercise. The following types of traffic demand have been analysed and presented:

- Existing Traffic Demand: This is the current traffic as captured during the traffic survey exercise carried out by the Consultant. The traffic growth rates worked out in the previous chapter have been applied to this traffic in order to estimate the future traffic on this corridor.
- Diverted Traffic: The values presented under this head is the sum total of the diverted and attracted traffic from various competing and complementing projects. Overall, the analysis portrays that the sum total is positive and the proposed Expressway will attract higher volume of traffic from other roads than it will lose to other projects.

- Shift to Metro: The values presented under this head refer to the expected shift from private vehicles, majorly cars and motor cycles, to the upcoming metro line along the project corridor.
- Induced Traffic: This head refers to the additional traffic generated due to increased commercial and industrial activity in the project corridor due to the development of the proposed Expressway.
- Traffic for Service Roads: This value refers to the traffic split between the Expressway and Service Roads.

Table 47 : Traffic assignment model

Year	Existing Traffic Demand *(Section-wise)*						Diverted Traffic to/from other road projects *(AADT)*	Shift to Metro *(% of projected demand)*	Induced Traffic *(% of projected demand)*	Traffic for Service Road *(% of total)*
	1	2	3	4	5	6	All Sections			
2019	42089	49965	40221	29815	44083	35969				
2022	Traffic Growth Rates defined in Table 39						-308		10%	51.3%
2025							5268	10%		
2030							5787	15%		
2035							6315	20%		
2040							6802	25%		
2045							7326	30%		

Based on the above traffic demand model analysis, traffic has been assigned to the project sections of the proposed Expressway in the following section of this chapter.

5.7. Traffic Projections

This section details out the considerations and future traffic projections that have been arrived based on the integration of the above analysis.

5.7.1. Project Sections

The table below describes the six defined project sections of the proposed Expressway. The sections have been defined based on the differing traffic characteristics observed during the traffic survey carried out by the Consultant.

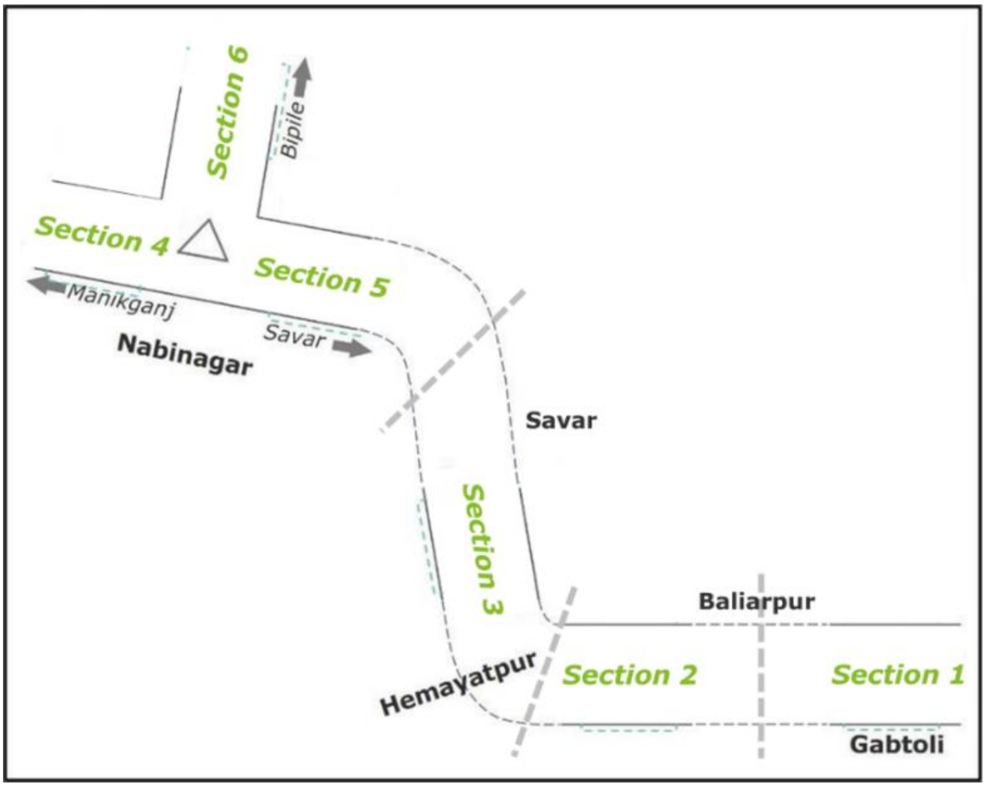
Table 48 : Project sections of the proposed expressway

Project Section		
No	Start Point	End Point
1	Gabtoli	Baliarpur

Project Section		
No	**Start Point**	**End Point**
2	Baliarpur	Hemayatpur
3	Hemayatpur	Savar
4	Savar	Nabinagar
5	Nabinagar	Dhamrai
6	Nabinagar	Bipile

The figure below portrays the above defined project sections graphically in order to define the locational aspects of each section.

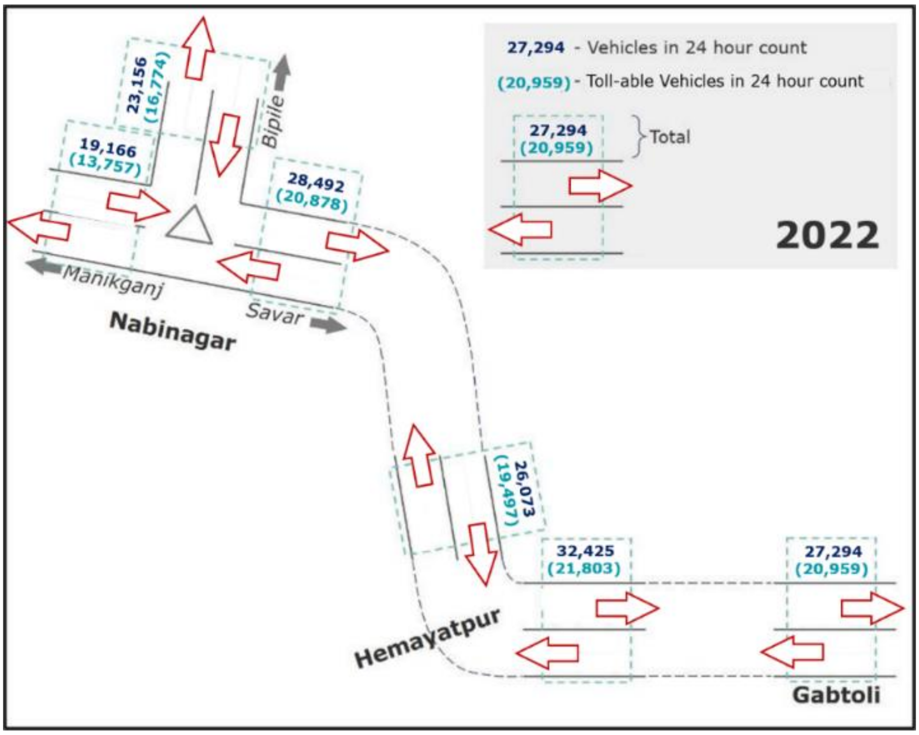
Figure 14 : Project sections



5.7.2. Vehicle Projections

The tables in Annexure present the traffic projections for vehicles (AADT) for the defined growth scenarios across all project sections for the defined period up to the horizon year. The vehicle projections for 2022, which is the expected year for start of operations, are provided in the following figure:

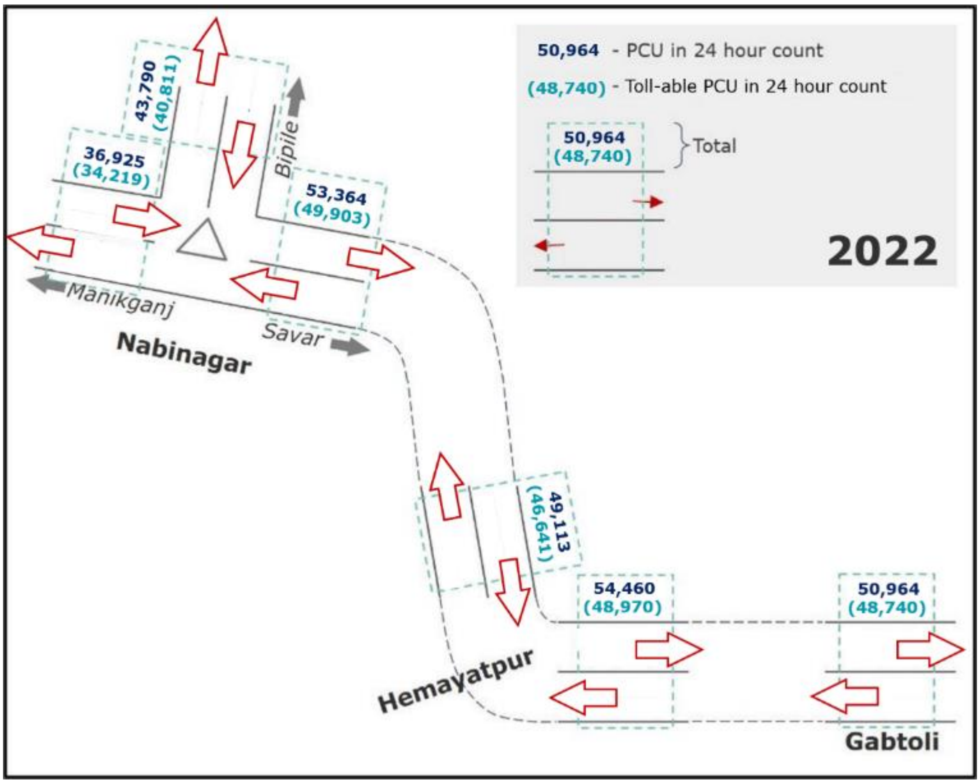
Figure 15 : Vehicle projections



5.7.3. PCU Projections

The tables in Annexure present the traffic projections in terms of PCU per day for the defined growth scenarios across all project sections for the defined period up to the horizon year. The PCU projections for 2022 are provided in exhibit.

Figure 16: PCU Projections



5.7.4. Observations and Project Implications

5.7.4.1. Capacity Analysis for Traffic Projections

The following table presents the projected traffic for each section of the proposed Expressway for the defined growth scenarios in terms of PCU per day in order to analyse the capacity constraints of the proposed Expressway. The corresponding level of service for each traffic projection value has been provided to estimate the driving conditions on the section for the defined year.

The light shaded cells refer to the year in which the projected traffic reaches the design service volume. This gives an indication to initiate the procedure for capacity expansion by preparing feasibility studies, drafting detailed project reports, project financing, and giving the work order for the construction. The dark shaded cells refer to the year when the project section will exceed its design capacity and is denoted by a lower LOS rank. In this case, the Expressway has been designed for LOS B and the corresponding design service volume of LOS B (Design Service Volume: 58,200 PCU; Range: 39,801 to 76,500 PCU) has been considered for capacity analysis.

Table 49 : Projected traffic for different scenarios

PCU on Expressway		Year	Conservative		Realistic		Optimistic	
			PCU	LOS	PCU	LOS	PCU	LOS
Project Section	1	2022	50,695	B	50,964	B	51,233	B
		2025	60,850	B	61,448	B	62,041	B
		2030	65,729	B	66,713	B	67,707	B
		2035	70,669	B	72,092	B	73,544	B
		2040	75,535	B	77,468	C	79,458	C
		2045	80,354	C	82,863	C	85,456	C
	2	2022	54,167	B	54,460	B	54,749	B
		2025	64,550	B	65,183	B	65,823	B
		2030	69,696	B	70,731	B	71,793	B
		2035	74,889	B	76,401	B	77,950	C
		2040	80,021	C	82,074	C	84,194	C
		2045	85,107	C	87,773	C	90,533	C
	3	2022	48,857	B	49,113	B	49,373	B
		2025	58,921	B	59,492	B	60,064	B
		2030	63,681	B	64,617	B	65,577	B
		2035	68,491	B	69,860	B	71,259	B
		2040	73,252	B	75,106	B	77,015	C
		2045	77,972	C	80,384	C	82,884	C
	4	2022	36,733	B	36,925	B	37,122	B
		2025	45,810	B	46,233	B	46,660	B

PCU on Expressway		Year	Conservative		Realistic		Optimistic	
			PCU	LOS	PCU	LOS	PCU	LOS
		2030	49,481	B	50,176	B	50,884	B
		2035	53,198	B	54,201	B	55,235	B
		2040	56,850	B	58,210	B	59,622	B
		2045	60,490	B	62,259	B	64,085	B
	5	2022	53,077	B	53,364	B	53,641	B
		2025	63,436	B	64,049	B	64,671	B
		2030	68,491	B	69,507	B	70,532	B
		2035	73,602	B	75,071	B	76,564	C
		2040	78,648	C	80,635	C	82,677	C
		2045	83,646	C	86,223	C	88,890	C
	6	2022	43,565	B	43,790	B	44,015	B
		2025	53,073	B	53,566	B	54,056	B
		2030	57,209	B	58,014	B	58,827	B
		2035	61,392	B	62,556	B	63,745	B
		2040	65,512	B	67,095	B	68,707	B
		2045	69,601	B	71,653	B	73,761	B

5.7.4.2. Toll-able Traffic

The proposed Expressway shall have two toll-plazas throughout its alignment as part of the open tolling mechanism. The first toll plaza shall be between sections 1 and 2, whereas the second toll plaza shall be between section 3 and 5. In order to estimate expected toll-able traffic at the toll plazas, the average projected toll-able traffic of section 1 and 2 has been considered for the first toll plaza, whereas the average toll-able traffic of sections 3, 5, and 6 have been considered for the second toll plaza. Section 4 is not part of the Expressway and hence has not been considered.

At each of the toll plazas, the toll will be charged for 50% of the distance travelled irrespective of the distance travelled. In case a vehicle crosses both the toll plazas, it will be charged 100% (i.e. 50% at each toll plaza). On the other hand, traffic initiated / crossing Toll Plaza – 1 only shall be charged for 50% of the total amount assuming that the distance travelled is equivalent of 50%. Similarly, traffic initiated after Toll Plaza – 1 and crossing Toll Plaza – 2 only shall also be charged for 50% of the total amount assuming that the distance travelled is equivalent of 50%.

It is imperative to note here that the number of toll able vehicles entering the toll plaza 1 are not expected in entirety to exit at toll plaza 2. Multiple exit points for the vehicles would render the collection at the two toll booths to be different.

5.7.4.3. Impact of Growth Scenarios on Section Capacity

The following figure represents the impact of traffic growth on the capacity of various sections of the project. The graphics states the year in which the section will reach threshold traffic and the year in which the section capacity will be exceeded.

Figure 17 : Conservative traffic growth scenario

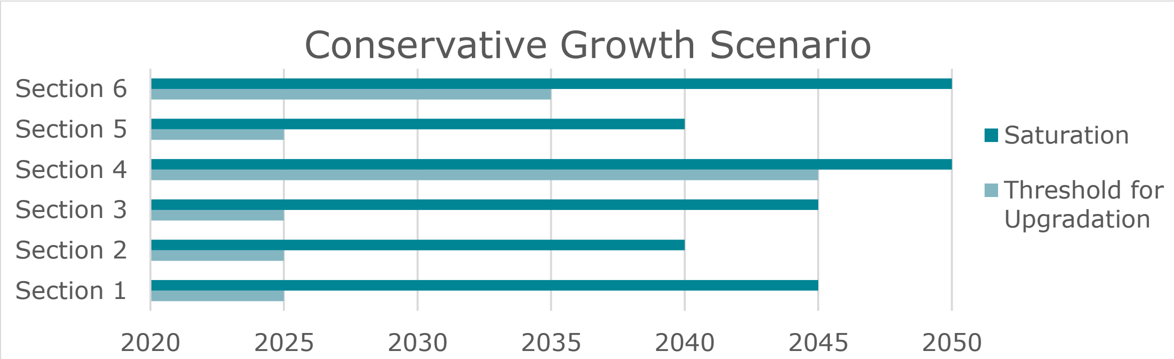


Figure 18 : Realistic traffic growth scenario

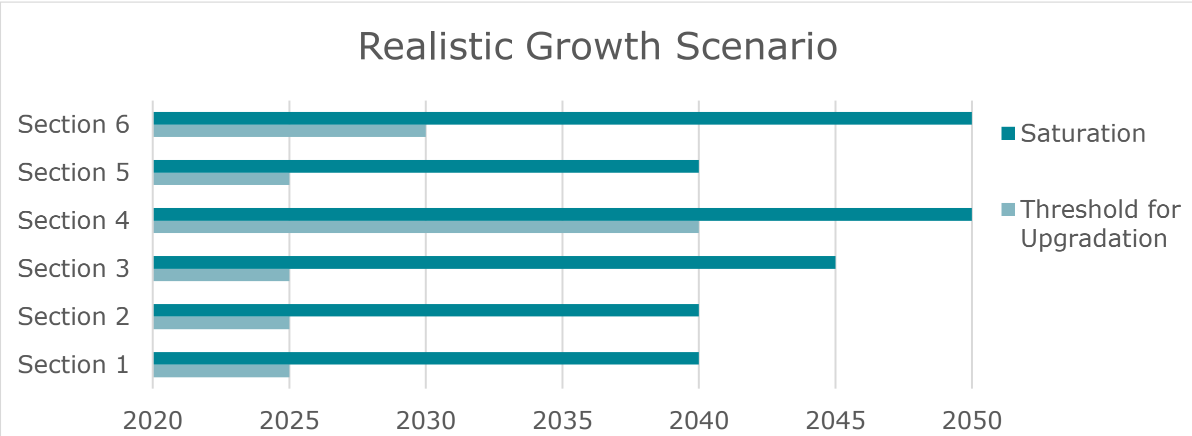
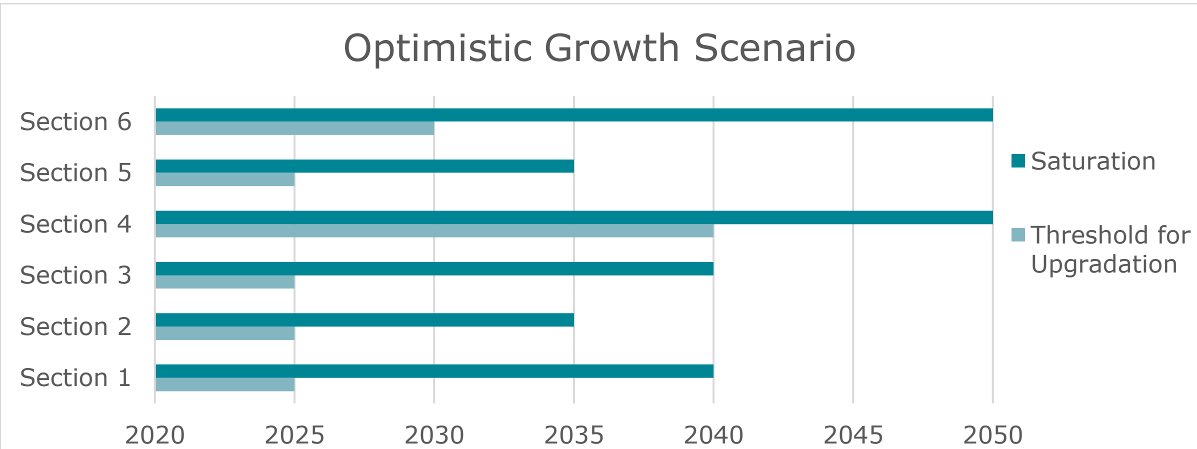


Figure 19 : Optimistic traffic growth scenario



While the above analysis depict the traffic assessment for the project corridor, the following sections detail out the assessment of various considerations including the application of ITS, analysis of applicability of various tolling mechanisms and associated best practices including institutional considerations and exploring non-tolling revenues mechanisms that can be evaluated for Bangladesh and incorporated for our project corridor.

5.8. Traffic management – Intelligent Transportation Systems (ITS)

The application of computer technology in the transport sector through ITS systems for improvement of the transport system is emerging across the world. The Intelligent transportation systems, integrated into the transportation system infrastructure and in vehicles themselves, help monitor and manage traffic flow, reduce congestion, provide alternate routes to travellers, enhance productivity, and save lives, time and money.

The application of ITS in the road transport system in developing countries like Bangladesh shall be important to achieve the following:

- Real time information, both for public transport and private road transport, so that users have up-to-the minute information on services to avoid incidents/delays and improve road safety
- The use of geographical information systems (GIS) and relational databases to keep inventories of transport infrastructure in an area to better manage and prioritise maintenance work.
- "Smartcard" ticketing on public transport, to give the passenger the best deal for the bundle of trips that they might be making in a particular period of time, and to provide the operator(s) with detailed information about their passengers' travel habits for apportioning revenue between operators, as well as for service planning.
- Detailed route planning information (often in real time) for both public transport and car users.
- Parking guidance systems, to reduce parking search time.
- Public transport information in various formats for disabled people.
- Traffic signal control, in real time, to improve the efficiency of traffic flow, or to afford priority to particular user groups such as bus passengers, or pedestrians, within a network.
- Sophisticated booking and scheduling software can help to maximise vehicle utilisation in a demand responsive transport (DRT) scheme.

5.8.1. Areas of Application of ITS

The application of ITS specific to our project corridor can involve the considerations of the following areas:

Incident detection: ITS can be used to detect when there has been an incident on any transport system, and to communicate this knowledge to a control centre. ITS can, further, be used to put into effect information and/or traffic management strategies in response to certain types of incidents, in order to reduce their impact.

Application

An incident is detected by roadside CCTV cameras, and picked up in the control room. Variable message signing (VMS) is then activated to:

(a) manage the traffic that is too close to the accident to take another route (by e.g. lane closures, lane control, temporary speed limits); and
(b) the VMS is used to advise traffic further away from the accident to take another route.

Similar concepts were developed by the GOTIC project in Sweden in incident detection and management on Gothenburg's tram system.

Roadside incident detection can save considerable energy by re-routeing traffic away from the area that is congested due to the incident, and by managing speeds of traffic on approach to the incident, to reduce congestion.

Variable speed limits: The application of ITS for managing speed limits to maximise road capacity and also to reduce congestion caused by the over- reaction of drivers to changes in speeds, and the "wave propagation" effect is catered to by application of variable speed limit signing with the required form of automatic enforcement (e.g. average or point speed cameras). The reduced congestion and speeds have a knock-on benefit on energy consumption on road transport.

Ramp control: Ramp control is used at peak periods to regulate the flow of traffic along a slip road onto a motorway or other grade-separated road. Sensors on the main road detect traffic density and then the optimum level and spacing of joining traffic is calculated, and its access onto the main road regulated by traffic lights which results in minimizing the congesting effect on the main road of the joining traffic.

Demand Responsive Transport Management: Demand Responsive Transport (DRT) is a form of public transport that, instead of operating on fixed routes at fixed times, operates with some level of diversion/flexibility to take users where they want, when they want. From the user perspective, the most flexible form of public transport is the taxi, but it comes with a matching price tag to ensure the highest possible utilisation of the vehicle and the driver(s).

Freight and Fleet Management: Fleet management is used to ensure that a fleet of vehicles is utilised to maximum efficiency and to manage services in real time. This is normally done using satellite and radio technology, although certain bus only automatic vehicle location (AVL) systems use roadside beacons for a limited vicinity.

Speeding Detection: Speeding is a major contributory factor to road accidents, and it increases both the risk of an accident occurring, and the severity of that accident. Some of the application of ITS include the following:

- Point speed cameras. These measure the speed of a vehicle at a short point on the road, such as at an accident blackspot, using radar detection, and conventional camera film
- Average speed cameras: These are linked to numberplate recognition systems that calculate the average speed of a car over that stretch.

- Signs that alert drivers to their speed, but without any enforcement.
- Intelligent Speed Adaptation (ISA) uses satellite GPS technology to indicate to a vehicle its own location relative to speed limits.

Passenger Information Systems and Route Guidance with Navigation: ITS has the ability to provide real time information to public transport passengers (RTPI) through a variety of media such as at-stop displays, SMS messaging and the internet leading to some energy saving by promoting modal shift in traffic.

Global Positioning Satellite (GPS), as used in fleet management and AVL can also be used to provide drivers with very detailed route guidance information to reduce the number of kilometres driven can be used in tandem with congestion information to give drivers advice on how to choose routes to avoid incidents.

Variable Message Signals : VMS application for ITS to provide real time information to the travellers to reflect prevailing conditions to advise drivers on main roads of difficult driving conditions, to give notice of incidents and also to advise of diversionary route.

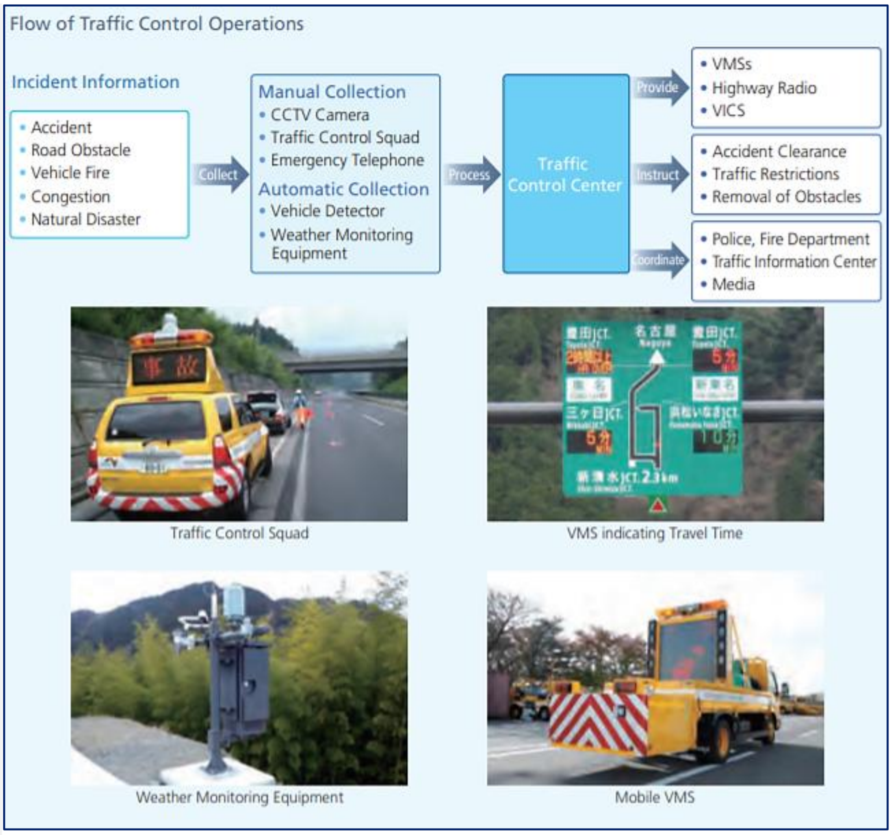
Road user charging (RUC), tolling, and access control through ITS: ITS can be an extremely useful tool for collecting tolls. Some applications of the ways in which it used are as follows:

- The London Congestion Charge is enforced by automatic number plate recognition (ANPR - cameras photograph number plates and then a computer compares the number plate with those stored in a database of people who have paid their charge that day). ITS must be used not for the number plate recognition, but also to allow people to register on the database when they pay. They can do this by paying in cash at a paystation (e.g. a petrol station), or by pre-registering and then paying on the internet, by SMS or by phone.
- Many toll bridges, toll motorways and all four congestion charging schemes in cities in Norway use a tag-based system for collecting revenue. Vehicles whose owners register for the scheme carry an electronic tag that is "read" by beacon when the car passes through a charging point. They are then billed monthly according to the number of charged trips they have made. ANPR is used for enforcement.
- In Singapore, a congestion charging scheme uses an in-car unit (IU) with which every vehicle must be equipped. The user buys a card rather like a phone card and inserts the card in the IU before driving into a charged area. Charges in Singapore vary by location and by time of day, but a beacon activates the IU when the vehicle drives past a charging point, and the correct amount of money is deducted from the card in the IU where ANPR is used for enforcement.

- ITS application for public transport payments through electronic ticketing machines and smart cards facilitate convenience and range of fare options for the users.

Case Study: Application of ITS in Japan- Traffic Control Centres

Traffic Control Centers in Japan feature state-of-the-art traffic and facilities control technologies. These centers collect information about roadway conditions and disseminate it to drivers. Once an accident happens, the staff coordinates with expressway traffic police units and fire departments to ensure fast accident clearance and traffic flow recovery.



Traffic Control Squad

VMS indicating Travel Time

Weather Monitoring Equipment

Mobile VMS

5.8.2. Current Scenario of ITS Application in Bangladesh [6]

To ensure smooth operation and timely maintenance of transportation facilities, applying appropriate management techniques with the application ITS can be the most effective solution. However, its application has been very limited in the country where some of the examples include the following:

- Dhaka Transport Coordination Authority (DTCA) has already introduced a "rapid pass", a digital fare collection system for commuters. Initially the rapid pass has been introduced on BRTC air-conditioned buses on a pilot basis and will be finally rolled-out by the beginning of 2019. The rapid pass will be designated as "One Card for All Transport". A commuter will have to pay Tk400 to buy a rapid pass.
- CCTVs are installed at strategic position of the bridge and toll plazas. The automation will cover: Auto Incident Detection System using CCTV and Auto Toll Collection Audit System using CCTV.
- The Dhaka North and South city corporations are implementing a digital signal system. The project is being implemented under the Clean Air and Sustainable Environment (CASE) project funded by the World Bank. The traffic police will be given remotes to control the lights under the new system and will be able to decide when they change to green or red.
- Introduction of Automatic Vehicle Location System (AVLS) in vehicle security by BDCOM Online Limited which started officially their operation in the country in July 2006.

[6] BUET Study

- Installation of CCTV cameras at the 26 points of Dhaka city to ensure peaceful observance and control of law and discipline and traffic movement

5.8.3. Potential applications in the future in Bangladesh

- Optimization of traffic signals by using Vehicle Actuated Demand Responsive Signal Control System to coordinate control of traffic signals across a network, adjusting the lengths of traffic signals based on prevailing traffic condition.
- For surveillance using remote sensing with detectors, sensors and close circuit TV. This facility can be used to monitor traffic condition on major arterial routes, which will enable implementing traffic-responsive control schemes through either automated system or manual implementation by traffic regulation enforcing personnel.
- Electronic Toll Collection (ETC) System can be more frequently used in bridges to increase the efficiency and to prevent manipulation in toll collection.
- An integrated transportation information management system can be developed to ensure proper coordination among different governmental agencies and private organizations related with the development activities of transportation infrastructure of Bangladesh.
- Introduction of the concept of e-transport and cellular-transport.

With the increasing focus on traffic management and introduction of innovative mechanisms in the transportation sector, proper application ITS technologies needs to be explored. Due to economic limitations in its applications, some steps can be taken to recover the cost of implementation of some feasible ITS technologies by user centric approach to compensate for the cost involved and exploring the introduction of some mechanisms in the agreements of the road/transport projects to the private sector. The emphasis should be given on application of IT in every possible and feasible sectors of transportation.

5.9. Tolling Best Practices Assessment

5.9.1. Tolling Mechanisms in the Road Sector

The financial feasibility of a tolled expressway is determined on its revenue generating potential. This revenue generating potential is directly related to the toll/user charge. Any implementation of tolling requires a balanced approach that aligns the goals and objectives of the project with the needs of the users and the transportation network. Toll technology has made significant strides in reducing the cost of toll collection and congestion worldwide, but effective and efficient toll collection can only be achieved if the business rules and legal framework are aligned with industry best practices.

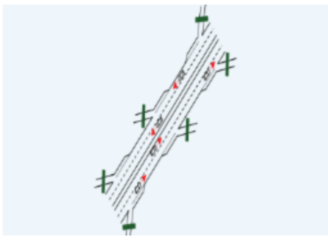
Several factors need to be considered while narrowing in on the type of toll facility. These factors include physical roadway constraints, traffic congestion, roadway user mix, project costs, complementary facilities and local mobility options. These factors provide a roadmap for finalization and operationalization of the toll facility.

Recent technological advancements have significantly altered the tolling ecosystem and expanded the types of toll facilities being operated to focus on improved customer experience, to add new roadway capacity, manage congestion and provide a sustainable revenue source for asset lifecycle costs in the road sector across the world.

5.9.2. Tolling Collection Systems

There are two main types of toll systems: Open and Closed Tolls. The following section provides a glimpse of both of these systems and their relative advantages and disadvantages.

Figure 20 : Closed Toll System



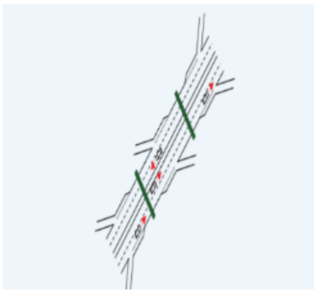
1) Closed Tolls: In closed tolling, the toll collection points are located at each of the road's gates of access. Ideally, this system requires that there are no other entry and exit points than the gates where toll collection points are situated, the highway is fenced off from other roads and tracks, and there is no possibility for U-turns once one enters the trunk. Thus, the toll payments are directly linked to the distance travelled in such system.

Advantages: The broad advantages of this system includes:

- It is a fairer system since it is easy to measure the distance travelled.
- It reduces the risk of congestion on the trunk, as vehicles do not need to slow down and stop to pay.
- Long distance travellers only need to stop at the entry and exit points.

Disadvantages: It involves higher investment and operations costs as more tolling points are required. Secondly, higher investment and maintenance cost is required to insulate the highway from its surroundings. Ensuring complete insulation may be a challenge and fences may be vandalized and cut open.

Figure 21 : Open Toll System



2) Open Tolls: Tolls are located on the trunk at several intervals. To ensure 100% capture of traffic, tolling points should be located between a pair of entry and exit points. However, in practice, the decision to opt for open tolls is often based on the idea of reducing toll collection costs by placing a smaller number of tolling points. In these cases, the operator calculates that the reduction in collection costs offsets the reduced share in captured traffic. Open tolls are also the only practical option when it is a challenge to insulate the highway from its vicinity.

Thus the toll is collected at points along the highway and are not determined by the distance travelled by the vehicle, as in case of closed tolling.

Advantages : The broad advantages of this system are:

- It is less costly in terms investment, operation, and maintenance costs.
- It is relatively easier to implement.
- This may be the only option to introduce tolls in already existing roads.
- Open tolls are often the only practical option to toll access roads to major cities or roads in urban environments.

Disadvantages: The broad disadvantages of this system includes:

- It is more difficult to correlate payment to distance travelled.
- There is a potential loss of revenue since 100% of traffic may not be captured if the road is not fully insulated.

- There is a higher risk of congestion inside the trunk.
- Long distance travellers will need to stop at several points.
- They may create boundary effects. This means travel patterns and location decisions on housing and setting up businesses are affected by the position of the tolling point. Areas beyond the tolling point become less attractive for business and housing, and land prices go down.

5.9.3. Toll Collection Techniques

As a common practice, exists three basic tolling collection techniques: manual tolling, electronic tolling and a mixture of the two, referred to as mixed tolling.

Manual Tolling	Electronic Tolling	Mixed Tolling

5.9.3.1. Manual Tolling through Toll plazas

These are the most traditional and common type of toll collection system. They consist of a series of tollgates located one next to the other. Each gate has a barrier that only opens once the driver pays the toll. Users may be offered the possibility to pay through various means: cash, bankcards, vouchers, or others.

Advantages:

- The range of payment options for drivers is broader, including cash and bankcards.
- They may be the most practical option in places where a substantial share of users do not have bank accounts and/or have nascent banking services.
- The existence of barriers and staff makes it a simple way of enforcing non-payment
- Manual tolls may provide a source of employment for low skilled and local people

Disadvantages:

- Investment in infrastructure may be higher than for electronic tolls.
- They involve managing an extensive workforce, often in dispersed locations, and organizing shifts to ensure a 24 hours x 365 days operation.
- Vehicles need to stop, which increases travel time and may cause congestion. In some cases, the total time required for taking out the card + swiping it + waiting time for processing of transaction may be more than time taken to pay cash.
- Substantial land area may be required to accommodate several tollgates in roads with dense traffic. That may be a major problem in urban or densely populated areas.
- Security challenges and lack of transparency may arise from the collection, manipulation, and transportation of high volumes of cash.

5.9.3.2. Electronic Tolling

A more prudent approach to reduce the wastage of time, fuel and resources is to switch to Electronic Toll Collection Techniques. Electronic tolling allow the vehicle owners to pay the toll without stopping. The process becomes faster and smoother due to the usage of sophisticated technology.

Electronic systems allow toll payment without requiring vehicles to stop and, with the more sophisticated systems, not even slow down. Toll plazas are replaced by gantries equipped with beacons and/or cameras designed to identify every crossing vehicle. Electronic tolling systems require that vehicles carry an authorized on-board unit (OBU), also called electronic tag or transponder, which is commonly attached to their windshield.

Regular users need to acquire or rent an OBU and provide a prepaid payment account where toll fares will be charged. Foreign vehicles will need to buy a prepaid tag for the time they expect to circulate in the foreign country or associate a rented OBU to a credit card.

Advantages:

- Investment in infrastructure will typically be lower than in toll plazas, although higher investment in information technology systems will be required.
- They do not cause congestion, as vehicles do not need to stop for toll payment.
- Operations are generally easier: less staff, revenue is channelled in just one way, no need to manipulate or transport cash.

Disadvantages:

- Procedures to fight non-payment and fraud should be set up. They may be complex and costly.
- Higher resistance from users may be found for several reasons: reluctance of occasional users to buy or rent a device for just a few trips, need to open and provide a bank account, or concerns about privacy.
- Revenue may be lost when devices are inoperative because of breakdowns, maintenance, or vandalism.
- Dependency on particular information technology providers or dedicated systems.

Electronic Tolling Technologies: There are several technologies that are used in electronic tolling and come with their own advantages and disadvantages. These are explained in detail below:

1) Number Plate recognition:

- In such a technology, the number plates are recognized by camera that are then used for tolling charges
- This technology works accurately and effectively in places where the number plates are standardized and there exists a national vehicle database (It is very much popular in expressways in North America)

2) Radio – Frequency Identification (RFID) Recognition

- Every vehicle is fitted with a radio frequency tag that is then used to distinguish the vehicle
- The tag communicates with a transponder on an overhead or roadside gantry to register its passage through the charge point. Unequipped users will typically have their number plate recorded by a camera and identified via automatic number plate recognition systems (ANPR).
- Non-paying vehicles identified with the ANPR will be subjected to enforcement procedures.

- Tag-and-beacon systems usually use microwave technologies that are virtually 100% efficient in detecting equipped vehicles.

- However, cameras with ANPR, may have less accuracy and are affected by many factors such as light, fog, poor maintenance or rogue manipulation of plates, and may find trouble in identifying foreign cars with exotic plates. So, some manual support is needed if higher detection ratios are expected.

3) Satellite-based systems

- They require vehicles to be equipped with a global positioning system (GPS) receiver on-board, combined with a digital map of the road, similar to a satellite navigation device.
- GPS transponder tracks vehicle and can be used to charge for the highway length travelled
- The downside: GPS technology on its own is sometimes not accurate enough to discern between two adjacent roads, back office is more complex, and there are some concerns about privacy.
- The worldwide use of this technology is not widespread.

5.9.3.3. Mixed Tolling:

Some countries, install a "mixed system" of toll collection where the traditional toll plazas coexist with the electronic tolling lanes. In this mixed method, the road user (with or without RFID tag) can enter the lane. In case the user has a valid RFID tag, the transaction goes through electronically. However, otherwise, the road user will be notified and the user will have the option to pay via other modes of payment, such as cash, smart cards, or mobile wallets.

This option offers best of both the worlds: It saves time, helps in emission control and fuel saving

Mixed Tolling Technologies: The following table gives a glimpse of different tolling methodologies and the time per transaction. The table clearly compares various electronic tolling technique showing that the traditional methods slower and less efficient.

Table 50 : Mixed tolling technologies

Technology	Approx. Time per transaction	Approx. Vehicle throughput per hour
Cash transaction	26 seconds	138 vehicles per hour
Credit card swipe	41 seconds	88 vehicles per hour
Touch Card	12 seconds	300 vehicles per hour
RFID	3~4 seconds	1000~1200 vehicles per hour

5.9.4. Tolling on Urban Motorways and Ring Roads

Tolls in high-capacity roads serving or crossing major cities are very common. As cities and motorization grow fast, congestion in urban roads has become a major problem. Many cities see privately financed urban motorways as the only option to increase road capacity.

However, it is to be noted that introducing tolls in urban roads may also create some perverse side effects. The advantages and disadvantages of tolling on urban motorways have been detailed out below:

Advantages

- High-capacity roads designed to alleviate congestion in urban environments are complex and expensive works, usually beyond the financial reach of local authorities.
- High-traffic demand in cities and metropolitan areas make urban motorways an attractive investment. They may be more attractive to private investment than intercity corridors with lower traffic.
- Tolls may be used to discourage the use of cars and encourage public transport.

Disadvantages

- The diversion of traffic created by tolls may further aggravate congestion in secondary non-toll roads.
- The introduction of tolls may distort the objective of a ring road that is to funnel crossing traffic away from the city as users unwilling to pay may keep on driving across it.
- Residents in areas served by the motorway may complain about paying tolls for local mobility.
- Tolls may create boundary effects affecting the attractiveness for business and housing of areas before and after toll barriers.
- Adding capacity in roads bound to the city will lead to pouring still more cars into inner-city streets that may already be incapable of providing enough space for circulation and parking

Case study of Kazakhstan

There are several countries where the cashless system of paying the toll (through pre-paid wallets, cards etc.) is at a nascent stage. Kazakhstan tackled this obstacle by introducing a non-cash form of payment. The National Roads Company, **KazAvtoZhol** introduced new noncash form of payment. These comprise subscription fees, and pre-payment via self-service terminals and transponders to reduce the load on the bill validators and preventing congestion on toll plazas.

Source: ADB Report

5.9.5. Existing Toll Collection in Bangladesh

In 2005, the government introduced computerized toll collection system at Meghna and Meghna-Gomoti Bridge on Dhaka Chittagong National Highway, to have greater transparency in collection of tolls and avoid pilferage and corrupt practices relating to toll collection.

In 2017, 'Touch and Go toll collection' [7] system was installed to make the process seamless.

Further, in an attempt to make this robust, the government has installed automated toll machines at Meghna and Meghna Gomoti Bridge in 2019. The toll system -works through the Radio Frequency Identification (RFID) the technology. This was primarily done to obviate the need for the driver and the toll authority to manually perform the toll transaction.

Figure 22 : Automated Toll in Bangladesh

Automated toll system introduced

Star Online Report

For the first time in Bangladesh automated toll system has been introduced for motor vehicles crossing the Meghna Bridge and the Gumti Bridge on Dhaka-Chattagram Highway.

"The automated system has been installed for one of the lanes of the bridges and if it gains popularity, all the lanes would be brought under this system," said Secretary of Road Transport and Highways Md Nazrul Islam.

File photo of the Meghna bridge.

As way forward, the government of Bangladesh is envisaging imposition of tolls on Vehicles using the National Highways and the RHD has been tasked with devising toll structure to aid implementation of the same.

5.9.6. Case Study: Growth of FASTag in India

India is at the cusp of a digital revolution in the roads and highways sector. Right from manual collection of the tolls to using technological interventions to make toll collection hassle free, India's toll collection is evolving.

The National Payments Corporation of India in conjunction with the National Highways Authority of India has developed the "National Electronic Toll Collection program" to foster electronic tolling in the country. India's first RFID based ETC was rolled out in 2013 and since then the government is pushing for digitization of toll payments. Thereafter, The Ministry of Road Transport & Highway (MoRTH) had initiated the setting up a committee with a mandate to examine all technologies available for electronic toll collection.

Subsequently, a closed loop solution implemented in partnership with an India private sector bank (ICICI Bank) wherein the issued RFID Tags also known as FASTag, were issued. This roll out was further strengthened when the National Payments Corporation of India (NPCI) stepped in to set up a central clearing-house for transactions received from all toll management systems.

The National Highways Authority of India (NHAI) has now mandated the implementation of National Electronic Toll Collection program for all national highways in India, to solve the problem of congestion, increase transparency in toll collection and minimize leakages in the process.

The program can be extended to offer greater synergies to corporate and retail consumers. For example, the corporate consumers can use track their vehicle location and optimize vehicles' route by using data from the program without requiring the agencies to install separate hardware for the features. The program can also be offered at state and municipal toll plazas to provide a seamless experience to Consumers. The initiative can also provide better values to the end consumer. For example, consumers could pay for fuel via FASTags, or use FASTag at electric vehicle charging stations for automated payments. The

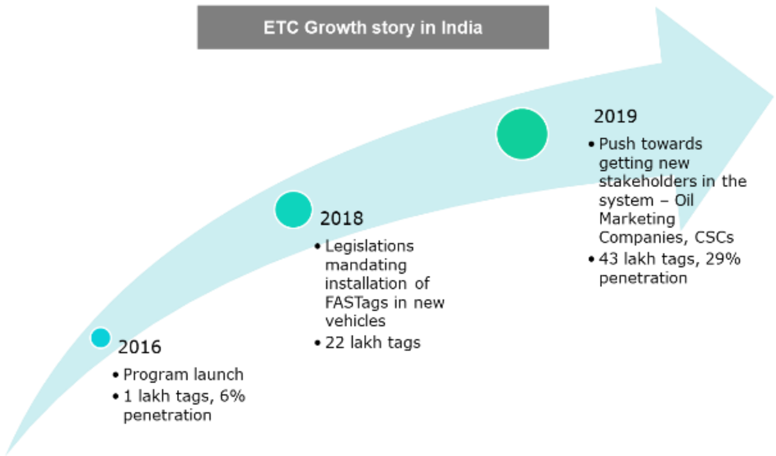
[7] NRB bank: https://www.nrbbankbd.com/portfolio/nrb-bank-limited-is-the-proud-banking-partner-of-touch-go-toll-collection-system/

program could also be linked with various parking points and city entries to charge fees from the consumers.

The program can also be extended to offer more streamlined governance mechanisms. For example, by linking the GST's e-way bill with FASTag, a vehicle can be provided with seamless movement across various districts and states, while ensuring that the vehicles origin, destination, and stoppages are tracked automatically. The initiative would also allow authorities to track commercial vehicles that may have deviated from their permit routes. It can also be linked with permits/PUCs/Insurance required for a vehicle and automatically track errant drivers.

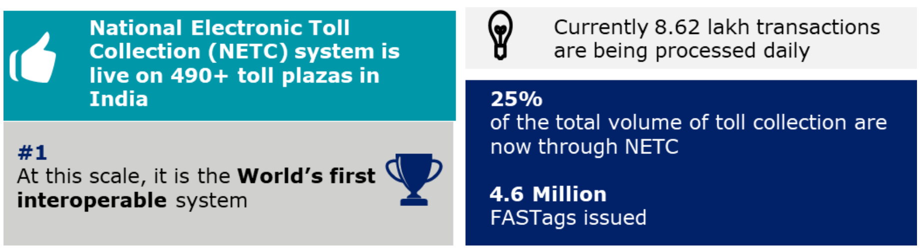
- State/city Toll Plazas across country - no need for multiple tags
- Parking stations - electronic payments
- Fuel pumps/electric vehicle charging points - automatic refuelling
- Vehicle movement - automated tracking
- GST Council - eway bill pinkage
- Enforecement - Tracking errant vehicle

Figure 23 : ETC growth story in India



The following gives a glimpse of India's National Electronic Toll Collection Program.

Figure 24 : Growth story of India's National Electronic Toll Collection



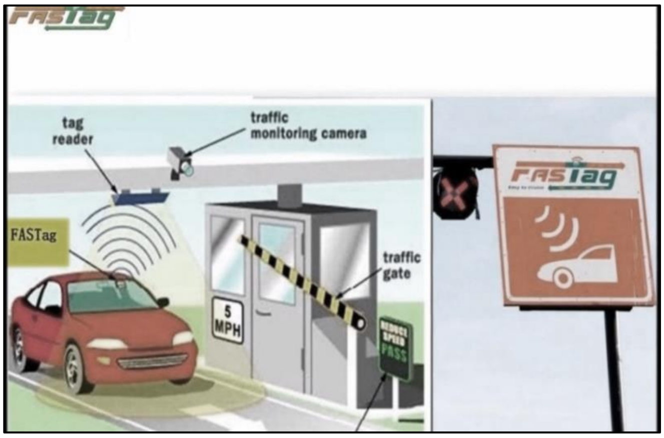
In India, the FASTag affixed on the vehicles has seen a tremendous increase year after year. The following presents a summary of the same.

Table 51 : Summary of FASTag

Parameter	Dec 2016	Dec 2017	May 2018
FASTag affixed on vehicles	1.09 Lakhs	9.15 Lakhs	22.5 lakhs
No. of transactions	31.92 Lakh per month	1.23 Crores month	1.45 Crores per month
Amount of transactions	88.12 Crores per month	320 Crores per month	500 crores per month

The initiation of toll collection using the RFID is a step towards making the toll collection seamless and transparent. The RFID based toll collection system does not require the vehicles to stop at the toll booths to pay the fare, unlike the traditional or manual toll collection system.

Figure 25 : FASTag Technology



Instead, the payment automatically takes place from the pre-paid account of the driver. The implementation of this technology requires installation of- RFID card (called FASTags in India), RFID readers and ANPR Cameras. The vehicles have the RFID cards/ tags affixed on the windscreen, and these tags have a unique vehicle identification number.

The RFID reader captures the visual information of the vehicle and uniquely identifies each vehicles. The ANPR cameras capture the number plate as the proof of the passage.

This information will be sent to the back office to connect with the vehicle owner's registered information and to charge the toll to the owner's account. In this manner, the vehicle passes the toll collection unit and the amount is deducted from the tag balance.

Simple illustration of the NETC Transaction process flow

Toll Plaza System → Acquirer → Online Switch and Mapper → Issuer Banks

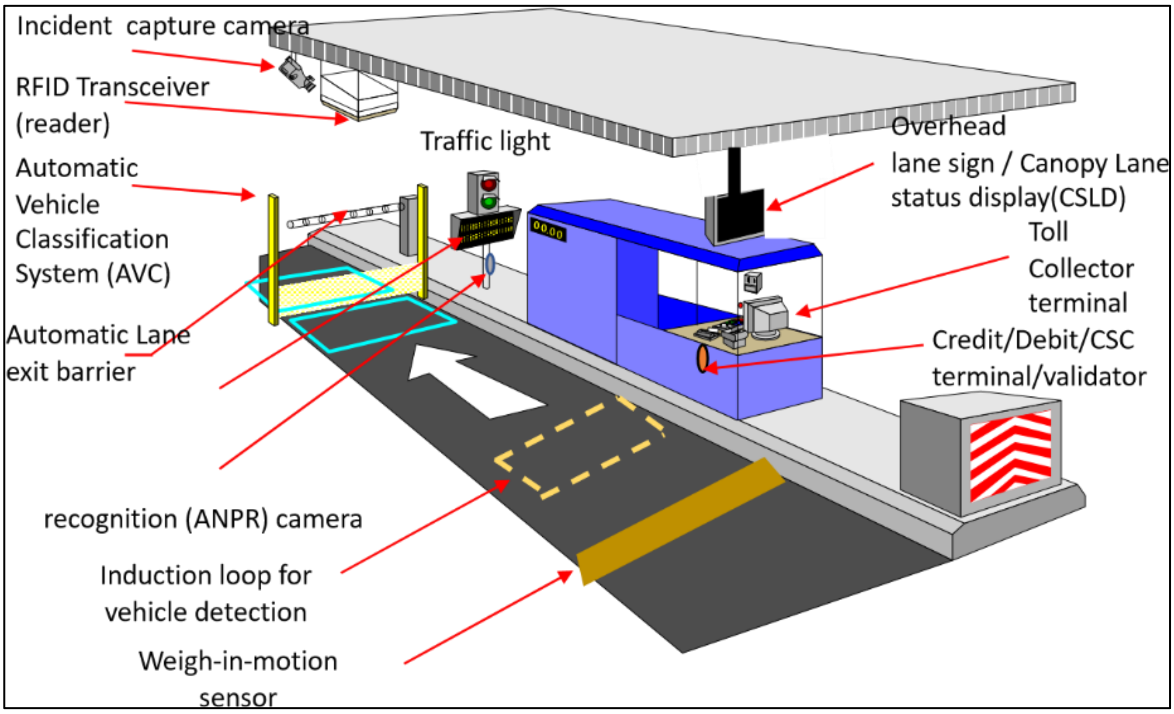
The above diagram illustrates a simpler transaction flow of the NETC system in India. When a vehicle passes through the ETC lane, the transaction is sent to acquiring bank for processing. The Acquiring System validates these transactions and the tag and sends it to NETC Switch. NPCI routes these transactions from the respective issuer banks which debit the amount for toll.

Source: National Payments Corporation of India

Interoperability – A success factor

An important characteristic of making the toll collection seamless is the interoperability of the RFID tags. In India, the customer can use the RFID tag as payment mode on any of the toll plazas irrespective of who has acquired it. This program has received a further push from the Government via a mandate that ensures that all vehicles sold in India are fitted with an operational FASTag. Owing to the push, the program now has been adopted in more than twenty-three lakh vehicles across the nation with around two and half lakh vehicles joining the program every month.

Figure 26 : Typical Toll Collection and Management System in India



Benefits

There are several benefits associated with switching to electronic tolling system. The benefits are not just accrued to the users but also to the government, by means of faster and transparent toll collection procedures. All these challenges are subject to proper technological ecosystem, which is a pre-requisite. The seamless movement shall also help in better congestion management.

Social Benefits	Environmental Benefits	Economic Benefits
• Reduction in the toll payments related hassles • Analytics and data for better highway management	• Reduction in congestion and consequent air pollution	• Reduced manpower in managing the highway/expressway • Increased productivity due to less traffic and seamless movement • Digitization of toll payments

Among several other benefits, RFID based tolling supplies the authorities with data and analytics for efficient traffic management. The RFID tag makes it easier to link the information collected on the roadside to the information of the vehicle owner stored in the backend.

Challenges in implementation of RFID Tolling

Among the several advantages that electronic tolling provides, there are certain challenges in its implementation. There are certain pre-requisites for seamless implementation of electronic tolling.

The key issues that are observed with Tolling can be divided into Plaza Level issues and Driver related issues.

Plaza Level issues

- Time wastage associated with cash operations
- Lack of lanes/issues with plaza design
- Equipment breakdown owing to extreme weather conditions
- There are a number of infrastructure related issues at Toll Plazas that hamper user experience. For instance, the handheld readers used at most of the toll plazas require proximity to the tag for operations. This leads to operators using ladders/stools to read tags mounted at trucks and creates a situation where FASTag lanes are slower than overall lanes.

Driver Issues

- Lack of lane discipline by drivers
- Overloaded vehicles
- Lack of compliance – speed limit, FASTag not pasted; The vehicle owners do not charge their RFID accounts timely

Other issues

- Unclear segregation of dedicated FASTag lane and hybrid lanes
- Cash users enter dedicated FASTag lane and slow the traffic movement for FASTag users
- There is no process for evaluating/testing the suppliers of the ETC equipment. There is also no strategy to ensure real time monitoring and uptime of ETC equipment.
- Each acquiring bank has provided a separate complaint redressal mechanism, which is neither defined not monitored by NHAI/IHMCL (Indian Highway Management Corporation Ltd.)

Resolution Strategies

- Uniform Hybrid ETC systems in all lanes of PPP toll plazas across the country
- Detailed minimum hardware specifications of all key components in RFID lane
- System logger to monitor lane uptime real time and key data fields to be reported on real-time basis
- Provision for penalty for vehicles entering exclusive FASTag lanes without active FASTags
- Supreme Court directives on overloaded vehicles under implementation
- Need for attitude adjustment to ensure road discipline and ensure better highways for all users
- Dedicated FASTag lane to be identified as FASTag express

- Some plazas have successfully installed readers at the entry point of the dedicated FASTag lanes, and thus reduced the risks of cash users entering these lanes – Others may also replicate the strategy
- Increasing awareness about FASTags through mobile applications etc. to ensure wide adoption

Table 52 : Case Study: South Delhi Municipal Corporation, New Delhi

Brief Description	• South Delhi Municipal Corporation (SDMC) collects MCD Entry Tax and Environment Collection Charge (ECC) at Delhi Entry Points at 124 locations for the traffic entering into Delhi. • SDMC has decided to modernize 10 entry points with the construction of proper Toll Plaza for RFID based toll collection system including cash/mixed lanes • 31 RFID lanes will be developed at nine locations for electronic collection of toll taxes.
Tolling Mechanism	• SDMC has decided to adopt technology to decongest the capital's borders by installing radio frequency identification (RFID) systems at nine prime locations to collect toll tax. • SDMC has recently issued an expression of interest to appoint consultants do structure and design the mechanism to use RFID based toll tax collection system in the city. Further details on its mechanism are not firmed up as of now.
Implementation mechanism	• RFID is a small device with a chip that acts like a bar code. • RFID tag is mounted on the vehicle's windscreen. • As the vehicle reaches the toll plaza, a unique identification number that is embedded on the tag is captured by the RFID reader and a unique number is sent to a central computer. • Applicable toll amount is deducted from a prepaid account that is linked to the particular RFID tag. • Vehicles can pay toll without stopping thus making the process faster and more efficient.

Case Study: Electronic Road Pricing Mechanism in Singapore

Singapore has introduced an Electronic Road Pricing (ERP) mechanism[8], wherein all vehicles have to pay a fee to enter the Central Business District of the city between 7:30am to 9:30am on weekdays. Later, the Electronic Road Pricing scheme replaced the manual system which was then extended to some of the key arterial roads beyond the city center. The ERP scheme had major advantages as it saved costs by replacing manual labor. It has also made it possible for the government to introduce flexible charges i.e the more congested the roads are, the higher the fees charged from road users.

[8] Electronic Road Pricing: The Singapore way: Eddie Lim Sing Loong, Land Transport Authority Singapore

Congestion pricing has attracted interest in the European Union, but formidable political obstacles remain. Even if congestion pricing gains more acceptance, it is very difficult to set up a regime under which anything close to optimal pricing is practiced.

Figure 27 : Congestion road pricing in Singapore

Singapore has handled the pressures of road pricing well but has not been completely unaffected by political pressures. The Central Expressway, for example, has not always been priced according to the government's own principles. It is noteworthy that decisions to change prices needs to be approved at the apex level. In other words, price changes are not just a minor technical matter to be left to functionaries. Expansions of the priced areas and the number of vehicles allowed are also troublesome politically. From the mid-1980 to the 1990s, the portion of tax receipts accounted for by the various charges for motor vehicles rose from about 5 percent to more than 20 percent.

Table 53 : Case Study: Electronic Road Pricing in Singapore

Brief Description	• Singapore was the first city to implement an electronic road toll collection system for purposes of congestion pricing[9]. • Since 1975 Singapore has priced vehicle entry into its central business district (CBD) via an electronic system. The key purpose of this pricing is to manage traffic volumes and reduce congestion in the CBD. Prices are adjusted on a quarterly basis based on traffic speeds. • The Electronic Road Pricing (ERP) was implemented by the Land Transport Authority in 1998.
Tolling Mechanism	• Gantries are used to scan vehicles as they use the thoroughfares and an In-Vehicle Unit (IU) with an attached smartcard is installed in the car. The car owner can either load value in the CashCard or pay directly via credit card.
	• The CashCard is a re-usable and can be topped up with cash at petrol stations or automated teller machines. The IU has a backlit liquid crystal display. It displays the Cash Card balance when the card is inserted into the IU and the remaining balance after the deduction of a charge after the vehicle goes under an ERP gantry.
Implementation mechanism	• Vehicle owners using priced roadways need to have an IU mounted inside the windshield of their vehicle. The newer dual mode IU has a cost of S$ 150 (about US$110). A smart card ("CashCard") is inserted into the IU. As the vehicle passes under a gantry, the IU

[9] ERP in Singapore: what's been learnt from five years of operation

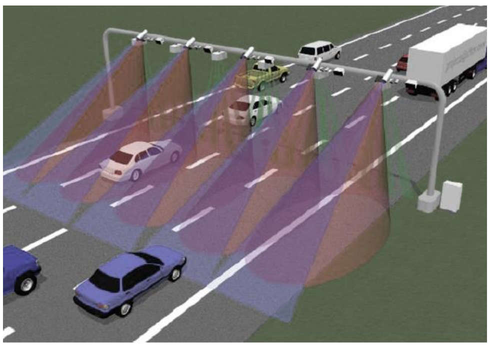
	responds with one beep to confirm that it has been charged. Several beeps are heard if the balance on the smart card is less than S$5. This indicates the need to recharge the card. The balance on a card can be recharged at an ATM machine. • The user who does not have IU or fails to insert his CashCard into the IU or fails to maintain a cash balance sufficient to pay a particular charge, automatically has the rear of his vehicle photographed as he passes through the gantry. Such users were originally issued court summons and had to pay a fine of S$70. Now, they need to pay an administrative charge of S$10 only along with the toll charges. • Hundreds of thousands of vehicles had to be outfitted with IUs before widespread electronic road pricing could begin. In 1998 a pilot program was launched under which electronic road pricing was introduced on the inbound lanes of the East Coast Parkway. Fullscale electronic road pricing in the central business district and on the inbound lanes of two other expressways began later in the year • From a technical standpoint the system is reported to have performed well. Recently, billing errors have occurred in less than 0.050 percent of all transactions, with more than 3.5 million transactions occurring on a typical day (Menon and Chin 2004: 63). Prices for entering the CBD currently range from zero to S$2.50, depending on the time of day.

5.10. Project Considerations

5.10.1. Tolling Options

Option: 1 Full Electronic Toll Collection with gantry but no barricading

Figure 28 : Free Flow movement of vehicles

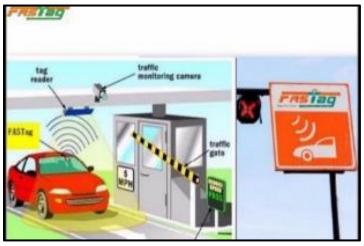


The major advantage of this type of tolling is that the vehicle is not required to stop or slow down to pay the toll charge. In some cases, this might reduce the congestion by allowing for more vehicles per hour/per lane. The disadvantage to this is the possibility of the leakage or violators who do not pay.

It shall also lead to saving of fuel due to zero stopping time and facilitation of digitation of payments.

Option: 2 Full Electronic Toll Collection with barricading (Mix of Tag and Cash Lanes i.e. Hybrid Model)

Figure 29 : Tolling using Barricades



This system shall involve lanes ETC as well as cash lanes. ETC transaction shall be processed with valid tag and positive account balance and the vehicle would be allowed to pass. Other vehicles will be allowed to use the cash lanes, where they can pass after paying the toll.

Here, enforcement is relatively easy as the violators can be coerced to pay cash, hence leakages are less unlike the earlier system.

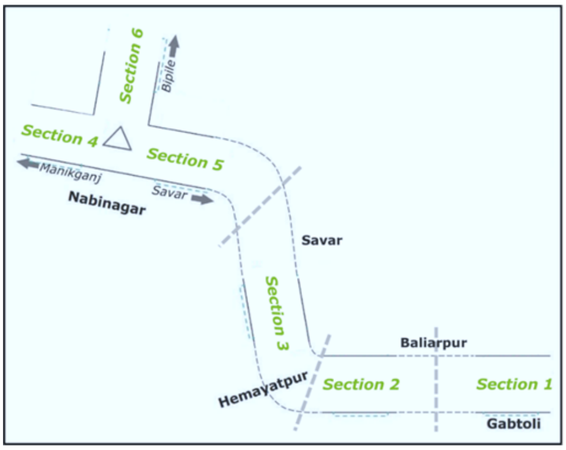
5.10.2. Tolling Lanes for the Project Corridor

In Bangladesh, Tolling technologies are underway and considering the high traffic volumes envisaged on the project corridor in the coming years, electronic tolling with barricading (mix of tag and cash lanes) is recommended for implementation. Out of the technologies, ANPR/ RFID is considered suitable as this is acceptable and used in other PPP projects in Bangladesh. The technological interventions shall not only provide greater transparency in toll collection, but will also cater to both cash and non-cash modes of payment. In addition to this, enforcement is envisaged to be relatively easier in this method. It will save time, help in emission control and fuel saving as well.

For operational purposes, the ETC transaction is proposed to be processed with valid tag and positive account balance and the vehicle would be allowed to pass. Other vehicles will be allowed to use the cash lanes and pass after paying the toll.

Toll plazas are proposed at two locations for this proejct. One at km 3+100 and the other 17+800 chainages. The first toll plaza is proposed between sections 1 and 2, whereas the second toll plaza is proposed between section 3 and 5.

Figure 30: Project Section for Tolling Analysis



Project Section		
No	**Start Point**	**End Point**
1	Gabtoli	Baliarpur
2	Baliarpur	Hemayatpur
3	Hemayatpur	Savar
4	Savar	Nabinagar
5	Nabinagar	Dhamrai
6	Nabinagar	Bipile

To arrive at the required toll lanes for each plaza, we have applied the queuing theory for modelling toll plaza behaviour. For analysis, we have considered two stages of the travel process: toll collection and merging. At the tollbooth, drivers wait for toll payment and receipt (in case of cash), while at a merging point, driver stop and wait for a chance to get onto the merged lane.

By applying the queuing theory to each stage, we have determined the optimal toll lanes that minimizes travel time based on derivation of the formula for computation of the average wasted time per driver in terms of number of incoming lanes, traffic lanes, and number of toll plazas. The queuing system evaluates this by assessing the arrival pattern of customers, service pattern of servers, number of servers, system capacity and queue discipline.

The average wasted time is the portion of the travel time that is dependent on the parameters of the system. Using this formula we have computed the average wasted time for a broad range of lane counts, traffic levels, and toll plaza numbers, from which the optimal toll lanes with a combination of hybrid and ETC lanes for each plaza have been estimated.

The assumptions included in this analysis are :

- **ETC Adoption Rate in 1st Year** =80%
- **Peak Hour traffic (PHT)** = 10% of Avg. Daily Traffic
- **Recommended number of ETC lanes** = Peak Hour Traffic / (0.75*0.9*1,200); Hybrid Lanes = PHT /(0.75*0.9*240)
- **Formula:** Time spent in toll Plazas = $\frac{1}{\mu_A - \Phi/T}$
- where μ_A : Service rate at toll booth
- Φ : Total Traffic flow
- **T :** Number of Toll lanes
- **Time spent in merging** is negligible for the recommended configuration

Based on the above analysis, toll lanes required are 5 lanes at Toll Plaza 1 and 4 lanes at Toll plaza 2 using hybrid tolling mechanism:

Table 54 : Number of Toll lanes

	Year	Projected Traffic	Peak hour traffic	ETC Lanes	Hybrid Lanes	Total Lanes	Time spent – ETC Lanes (sec)	Time spent - Hybrid Lanes (sec)
Toll Plaza 1	2023	21384	2138	2	3	**5**	9.2	46
	2045	32711	3271	5	0	**5**	6.2	0
Toll Plaza 2	2023	16675	1668	2	2	**4**	9.2	46
	2045	26360	2636	4	0	**4**	6.5	0

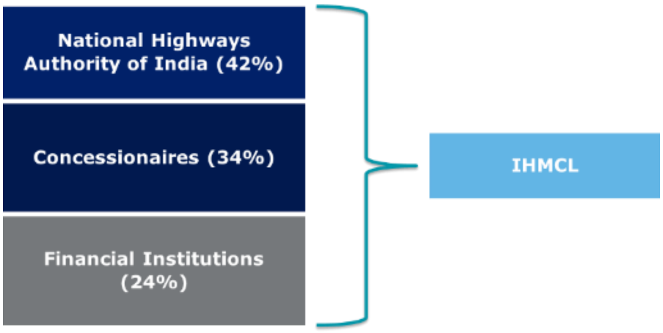
5.11. Institutional Considerations:

The implementation of the tolling mechanism governed by an institutional set up is imperative for its effective implementation in the country.

Case Study: IHMCL (Indian Highways Management Company Limited (IHMCL) in India

Incorporation and Three Way Collaboration

India is at the cusp of a digital revolution in the roads and highways sector. Right from manual collection of the tolls to using technological interventions to make toll collection hassle free, India’s toll collection is evolving.



The National Highways Authority of India (NHAI), established the **Indian Highways Management Company Limited (IHMCL),** jointly with its concessionaires and financial institutions in 2012 under the Companies Act, 1956 to carry out **Electronic Tolling** and other ancillary projects of NHAI. The shareholding pattern of stakeholders is NHAI 41.38%, Concessionaires-33.81percentage and Financial Institutions 24.81%. The entities that have picked up stakes in this company includes Reliance Industries (an Indian conglomerate), ICICI bank (a private sector bank in India) and L&T Finance (A construction finance company)

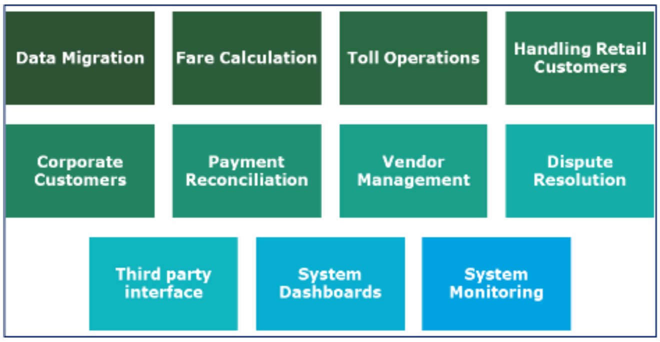
Mandates: IHMCL is a legal entity that is mandated to carry out manifold functions by NHAI (jointly with the concessionaires and financial institutions), such as Electronic Toll Collection; 24*7 National Highways Helpline; CCTV Surveillance systems and traffic survey. These functions are aimed to assist National Highways Authority of India in certain ancillary activities. Essentially, IHMCL is that arm of NHAI that is mandated to undertake the implementation aspect.

IHMCL Electronic Toll Collection Programs: In the wake of implementing technological interventions to make the toll collection process seamless and transparent, IHMCL has been at the forefront of implementing unified and interoperable ETC solutions for National Highways in India based on RFID technology. IHMCL has been therefore mandated by the NHAI for providing services of Hybrid ETC and Toll Management Systems at the toll plazas allotted by NHAI to IHMCL for implementation of Hybrid ETC infrastructure and Toll Management Systems

24*7 National Highways Helpline: The National Highways are characterised by high-speed, high-load vehicles and there is a tendency for fatalities and injuries. To help those distressed road users in cases of emergencies/improve the accessibility for the road users, it developed a 24*7 National Highways Helpline.

CCTV surveillance systems: IHMCL implements the Toll Management System, CCTV Surveillance system along with Weigh in Motion and Static Weigh Bridge which helps in regulating the government weigh enforcement policies and prevent overloading of vehicles.

Traffic Survey: IHMCL is also mandated to manage the traffic surveys on the National Highways, with the aim of collecting data for planning and analysis. Under the traditional system where the regional transport authorities were mandated to conduct the traffic surveys, there was a need for standardisation of the data collection and creating a central repository of data, so IHMCL was given the responsibility of the management of the traffic surveys on some specific locations, to be conducted twice, in a year.



Benefits of having a corporation like IHMCL

Focussed Subsidiary: IHMCL is an entity with a much-focussed mandate. An organisation is subsidiary to National Highways Authority of India and is mosly mandated to undertake implementation and enforcement related tasks such as rolling out RFID based tolling in India etc. For instance, it is IHMCL's mandate to set up a Central Clearing House (CCH) for nation-wide ETC interoperability and infrastructure for tag distribution. This model frees NHAI and it can focus on other aspects of road sector development be it policymaking, asset recycling etc.

5.11.1. Case for Establishing a Similar Institution: Aligning it with goals of Bangladesh

For a country like Bangladesh, The RHD represents a counterpart of the National Highways Authority of India. With the increasing focus on undertaking PPP projects in the road sector in Bangladesh and with the significance of introducing enhanced toll mechanisms, the establishment of a Highway Management Corporation shall be imperative to ensure the implementation of effective toll collection in the country. With the current initial stage of a lack of streamlined toll collection mechanism in the country, the establishment of an institutional established shall play a facilitating role for ensuring integration of functions.

By incorporating the defined mechanisms in India for formation of a collaboration and division of ownership between the corporation, concessionaires and financial institutions including some banks, construction finance companies and so on, the concept of IHMCL can also be introduced in Bangladesh for a streamlined and effective toll collection in the country.

Objectives that can be achieved in Bangladesh: The benefits of this can be achieved with overall mandate shall be multi-fold in undertaking the following:

- Managing Electronic Toll Collection project including toll transactions and clearing house operations. This would involve setting up of call centres, managing the internet network, installation of telecom towers, laying of Optical Fiber ducts, comprehensive corridor management
- Monitoring of the traffic and conducting traffic surveys involving several vehicle classes.
- Deployment of Information and Communication Technologies in the sector. For instance: Developing a toll management system to track toll collection on a real time basis; developing apps to offer better customer service, reload and balance/top-up etc.
- Establishing a payment collection system for collection of funds through pre-paid instruments, or other related technologies
- Monitoring the above-mentioned payment collection system and related issues in the set-up
- Issuance of the pre-paid instruments in the form of RFID Tags, smart cards etc.
- Partnering with the financial institutions for the issuance of the pre-paid instruments

All the above considerations and the key learnings are critical for introducing effective development and implementation of road transport in Bangladesh by incorporating best case examples under various parameters.

5.12. Non-Tolling Revenues

The section describes an assessment of some potential options for exploring non-tolling revenues for Bangladesh.

5.12.1. Wayside Amenities

The concept of development of wayside amenities has been emerging across multiple countries to provide rest areas to the drivers and passengers. It aims to improve the travel experience of highway users to meet the need for establishing safe and useful stopping points for the highway commuters and truckers with the increasing development of highways and vehicular traffic. Developed countries like Germany, Europe and US have been successful in developing wayside amenities.

Case Study: Wayside Amenities Program in India

The Ministry of Road, Transport and Highways has introduced the Wayside Amenities programs for Highways in India for meeting the following objectives:

- **Reducing Accidents –** Encouraging frequent breaks during the journey to reduce driver-fatigue related accidents
- **Generate Employment -** Opportunity for local artisans and craftsmen to showcase their offerings
- **Evacuation for Disaster Relief –**Evacuation during medical emergencies and providing disaster relief
- **Reducing Theft –**Safe location for truckers and passengers to park their vehicles and spend the night to reduce incidents of theft and robbery

Key Features: The program envisaged to develop wayside amenities every 50 kms and more than 1000 amenities across the country along National Highways. The concepts introduced under this program included the following:

Highway Village: On the land owned by NHAI of more than 5 acres across 183 identified locations in India under PPP Model for development.

Highway Nest: On private land of more than 1 acre along the National Highways, to be constructed and managed by the private parties in collaboration with NHAI on Franchise Model

Figure 31: Wayside Amenities -Model key features

Under the program, the facilities are defined into two categories:

Category I: The facilities to be provided in category-I include food court/dhaba, parking, toilets, fuel pump etc.

Category II: In category-II facility shall be developed as Highway Plaza on the full area of the site including Motels/ guest rooms, food court, parking, toilets, fuel pump, etc.

Figure 32 : Highway Plaza

Key Takeaways

- **Location of the Site** is paramount for the success of such facilities. Sites **closer to urban agglomerations, toll plazas etc**. were higher in demand than other sites.
- **Structuring the facilities** according to the socio-economic profile of facility users is paramount.
- **Developers of such facilities are different** from traditional NH developers.
- Further, they tend to be **highly localized**. Therefore, a marketing outreach programme for each Wayside Amenity facility is essential.

5.12.2. Other Options for Non- Tolling Revenues

Commercialization of small land parcels: The road expressways would provide an opportunity for commercialization at interchanges and also at some regions where the space is available, and roads are wide enough for this type of development. These spaces provide an opportunity for commercial use. These spaces could provide commercial space for coffee shops, restaurants, car parking, ATM machines etc on annual lease rentals per 100 sqft. There are various examples in India and also internationally where the vacant space near the public infrastructure has been used for commercial purposes successfully and there is a demand for these spaces considering the increased customer base that it attracts.

Advertisements/ Hoardings: Advertising along the road corridors can also act as a source of funding for the government. For revenue projections through advertisement/ hoardings on the corridors, it is assumed that after every few kms, the corridor would have at least one hoarding with an average license fee per annum for each of them.

Commercial use of vertical space:

This road corridors also provides opportunities to utilize the vertical space above for commercialization. Many form of public utilities, mobile towers, optical fiber cable (OFC) can be explored for generating revenues to the government on monthly rents for telecom towers and fees for OPC based on per metre per annum basis.

5.12.3. Current Scenario in Bangladesh

The Road and Highways Department has taken initiatives to introduce rest areas/ rest houses along highways by construction of such facilities for highway drivers in 2019.

Further, recent project developments such as Dhaka Elevated expressway also has included the development of wayside amenities in the scope of work for the private developer. The importance of highway amenities to develop rest areas and facilities in order to reduce travel fatigue and ensure road safety has been improving in the recent years.

However, our current project corridor being an urban stretch and while we have considered advertisements as a non-tolling revenue option, way side amenities are not envisaged in this project due to non-availability of land parcel with RHD. In this case, acquiring land and then developing these facilities won't be a commercially viable proposition for RHD.

6. Highway Engineering – Preliminary Designs

6.1. The Existing Road

The Gabtoli-Savar-Nabinagar-Bipile stretch of National Highway N5 amounting to 24.445 km long is divided into three traffic homogeneous sections is an integral part of N5, which plays an important strategic and crucial role in the transportation network of Bangladesh. The highway is connecting 28 districts of northern and north-western and 25 south western districts of the country with Dhaka, the capital City. In light of the macro objective of improving regional surface connectivity and the need to de-congest traffic pressure in and around Dhaka area, the PPP office within the PMO intends to undertake the upgradation of Gabtali-Savar-Nabinagar-Bipile section of N5 into a 6-Lane Expressway on PPP basis, while maintaining another 4-lane road for service road.

The project road starts from Gabtali Bus Terminal on the mid-west boundary of the city area and passes through Aminbazar, Hemayetpur intersection and Savar Bazar and passes Nabinagar intersection at National Monument Site and ends at Bipile intersection on Nabinagar-Chandra R505 highway. The road crosses a major river Buriganga at Aminbazar (Gabtali) and river Bangshi, a distributor of river Dhaleswari at Genda, Savar.

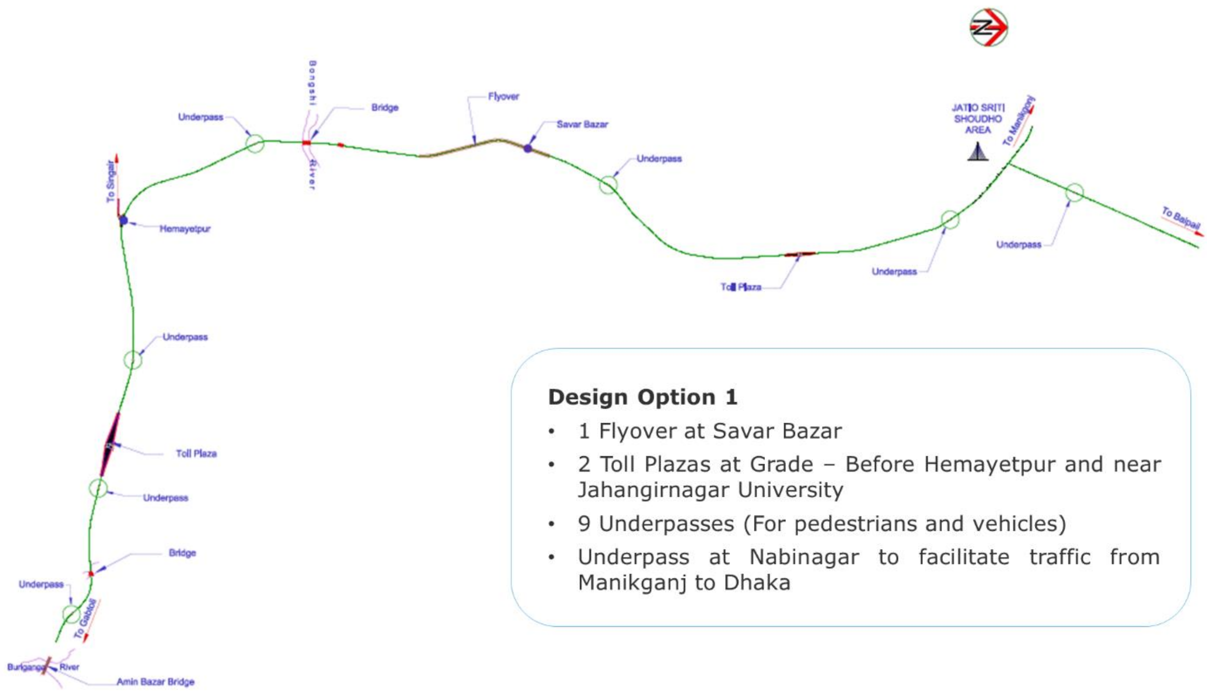
The road passes through brown field development area for most of the alignment except urbanized agglomeration of Savar commercial, residential and cantonment areas. The existing right of way (ROW) of the road varies from 300 feet to150 feet in width. RHD has been maintaining the existing 4-lane highway regularly. The ROW in brown field area gradually reduced to 150 feet around urbanized area near Savar Bazar.

6.2. Design Option Analysis

During the design stage, the multiple project configuration / design options were considered for the proposed Expressway with the objective of proposing an optimum design configuration which minimizes cost and maximizes benefits to the intended users. At each stage, we have consulted with the client counterparts to arrive at consensus on the design parameters and project features. The traffic survey analysis pointed towards need for expanding the project from a 4 lane to 6 lane configuration in order to provide comfortable driving experience. The project stretch was also analyzed to identify critical choke-points and suitable design solutions were deliberated and presented to the Client. The consultant analyzed 4 alternatives with respect to project configuration and arrived at the finalized model best suited for the project development further detailed out in the chapter. In order to ensure cost optimization and integrate innovation in the finalized configuration, the options that were assessed included the following:

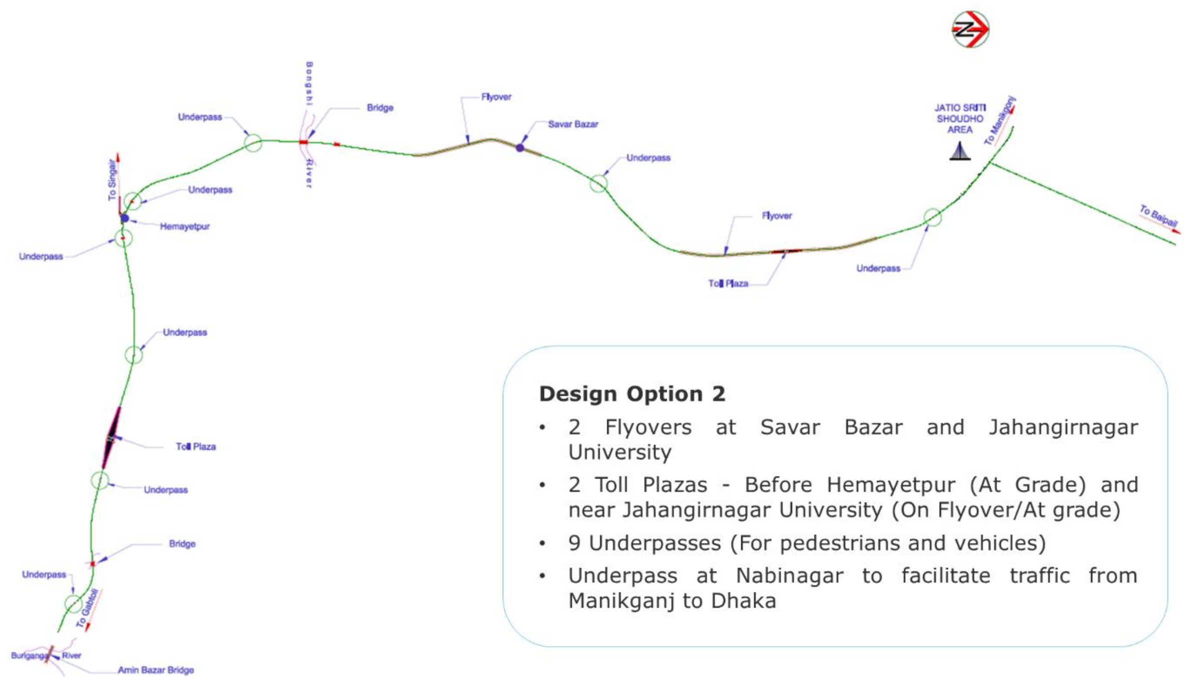
Option 1: 6 lane at-grade expressway with flyover at Savar Bazar only

Rationale: Savar Bazar is a heavily commercialized area with complexes in immediate vicinity of the current highway. Due to permanent construction, heavy localized movement and low availability of land, construction of flyover is envisaged for seamless movement on the expressway in this option.



Option 2: 6 lane at-grade expressway with flyover at Savar Bazar and Hemayetpur

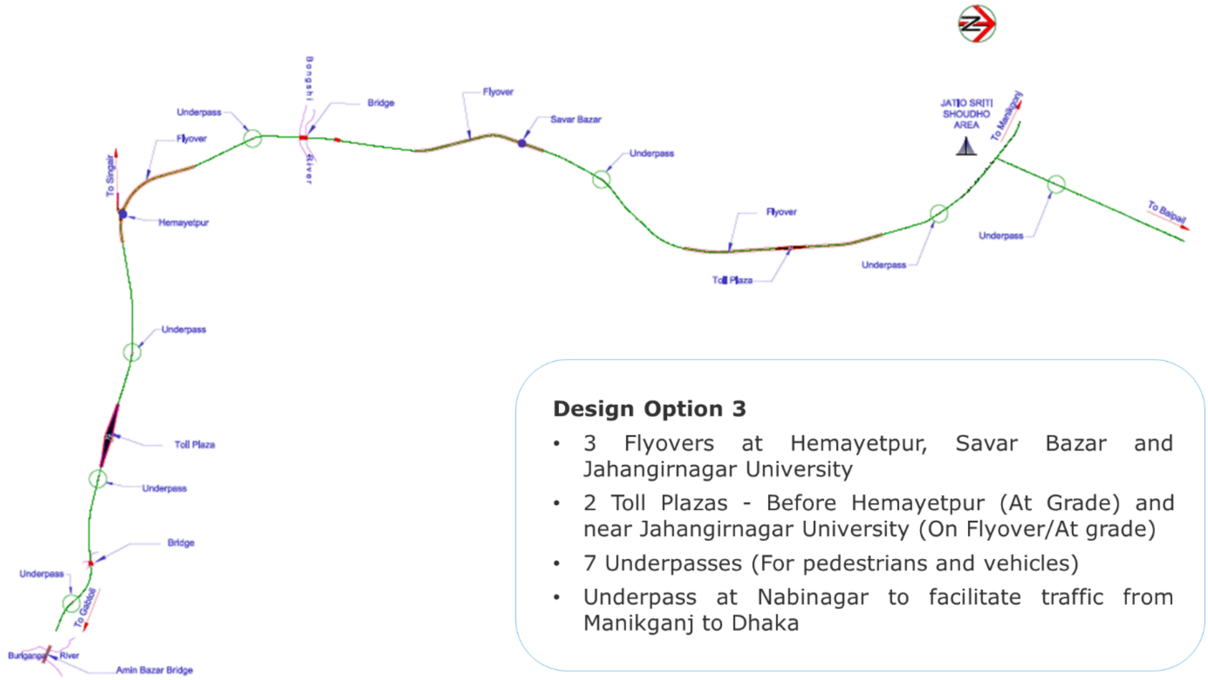
Rationale: In addition to nuances of Savar Bazar area, Hemayetpur area is also commercialized with significant local movement. Land in this area is also a constraint therefore for seamless movement on expressway, a flyover at Hemayetpur is also envisaged.



Option 3: 6 lane at-grade expressway with flyover at Savar Bazar, Hemayetpur and Jahangirnagar University

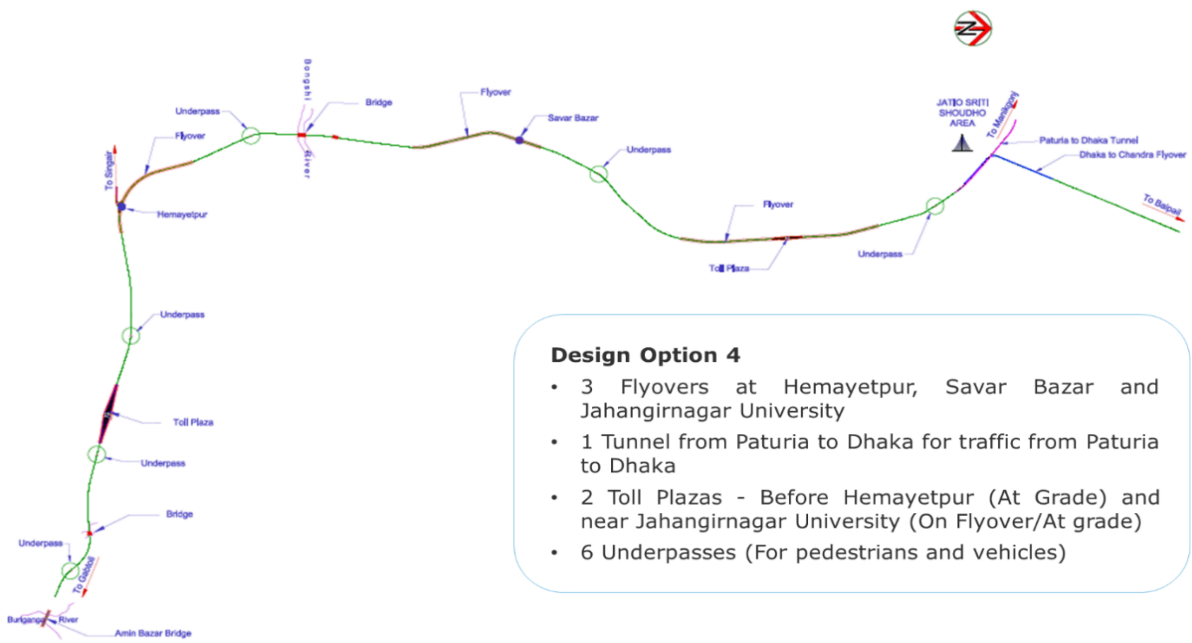
Rationale: In addition to flyovers at Savar Bazar and Hemayetpur, third option includes constructing a flyover at Jahangirnagar University area. The project stretch passes through

Jahangirnagar University, training center and cantonment. Considering the sensitivities of the area and limited availability of land, a flyover in this area is essential and proposed in this option.



Option 4: 6-lane at-grade expressway with flyover at Savar Bazar, Hemayetpur and Jahangirnagar University and a tunnel at Nabinagar

Rationale: In addition to grade-separated structures proposed in option 3, the 4th option envisages a tunnel at Nabinagar from Dhaka towards Paturia to facilitate quick crossing of Nabinagar junction. This tunnel was deemed critical for the project stretch once the new bridge on Padma at Paturia becomes operational which will increase the traffic at Nabinagar junction substantially.



Preferred Design Option: Based on the traffic and congestion considerations, and the potential benefits and costs associated with each option, design option 4 was preferred. This option envisages grade-separated structures at all major choke-points, thereby providing a smooth and rapid drive for the Expressway users, as well as safe and convenient conditions for the people living and working along the project stretch. It has further been detailed out in the following sections:

The proposed 6-Lane expressway shall mostly follow the existing 4-Lane highway alignment. The service roads are proposed on either side of the proposed 6-Lane highway and use existing 4-Lane highway underneath while the proposed 6-Lane expressway is flying over at the following elevated stretches, comprising the total elevated length of over 10 km out of total length of 24.445 km. The details of elevated stretches are as mentioned below:

Table 55 : Chainages for elevated stretches

S.No.	Start Chainage	End Chainage	Locations
1.	5+700	8+550	Hemayetpur
2.	10+980	13+990	Savar Baazar
3.	15+600	19+660	Jahangirnagar University
4.	20+530	22+230	Nabinagar Intersection

In the proposed expressway Vehicular Underpasses (VUP) are proposed to provide the expressway traffic an un-interrupted flow at locations as mentioned below:

Table 56 : Chainages for VUP

Sl No	Start Chainage	End Chainage	Flying over Junctions
1	0+280	0+740	Amin Bazar
2	2+280	2+720	Bilamalia Bus Stand
3	4+260	4+740	Baliarpur Bus Stand

Bridges are proposed at 4 river/canal locations considering the widening of existing 4-Lane Bridges on either side and rehabilitation of existing 4-Lane Bridges. There shall be 2-Lane bridges separately on service roads on either side at these river/canal locations.

A 6-Lane two-way underground tunnel is proposed at Nabinagar Junction for length of about 500 metres to provide un-interrupted traffic flow at this 3-arm junction. The cost for construction of tunnel is considered tentatively, in view of the following parameters:

(i) The construction of the tunnel: Whether as Cut and Cover or as Bored Tunnel

(ii) In case of Cut and Cover tunnel. there must be adequate space in the RoW to divert the existing traffic.

(iii) To know about the suitability for Bored or Cut and Cover Tunnel, detail soil investigation will be required at the DPR-stage.

(iv) As per the presently collected soil data, Cut and Cover Tunnel is envisaged. But this requires adequate RoW to divert the existing traffic flow with about two years' time of tunnel construction.

6.2.1. Intersection

The road has five major junctions in connection with National and Regional Highways. They need to be redesigned in order to meet the dual carriageway requirements. Besides these major junctions, there are several minor junctions. Latitudes and longitude of important intersections and key location points are shown in the table below:

Table 57 : Latitude and longitude of intersections and key location points

Chainage	Location	Easting	Northing	Remarks
0+000	Gabtali Terminal	229203.08	2632708.47	Intersection with Sadarghat – Gabtali - Ashuliaroad (Inner Ring Road)
7+200	Hemayetpur	221546.42	2634135.82	Intersection with Dhaka-singair-Manikganjroad R 504
17+100	CMB Moore	222299.27	2642756.32	Intersection with Anwar Jong road N511
22+000	Nabinagar	220899.15	2647346.25	Intersection of Nabinagar-Chandra road and Nabinagar –Paturia road
24+450	Bipile	222568.35	2651128.52	Intersection with Abdullpur-Ashulia road.

Source: PPP Transaction Advisory Study, 2020

6.3. Topographic Survey

Before commencing the topographic survey, a preliminary alignment was drawn on satellite imagery following the design standards. The consultants have been working on them to estimate provisional bill of quantities and investment costs.

Topographic survey was carried out by BSO, a private survey company which commenced on 20th August, 2019 and was completed on 30th September, 2019. Four teams were engaged for the field work. After completion of the field work, the survey data were prepared and given to the design team for arriving at the engineering designs.

The topographic survey was carried out for a strip of 100 m plus the areas anticipated to be required for alignment improvement, construction of toll plaza, passenger rest area, petrol stations and intersections. The survey was carried out by using modern equipment like Total Station, GPS and Auto Levelling Equipment.

The information of reference Bench Marks (BM) from Survey of Bangladesh (SOB) were studied and referred to accordingly. Permanent Bench Marks (horizontal and vertical control stations) were established within the project location with reference to the SOB BM list presented in the table below.

The topographic surveys were carried out in UTM WGS 84 coordinate system. Prior to the survey of topographical details, polygonal traverses were fixed. Permanent traverse points by concrete pillars were established, numbered and surveyed. In addition to the tachometric survey, all traverse points were levelled and connected to the Public Work Department (PWD) datum. All topographical details within the 100m corridor were captured like existing roads, tracks, drainage structures, buildings, etc. The photograph of SOB BM and Project PM are shown in the following figures:

Figure 34 : SOB Bench Mark

Figure 33 : Project Bench Mark

Table 58 : List of horizontal and vertical control stations

SL NO.	BM/TBM	Description	R.L. (SOB)	Easting	Northing	Chainage (km)
1	SOB BM No.-6194	The pillar is situated in the TB Clinic compound at Shyamoli, Dhaka	7.101	-	-	-
2	BM-1	RCC pillar has been embedded on the right side edge of Gabtoli-savar rtoad about 9.40m N/E corner from Gabtoli bridge towards Gabtoli, Dhaka	14.433	228582.427	2632844.076	0+680
3	BM-2	RCC pillar has been embedded on the right side edge of Gabtoli-Savar road about 5.30m N/W corner from Gabtoli bridge towards Savar at Gabtoli, Dhaka	14.743	228329.925	2632953.173	0+955
4	BM-3	RCC pillar has been embedded on the left side of Gabtoli-Savar road about 7.00m N/E corner of ditch nera gate of Jamuna Nar=tural Park at Hemayetpur, Savar, Dhaka	7.857	224555.504	2633992.605	4+958
5	BM-4	RCC pillar has been embedded on the right side of Gabtoli-savar road about 15, east from Foton Service Centre fence boundary limit at Boliapur, Savar, Dhaka	8.365	224439.449	2634038.352	5+090
6	BM-5	RCC piller has been embedded at 20m front side Police town main gate at Ramchndrapur, savar, Dhaka	10.547	220590.738	2636600.902	10+767
7	BM-6	RCC pillaer has been embedded on the right side of Dhaka-Aricha road near Bongshi river bridge at Ramchandrapur, Savar, Dhaka	13.105		2636725.945	10+892
8	SOB BM No.-3398	The pillar is situated about 1.5km north east from Savar bus Stand and about 400m north-east from Savar Radio Colony bus stand. It is 25m m north-east corner from Mr. Adam Ali's house at Savar, Dhaka	10.041	221380.519	2641509.402	15+918
9	BM-7	RCC pillar has been embedded on the right side of Dhaka-Savar road infront of Ibrahim General Hospital at Savar Military Farm, Savar, Dhaka	10.125	221419.905	2641502.647	15+948

SL NO.	BM/TBM	Description	R.L. (SOB)	Easting	Northing	Chainage (km)
10	BM-8	RCC pillar has been embedded on the right side of Dhaka-Savar road at Savar Military Farm, Savar, Dhaka	10.229	221564.336	2641610.237	16+127
11	SOB BM No. - 6192	The pillar is situated about 100m north from PATC gate and 18m west from Dhaka-Aricha road at Savar, Dhaka	8.268	222171.816	2642349.650	17+095
12	BM-9	RCC pillar has been embedded on the island at Nabinagar intersection, Savar, Dhaka	11.357	220921.432	2647343.666	22+535
13	BM-10	RCC pillar has been embedded on the right side gate of Nationalk martyrs Monument at Nabinagar, Savar, Dhaka	11.273	220769.274	2647412.304	22+697

Source: PPP Transaction Advisory Study, 2020

6.4. Hydrographic Survey

The hydrographic survey was conducted in order to assess the following parameters pertaining to the project stretch:

6.4.1.1. Bridge Location & River Survey:

Major Rivers (of width over 100m): (i) The river Buriganga (mixed flow of river Turag and Bangshi at Aminbazar), at Gabtali and (ii) the river Bangshi at Police Town, Savar were surveyed for hydrographic information. The following necessary information of the existing bridges was assessed:

Table 59 : Information on Bridges

Structure ID	Chainage	Length (m) , Existing	Length (m), Proposed	Top level (Existing, m PWD)	Top level (proposed , m PWD)	BIWTA Class	Highest Flood Level (m PWD)	Vertical clearance requirement (m)	Vertical clearance (Existing, m)	Soffit Level (Proposed, m PWD)	Vertical clearance (Proposed, m)	Remarks
BR-01	1+173	3X21=63	3X21.34=64.02	9.805	11.37	-	7.45	1.5	0.26 (Not Ok)	9.27	1.82 (Ok)	-
BR-02	9+714	3X40=120	3X42.68=128.04	13.23	14.90	-	10.03	3.0	0.00 (Not Ok)	11.70	1.67 (Not Ok)	Bridge top level should be raised up to 16.23 m PWD
BR-03	10+248	2X38=78	2X42.68=85.36	10.84	12.50	-	10.17	1.5	0.00 (Not Ok)	9.30	0.00 (Not Ok)	Bridge top level should be raised up to 14.87 m PWD

6.4.1.2. River Profile Survey:

River profile survey was carried out longitudinally along the assumed centre line of the river. The extent of survey covered was 500m upstream of the proposed and 500m downstream of the proposed bridge location.

6.4.1.3. River cross section survey:

River cross sections were taken as follows:

1. At bridge Centerline:
    a. Bank to bank top width of the river
    b. Location and RL of deepest point of the river bed
    c. RL of both bank of the river
2. 20 m upstream and 20m downstream of the bridge location
3. 50 m upstream and 50m downstream of the bridge location
4. 100 m upstream and 100m downstream of the bridge location
5. 500 m upstream and 500m downstream of the bridge location

The sonic sounding was taken at 3-5m intervals. River cross section survey was conducted perpendicular to the centerline on the river.

6.4.1.4. Small bridge & culvert surveys:

Small bridges & culverts were surveyed showing river/canal bank line and bed line covering 100m upstream and 100m downstream strip with a width of 80m. Cross- sections were taken at 20m interval. Following information was collected for bridges and culverts surveys:

Table 60 : Information on Culverts

Structure ID	Chainage	Size (Existing, No-w X h)	Size (Proposed, No- w X h)	Road Top level (Existing, m PWD)	Road Top level (proposed m, PWD)	Highest Flood Level (m, PWD)	Remarks
BC-01	4+030	3-6X6	3-6X6	9.055	10.53	8.30	Replaced by new Box Culvert up to full road width
BC-02	5+130	7-6X6	7-6X6	10.30	12.51	8.64	Replaced by new Box Culvert up to full road width
BC -03	7+700	3-6X6	3-6X6	9.74	11.24	9.41	Replaced by new Box Culvert up to full road width

6.4.2. Objective of the Hydrological Study

The objective of this hydrological study was to determine the hydraulic parameters for the road embankment, bridges, culverts and surface drains where the road passes through buildup areas. Design parameters primarily included appropriate design flood levels (DFL) for the road embankment, so that the road embankments are not affected during peak flooding in the area.

6.4.3. Description of the Project Road:

The road starts after crossing the Aminbazar bridge, approximately at a distance of 150m from the bridge into Aminbazar area. The total length of the road is about 24.445 km. The road intersects with rivers Turag and Bongshai. Several water bodies lie adjacent to the road at different places.

The consultant's team had collected list of all drainage structures, bridges and culverts on the project road from previous study and RHD data base. Total number of structures is shown in the table below:

Table 61 : Total number of structures

Sl No	Name of Road	Category	Bridges	Flyover/ Overpass	Underpass	Culverts	Tunnel	Total
1	Gabtoli-Savar-Nabinagar-Bipile	N5	4	4	3	4	1	16

6.4.4. Methodology for Hydrological Study:

The methodology consisted mainly of the following steps:

- Collection of Primary data from the field (Inventory Survey);
- Collection of Time Series data of water levels, discharge measurements, rainfall from BWDB;
- Checking and validation of the collected time series data;
- Frequency analysis using the validated time series data;
- Determination of all design parameters such as design flood level (DFL)

6.4.5. Data Collection:

6.4.5.1. Field Data:

Primary database has been built up from field investigations and local enquiries. Hydrological investigations at the sites for the project road were undertaken at different periods in 2019. Based on the survey, the following information was collected:

- Submergence of existing roads during the 1988, 1998, and 2004 floods;
- Erosion of roadside slopes;
- Adequacy of opening of bridges/culverts on the existing roads;
- Requirement and location of additional bridges/culverts on the existing roads;
- Location and requirement of waterway opening of bridges/culverts on the bypasses;
- Erosion of bridge/culvert approaches; and
- Location and requirement of roadside drains.

6.4.5.2. Collection of Hydrological Data from BWDB:

Bangladesh Water Development Board (BWDB) is primarily responsible for maintaining a national hydrological database, and operates water level gauging stations all over the country. There are only 2 water level recording stations identified around the project roads, which are located at the main and secondary rivers. The annual maximum series of the water level data are used for frequency analysis and the water levels corresponding to the design frequency is taken as the design water level for that particular river. In addition to water level record, rainfall records have also been collected around the project roads.

The annual maximum and minimum series of water levels (from year 1989 -2019), for 2 Water level recording stations are shown in the table below:

Table 62 : Annual maximum and minimum water level (m-PWD)

Year	Mirzapur (SW14)		Mirpur SW302	
	Max	Min	Max	Min
1989	8.39	1.4	5.38	0.84
1990	9.1	2.26	5.45	0.75
1991	9.23	1.83	6.01	0.12
1992	6.96	1.63	4.65	0.77
1993	9.07	1.7	6.03	0.68
1994	6.79	1.71	5.20	0.88
1995	8.73	1.5	6.37	0.51
1996	7.814	1.59	6.17	0.62
1997	7.69	1.68	5.80	0.84
1998	10.192	1.4	7.97	0.77
1999	8.568	1.37	6.30	0.93
2000	8.566	1.794	6.12	0.94
2001	7.824	1.506	5.46	0.99
2002	9.12	1.626	6.10	1.24
2003	8.908	1.616	6.19	0.89
2004	10.07	1.76	7.29	1.05
2005	8.29	1.68	6.00	1.71
2006	7.134	1.19	5.69	1.19
2007	9.964	1.47	6.62	0.93
2008	8.96	1.45	6.10	0.76
2009	7.42	1.4	5.37	0.9
2010	7.588	1.24	5.36	0.79
2011	8.51	1.352	5.70	0.85
2012	7.61	1.3	5.20	0.88

Year	Mirzapur (SW14)		Mirpur SW302	
	Max	Min	Max	Min
2013	7.68	1.25	5.18	0.75
2014	8.81	1.512	6.00	0.64
2015	8.16	1.544	5.60	0.95
2016	8.99	1.496	5.90	0.94
2017	9.382	1.406	5.89	1.1
2018	8.28	1.39	5.05	1.18
2019	5.966	1.254	3.59	0.65

6.4.5.3. Data Analysis:

Available historical data has been analysed adopting Log - Pearson method and the results of the frequency analysis of the available water level data for all the stations in the project area are compiled in the table below. These have been used to determine the road formation level and to recommend the bridge soffit level.

Table 63 : High water level analysis - Results summary

Sl No	Hydrological Gauging Station	HWL (m+PWD)					
		10	20	30	50	100	200
1	Mirzapur (SW14)	9.59	9.87	10.03	10.13	10.29	10.42
2	Mirpur (SW302)	6.75	6.98	7.10	7.18	7.31	7.42

6.4.6. RHD Design Standard for Bridge:

Roads and Highway Department set up a guideline for hydraulic design of bridges which is explained below:

6.4.6.1. Vertical Alignment:

The vertical alignment of the roads should be designed for smooth transition from elevated bridge level to the designed road level or the nominal road level as recommended by the hydrologist. Maximum 3.0% longitudinal gradient to be provided for the approach roads. Navigational clearances for Bridge should be provided as per requirements of Bangladesh Inland Water Transport Authority (BIWTA).

6.4.6.2. Determination of Soffit Level of Bridges:

The bottom surface of the superstructure, which is normally the bottom of girder for a girder bridge is determined by providing the required freeboard above the design HFL or the navigation clearance above standard high water level (SHWL).

The Consultant proposes to adopt different freeboard and design return periods for different bridge and culvert categories.

6.4.6.3. Navigational Clearance:

The Navigational Clearance shall be in accordance with the current BIWTA requirements. Any possible change in regulation will be verified with BIWTA. The table below shows the minimum vertical and horizontal navigation clearance as per BIWTA requirement.

Table 64 : Navigation clearance requirements

Sl. No.	Classification of Navigation Routes	Definition for different classes of Navigation Routes	Minimum vertical Clearance (m) above SHWL	Minimum Horizontal Clearance (m)
1.0	Class I	First Class Waterway" means the waterway in which the depth of the water level remains minimum 3.60-3.90 meters throughout the year	18.30	76.22
2.0	Class II	Second Class Waterway" means the waterway in which the depth of the water level remains minimum 2.10-2.40 meters throughout the year	12.20	76.22
3.0	Class III	Third Class Waterway" means the waterway in which the depth of the water level remains minimum 1.50-1.80 meters throughout the year	7.62	30.48
4.0	Class IV	Fourth Class Waterway" means the waterway in which the depth of the water level remains below 1.5 meters in the dry season	5.00	20.00

6.4.6.4. Vertical Clearance for Other Bridges:

For waterways which have not been classified by BIWTA, consideration has been given to the local requirement for passage of fishing vessel, boats, trawlers, barges, etc. At least one span must be kept wide enough to accommodate intended river traffic. The vertical clearance should be measured from High Water Level (HFL)'. The absolute minimum vertical clearance should be 1.20m above HFL. The table below describes consultants proposed vertical clearances for bridges which is no BIWTA requirement.

Table 65 : Proposed vertical clearance for bridges

Structure	Freeboard (m)	Return period of Design Flood WL, Q and V
Major Bridge >75m	3.00	50

Structure	Freeboard (m)	Return period of Design Flood WL, Q and V
Bridge <75m	1.50	50
Minor Bridges<50m	1.20	50

Further details have already been mentioned above under section 7.3 – Hydrographic Survey.

6.4.6.5. Standard High Water (SHW) and Standard Low Water (SLW) Level:

In order to provide vertical clearance and also in order to have an estimate of least available depth (LAD) for navigation purpose, BIWTA has defined Standard High Water and Standard Low Water levels at all major navigation channels. The definitions of SHW and SLW are presented below.

For the rivers with tidal effects the definition of SHW and SLW is:

- SLW = FML95% + Tidal Reduction
- SHW = FML5% + Tidal Addition

The corresponding definition for non-tidal rivers is:

- SLW = FML95%
- SHW = FML5%, where
- FML95% is the fortnightly mean water level with 95% exceedance probability and
- FML5% is the fortnightly mean water level with 5% exceedance probability

Taking hydrological years as the boundary limits for each data set, it can be said that SHW level will be exceeded for about 18 days in a year on the long-term average. Normally it is observed that the SHW is close to 2.0 years' flood (also known as average year's flood) in most of the rivers with a variation of 10-15 cm. Therefore, in this study, the SHW is considered as the 2.0 years' flood.

6.4.7. Roadside Drains

Road drains are important where the road passes through towns markets and other built up areas. If proper drainage is not provided along the road in such locations, the area suffers water logging during heavy rainfall and consequently the road is damaged due to vehicular movement over the submerged road surface. To avoid that situation, surface drainage along the road shall be proposed for the road stretch passing in and around towns and villages.

Curbs and gutters are used at the outer edge of the travelled way in the urban areas to prevent the water that flows from the crowned surface from spilling over and eroding the shoulder and side slopes. They also help to provide a measure of protection to pedestrians as well as facilitate drainage. Only the curb or the combination of curb and gutter may be used for the purpose. At certain intervals, water that collects against the curb or in the gutter is made to flow through gratings into the gullies and is drained off through an outlet pipe to a storm sever which takes the water away to a natural water disposal point.

Drains on both sides of the roads can be considered by providing slope on both sides across the road pavement. If any drain is located by the side of the road for surface water drainage, it will reduce the effective width of the roadway. As such, it should be considered essential that the drain should be of such a shape so that it could function both as a drain and also as a part of road surface or as footpath. Thus, if a vehicle is forced to move to the extreme edge of the road, even inside the drain to avoid an accident, it should be able to come out easily. Considering this situation, side drains are made to be either angular or parabolic or fixed with curb.

6.4.7.1. Design Criteria for Drains

Open drains are designed to flow full when carrying the design flow with an allowance for freeboard. Recommended storm frequency and free board for different types of drain are given below in the table below :

Table 66 : Drainage Design Return Periods

Sl. No.	Drain Type	Design Storm Frequency	Drain Freeboard
01.	Tertiary Drain	Once in 1.1 years	100 mm
02.	Secondary Drain	Once in 2 years	150 mm
03.	Primary Drain	Once in 5 years	200 mm

Source: *Urban Drainage Manual, LGED, 1998*

The free-boards are normally provided when the drain passes through flat area and the depth of drain is significant. But in the Project Area, the tertiary drains will be located at the edge of the road surface along the footpath where the average depth of the drain will not be more than 50mm. Therefore, for the drains in the road pavement, no freeboard has been considered.

From the table above, the recommended design storm frequency for tertiary drain is once in 1.1 year. This may result in over flooding of the street gullies in every alternate year. Considering possible damage of the pavement due to frequent movement of heavy vehicle while there is drain spillage and as no free board has been considered, 5 years return period is recommended for computing the drainage flow for the side drains (Soccer drain). Similarly considering the importance of the road, the primary drains have been designed for a rainfall return period of 1 in 10 years.

The capacities of the required drains and culverts are calculated using Manning's equation. The hydraulic roughness 'n' values to be used in the calculation of capacities are dependent on the type of material used to construct the drain and the standard of maintenance. For design purposes the drains are assumed to be in smooth condition. The values of Manning's 'n' to be used in the equation are set out in the table below:

Table 67 : Design Roughness Factors

Sl. No.	Type of Drain Surface	Roughness Factor 'n'
01	Concrete Surface	0.014
02	Plastered Brick Surface	0.014
03	PVC pipe	0.012

Source*: Urban Drainage Manual, LGED, 1998*

6.4.7.2. Design Method

Rainfall intensities for any area in Dhaka for different return period is available in the Urban Drainage Manual published in 1998 under LGED. Rainfall intensity in the Project area is similar to Dhaka. Therefore, drainage calculation along the Project road (Gabtoli- Savar-Nabinagar National Highway, N5), has been done using the IDF curves of Dhaka. Using these design rainfall intensities the resulting peak flows are calculated using the Modified Rational Method.

The duration of the design rainfall intensity is selected as the time of concentration for the particular catchment area. The time of concentration is the time taken for flow from the most remote point in the catchments to reach the downstream end of the drain.

The Rational Method was derived by considering the effect of a uniform intensity rainfall of a long duration on a catchment. The runoff rate starts at zero and reaches a maximum value when flow from the most remote part of the catchment reaches the outlet. The flow would then remain constant.

6.4.7.3. Drain Capacities

The Manning's equation is recommended for the calculation of the flow velocity and drain capacities. The equation can be used for all shapes of drain as only the area and wetted perimeter of the drain needs to be calculated to assess the drain capacity.

The hydraulic gradient is the slope of the water level along the drain. For a channel of constant depth and for steady flow condition the bed slope of the drain can be considered the same as the hydraulic gradient. Use of the Manning equation to calculate velocities and flow capacity is relatively simple for rectangular and trapezoidal drains which are the shapes generally adopted for road side drains.

6.5. Geometric Designs

6.5.1. Design Standards

Principally RHD Geometric Design Standards Manual (Revised) 2005 was followed for design parameters. Besides this, the following reference recommendations and standards have been consulted for references:

- AASHTO "A policy on Geometric Design of Highway and Streets" 2011
- Asian Highway Classification and Design Standards, UN- ESCAP
- Overseas Road Note 6 "A Guide to Geometric Design" published by TRRL 1988.

For traffic signs and road markings, Traffic Signs Manuel 2004, Bangladesh Road Transport Authority (BRTA), was followed.

According to the ToR, it is mentioned that RHD has taken a policy for designing Expressway on the existing road alignment and to keep a provision of minimum 4 lanes dual carriageway with service lanes on both sides. The principal geometric design criteria is summarized in the table below:

Table 68 : Adopted geometric design criteria

Sl. No	Design Criteria		Value
1.	Speed Control	Design Speed (km/h)	100

Deloitte.

Sl. No	Design Criteria		Value
2.	Stopping Controls	Stopping Sight Distance (SSD) in meter	150
3.	Horizontal Controls	Minimum Curve Radius (m) (constrained) Maximum Super Elevation Radius beyond which S.E. not required Minimum Transition (m)	500 5% 2000 55
4.	Vertical Controls	Maximum Gradients Minimum K value (crest curve) Minimum K value (sag curve) **Vertical clearance** Over road (m)	4% 70 50 4.5 & 5.7
5.	Cross-section Elements for Main Carriageway	Carriageway width (each direction) in meter Traffic lane width (m) Hard Shoulder (m) **Cross slope** Carriageway Hard Shoulder Inner marginal shoulder (m) **Divider width** On main carriageway(m) On service road (m)	11.00 3.65 1.5 3% 3% 0.3 3.5 1.2
6.	Cross-Section elements for Service Road	Carriageway width (m) Carriageway cross fall Verge width(m) Verge cross fall Embankment slope	7.3 3% 1.5 5% 2H:1V

6.5.2. Preliminary Geometric Design

Geometric design has focused on the creation of a modern efficient 6- lane road divided carriageway with separated service road on both sides, including a 3.5 m median barrier that physically separates the traffic streams travelling in opposite directions.

6.5.3. Improvement of alignment

Horizontal : The horizontal alignment was designed to follow the existing road as much as possible with minor modifications like easing sharp bends and realigning short sections to connect some structures constructed or under construction by RHD and to avoid religious structures like mosques, temples, graveyards, etc. Alignment shifting was also done to connect proposed bridges. Visibility problems and site distance at intersections was addressed accordingly.

Vertical: The vertical alignment improvement has been done to provide proper visibility and driving comfort for the road users. K value for crest and sag curves has been adopted as 70 and 50 respectively. Maximum 4.0% longitudinal gradient has been provided for the approach roads. The design heights of the embankments have been fixed with adequate free board (as per RHD guidelines) on top of HFL determined based on 30 years return period.

6.5.4. Cross-section of Road

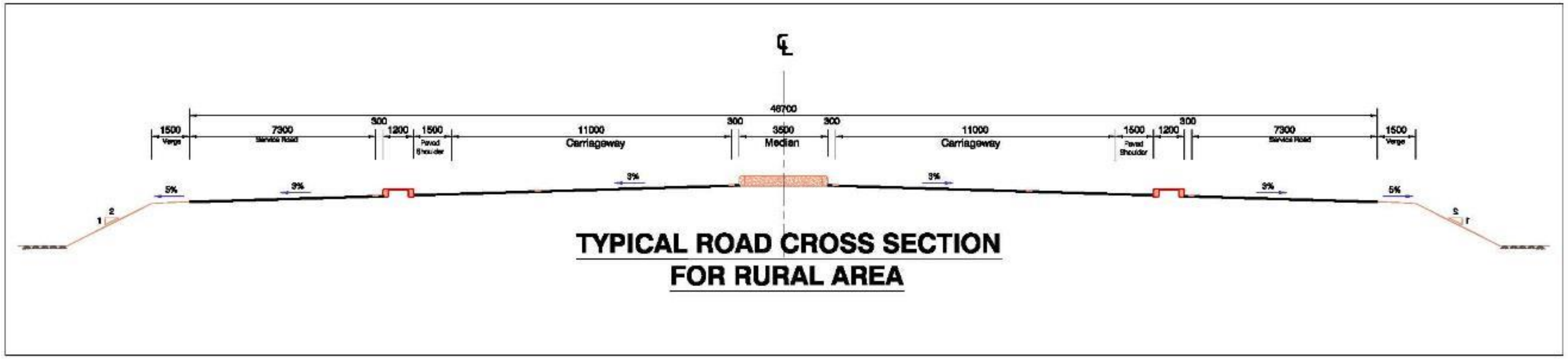
The carriageway width of the expressway is 7.3 m with a central median of 3.5m and service lanes of 7.3m on each side of the main carriageway having 2.5m hard shoulder and 1.2m barrier for each side following the RHD Geometric Standards Design Manual (Revised) 2005. Service Road has been proposed on both sides of the highway, hence segregating local traffic from the main traffic flow of the expressway.

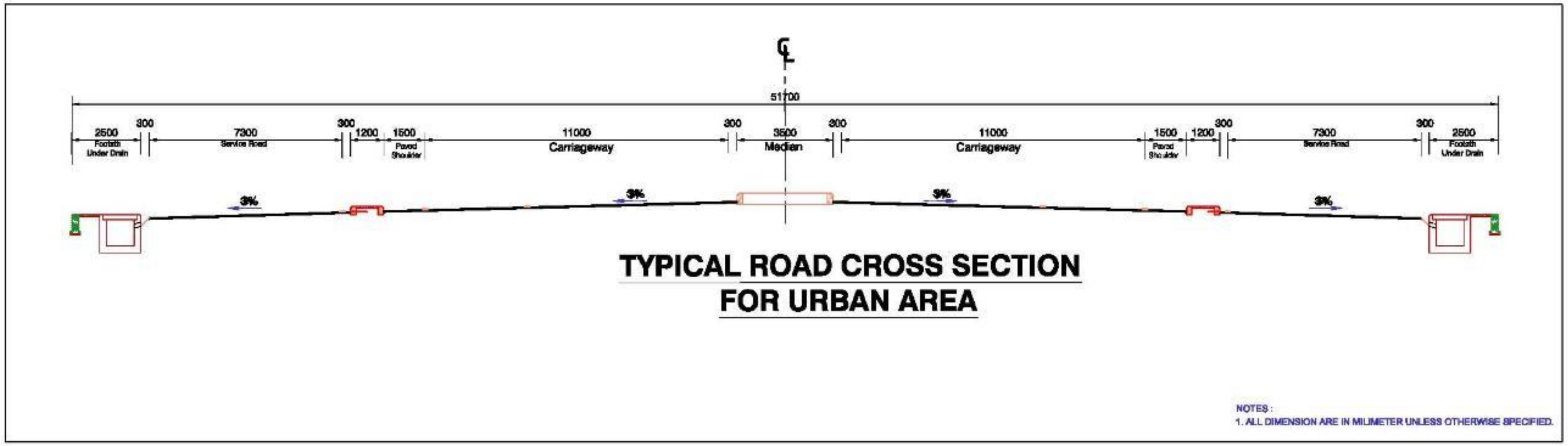
- Width of Service Road has been taken as 7.3m.
- A minimum width of 1.5 m is proposed for footpath (except at flyovers)
- The median width generally proposed 5m but RHD accepted it as 3.5m
- The normal cross fall of the carriageway is 3% with a steeper cross fall of 5% across the verge.

Typical cross-section of the road is presented below:

Figure 35 : Proposed road- Cross section

TYPICAL ROAD CROSS SECTION 3.5M MEDIAN (RURAL & URBAN AREA)





6.5.5. Intersection

Improvement of intersections has been addressed by designing grade separated structures (overpass/ underpass) at Gabtoli, Hemayetpur, Savar, Nabinagar and Bipile with access controlled entry and exit to the main carriageway.

Flyover has been proposed to eliminate traffic congestion and improve road safety at the large market places in city center, close to the PATC entryway, Jahangirnagar University gate and Nabinagar intersection for Savar to Chandra directional traffic. In addition, the tunnel has been proposed at Nabinagar intersection only for Savar to Paturia direction for both incoming and outgoing traffic.

6.5.6. Bus stop

Bus stops have been proposed at convenient locations as close as possible to the locations of passenger's destination such as village, market, educational institute, important intersections, etc. The location has been selected upon field survey and the inspection of conditions of surrounding area. Additional lane (Bus Bay), passenger shelters, seating arrangement, and footways have been proposed.

Table 69 : Chainages for bus stops

Gabtoli - Nabinagar Road Busbay location

Left				Right				Remarks
Entry		Exit		Entry		Exit		
Start	End	Start	End	Start	End	Start	End	
0+450	0+490	0+520	0+560	0+450	0+490	0+520	0+560	Underpass 1
2+450	2+490	2+520	2+560	2+450	2+490	2+520	2+560	Underpass 2
4+450	4+490	4+520	4+560	4+450	4+490	4+520	4+560	Underpass 3
6+300	6+340	6+370	6+410	7+890	7+930	7+960	8+000	Hemayetpur Flyover
12+200	12+240	12+270	12+310	12+200	12+240	12+270	12+310	Savar Flyover
13+100	13+140	13+170	13+210	13+100	13+140	13+170	13+210	Savar Flyover
17+250	17+290	17+320	17+360	17+250	17+290	17+320	17+360	Jahangirnagar University
18+280	18+320	18+350	18+390	18+280	18+320	18+350	18+390	Jahangirnagar University

6.5.7. Toll plaza

The consultant has proposed Toll plaza at two locations at km 3+100 and 17+800 chain ages. Additional location of toll plaza/booth and number of lanes will be finalised during detailed design. Each toll plaza shall be furnished with police booth, fire stations, and dormitory building for toll collection staff, car services and restaurant facilities.

6.6. Preliminary Design Drawings

Preliminary highway design drawings have been prepared for the project roads, consisting of alignment plans, longitudinal profiles and typical cross-sections. In addition, cross-section at regular interval plotted and these are presented in Annexure.

The drawings show the existing RoW which was plotted from the survey details, established by locating RHD boundary pillars and in case of missing pillars, demarcation was drawn in consultation with local inhabitants by the surveyors. Confirmation of the accuracy of the RoW delineation was made by consulting the land acquisition plans which were collected from the respective RHD field division offices.

6.7. Pavement Design

6.7.1. Engineering Surveys and Investigations for Pavement Design

The Engineering surveys and investigations of the pavement in carriageways on either side, for the present project are limited to visual inspection and details noted for the entire length of the project highway.

Road Inventory Survey and Pavement Condition Surveys were carried out through visual inspection. The necessary data were collated, reviewed and analyzed in line with the scope of services.

The detailed investigation of the existing pavement is to be carried out by the selected bidder/ concessionaire in respect of Pavement Crust Composition, Roughness Surveys using Bump Integrator, Benkelman Beam Deflection (BBD) studies to obtain Pavement Rebound Deflection, Sub-soil Investigations, Material Investigations, Traffic Surveys, Topographic surveys etc.

6.7.2. Existing Pavement Condition

The existing highway has dual carriageway configuration with 2-lane configuration in each carriageway. There is no paved shoulder in the carriageways. Earthen shoulders are available of varying width for which an average of 2 m may be considered.

The pavement in the existing highway is ‘Flexible’ type. Despite of high traffic volume of about 30,000 vehicles per day and adversely affected by ‘Channelization’ effect due to inadequate width, still, in general, the condition of the existing pavement surface is good to fair. Earthen shoulders throughout the project road are in fair to poor condition.

A Roughness value is expected to be in the range from 5.5 m/km to 9.5 m/km and average value at 7 m/km, which indicates that the existing pavement surface requires strengthening of pavement surface as per IRC 81 using Benkelman Beam Deflection Studies & analysis. If overlay thickness is not indicated from characteristic deflection values as obtained from Benkelman beam deflection study analysis, thin resurfacing shall be provided to improve the riding quality. The objective of the Benkelman Beam Deflection (BBD) technique is to assess the structural strength of the existing pavement and to determine the requirements for strengthening of flexible pavements.

Expected properties of Subgrade / Improved Subgrade material is summarized as below using the above test results:

1) Soil Group: A-2/A-3 (coarse grained gravelly/sandy mixture)

2) Drainage Characteristics: Good to Fair

3) Potential Frost action: Slight to medium

4) Volume change characteristics: Slight to medium

5) Stability: Good

6) Value as subgrade material: Fair to Good

7) CBR, MDD, OMC of Subgrade materials should be 8%, 1.80 gms/cc and 19%

8) CBR, MDD, OMC of Improved Subgrade materials should be 12%, 1.90 gms/cc and 19%

6.7.3. Proposed Upgradation

The existing configuration of highway is 4-Lane Dual Carriageway and it is proposed to be upgraded as 6-Lane Dual Carriageway with 2-Lane Service Road on either side of the main expressway. This will help in segregating animal drawn, and agricultural vehicles from the main line traffic to the service roads. Out of total length of about 24.445 km about 10 km is proposed as elevated flyover. A few Vehicular Under Passes (VUPs) are also proposed at local road crossings to provide un-interrupted flow of traffic in the proposed expressway. A tunnel of length 500 metres is proposed at Nabinagar junction to avoid signalized stoppage of vehicles. There are 4 bridges on rivers/canals cross by the proposed expressway.

At locations where the proposed expressway is at grade, it is required to strengthen and widen the existing pavement in either side of the carriageway. The width of each carriageway is 2x3.5 = 7.0m, which is proposed to be upgraded as 3x3.5 (Carriageway) + 2x0.3 (Shyness zone) = 11.1 metres. In this width of 11.0 metres, the existing pavement of width 7.0 m in each carriageway is to be treated with profile correction and is to be strengthened as determined by Benkelman Beam Deflection Test. The balance width of (11.1-7.0=4.1m) is to be constructed as new pavement to widen the 2-Lane carriageway to 3-Lane carriageway. This is to be done in each carriageway of the proposed Dual Carriageway expressway.

On existing surface, it is considered to overlay with 140mm DBM and 50mm Binder Course (BC), and the new construction on either side shall have thickness of full pavement structure as derived from the design. At elevated flyovers of about 10 km, length, on VUPs, Bridges and the Tunnel will be pavement wearing course by layers of 140mm DBM and 50mm BC only. At Toll Plaza locations, the pavement will be Rigid Concrete Pavement with Tie Bars in Transverse directions and Dowel bars in longitudinal direction.

At stretches where the proposed expressway is to be constructed as at-grade, there the service roads will be on either side of the main expressway. Therefore, at river canal bridge locations, the service roads will be on either side of the main expressway and on separate 2-Lane bridges over the rivers/canals.

At stretches where the proposed expressway is to be constructed as elevated flyovers, the present existing highway under such elevated flyovers shall serve as the service roads with no widening but strengthening only.

6.7.4. Proposed Pavement Structure

As the project is upgrading the existing 4-Lane highway to 6-Lane expressway, therefore we have four different situations for pavement construction described as below:

(i) The design of Overlay for pavement strengthening shall require Benkelman Beam Deflection test to obtain the deflection acted on by temperature and seasonal corrections. Next by applying statistical computation, the characteristic deflection and finally the design overlay thickness is determined.

The Overlay thickness for strengthening the existing pavement is tentatively proposed as:

DBM	140mm
BC	50mm

(ii) For the thickness of layer wise pavement structure, required for widening by new construction needs Traffic count in terms of Equivalent Standard Axles (ESAL) is projected over the entire analysis period of the pavement. In this project, the analysis period is considered as 20 years. To economize, a 2-stage strategy is considered, in which the first 10 years will be provided with initial pavement structure for the widening portion and next 10 years will be proposed for a designed overlay.

The data is also required by conducting axle load survey for Vehicle Damage Factor (VDF), Subgrade CBR, Layer Coefficients and drainage coefficients, soil resilient modulus etc. For the feasibility report, most common and practicable pavement structure is proposed and the cost has been estimated accordingly.

Considering **Flexible Pavement for widening by new construction in the proposed expressway**, by computing traffic load as 179.3 MSA (ESAL in Millions) the following layer structures for Flexible pavement is proposed -

Selected Layers	Selected Thickness (mm)
Bituminous Wearing Course (Modified Bitumen)	50
Bituminous Binder Course (VG-40)	135
Aggr. Base Type-1	250
Aggr. Sub-base	250
	Total =685
Thickness of Improved Subgrade	300
	Total = 985 mm

(iii) Considering **Rigid Concrete Pavement at Toll Plaza Location in the proposed expressway,** the following thickness for Rigid Pavement is proposed:

Selected Layers	Selected Thickness (mm)
Pavement slab thickness (Flexural strength 4.5 Mpa)	= 350 mm
Lean concrete slab thickness (concrete class 15)	= 100 mm
Aggregate base course	= 200 mm
Sub-base	= 250 mm
Improved subgrade	= 300 mm
Total	= 1200 mm

(iv) Considering, traffic load as ESAL = 10% of main carriageway or minimum 10 msa = 17.8msa in **Service Roads**, the following layer wise flexible pavement structure is proposed for Service Roads:

Selected Layers	Selected Thickness (mm)
Bituminous Wearing Course (Modified Bitumen)	50mm
Bituminous Binder Course (VG-40)	50mm
Aggr. Base Type-1	250mm
Aggr. Sub-base	250mm
Total =	600mm
Thickness of Improved Sub-grade	300mm
Total =	900mm

6.8. Structure

New structures for the project comprise of bridges over water courses, flyovers (i.e. elevated structure/bridges over roads), overpasses, underpasses, tunnel and small drainage structures such as culverts through highway embankments.

The numbers of structures in each category identified during feasibility study investigation and design are given in the table below:

Table 70: Number of Structures by Function

Structure Type	Road No:
Bridges over Rivers (6-Lane Highway + 2-Lane Service Road)	4
Road Overpass (6-Lane Highway)	3
Flyover (6-Lane Highway)	3
Flyover (Box-Girder at Nabinagar Junction)	1
Tunnel (At Nabinagar Junction)	1
Underpass	1
Drainage Culverts	3

6.8.1. Surveys, Studies, and Investigations

As part of the initial investigations in the field, the bridge engineering team carried out condition surveys on the existing structures to determine the feasibility of retaining the existing structures as part of the improved highway. Highway alignment design, together with decisions made during this survey, especially for river crossings, dictated the type of new structure(s) selected.

Another critical study for structure design is the hydrology and hydraulics study. From this comes, inter-alia, design flood level, low water level, required waterway openings, design scour depths at each foundation, design current speed, and bank protection work to avoid scour or outflanking at abutments. Associated with this study, we have complied with the Bangladesh Inland Water Transport Authority (BIWTA) regulations on navigation clearances required at the class of river crossings.

6.8.2. Design Criteria

The criteria set out in this section are those which has been used for design. If required, this could also be developed into a set of criteria for issue for contractors' alternative designs.

6.8.2.1. Design Standards and Criteria

The structures have been designed according to the latest AASHTO LRFD (Vehicle Class HL-93 in 3 Lanes) standard with site specific environmental loading and effects based on river engineering studies, studies of vessels using navigable waterways, and data from the Bangladesh National Building Code (BNBC).

A revised version of the BNBC incorporating some important amendments has been published, but is not yet fully implemented within Bangladesh. For design, the most onerous of the old and new draft version requirements are adopted. All applicable limit states (Strength, Extreme Event, Service, and Fatigue) were satisfied in accordance with the LRFD Specifications.

Design Code/ Standard Followed:

AASHTO LRFD Bridge Design Specifications 2017 (8th edition)

Bangladesh National Building Code, BNBC-2012 (draft)

Bangladesh National Building Code, BNBC-1993

Bridge Design Standards for RHD, 2004

Concrete Design Strength:

Prestress Concrete (Box Girder)	45MPa
Prestress Concrete (PC) component (I/T girder)	40MPa
Deck Slab, Abutment, Pier, Approach Slab, Parapet	35MPa
Grouting concrete	Same as host member
RCC component (except cast-in-place (CIP) pile)	35MPa
CIP bored pile	25MPa
CC Block	20MPa
Blinding concrete	15MPa

Mild Reinforcement Strength:

Foundation including pile cap	60 Grade
Other than foundation,	72 Grade

For seismic load resisting member 60 grade steel may use for lateral reinforcement

Prestress Steel Strength:

Low relaxation type 7 wire Strand	270 Grade

Dead Loads

Dead loads include concrete, steel reinforcement, pre-stressing tendons and any other embedded components or the weight of overburden, based on the following unit weights:

Reinforced Concrete	25.0 kN/m3
Asphaltic Concrete	22.5 kN/ m3
Steelwork	78.5 kN/ m3
Soil, compacted sand, silt or clay	18.0 kN/ m3
Water	10.0 kN/ m3

Superimposed Dead Loads

Superimposed dead loads have been checked in accordance with the AASHTO Bridge Design Specification. Loads include the effects of utilities, waterproof membrane, road surfacing and non-composite barriers. Bridge surfacing used 50mm asphaltic concrete but allowance for 100mm thickness has been made in the design.

Live Loads

Vehicular loading on bridges, designated for the followings

AASHTO LRFD specified HL93 loading

IRC: 6-2017specified Class A loading with considering congestion factor

6.9. Basic Concepts of Design

The basic design concept for these bridges uses pre-fabricated Pre-stressed I-girder superstructure and balanced cantilever pre-stressed box girder for special cases. Most of the PSC bridges have been designed considering simply supported with splayed type wing wall. Spacing of PC girders are within the range of 1.325m to 2.3m. Multi column piers have been used which alternately are designed by oval shaped wall type columns. Portal frame has also been introduced for larger bridge width portion.

The PSC I-cross section is widely used in Bangladesh and has shown its advantages in relative low cost and fast construction technology. A Finite Element method for analyzing has been used to determine the vertical load distribution to the individual PSC girder and bearings. Vertical loads comprise self-weight, superimposed loads and live loads. The PSC girder is subjected to loadings in stages.

The bridge system can form an integral bridge system using continuous deck slab. Link slabs have been provided between the adjacent spans within each module to achieve a continuous surface for vehicles. Link slabs allows the vertical rotation of the main girders and transfer sudden loads such as horizontal longitudinal braking force and seismic forces to piers.

The width of the deck varies in the bridges. In the project, there are different total widths in the superstructures. The minimum thickness of deck slab on PSC I-Girder is 250mm. For most of the bridges, each span comprises post-tensioned I-girders, are spaced at approximately 2.0m centers. Transverse diaphragm between the girders, at the end of girders and at intermediate locations provides torsional restraints for the girders. These diaphragm beams also provide a jacking point to raise the superstructure for bearing replacement if necessary.

Deck slab thickness minimum 250mm.

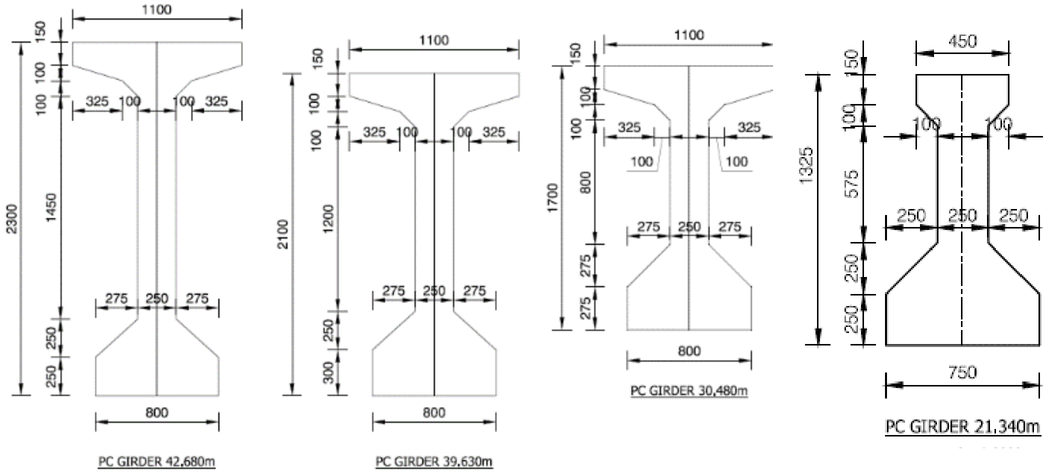
For retained culverts, extended portion have the same opening as the existing one.

A Typical Deck Section of Bridge/Flyover/Overpass in the figure below has been used in the design.

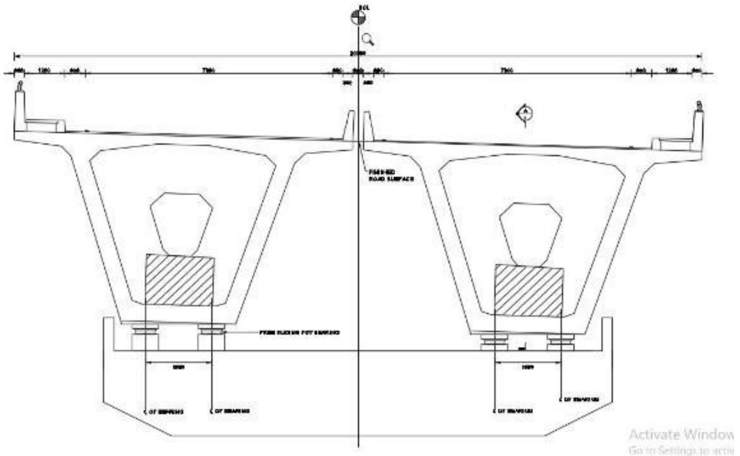
In pre-stressed concrete superstructures, generally, post-tensioning system is adopted and commonly used methods are –Cast-in-Place and Precast post tensioned. Many ingenious methods of construction presently exist for both cast-in-place and precast pre-stressed bridges. The choice of pre-stressed concrete bridge depends on span, site condition, location and availability of sections, cost of materials, etc.

For Precast Prestress post tensioned I/T girder with CIP deck slab type structure. Following PC girder sections have been used for design.

Figure 36 : Typical section of PC I-girder



For Prestress Box girder following sections have been used for design:



6.10. Traffic and Facilities to be carried through Structures

The aim is to upgrade the relevant existing 2-lane roads to 6-lane dual carriageway highways. However, as mentioned, special consideration has been given to local communities to enable the smooth flow of traffic on the improved highway.

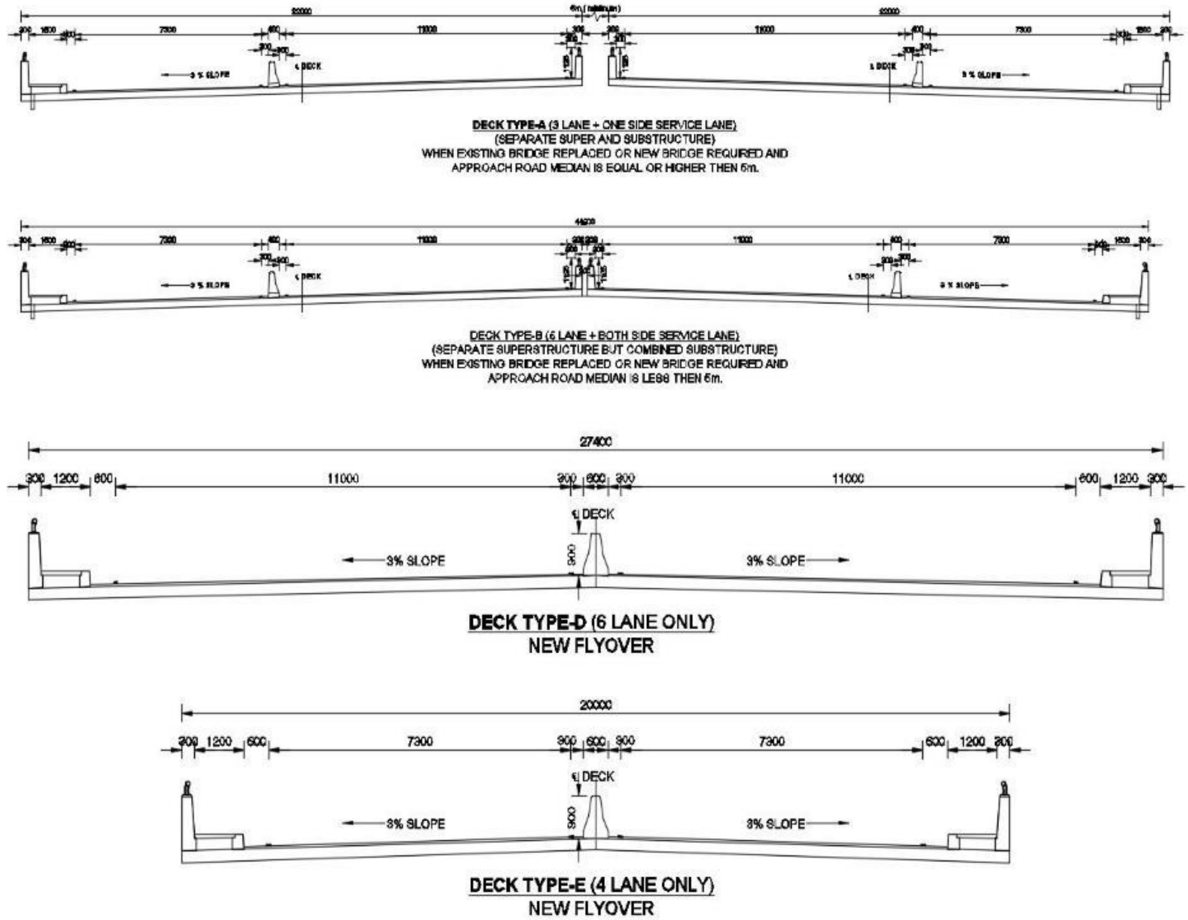
Where a completely new bridge is required for dual carriageway, then separate Service lanes are included on the same deck, either side of the highway carriageways. If in case the median width of joining road is 5m or more then separate bridge has been designed for each divided carriageway.

At this stage, no requirement to carry utilities on bridges has been identified. However, where bridges are located in or close to urban areas, or are more than 100 m long, provision for future installation of roadway lighting has been incorporated within the structure.

Configuration of Highway and Service Carriageways and Footways:

The final cross-section configurations for the different bridge requirements are shown in the figures below:

Figure 37: New Bridge Roadway Configurations

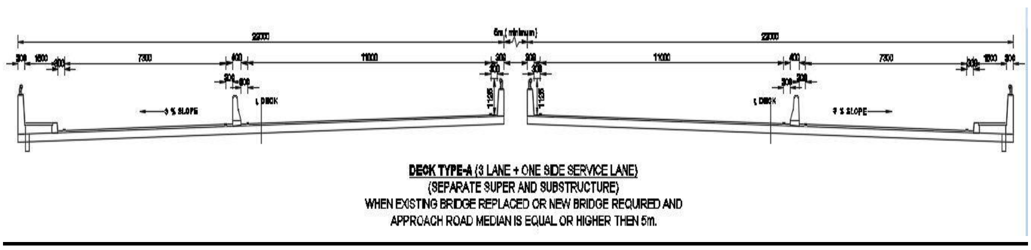


There are four River Bridges and four elevated Flyovers proposed under this project.

Type A Bridge system: Considered for rehabilitation and widening of three existing river bridges.

Proposed at Locations: Proposed as BR-01 (Chainage 1+173), BR-02 (Chainage 9+714) and BR-03 (Chainage 10+248) for river bridges configured for traffic of the main 6-Lane expressway and 2-Lane service roads on either side. Service roads are separated from the main expressway by providing barriers along with divider verges. This configuration is considered for bridges where approach road median is 5 metres or more. The provision of open median in between the two separate bridges shall be suitably treated for varying separating distances in these bridges. As the vertical navigational clearance of the existing bridges are adequate, it is therefore proposed to rehabilitate the existing 2 x 2-Lane bridges and widen by constructing one additional lane in the main carriageway and along with service roads. Each side of widening with service road is to be supported by a new set of abutments and piers on either side of the existing bridge.

Figure 38 : Type A Bridge System



Elements of Cross Section and dimension on each side of proposed bridge:

Barrier	0.3 m.
Side walk	1.5 m.
Shy distance	0.3 m.
Service lane	7.3 m.
Shy distance	0.3 m.
Divider Verge	0.4 m.
Shy distance	0.3 m.
3-Lane Main Carriageway	11.0 m.
Shy Distance	0.3 m.
Barrier	0.3 m.

Width on each side = 22.000 m. Total width = 2x22 + Central Open Median

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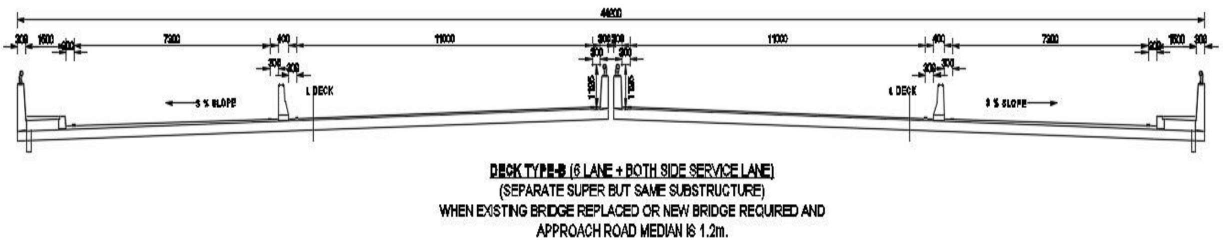
Type B Bridge system: Considered for one new river bridge, by replacing old / weak existing bridge

Proposed at Locations:

Proposed as BR-04 (Chainage Km 24+145) for river bridges configured for traffic of the main 6-Lane expressway and 2-Lane service roads on either side. Service roads are separated from the main expressway by providing barriers along with divider verges. This configuration is considered for bridges where approach road median is 1.2 metres. The provision of 200 mm shall be there in between the two separate deck slabs. The construction shall be for 3-Lane main carriageway and along with service road, on each side and entire bridge deck shall be supported by same central abutments and piers of new bridge.

Figure 39 : Type B Bridge System



Elements of Cross Section and dimension on each side of proposed bridge:

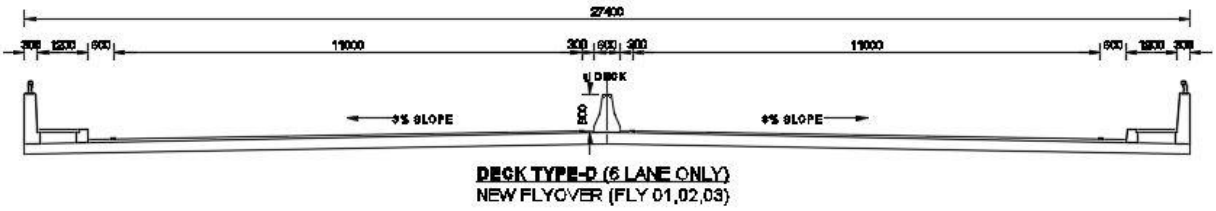
Barrier	0.3 m.
Side walk	1.5 m.
Shy distance	0.3 m.
Service lane	7.3 m.
Shy distance	0.3 m.
Divider Verge	0.4 m.
Shy distance	0.3 m.
3-Lane Main Carriageway	11.0 m.
Shy Distance	0.3 m.
Barrier	0.3 m.

Width on each side = 22.000 m. separated by gap of 200 mm in between decks.

Type D Bridge system: Considered for three new 6-Lane elevated Flyovers for main expressway,

Proposed at Locations: Proposed as Fly01 (Chainage Km 5+946, length 2338.17m), Fly02 (Chainage Km 11+240, length 2496.69m) and Fly03 (Chainage Km 15+902, length 3487.44m.) for elevated Flyovers configured for traffic of the main 6-Lane expressway. Service roads are provided under the Flyovers of the main expressway by using the existing 4-Lane divided highway. The construction shall be for 2x3-Lane main carriageway and entire bridge deck shall be supported by same central abutments and piers by new construction.

Figure 40 : Type D Bridge System



Elements of Cross Section and dimension on each side of proposed Flyover Centre line:

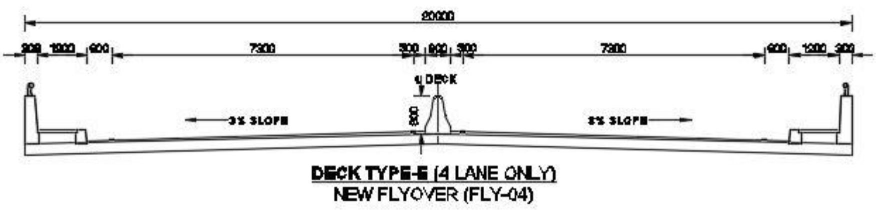
Half of Central Divider	0.3 m.
Shy distance	0.3 m.
3-Lane Main Carriageway	11.0 m.
Shy distance	0.6 m.
Side walk	1.2 m.
Parapet/ railing	0.3 m.

Width on each side = 13.70 m., Total width = 2 x 13.7m = 27.4 m.

Type E Bridge system: Considered for one new 4-Lane elevated Flyovers at Nabinagar Junction,

Proposed at Locations: Proposed as Fly04 (Chainage Km 20+764, length 1203.05 m) for elevated Flyover configured for Bipile traffic of the main 4-Lane expressway. Service roads are not provided along this Flyover of the main expressway. The construction shall be for 2x2-Lane Pre-stressed Concrete Box-Girder bridges for main carriageway and the Box-Girders shall be supported by same central abutments and piers by new construction. The Box-Girder structure is considered for segmental construction for requirement of large span at the Nabinagar junction.

Figure 41 : Type E Bridge System



Elements of Cross Section and dimension on each side of proposed Flyover Centre line:

Half of Central Divider	0.3 m.
Shy distance	0.3 m.
2-Lane Main Carriageway	7.3 m.
Shy distance	0.6 m.
Side walk	1.2 m.
Parapet/ railing	0.3 m

Width on each side = 10.000 m., Total width = 2 x 10.0m = 20.0 m.

This is to be noted that, there are Bridges and Flyovers in project designated by Type-A, B, D and E. There is no Type-C bridge in the project. The slot 'C' has been kept for newly introduced deck system for river bridges, but is not considered in the current project.

6.10.1.1. Utilities and Lighting Cables

As mentioned above, no requirement to carry utilities has been identified. However, the footway voids can carry electrical or fibre optic cables, should this be necessary. The cables for highway lighting and navigation lighting on bridges will be carried within these footways voids.

6.10.1.2. Limiting Gradient

The maximum gradient on bridge approaches has been fixed as 3%.

6.10.1.3. Vertical and Horizontal Alignment of the Bridges

Where sensible and practical, the horizontal alignment over all bridges has been kept straight. The horizontal alignment over the major bridge has been straight.

Vertical alignment over bridges is derived from the vertical clearance requirements as described below, together with the maximum gradient of 3% on the approaches, and taking account of the depth of the structure, and any long-term deflections.

6.10.1.4. Clearances

The required clearances for design are set out in the table below, together with the source of each requirement. These designs have been based on these minimum requirements.

Table 71 : Required clearances

Obstacle	Regulatory document (or other source)	Minimum Vertical Clearance	Minimum Horizontal Clearance
Waves and debris	Bridge Design Standard, RHD 2004	1.50m above Standard High Water Level	N/A
Navigation channel	Bangladesh Inland Water Transport Authority (BIWTA)	12.20m for Class-II 7.62m for Class-III 5.00m for Class-IV above Standard High Water Level	76.22m for Class-II 30.48m for Class-III 20.00m for Class-IV
Highway	Geometric Design Standards, Manual (revised) 2005 by RHD	5.7m	Clearance from carriageway to edge barriers 1m.

6.10.1.5. Scour Depth

Scour depths at bridge locations, including local scour around a single pile, have been calculated by the Hydrologist/River Engineer[10] . The Hydrologist/River Engineer also has stated that the rivers are stable at crossing locations, and so we do not need to consider any shifting of the main channel for the 100-year design life of the structures.

6.10.1.6. Loading

Design loading will generally be in accordance with AASHTO LRFD except as mentioned below.

Permanent Load

Design permanent loads is based on the AASHTO LRFD suggested values, or on values based on historic data on densities of materials used in Bangladesh, whichever is more onerous.

Live Loading

For live loading, in addition to the various AASHTO LRFD loading configurations and combinations, the Indian Class A loading (code specified the figures below) has also been considered.

[10] It is understood that provided the spacing of piles is equal to or greater than 3 x diameter, then local scour due to a single pile is considered rather than considering the geometry of the pile group.

Figure 42 : Loading Configurations

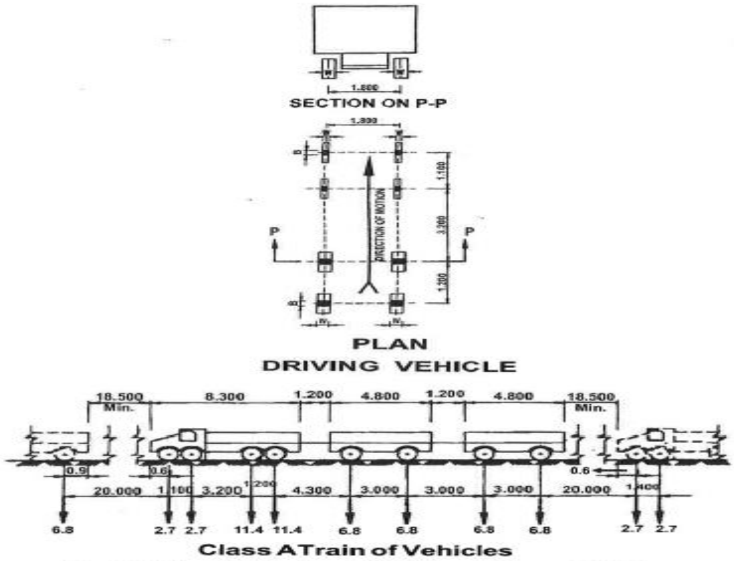
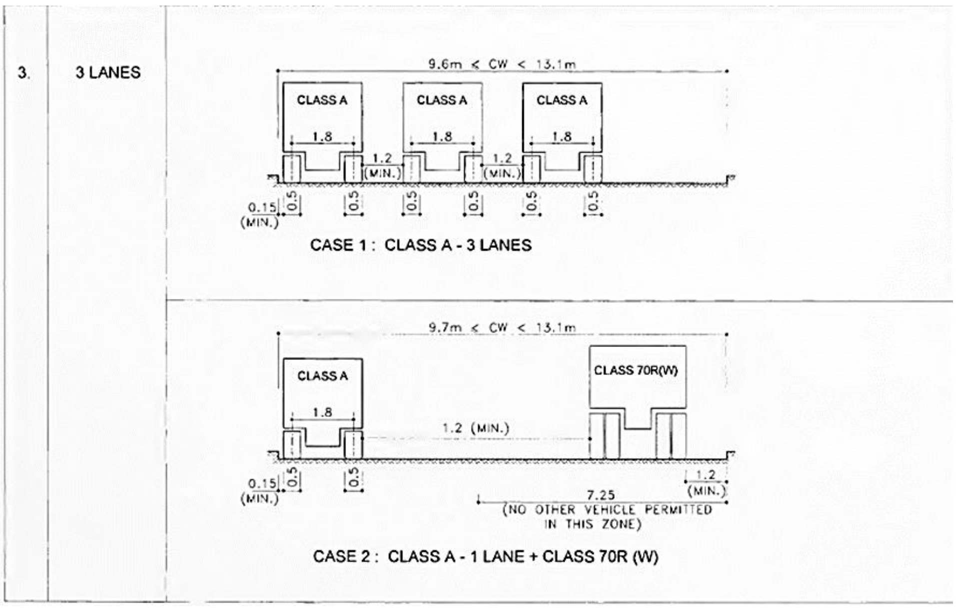


Fig. 2: Class 'A' Train of Vehicles (Clause 204.1)

Notes:

1) *The nose to tail distance between successive trains shall not be less than 18.5 m.*
2) *For single lane bridges having carriageway width less than 5.3 m, one lane of Class A shall be considered to occupy 2.3 m. Remaining width of carriageway shall be loaded with 500 Kg/m², as shown in **Table 6**.*
3) *For multi-lane bridges each Class A loading shall be considered to occupy single lane for design purpose. Live load combinations as shown in **Table 6** shall be followed.*
4) *The ground contact area of the wheels shall be as given in **Table 2**.*



6.10.2. Temperature Effects

Temperature Range

The BNBC does not provide contour maps of Bangladesh for maximum and minimum design temperatures. An internet search (e.g. http://en.wikipedia.org/wiki/ User: Howardrford/Asia) suggests that the lowest temperature ever recorded was 1.1°C at Dinajpur in February 2005, and the highest was 45.1 °C at Rajshahi in May 1972. Due to thermal inertia, effective bridge temperature range will be less than the range between maximum and minimum air temperatures, especially for concrete bridges. The following values for effective bridge temperatures will replace those in AASHTO LRFD: The below table Procedure A for concrete bridges:

Table 72 : Tmin design and Tmax design for temperature range

Temperature Range	Concrete	Steel Girder
$T_{min\ Design}$	5°C	0°C
$T_{max\ Design}$	40°C	50°C

These values were used when calculating design temperature movement range.

Temperature Gradient

For the purpose of calculating temperature gradient effects in bridge decks, the AASHTO LRFD values for Zone 3 have been adopted from basis for Temperature Gradients, i.e. T1=23°C and T2=6°C; T3 is taken as 0°C. These are not absolute values, but in conjunction with AASHTO LRFD, they define temperature gradients through the depth of the structure.

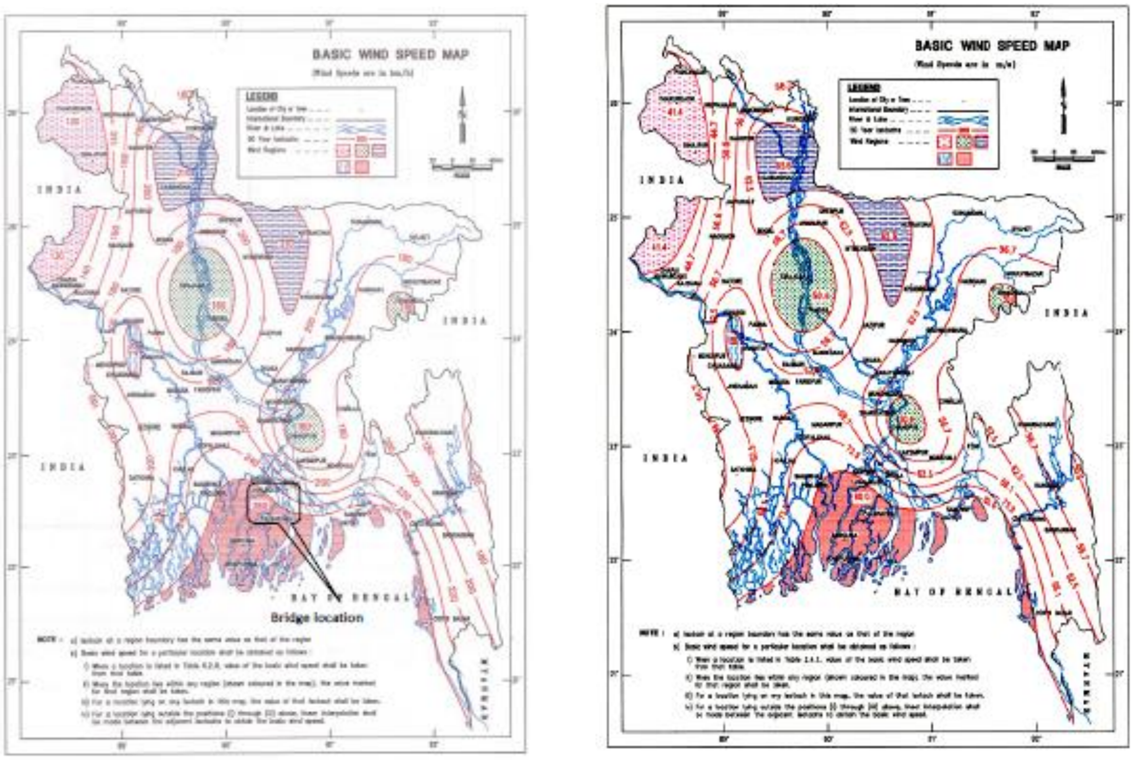
6.10.2.1. Wind Loads

The 1993 version of the BNBC has contours of Basic Wind Speed, V_b, which was defined as *"Fastest-mile wind speed in km/h corresponding to the level of 10 metres above the ground of terrain Exposure-B and associated with an annual probability of occurrence of 0.02"*. Exposure B was defined as "*Open terrain with scattered obstructions having heights generally less than 10m extending 800 m or more from the site in any full quadrant. This category includes air fields, open park lands, sparsely built-up outskirts of towns, flat open country and grasslands"*.

The 2013 draft BNBC shows identical shaped contours (see figure below) but the values associated with them are "Three second gust speed at 10 m above the ground in Exposure B (see Section 2.4.8.3 of relevant code) having a return period of 50 years". In this case, Exposure B is defined as "Exposure B shall apply for all cases where Exposures A or C do not apply". Exposure A is defined as "Urban and sub-urban areas, industrial areas, wooded areas, hilly or other terrain covering at least 20 per cent of the area with obstructions of 6 meters or more in height and extending from the site at least 500 meters or 10 times the height of the structure, whichever is greater". Exposure C is defined as "Flat and unobstructed open terrain, coastal areas and riversides facing large bodies of water, over 1.5 km or more in width. Exposure C extends inland from the shoreline 400 m or 10 times the height of structure, whichever is greater". The change to the latest edition of the BNBC may increase design wind pressure by about 4 to 5 percent.

For detailed design, the most onerous version from the two editions has been used.

Figure 43 : BNBC Wind Speed Maps



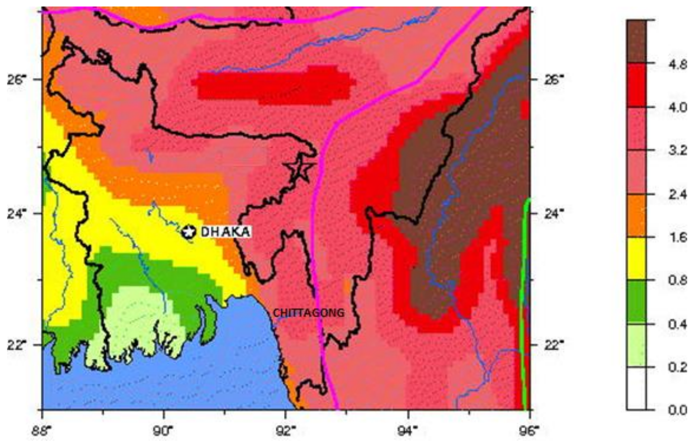
Left: Basic wind speed (V_b) km/h map of Bangladesh from BNBC 1993**.**

Right: Basic wind speed (V_b) m/s map of Bangladesh from 2013 Draft BNBC.

6.10.2.2. Seismic Effects

The Global Seismic Hazard Assessment Program (GSHAP), instigated within the framework of the UN sponsored International Decade of Disaster Reduction (IDNDR), produced the hazard map for Bangladesh shown in the figure below :

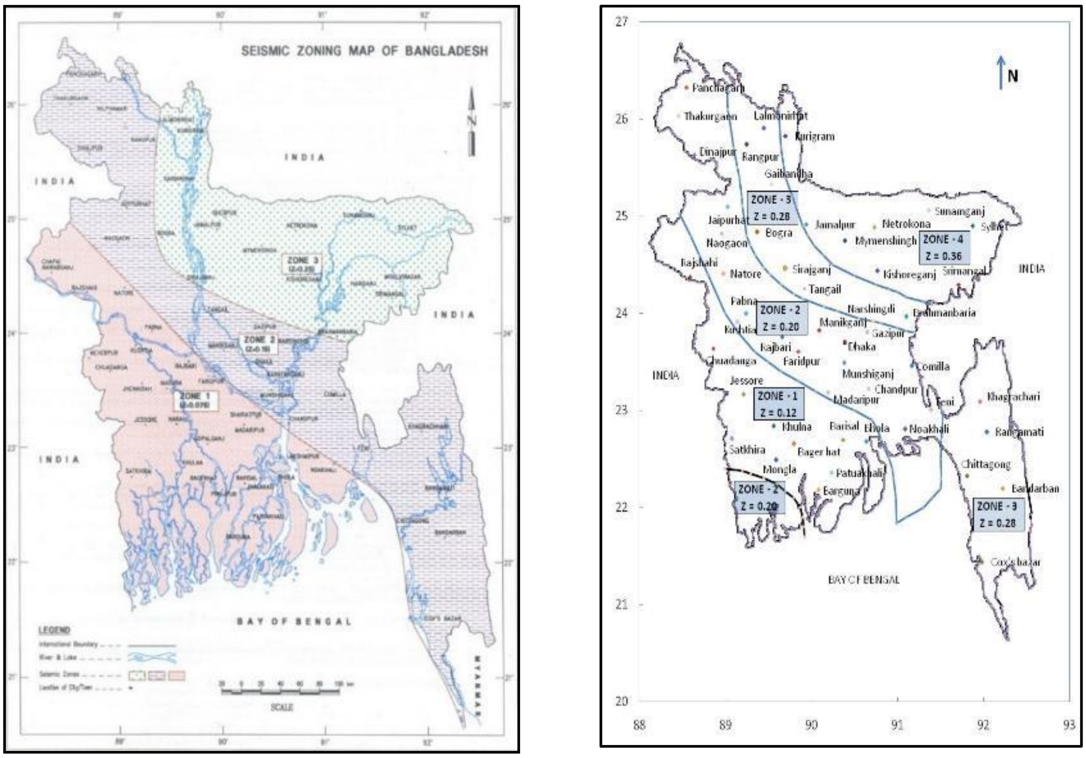
Figure 44 : GSHAP Seismic Hazard Map for Bangladesh and India Border



(Peak Ground Acceleration (PGA) m/s^2 with 10% Probability of Exceedence in 50 Years) From USGS sitehttp://seisan.ird.nc/USGS/mirror/neic.usgs.gov/neis/bulletin/neic_fiag_w.html

For design, the requirements of AASHTO LRFD 2017 has been followed except that instead of the approximately 1 in 1000-year return (7% probability in 75 years) peak ground acceleration (PGA) in AASHTO, we used the most onerous of either the 475-year return period PGA from the 1993 edition of the BNBC or 2/3 of the 2,500-year return PGA from the "Maximum Considered Earthquake" in the latest draft BNBC:

Figure 45 : BNBC Seismic Hazard Zoning Maps



Left: Zoning Map from 1993 BNBC (Peak Ground Acceleration with 10% probability of exceedance in 50 Years)

Right: Zoning Map from Latest Draft BNBC (Peak Ground Acceleration with 2% probability of exceedance in 50 Years)

6.10.2.3. Boat Impact Loading

The risk of vessel collision is linked to four factors: the vessel traffic, the bridge configuration, the waterway, and navigation characteristics. For detailed design, following possible approaches have been adopted, either:

1. Method I: Select design impact loads on substructure and superstructure following approach set out in the latest version of the AASHTO "Guide Specification and Commentary for Vessel Collision Design of Highway Bridges", and design to resist these loads; or
2. Method II: Perform a probability analysis and select appropriate pier capacities in accordance with the approach set out in Article 3.14 of AASHTO LRFD or the AASHTO Guide Specification.

6.10.2.4. Construction Stages and Loads

Detailed design has been taken account of the influence of construction sequence/stages on both temporary and permanent stresses in the structures.

6.10.2.5. Pre-camber

In order to obtain the intended vertical highway profiles over structures, decks will be precambered. Immediate deflections together with 50% of predicted long-term effects due to shrinkage and creep was taken into account when determining the required pre-camber.

6.10.3. Choice of Structural Form

6.10.3.1. Bridges and Flyovers

As described and illustrated in the Design Criteria, new 6-lane bridges have been introduced where damaged or sub-standard existing bridges are to be replaced, or where a bridge is required on a new road alignment.

The headroom provided for traffic below elevated road sections, flyovers, or road overpasses is 5.7m.

The basic and important factors which were considered in selecting the bridge type were as follows:

- Geological/Geotechnical conditions
- Hydraulic conditions
- Global flooding pattern
- Environmental conditions
- Availability of materials
- Construction time
- Available construction technology
- Requirement of maintenance
- Aesthetic view and
- Overall cost

In the design of new bridges and flyovers, it is important to undertake comprehensive studies and analysis to select the most appropriate type of bridge structure i.e. the type of superstructure and substructure members, which has been considered in the design phase.

To minimize the cost and to reduce the need for maintenance, experience has shown that for short spans (less than 21m) conventional RCC rectangular beam-and-slab decks are most economical option. For spans beyond 21m and up to 43mprestressed concrete I-girders with composite in-situ RCC concrete deck options have proven most cost effective. Also, it is easy to construct a curved elevated roadway with radius equal to or greater than 500m with varying super elevation with a curved deck slab on a series of straight beams. For span larger than 60m balanced cantilever prestressed box girder system is widely appreciable. Hence, these structural forms have been selected for both single and multi-span bridges as well as for overpasses. Similarly, deep foundations of bored cast in-situ piles (also known as drilled shafts) together with RCC pile caps and columns have been shown to be the most cost effective substructure form, and these have been adopted for this project.

6.10.3.2. Culverts, Overpass, Tunnel and Underpasses

Conventional RCC boxes have been selected for both single and multi-barrelled box culverts as well as for Tunnel, overpasses & underpasses. Return type wing wall, monolithic with the culvert/underpass walls and bottom slab have been provided.

A vertical clearance of 600mm has been provided between the design flood level and the top slab of culverts.

Vertical clearances of 5.7m for highway overpasses & Tunnel have been provided. For retained underpass the size has been kept as existing one.

At some locations the main road runs parallel and close to local roads. For example, where local traffic needs to do a U-turn under the main road beneath flyovers in bazar areas, beneath rail over bridges, or beneath the flyover ramps. In these cases, relatively high vertical retaining walls are needed to keep the road corridor to a minimum by reducing the width of embankment.

The choice of retaining structure lies between traditional RCC walls or Mechanically Stabilized Earth (MSE) wall. MSE walls have been widely used in Bangladesh. They are fairly rapid and easy to install, they are flexible, and can be aesthetically pleasing. Furthermore, previous projects have shown that MSE walls are generally cheaper than RCC; and so reinforced earth has been chosen for this project.

6.10.4. Structural Design

6.10.4.1. Bridges and Flyovers

The principal purposes of preliminary design of any structure are: (1) to obtain quantities of materials for making estimates of cost. (2) to obtain a clear picture of the structural action, (3) to establish the dimensions of the structure, and (4) to provide the concrete outline for the final design.

For each bridge and flyover a general arrangement drawing has been prepared together with standardized typical decks, girders, abutments, piers, expansion joints, bearings, and miscellaneous drawings

In case of PC girders with deck (both for three lanes and six lanes) the spans are standardized as 21.34m, 30. 48m, 39.63m and 42.68m. Abutment heights are standardized as 5m, 6m, and 7.5m. Abutment wing walls are return type. CC blocks are provided for the approach slope protection.

Piers comprise two or more circular columns with hammer-head pier caps.

1200mm diameter bored cast-in-situ piles are generally provided for foundations. The pile toes rest on stiff clay or dense sand strata as recommended by the geotechnical engineers.

Elastomeric neoprene bearings support the end of each simply supported girder on abutments and piers.

Expansion joints are provided at both ends of the structure at abutments and also at the piers. The joints are of the watertight type.

6.10.4.2. Culverts, Tunnel, Overpasses and Underpass

Typical drawings showing the concrete outline for the RCC box culverts, tunnel, overpasses and underpasses have been prepared for both single and multi-span box culverts as well as for underpasses.

Approach of tunnel, overpasses and underpasses is Mechanically Stabilized Earth (MSE) wall. Return type wing walls for culverts have been used. Individual precise design has been done during the detailed design phase.

6.10.5. Materials and Durability

6.10.5.1. Concrete Durability

Concrete durability has been assured by various measures, including:

A. Selecting a class of concrete suitable for each application in the particular environment. Most importantly it must have a low permeability achieved by using the lowest water cement ratio compatible with the workability necessary to place the concrete satisfactorily. Approved water reducing admixtures is permitted to obtain the best balance between w/c ratio and workability.

B. Controlling early thermal cracking by control of the temperature of materials and providing an adequate amount of reinforcement to distribute thermal strains and limit crack widths. The benefits of using mineral additions are well established, and the possibility of incorporating either ground granulated blastfurnace slag (GGBS) or pulverized fuel ash (PFA) was considered.

C. Values of minimum concrete cover has been selected to ensure the required durability. These are at least the minimum value permitted by the code, but may be greater depending on the environment and any particulars related to Bangladesh experience and construction.

D. Surface shapes were designed to be self-cleansing, avoiding traps for dirt and moisture.

E. Watertight deck expansion joints has been used to avoid water and dirt from the deck running down on to bearings and seismic devices.

6.10.5.2. Durable Pre-stressing

There have been some notable durability problems with post-tensioned bridges in the past. Failure to control quality, especially when grouting the stressed tendons, led to a number of failures (and there will be many more to come). Corrosion of tendons within voids in grout has been the most usual cause. With historic grouting techniques, these voids have often contained bleed water and air. These two components are sufficient to initiate corrosion of the strands, and if chlorides are added to the mix as a result of seepage into the void, then corrosion can be rapid. Because tendon strands have a high surface area compared to the volume of steel, and because the corrosion product expands into the void without disturbing the surrounding concrete, failure of a post-tensioned span can occur quite quickly with very little or no warning.

The collapse of a precast segmental bridge in Wales in the UK in 1985, together with several other incidents worldwide, led the UK government to impose a moratorium on the use of bonded post-tensioned concrete bridges in 1992. Over a 5-year period, the UK Highways Agency carried out a program of inspections of existing bridges to determine the extent of corrosion of tendons within the existing bridge stock. Subsequently, government and industry developed proposals to improve materials and methods for protecting post-tensioning tendons to limit the risk of premature deterioration.

To safeguard the durability of post-tensioning for the major bridges the engineering team incorporate special measures on the Drawings and within the Specification, including:

A. Consideration of the use of high density plastic prestressing ducts and watertight connections to ensure a continuous barrier against the ingress of moisture, oxygen, or aggressive salts (as per the recommendations of UK Concrete Society report TR72[11] and the US Florida DoT Report[12]. Spiral wound metal tendon ducts allow moisture and salts in solution to pass through the wall of the ducts, leading to corrosion.

B. The use of the latest recommendations for grouting of prestressing ducts and trials and testing of grout, following the recommendations of UK Concrete Society report TR72 and the US Florida DoT Report referred to above. Reference may also be made to the following UK implementation of relevant Eurocodes if they contain reasonable durability requirements not yet included in AASHTO:
   - BS EN 13670 Execution of Concrete Structures. BSI London 2009.
   - BS EN 445, Grout for Prestressing Tendons, BSI London 2007.
   - BS EN 446, Grout for Prestressing Tendons - Grouting Procedures, BSI London 2007.

[11] Concrete Society Technical Report TR72 "Durable Bonded Post-Tensioned Structures", 2010

[12] Florida Department of Transport "New Directions for Florida Post-Tensioned Bridges", 2002

7. Sources of Materials for Pavement and Structure

7.1. Materials for Sub Grade and Embankment Construction

As per our assessment, we understand that various construction materials are not readily available in Bangladesh. Therefore, following the practice adopted in other similar projects, it is envisaged that the various construction materials need to be imported from various sources outside the country. This practice in the country has resulted in the limited use of the Bangladesh Schedule of Rates (SOR) to reach a practicable project cost. The items rates under the assessment were collected from various other projects, which have been recently completed or are ongoing in the country. This has also resulted in the increase in the project cost significantly in order to arrive at a balance of practicable costs and in consideration of the costs obtained from other projects.

7.1.1. Soils from Borrow Pits

In general, materials obtained from borrow pits in Bangladesh are mostly clayey and cohesive in nature. Because of their cohesive properties, clay soils have certain advantages in the construction of embankments. The clay tends to protect the embankment slopes against erosion by rain, or drainage discharge, and is also conducive to the growth of vegetation which in turn helps to stabilize the slope against failure. For high embankment fill, clay slopes are less vulnerable to rotational shear failure.

However, there are also certain disadvantages to the use of clayey soils in embankment construction. Clayey soils are difficult to compact and can possess inferior engineering properties. Long term performance of pavements constructed on clay embankments has been found to be unsatisfactory. In addition, embankment construction using clayey soils can be very time consuming if attempted during the rainy season.

When soils from borrow pits are used, properties tested are Maximum Dry Density (MDD), Optimum Moisture Content (OMC), CBR, Atterberg limit, Soil Type and % of sand as mentioned in the Technical Specification.

7.1.2. Dredged River Sand

To overcome the several disadvantages described above it is recommended that dredged river sand be used for embankment fill.

In addition, the GoB encourages the use of dredged sand in the construction of embankments, in preference to the use of clayey soils, in order to save the loss of valuable agricultural land.

Sources of sand (dredged or natural) are Buriganga, Sitalakhya, Balu, Turag, Dhaleshwari and Bongshi rivers. Dhaka is surrounded by these 6 rivers and these rivers are sources of sand of any project in Dhaka.

7.1.3. Sub-grade and Improved Sub-grade Materials

Essentially, this layer is composed of a less expensive material than the Sub-base material, but it will usually require a greater thickness than the equivalent Sub-base material thickness. Nevertheless, the use of such a layer is intended to produce a reduction in the combined overall cost of pavement and embankment materials and, unless it does so, there is little point in introducing such a layer, unless sustainability (of sub-base materials) is a consideration.

Where embankment fill materials, or the natural sub-grade, are of inferior quality, an improved sub-grade material should be introduced to form a layer of better-quality material directly beneath the Sub-base. Such a layer provides the dual benefits of improved pavement performance and construction economy. Where clayey soil forms the sub-grade, material from selected borrow-pits, having lower liquid limit, plastic limit and higher CBR properties, should be used wherever possible.

Sand can be used successfully as an improved sub-grade material. Sand layers, as improved sub-grade, provide excellent drainage and act as a capillary barrier to prevent moisture ingress to the pavement. Due to the scarcity of good natural sub-grade materials in Bangladesh, the use of an improved sub-grade layer in road pavements is generally practiced. An improved Sub-grade may be achieved by the blending of natural clay materials (having specified values of CBR, LL and PI) and river sand. Sands which could potentially be used for improved sub-grade production were sampled and tested. Sources of sand are Padma, Buriganga, Sitalakhya, Balu, Turag, Dhaleshwari and Bongshi rivers.

7.2. Materials for Pavement Construction

7.2.1. Sub-Base

Hard Stone Sources

There is an acute scarcity of high quality natural materials for use as aggregates in pavements and concrete, throughout Bangladesh, due to the geological landform of the land.

Although some sources of inferior rocks are utilized in the production of aggregates suitable for use as sub-base layers in pavement construction, to obtain sufficient quantities for this production is difficult when the sources are also limited.

Quarries are located at Jhenaigat iof Sherpur district (180 km), Panchagar district (410 km) and Lama in Bandarbon (325 km) district. Some stones are also available in Khagrachari district. All the sources are located near the Bangladesh-India border. The Los Angeles Abrasion values of these materials are typically in the range of 40-50. Specific Gravity and water absorptions are moderate. These materials have been used successfully in some other projects in Bangladesh.

7.2.2. Base Course and Asphalt

Stone/Aggregates

Aggregates produced for use in Base course, Asphaltic Concrete and Cement Concrete; require rocks which possess high quality engineering qualities.

Due to geological formation most of the lands in Bangladesh are plain agricultural land. It is of alluvial deposit of silt or silt clay mixture. Rocks required for good quality aggregates are not abundantly available. Rapid development of infrastructure in Bangladesh, demands very large quantities of rock aggregates. The following quarries are the main sources of hard rock in Bangladesh:

- Sylhet source (Jaflong, Bholagonj, Guineghat) 295 km.
- Modhayapara in Dinajpur District. 349 km
- Panchagar in Dinajpur District. 410 km
- SherpurDistrict (Jhenaigati). 180 km
- Banderban&Khagrachari District.325 km

Sylhet and Madhayapara are proven quarries from which quality stone for use in the production of high quality concrete and asphalt works is obtained. Stone from Jhenaigati and Banderban is of comparatively inferior quality but is suitable for use in pavement construction as base and sub-base materials.

Unfortunately, the total production of all the above-mentioned sources is insufficient to meet the demand for hard rock required for the production of aggregates for use in all construction activities in Bangladesh.

To meet the current demand, hard stone for production of aggregates must be imported into the country. For the implementation of any large project in Bangladesh, it has been observed that contractors import hard rock for aggregate production. The source for hard rock imported into Bangladesh is the neighbouring country of India, and hard rock from this source has been used extensively on different large projects in Bangladesh.

Hard stone is generally imported through three India- Bangladesh border crossing points. These are;

- Sona Masjid at Chapai Nawabgonj District (Pakur stone)
- Kamalpur of Sherpur District (Meghalaya stone)
- Dawki-Jaflong border at Sylhet district (Meghalaya stone)

Using all of the previously mentioned quarries, it may be possible to obtain sufficient good quality stone or aggregates to meet the large demands of this project. Importers sometimes import stone from India and crush it in Bangladesh.

For source approval, it is required to check the nature of rock, its specific gravity and water absorption, soundness, and resistance to abrasion and impact (toughness).

7.2.3. Bitumen

Economy and performance of bitumen bound pavement layers is highly dependent upon the quality and optimal use of bitumen. In Bangladesh generally, penetration grade bitumen are used in asphaltic pavement works. Penetration Grades of 60-70 and 80-100 are commonly in use. The construction industry in Bangladesh exerts a high demand for bitumen. As Eastern Refinery, the only bitumen producing company in Bangladesh, is unable to cope with the demand, Bangladesh has to import Bitumen to meet the requirements.

In this project, Polymer Modified Bitumen (PMB) is recommended for use in Wearing course and VG-40 bitumen is recommended for use in Binder course. PMB may be plant produced or site mixed, but VG-40 is only produced in plants. Contractors have to import these bitumen. If PMB is produced at site, the modifier polymer must be imported from foreign countries. Importers may import Bitumen from India, Iran and Singapore. Well known source of polymer is USA (DuPont).

7.2.4. Adhesion Agents (anti-stripping additives)

Adhesion agents are sometimes used in bituminous mixes where damp weather conditions prevail during or immediately after laying, or where aggregates which are prone to stripping in the presence of water are used in a mix. Different types of adhesion agent can be used to reduce the risk of stripping taking place. These are:

- Anti-stripping chemicals
- Lime dust (hydrated lime)
- OPC cement.

Bangladesh does not produce any anti-stripping chemicals. If such chemicals should be specified for use in a bituminous mix, the material would need to be imported.

However, lime dust and cement are available in Bangladesh. The quality and suitability of lime, for use as an adhesion agent, should be verified by the laying of trial mixes.

7.3. Materials for Concrete Works

7.3.1. General

Normally concrete is produced from the following ingredients:

- Aggregates
- Natural coarse sand
- Cement
- Admixture
- Water

Different strengths of concrete can be produced by varying the above ingredients. If extremely high strength or high durability concrete is required then additives such as fly ash, silica fume (a highly reactive pozzolan) and super plasticizer may be incorporated into the mix to produce what is known as high performance concrete. High performance concrete can provide not only high strength, but also improved long-term engineering properties and durability. It performs well in environmentally extreme conditions.

7.3.1.1. Aggregates

Source and availability of natural aggregates has been discussed and investigated. The availability of other concrete ingredient materials is discussed hereunder.

7.3.1.2. Natural Coarse Sand

A large quantity of natural coarse sand is required for the construction of the project road due to the high number of concrete structures (culverts and bridges) incorporated in the works. Sand quarries for natural coarse sand are not abundant in Bangladesh and sources of good quality sand are limited. Existing borrow areas are heavily used but may not be capable of producing the full quantity of sand required. Generally, importation of sand has not been practiced in Bangladesh. Existing coarse sand borrow areas are located at the following places:

- Sylhet District known as Sylhet sand.
- Dinajpur District known as Dumer sand
- Sherpur District known as Jhenaigati sand.
- Kustia District Known as Garagonj sand.

The Fineness modulus of this sand varies from 2.5 to 3.5. These are clean natural sands, with silt and clay content within acceptable limit and sands are free from harmful deleterious substances. No injurious salt is present. Sand from all the above-mentioned sources has proven quality and performance.

7.3.1.3. Cement

Cement is abundantly available in Bangladesh. Although some of the raw materials for cement production are totally absent in Bangladesh, a sufficient number of cement companies have been established through the importation of raw materials. The world-famous company La Farge has set up a cement factory in Sylhet and imports limestone from India. This is a privately owned limited company.

Most other cement companies import clinker as raw material and grind the clinker with gypsum to produce cement. A new trend has been developed by the addition of fly ash or blast furnace slag during grinding. The products are sold as Portland composite cement (PCC). PCC is less expensive than Ordinary Portland Cement (OPC). Sulphate resistant cement (Type-V) should be used in foundations of structures which will be in contact with sulphate bearing soils. As this type of cement is not readily available in Bangladesh, it may be required to import sulphate resistance cement.

7.3.1.4. Admixtures

Internationally reputed admixture manufacturing companies have agents in Bangladesh for the supply of different types of admixture, as used in concrete works. BASF from Germany has its own factory in Dhaka.

Plasticizers, which may be super plasticizers or normal plasticizers, are very commonly used in Bangladesh. These are usually used for two main purposes. One is to reduce the water demand of the concrete and hence provide higher strength. The other is to obtain higher workability at the same water/cement ratio. Good quality and effective admixtures are available, and the agents can supply the required quantity of admixture.

The followings are the internationally renowned companies operating in Bangladesh:

- BASF from Germany.
- Fosrock from Latin America.
- Sika from UAE/India.

The agent’s offices are at Dhaka & Chittagong and they can supply their product, in any quantity, to any location in Bangladesh. Admixtures for concrete should be chloride free.

7.3.1.5. Water:

There is no scarcity of water for construction purposes in Bangladesh. In locations along the project road, the source of water for construction purposes is surface water which is free from injurious salt. In the case of saline water zones, sufficient quantities of sub-surface water can be successfully pumped from boreholes.

7.3.2. Reinforcing Steel

There is no raw material (iron ore) available in Bangladesh to produce steel, but a number of steel mills have been established in the country by Bangladeshi entrepreneurs.

Some steel mills produce good quality rebar required for the production of reinforced concrete. However, most of the mills produce the rebar from scrap iron. Generally, rebar made from scrap iron is not of good quality because the producer cannot maintain a constant chemical composition and consequently the physical requirements pursuant to the specification. The reputed steel mills that produce the rebar from billet steel are:

- BSRM
- KSRM
- RSM
- Anwar steel mill

- AKS (Abul Khair Steel Mill)
- Basundhara Steel Mill.

All the mills are situated in well communicated locations and are capable of supplying sufficient quantities of steel to satisfy the requirements of the project road.

7.3.2.1. Strand (HT wire)

Neither pre-tensioning nor post-tensioning HT wire is produced in Bangladesh. These materials will need to be imported for the project.

7.3.2.2. Expansion Joints and Bridge Bearings

Standard expansion joint items/materials are not manufactured in Bangladesh. Such items/materials need to be imported.

Some entrepreneurs have started to produce bridge bearings (specifically neoprene bearings) and these have been used in some important projects in Bangladesh. The bearings were tested by BUET and results were found to be satisfactory, but long-term performance is still unknown.

Based on the above analysis and our understanding, we understand that while some of the materials are available locally, the prevailing practice requires materials and their specifications to be adopted based on imports. In consideration of the above, the materials and high level specifications shall be suggested to the concessionaire during the project development and implementation stage in order to arrive at the most feasible and sustainable technical solution for the project.

8. Environmental Impact Assessment

The capacity of this national highway including major district roads network is constrained and has safety related issues for the growing traffic. The capacity limitation is due to congested junctions, markets, and community areas. The road is two lanes with no shoulders and no provision for slow moving vehicular traffic (SMVT) or non-motorized traffic (NMT). Consequently the existing road cannot cater for fixed traffic such as SMVT and NMV in the same carriage way. However there is a need to separate the road to local traffic from the main road and create a dedicated expressway to accommodate the increased traffic volume and meet the demand for fostering the national and international economic trade, ensure road safety and to reduce journey time. Moreover, The PPPA also envisages that the expressway will be a part of Asian Highway route in Bangladesh and it is vital for establishing an improved transport link on the Trans Asian Highway.

8.1. The Project

The project road starts from Gabtali Bus Terminal on the mid-west boundary of the city area and passes through Aminbazar, Hemayetpur intersection and Savar Bazar and ends at Nabinagar intersection at Naional Monument Site. Existing road is 2-lane with poor horizontal and vertical profile, degraded shoulder, inadequate cross drainage structures, side drains, safety installations, protection works and road furniture etc. The project will upgrade this road into a 4- Lane main road with safety features, dedicated SMVT lane, three 6-Lane highway Road Overpass, three 6-Lane highway Flyover, one 4-Lane highway Flyover, one 4-Lane highway Tunnel and underpass. The upgradation work will require widening and heightening of the existing road embankment, replacement of narrow opening existing cross drainage structures by four Bridges over Rivers as 6-Lane Highway + 2-Lane Service Road and three drainage culverts. In addition, the provision of covered drain in built-up sections, bus bays /truck lay- bays, and installation of safety measures for communities and public road users are included in the project. Two Toll plaza at two locations at km 3+100 and 17+800 are proposed and additional location of toll plaza/booth and number of lanes will be finalised during detailed design. Each toll plaza shall be furnished with police booth, fire stations, and dormitory building for toll collection staff, car servings and restaurant facilities.

8.2. Environmental Sensitivity and Project Categorization:

The Project interventions include the extensive civil works and requirement of linear land acquisition some sections for widening 2-Lane National Highway into 4-Lane highways with services roads and other facilities, hence their impacts may be significant on physical environment, ecological resources, livelihoods, infrastructure and pollution. The project is categorized as Category ‘Red’ in accordance with Bangladesh Environmental Conservation Rules 1997, Schedule 1, warranted to carry out an IEE followed by EIA. While in accordance with ADB Safeguard Policy Statement (SPS) 2009, World Bank safeguard policy this Project may be Categorized ‘B’ requiring only an IEE. Whereas the project area is congested commercial and industrial areas, requires substantial lands acquisition, displacement of titled holder and non-titled (squatters or encroachers) affected persons and some critical aspects of the work could result in longer-term negative effects, underscoring the need for the EIA.

However, the intervention of these upgrading of the road will have its associated environmental impacts that requires due consideration in project design for its mitigation and management based on detailed environmental assessment. In relation to this, an IEE is carried out to determine the likely significant environmental changes due to the project and crafts mitigation measures to avoid, minimize, or compensate these impacts.

In this IEE study, the assessment of the environment and social impacts is conducted in relation to the project activities through a broad environmental and social examination and screening of the anticipated impacts. The potential environmental impacts of the project on the biotic/abiotic environment were identified and evaluated to get a complete scenario of the likely environmental impacts due to the project and formulated a strategy in the form of an Environmental and Social Assessment, highlighting issues and mitigation measures incorporated in the project implementation.

8.3. Baseline Condition:

Baseline environmental assessment was conducted covering the environmental and ecological features of the 24.445 km catchment project area. The Project area represents an urban and semi urban area, much of it is modified from its natural state and intended for further development into urban settlements. Baseline condition of the physio-chemical, ecological and social environments of the project area were collected through field investigation, observations, instrumental testing and consultations process. Instrumental testing of the Biophysical parameters (air, noise vibration and surface water quality) were performed by the EQMS Consultant Ltd during month of October 2019. The major habitat types of the area are seasonal floodplains, agricultural lands, homesteads, commercial settlement and roadside verges. The socio-economic study was carried out for the local population to assess their livelihood and record the reaction of the local population for the upcoming of the upgradation of the road project.

8.3.1. Climate:

According to Statistical Yearbook of Bangladesh 2016, the monthly variation of climatic data were recorded in Dhaka district. Temperature ranging from an average was minimum 14.2 °C in the cold season to a top of 35.5°C in the hot season. Rainfall varies from 03 mm in January to 406 mm in July.

8.3.2. Topography and Landform:

The city is characterized by low relief with many low depressions. The average elevation of the city is about 6 m above M.S.L (Mean Sea Level). The maximum and minimum elevation occurs in the Mirpur zoo and the peripheral area of the Dhaka city. The ground surface slopes towards both east and west but general slope in from the north towards the south and southeast. The area is generally flat and poorly drained. Soils are somewhat porous allowing for some seepage of surface water into the soil. Channelized drainage covers most of the land, in which slowly draining streams will transport surface runoff to the major rivers.

Three distinct landforms can be recognized in the city. These are high lands, low land and abandoned channels and depressions. The high land areas have greater N-S extent and constitute about 40 percent of the land areas. This unit remains unaffected during flooding. The peripheral part of the city is low and constitutes about 35 percent of the city. It is affected by flood during monsoon season. The north western, central eastern and southeastern part of the city is marked by abandoned channels and depressions which constitute 25 percent of the study area.

8.3.3. Air Quality and Noise level:

Air quality measurement was carried out in 4 locations at Hemayetpur Intersection in Savar, in front of Savar New market, Prantic Gate of the Jahangirnagar University and in front of National Martyrs' Memorial, Nabinagar to assess the background air pollution level within project area. The measurement were out to determine the emission of Carbon Monoxide (CO), Oxides of Nitrogen (NOx), Particulate matter ($PM_{2.5}$ and PM_{10}), Ozone (O_3), Sulphur

Dioxide (SO_2), and meteorological parameters like temperature, humidity, and the wind speed and direction were measured during the monitoring period. The samples were collected for 8 hours for CO and for other parameters were 24 hours. The testing results showed that the emission of air pollutants were below the standard values set under the Environmental Conservation Rules, 1997, amendment 2005, schedule 2.

Noise measurements were conducted at same 4 locations for one-hour duration during the day time and duration during the night time. Background sound level was monitored in time weighted average Leq in dBA both at day and night time encompassing each of the sample sites. The testing results showed that the noise level were exceeded the standard values set for the mixed areas and commercial areas under the Environmental Conservation Rules, 1997 and Noise Pollution Control Rule 2006. Highest noise pollution was recorded in front of Saver new market area.

8.3.4. Vibration Level Measurement:

Vibration Level Measurement was analyzed at four project influenced locations. Vibration readings were taken at Hemayetpur Intersection, in front of Savar new market, Jahangirnagar University and in front gate of National Martyrs' Memorial, Nabinagar The variation of vibration measurement were ranged from 0.25mm/s to 0.35 mm/s and highest was at front of Saver new market area .

8.3.5. General Hydrology, Flooding and Surface Water Quality:

The project road cross rivers and canal at seven locations. The major river are Buriganga at Aminbazar (Gabtali) and Bangshi river, a distributor of river Dhaleswari at Savar. The Buriganga river, which is connected with Turag river at 15 m downstream and Dhaleshwari at 12 km upstream. Dhaleshwar and their branches also crosses the project road. The project areas is floodplain area. Two surface water samples were collected from 100m the upstream and downstream of the Karnatali River at bridge location, Saver. The parameters measured were Total Organic Carbon (TOC), phosphate (PO_4), Nitrate (NO_3), Total suspended Solids (TSS), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), oil and grease. The test result analysis indicated that BOD concentrations of both water samples were exceeded the standard values, whereas COD concentration was higher than standard values in downstream water samples. Because most river surrounding in the Saver are well polluted due to direct discharge of liquid waste from the nearby industries. The concentration of DO, TSS, NOx and PO4 values were within permissible limit of Bangladesh Standard.

8.3.6. Removal of Trees and Vegetation:

The tree survey was carried out within the proposed Right of Way (RoW). Survey was conducted in quadrate method with inventories on plants including terrestrial and aquatic plants. Widening of existing road could adversely affect the residential and commercial viability as well vegetation of Jahangirnagar University jurisdiction, Cantonment area vegetation, BPSC vegetation etc. which are developed alongside the road. This will cut down during the construction stage. Homestead tree in some sections may be affected due to requirement of land acquisition if existing RoW is not enough for the construction of 6-lane. In total 26 species of aquatic and 80 species of terrestrial plants inventoried. Trees were inventoried from Technical Institute side, Gabtoli Dhaka to National Martyrs' Memorial, Nabinagar. Total 21631 trees will be removed before construction. Among them number of trees on the Left side was 3685, on middle 14938 and on right side was 3065 comprised large 894 large, 3197medium, 5646 small and 1894 sapling. Most of the trees are planted within RoW of the RHD, particularly, on the median of the existing road. *Terminalia arjuna*

(Arjun), *Lannea coromandelica* (Jiol), *Delonix regia* (Krishsachura), *Tectona Grandis* (Segun) etc. were found as most common roadside plantation.

8.3.7. Fishery:

Fish survey was conducted in the rivers and other water bodies crosses the project road and ponds/ditches alongside the alignment to identify the abundance, types and habitats area of different fish species and fishing gears used around the proposed alignment location. Lack of fish resources are observed in the waterbodies under the existing bridges and culverts locations. While during the monsoon large amounts of fish are caught from these habitats. Inventory of fish species, their availability like common, fairly common, least common and rare according to Red data book of IUCN (International Union for Conservation of Nature and Natural Resources)-Bangladesh were categorized along with the threatened status like critical endangered, endangered, vulnerable, least concern etc. From the survey, a total of 18 species of fish were identified.

8.3.8. Avifauna/Birds:

Avifauna like Gugu/Dove (*Streptopelia chinensis*), Paira/Pigeon, Doyal (Magpie Robbin), House sparrow/Choroi, Parrot/Tiya, Crow (*Corvus splendens*), Myna/Shalik, Babui/Baya Weaver (*Ploceus philippinus*), Dhooli Bawk, Sarosh/Eastern Great Egret (*Ardea modesta*), Kaali Bawk, Machranga/Kingfisher (*Halcyn smyrensis*), Eagle, Koyal/Kokil (*Eudynamys scolopaceus*), Baali, Dhanesh/ Indian grey hornbill(*Ocyceros birostris*), Baijja hash, blue throated barbet (*Megalaima asiatica*), Duck (*Anatidae anatinae*), Dhar Bawk/Egret, Heron (*Ardeola grayii*) are found in the study area. Some of them are Goshawk (*Accipiter gentillis*), Sparrow, hawk (*Accipiter nisus*) and Pied Harrier (*Circus melanoleucus*). Out of 41 species of bird's Fallow land *(Francolinus francolinus)* is endangered species, 25 species are Lower risk and two species are not threatened species.

8.3.9. Wildlife:

Cows, goats, dogs, cats, mule, horse, and monkey are found in the study area during the visit. As per discussion with local people it was learned that fox is found in bushy area but none were spotted during visit. In the forested or bushy area forest wild animals like Fox, Wild Cats, Kat Biral, Rabbits etc. were found. Apart from the mammals, reptiles like chameleon, garden lizard & Ghar Saap were also observed during the visit. Out of 13 species of mammals KhekShial (Bengal Fox) *Vulpesbengalensis* is vulnerable according to Red data book on Mammalis vulnerable. 11 species are least common and 1 species are not threatened,

8.3.10. Socio-economic Condition:

The Greater Dhaka Area has a population of over 18.237 million as of 2017(Feb), while the city itself has a population estimated at about 8.5 million. It is one of the most densely populated areas in the world, with a density of 23,234 people per square kilometer within a total area of 300 square kilometers. The city has shown population growth of about 4.2% annually. As of the 2011 Bangladesh census, Savar Upazila had a population of 1,387,426. Males constituted 54.20% of the population, and females 45.80%.

8.3.11. Land Use:

Land use within 100m of either side of the road comprises of commercial, structure, religious structures, resident, cropland, social forestry, water bodies including canal, pond, ditch, and open lands etc. Three types of Settlement are found within the surveyed area that is Residential, Commercial and Industrial.

8.3.12. Archaeological and Cultural Heritage:

There are 38 Common Property Resources are located alongside the project road and about 27 are sensitive receptors, like 13 mosques, one temple, Savar Baptist Church, nine educational institutions including Jahangirnagar University, three hospitals.

8.4. Environmental Anticipated Impacts and Mitigation Measures:

The implementation of the project will have the potential impact on the environment, society and economy in both positive and negative ways. The physical, biological, socio-economic aspects have been categorized into pre-construction, construction and operational periods. The proposed Project will have noticeable impacts during the construction period, but can be easily prevented or mitigated.

Categorization of the project and formulation of mitigation measures have been guided by ADB's Rapid Environmental Assessment (ERA) Checklist and following DoE Environmental Guidelines. Possible Environmental impacts during the construction phase are noise, air pollution, surface and ground water pollution, soil contamination, material transportation and handling, movement of heavy vehicles for construction material transportation, solid and liquid waste generation, river dredging, soil contamination due to spill and leakage of oils, lubricant and chemical, operation of labor camps and yards, riverbank erosion, and trees removal, impact on avifauna, land acquisition and resettlement issues as well occupational health and safety during construction activities.

Mitigation measures were defined that mainly focus on inspection of contractor work areas, their waste disposal sites, rehabilitation/re-vegetation, proper landscaping, re-establishment of local access, debris clearance from reconstructed culverts, etc. The Concessioner will implement an air and noise quality monitoring programme during three operating years to establish the noise and air quality degradation (if any) at sensitive sites, identified during the EIA and to implement proper noise and air quality attenuation measures.

8.5. Public Consultation:

The Public Consultation meeting and several Focus Group Discussion were conducted before the start of the primary data generation and onward. Inhabitants in the project surrounding areas and other stakeholders including local government representatives are to be consulted meaningfully at the initial stage of the project to obtain their knowledge and experience about the baseline information, potential impacts, and feasible mitigation measures. Consultation and participation increase the level of support of the stakeholders to the project activities that can speed up processing and reducing challenges during implementation. Views of community level stakeholders are needed to be considered in decision-making about project design, impact assessment, mitigation measures, and implementation.

8.6. Environmental Management Plan and institutional Arrangement:

The impacts, mitigation measures and monitoring requirements are included in an EMP (Environment Management Plan) of IEE and will be included elaborately in the EIA into three phases of the project implantation stages; pre-construction, construction and operations. Most of the pre-construction and operating period measures will be implemented by the Client, RHD (the Grantor's representative) while the construction period measures will be the Concessionaire's responsibility, enforced by the CSC and overseen by Independent Engineers (IE). The EMP will be incorporated into the Concession Agreement between the

Grantor's representative and Concessioner as a set of environment issues allowing for easy calculation of financial penalties.

The Concessioner will be required to conduct a regular air, water and noise quality monitoring programme, as specified in the EMP, and submit reports, on a monthly, quarterly, and on annual basis. The Concessioner's environmental safeguard personnel will have to attend a mandatory training workshop on EMP implementation, prior to the start of work.

Mitigation and monitoring measures are incorporated in EMP that mainly focus on inspection of contractor work areas, their waste disposal sites, rehabilitation/revegetation, proper landscaping, re-establishment of local access, debris clearance from reconstructed culverts, etc. The Grantor will implement an air and noise quality monitoring programme during three operating years to establish the noise and air quality degradation (if any) at sensitive sites, identified during the EIA and to implement proper noise and air quality attenuation measures.

8.7. Institutional Arrangement:

The GoB through PPPA and RHD will sign Concession Agreement with the Concessionaire to grant the right to the Concessionaire to complete the project through PPP on BOT basis for construction, operation, maintenance and management of the project as environmental sound and sustainable manner. Implementation of the EMP is a responsibility to both the Grantor's Representative (RHD) and the Concessionaire (construction contractor). The Client, RHD (the Grantor's representative) and the Concessionaire will appoint an Independent Engineer (IE) to act day to day implement Gabtoli- Nabinagar-Bipile Expressway PPP project. Concessioner shall be responsible for implementation of the required EMP through their prepared Site Specific Environmental Management Plan (SSEMP) based on the EMP of the EIA and get approval from the IE's Environmental Specialist. Preparation of this work plan will force the Concessioner to become fully familiar with the EMP. The RHD may retain an NGO to carry out plantation activities under a social forestry scheme as done by the Forest Department, or through making agreements with local communities to undertake the planting and maintenance of new plantings.

Monitoring and evaluation by a third party on the impacts of the Project in the middle of the Project implementation and during the defect liability period would help the compliance of environmental safeguard during construction activities of the Concessioner as per national environmental rules and regulations as well the international Safeguard Policies.

8.7.1. Institutional Capacity:

RHD may move forward with the establishment of an Environmental Unit (EU) at the Project level. An environmental specialist(s) will be housed within the Project Implementation Unit (PIU) who will be responsible for monitoring the environmental compliance of the environmental and social measures during construction activities. This expertise will be essential and will make the job of implementing environmental safeguards much more credible, since expertise will reside in RHD, overseeing the entire EIA procedure, instead of it being only with outside consultants.

8.8. Grievance Redress Mechanism:

A Grievance Redress Mechanism (GRM) has been designed and will be implemented to receive, evaluate and facilitate the resolution of affected people's concerns, complaints, and grievances. The GRM aims to provide a time-bound and transparent mechanism for expressing and resolving social and environmental concerns linked to the Project. Two tiers

Grievance Redress Committees (GRCs) as Local / Field Level (PIU) will be formed in Upazila/Thana like Darus Salam, Savar Upazila etc., and Project Level (PMU) in Dhaka District for this project.

8.9. IEE Findings:

The IEE Study reveals that the project will trigger significant both positive and negative impacts due to implementation. Based on the screening of anticipated impacts, the sectors such as infrastructure, transportation and communication, health and education facilities, and tourism have major positive impacts. The industry and agriculture will also have positive impact from this proposed construction activity.

The project will have adverse negative impacts due to stockpiling of construction materials and haphazard parking of construction equipment and vehicles. This may cause air, noise and water pollution during the implementation of project. To maximize the positive impact, environmental parameters have been screened through matrices and regulatory framework based on the baseline information of the project area and mitigation measures will be adapted to reduce the negative impacts. The major adverse impacts are:

- The generation of solid waste and the wetland habitats will have negative impacts by the construction activities, especially in case of bridge. These issues might be problematic, concerned with environmental issues for the studied area if necessary mitigation measures would not be taken consideration.

- The Project will generate a number of environmental impacts, such as those associated with the embankment construction, cross drainage structures, flyover and tunnel constructions, and poor housekeeping by the Concessioner. The identified adverse impacts are localized in spatial extent and short in duration and are manageable by implementing mitigation measures during construction works

- Most people are in favor of the project because it wills create employment opportunity and generate economic development, nevertheless, local people have suggested some mitigation measures that should be assessed and considered in next phases.

- Implementation of appropriate mitigation measures during the pre-construction, construction, and operation phases will minimize the negative impacts of the project to acceptable levels. Environmental monitoring of the project will be undertaken regularly and ensure that the measures are being implemented properly.

8.10. Recommendations and Conclusion:

The following conclusions could be drawn, and recommendation may be made from this IEE Study:

- This IEE study finds that the Project development will cause a range of potential adverse impacts on the local environment. However, most of them are minor to moderate severity, short term duration, the physical extent within the confined area of protect. Residual impact found to be none, except land acquisition impact and resettlement issues and if the permanent alteration of surface water movement during construction of bridges. Again, all of the negative impacts can be reduced, avoided and/ or offset by undertaking mitigation measures defined in the EMP of the IEE/EIA Report.

- Since the cumulative impacts resulting from the implementation of 6- Lane Project in the proximity within the same Project area will be enormous, particularly affecting major economic activities of the area, drainage, and livelihood of local people, all Projects need to hold dialogue and design mitigation measure considering the cumulative effects.
- The compliance with mitigation measures in the EMP and provisions for regular monitoring providing feedback on environmental conditions will ensure that the biophysical, ecological and socio-cultural environments are not unduly affected (impacts remain within acceptable GoB) by the construction and can be concluded that undertaking of Project development is environmentally sound and socially feasible.
- The EMP and its mitigation and monitoring programs will be included in the bidding/tender documents as environmental specifications and Bill of Quantities (BOQ) items and implementation of which will be binding to the Concessioner through developing and implementing Concessioner's ' Construction Environmental Management Work Plan (CEMWP) or Site Specific Environmental Management Plan (SSEMP) based on the Project's EMP.
- The Concessionaire will be required to conduct quarterly air, water and noise quality monitoring and submit reports to the IE and the Client Grantor, as well to the PPPA
- Monitoring and evaluation by a third party on the impacts of the component in the hallway of the Project implementation and during the defects liability period is required to ensure the proper application of EMP of the Project as well this would help to design corrective measures in safeguarding the environment and Socio-cultural environments.
- RHD and PPPA will post the final Project EIA document on its website, so that the affected people, other stakeholders, and the general public can provide meaningful inputs into the Project design and implementation.
- This IEE reveals the requirement of EIA study for this project is obligatory to comply the Environmental Conservation Rules, 1997. The EIA will address all relevant likely impacts identified in IEE, and proposes a full set of time-bounded mitigative and monitoring actions, including the assignment of responsibilities for the implementation of the Project. The DoE under MoEFCC will grant an Environmental Clearance Certificate for the Project commencement after their approval of EIA report.

9. Social Impact Assessment

The subject project Gabtoli-Savar-Nabinagar-Bipile expressway serves the southern districts of Khulna and Barisal Divisions through Dhaka-Paturia- Daulatdia ferry- Jessore-Khulna/ Benapole using N5 and N7 and Faridpur-Barisal-Paira port through N5 and N8. It serves the northern district via N5, R505, N4 and N6 to Rajshahi and Sona Masjid land port using N4 and N6 and N4 and N5 to Rangpur, Dinajpur and Banglabandha/Burimmari land port. The road passes through brown field development area (low laying flood plain) in the first section then through Savar urban areas where highway traffic meets local slow moving traffic creating congestion. The highway section is an ordinary poor 4-lane road without service lanes and hard and soft shoulders. Moreover the road section is also used as parking lots at places in Aminbazar, Hemayetpur, Bank Town, Police Town and Savar Bazar, Nabinagar and Bipile areas. Freight carrying trucks has to park them on the highway waiting for permitted access time. Traffic growth in this section surpasses more than 10% annually. Under the circumstances the road cannot support the delivery of traffic services as desired. Travel speed gets to 12-15 km /an hour.

The objectives of the project are therefore, to remove or minimize traffic congestion and ensure timely arrivals for travelling passengers and freight ; provide expressway services offering the best quality of service free of obstruction and traffic friction or road accident; cater to long haul traffic travelling to northern and southern destinations via connecting improved road networks; improve economic lifeline efficiency carrying export and import goods to and from sea and land ports particularly industrial raw materials such as yarn, fabrics, dye and chemicals, equipment and machinery across the borders; to avoid congested places in the bazaar areas, violence prone areas of gathering, such as labour congress, university students blockade, football stadium, political party offices, etc; expected regular and timely maintenance of roads and structures to upkeep them to best workable condition;reducing vehicle operating cost due to less burning of fuel and oil; collect tolls from vehicle users to meet the operation and maintenance cost; provide small maintenance for vehicle servicing passenger rest and restaurant area;provide safe parking of cars and other vehicles and provide rescue and recovery services in case of emergency and road accidents.

9.1. Social impact assessment for the project

Social Assessment (SA) is a process that enables project planners to understand the influences a project may have on the affected population. Specifically, SA helps to explain social diversity, reflect relevant gender and ethnic factors recognize vulnerable groups and identify the structural reasons for their vulnerability. It is both an analytical and participatory process that gathers and analyses information about the project impacted population in influence zone. It enables project planners, in consultation with the population in the project influence zone, to identify and prioritize critical social and economic issues and to address them in the design and implementation of the project. SA is carried out within a project context to accomplish the following:

- Identify all major stakeholders.
- Ensure that project objectives and incentives for change are appropriate for the range of intended beneficiaries including gender and other social differences
- Identify adverse impacts and determine how they can be overcome or substantially mitigated.
- Suggest mechanisms to enable participation, resolve conflict, permit service delivery and carry out mitigation measures as required.
- Increase social inclusion.

- Establish an appropriate framework for the participation of key stakeholders in all the stages of the project cycle including monitoring and evaluation.
- Analyze the key social contributions of investment projects based on empirical information.
- Assess the social impact of investment projects, including evaluation of the adequacy of mechanisms for involving the poor and vulnerable groups.

9.2. Objective and Methodology

The Social Assessment of the Gabtali-Hemayetpur- Savar-Nabinagar-Bipile 6-lane Expressway (GNP) is carried out in two phases: exploratory phase where socioeconomic condition of the project area has been done by collecting and reviewing and previous documents, RHD data and reports of other government agencies as well as secondary sources of information. The second phase is the primary data collection of affected persons who will be compensated for land and other property lost for the project. The second part is very important for planning the resettlement action plan. The primary survey expects to cover the influence zone of the project expressway as per the Terms of Reference (TOR) which mentions: "Conduct 20 percent poverty and social assessment taking into account socioeconomic and poverty status of the project PAP in area of influence, including the nature, extent and determinants of poverty in the project area. Identify and estimate the likely socioeconomic and poverty reduction impacts of the project.".

9.3. Areas of Influence of Project Road

The project road N5 starts from Gabtoli Bus Terminal on the central west of the Dhaka city under Darus-Salam Thana in Dhaka North City Corporation (DNCC) under Dhaka district and passes over through Aminbazar Bridge over the Buriganga river and enters Savar Upazila (Thana) area and then Savar Municipality. Almost entire stretch of 24.5 km road falls under the Savar Upazila and mostly within the Savar Municipality Area. Therefore, the immediate influence area of the project road after DNCC are urban agglomeration of Hemayetpur, Savar Municipality, Administrative, Commercial and Residential areas, Jahangirnagar University, PACT Complex and Savar Cantonment area, National Monument, Dhamrai urban area, Ganosastha Medical college and University, Dhaka Export processing Zones I and II areas. This also includes the newly established Leather Processing Tannery and Industrial City and Singair urban areas. The greater influence areas of the Expressway are the 28 districts in the northern Bangladesh across the Bangabandhu Jamuna Bridge and 12 districts of the west and southwestern districts of the country across the Paturia-Daulatdia ferry. But our study is concentrated within the immediate zone of influence that is Dhaka District its Metropolitan area and particularly urban Keraniganj, Savar and Dhamrai upazilas where the road stretch is passing through. The table below describes the land area of the influence zone:

Table 73: Area of Dhaka District and its metro and upazilas

Name of Metro/upazila	Total Land area (sq.km)	Actual Land Area (sq.km)	Forest Area (sq.km)	River Area (sq.km)
Dhaka Metro	302.92	279.43	0	23.49
Dhamrai Upazila	307.41	301.43	0	5.98
Savar Upazila	280.11	274.78	0.28	5.05

Name of Metro/upazila	Total Land area (sq.km)	Actual Land Area (sq.km)	Forest Area (sq.km)	River Area (sq.km)
Dohar Upazila	161.49	151.83	0	9.66
Nawbganj Upazila	244.8	234.85	0	9.95
Keraniganj Upazila	166.87	157.08	0	9.79
Total:	**1463.60**	**1399.40**	**0.28**	**63.92**

Source: *BBS 2011*

The land area of the influence area is 1463.6 sq. km in total but actual land area is less 1399.4 sq. km. and the remaining area covered the water bodies and riverine area. This indicates that the area is covered low laying flood prone plane and 4 major rivers around the city and their distributors.

The numbers of administrative units, local government bodies, and urban and rural units is presented in the table below. Within the influence area there are 2 Metropolitan Corporations, 3 municipalities, 80 union parishad, 119 wards, 585 mauzas and 1999 villages according to BBS, 2011. The situation now may have changed with the recent revision of DAP after 2011. Now all the upazila has Municipality of its own.

Table 74: Number of administrative units in Dhaka District

Name of Metro/upazila	City Corp./ Municipality	Ward (PSA)	Mahalla	Union Parishad	Mauza	Village
Dhaka Metro	**2**	**92**	**855**	**17**	**86**	**123**
Dhamrai	1	9	44	16	306	396
Savar	1	9	57	13	220	380
Dohar	0	0	26	8	91	133
Nawabganj	0	0	0	14	140	342
Keraniganj	1	9	34	12	122	423
Total:	**05**	**119**	**1016**	**80**	**585**	**1999**

Source: *BBS 2011*

Among the 5 upazilas of the district at least 3 such as Savar, Dhamrai and Keraniganj has almost transformed into urban agglomeration and rural areas have reduced. This has deep impacts on the socioeconomic situation of the influence area.

9.4. Population, Household, Household Size and Density

According to the latest Census of 2011 the total area and population of Dhaka district and Savar Upazila are 1463.6 sq. and 280.11 sq.km and 12043,977 and 1385,910 (2011) respectively. The population density of this project influence area is 4948 per sq.km, while for Dhaka Metro it is 30,551 per sq. km (2011). But within last 9 years these figures must have undergone huge changes due to rapid urbanization of Dhaka suburbs and rapid industrialization of surrounding agglomerations. The population of Dhaka Metro and 5 upazila is presented in the table below.

Table 75 : Number of household, population, HH size and density, Dhaka, 2011

Administrative Unit	Household	Population			Sex Ratio	HH Size	Density (per sq. km)
		Male	Female	Both Sex			
Dhaka Metro	2034,146	4931,802	3974,237	8906,039	125	8.42	30,551
Dhamrai	94,776	207,078	205,340	412,418	101	4.29	1,342
Savar	359,084	738,764	647,146	1385,910	114	3.77	4948
Dohar	49,400	107,041	119,398	226,439	90	4.56	1402
Nawabganj	70,757	149,298	169,513	318,811	88	4.47	1302
Keraniganj	177,970	421,809	372,551	794,360	113	4.42	4760
Total:	**2786,133**	**6176,163**	**5487,185**	**12043,977**	**105.2**	**4.98**	**7,384**

Source: *BBS 2011*

The Sex Ratio: The sex ratio shown in the table indicated that a well balance is maintained in sex distribution of people. In urban areas more male and in rural area more women are found particularly Dohar and Nawabganj upazila a little away from urban city environment.

Household Size: The average Household size is 4.98 persons per house which is greater than national average of 4.5 persons. Urban Metro shows unexpectedly high members per household 8.42. But in upazila level the household size is 4.3 persons less than country average. Family Planning Programme has made the contribution to keep family size controlled.

Density of population: the table shows that the population density of Dhaka Metro was 30,551 per sq. km. in 2011. Two urban upazila Savar and Keraniganj had density of 4949 persons and 4760 persons per sq. km respectively. In other rural upazilas the density is below the national average.

9.4.1. UN Population Projection of Dhaka Metro

People are worried about the uncertain and unsustainable future of Dhaka Metro in terms of population explosions. The Dhaka Metro is the one of the most densely cities of the world. The density was increasing since the liberation in 2071. According to Population Census, 2011 the density was 30,551 persons per sq. km., which has increased to more than 65,000 per sq. km. in 2019 according to a recent estimate. Following recent statistics are available for Dhaka including Metro areas:

Table 76: UN Population projection of Dhaka Metro

Year	Population	Growth rate (%)	Density per sq. km.
2012	15,264,000	3.62	38,160
2013	15,982, 000	3.62	39,955

Year	Population	Growth rate (%)	Density per sq. km.
2014	16,389,000	3.62	40,972
2015	16,982,000	3.62	42,455
2016	17,597,000	3.62	43,992
2017	18,894,000	3.62	47,235
2018	19,578,000	3.61	48,945
2019	20,284,000	3,61	50,710
2020	21,006,000	3.56	52,515
.	.	.	.
.	.	.	.
2030	30,627,000	2.70	76,567

Source: *United Nations World Population Perspectives, 2010*

The Table shows the population projection and corresponding population density per sq.km. in Dhaka Metro Area in different years after 2011 Census. This indicates that population will reach to 30 million mark in 2030 when densification will reach to unsustainable point.

Migration from urban centers as well as rural areas of the country to urban Dhaka to seek opportunities in business, administration, employment in industrial and service sectors is an active contributor to the population growth of the city. The rural migration accounted for 60% population growth throughout the 1960s and 1970s. During the period rate of growth continued at 10% per annum. This growth had been slowed down steadily to 5% during 2000s, and 4% in 2010s and now 3.6% in 2020. The fast-growing population has already put tremendous stress on the city, as evidenced by its high rates of poverty, include increasing congestion, a higher rate of unemployment and inadequate infrastructure.

9.5. Population, Literacy, Religion and Occupation

During the independence from British the education system was introduced for big urban cities emphasizing English. The vast rural India and Bangladesh was outside the public education system and people remained illiterate. The newly constituted countries gradually introduced their public education system but at slow pace. The table below presents the literacy rates even after 35 years of first Azadi in the reference area was around mid 20% of the population. Subsequent decades the literacy rate improved about 10% every 10 years until 2011. In 1980s the rates were in mid 20%, then in 1990s it was mid 30%, in 2000 it was mid 40% and 2010s nearly 60%. Urban Dhaka Metro rates were 61% in 1980s, 64% in 1990s, nearly 70% in 2000s and 75% in 2010s. Still after having high emphasize on education particularly primary education about one quarter of people remained illiterate. This is very unfortunate.

Table 77 : Literacy rates in Dhaka and its suburban upazilas

Administrative Unit	Year-1981	Year-1991	Year-2001	Yar-2011
	(% of population)			

Dhaka Metro	**61.2**	**63.9**	**69.2**	**74.6**
Dhamrai	20.8	29.5	43.9	50.8
Savar	25.2	37.8	58.2	68.0
Dohar	27.6	32.9	49.3	57.5
Nawabganj	26.5	34.5	54.4	57.8
Keraniganj	29.4	37.7	51.8	58.5

Source: *BBS 2011*

9.6. Population, Literacy, Religion & Occupation of Savar Upazila: the closest entity of the project

Population: As of the 2011 Bangladesh Population Census, Savar Upazila had a total population of 1,387,426 persons of both sex. Males constituted 54.20% of the population, and females 45.80%. It is reported that population growth rate in Savar has been 4.2% for last decades since the growth of industrial and business sectors started during 1990s. A population projection of Savar by 4.2 % rate of growth can be seen in the following table:

Table 78: Population projection of Savar Upazila

Base year=2011	2016	2021	2026
13,87,426	16,78,785	20,31,330	24,57,909

Literacy Rate: The literacy rate of the Savar suburban upazila has been increasing over the years, rising from 25.2% in 1981 to 68% in 2011. It is expected that by 2020 it has reached 80%. Savar has now grown to be an excellent environment for higher education and training at Jahangir Nagar University, Ganosastha University, Private Sector Universities, college of higher education and PATC.

Religion: The religious breakdown of population shows that Muslims accounted for 90.59%, Hindu for 08.41%, Christian 0.93%, Buddhist 0.03% and others 0.04%.

Occupation Pattern: The main occupations of people in Savar are Agriculture accounted for 24.34%, agricultural laborer 12.84%, wage labourer 4.44%, cattle breeding, forestry and fishing 1.90%, industry 1.37%, commerce 17.35%, service 20.06%, construction 1.66%, transport 3.96% and others 11.46%. The industrial labour working for export processing are excluded being inhabitants of other areas of Bangladesh.

9.7. Economy of Savar

Agriculture and manufacturing are the two major economic sector activities in Savar. The main crops grown are Paddy, Jute, peanut, onion, garlic, chili and other vegetables. Due to tremendous pressure on land for non-agriculture purposes agriculture crop production has already shrunk to nearly extinction. People undertake agro-based small enterprises such as 181 combined fisheries, 5 hatcheries, 209 poultries, and 1319 small fisheries. Manufacturing facilities include Ceramic industry, beverage industry, press and publication, garments manufacturing industry, foot ware, electronics, jute mills, textile mills, printing and dying factories, electric goods and transformer industry, automobile assembling industry, biscuit and bread factory, pharmaceutical industry, soap and detergent factory, brick fields, cold storage, welding, plant nursery, etc.

The Cottage industry includes 8 weaving factories, 100 goldsmiths and 29 others vehicle maintenance workshops. The main horticulture products sold to Dhaka are Jackfruit, mango, papaya, flower, sapling, dairy products, meat, transformer, fabrics, dye, medicine, readymade garments, electronics and electric goods, shoe, bricks, sweetmeat etc.

According to the Upazila at a Glance (Booklet) the labour force engaged in the activities are principally three sectors such as agriculture (24.34%), commerce and industries (55.6%), and service sector jobs (20.06%).

9.8. Poverty Profile of Project Area

9.8.1. National Perspective

Poverty reduction has been the prime goal and objective of our planning and economic development activities since the liberation in 1971. This has been successful to a great extent reducing national poverty rate from 67.0 percent in 1975 to 24.3 percent in 2016 and 21.8 percent (estimated) in 2018 using upper poverty line. The poverty reduction for extreme poor has happened, reduced from 34.3 percent in 2000 to 11.3 percent in 2018.

The table depicts the chronological improvement of poverty situation in the country since 2000 studied by BBS through its regular Household Income - Expenditure Surveys (HIES) every five-year interval. This has been a very extensive survey carried out throughout the country collecting and analysing household income and expenditure data from all strata identified.

Table 79: Poverty reduction trend in Bangladesh between 2000 and 2018

Item	HIES Y-2000	HIES Y-2005	HIES Y-2010	HIES Y-2016	HIES Y-2018
Upper poverty rate	48.9	40.0	31.5	24.3	21.8
Lower (extreme) poverty rate	34.3	25.1	17.6	12.9	11.3

Source: *BBS HIES for 2000, 2005, 2010 and 2016, and Estimates for 2018*

The table presented that how the poverty incidences have reduced between the reference years using upper and lower poverty rates. Upper poverty rate is the income level which cannot buy the required kilo calorie of food and drinks fixed for members of the household. The lower poverty level is the income which cannot buy minimum kilo calorie of food and drinks to keep the body and soul together. This group of people is called “hard core” or “extreme” poor needs assistance for income supplement to the next level

9.8.2. Regional Perspectives

The head count rates (HCR) of incidence of poverty using lower poverty line is 17.6 percent at national level, 21.1 percent in rural areas and 7.7 percent in urban area of Bangladesh in 2010. In 2005 the corresponding figures were 25.1 percent, 28.6 percent and 14.6 percent. In Dhaka division the head count rates (HCR) of incidences of poverty by using lower poverty line in 2010 have recorded 15.6 percent at national level, 23.5 percent at rural level and 3.8 percent at urban level. In 2005 corresponding figures were 19.9 percent, 26.1 percent and 9.6 percent respectively. It has been observed that like national level the HCR in Dhaka division have reduced from 2005.

According to the Upper Poverty Line the head count rates (HCR) of incidence of poverty in 2010 was 31.5 percent at national level, 35.2 percent in rural level and 21.3 percent in urban level. The corresponding figures were 40.0 percent, 43.8 percent and 28.4 percent in 2005. It is seen that the moderate poverty situation has improved in 2010 than 2005. The corresponding figures for Dhaka division were 30.5 percent at national level, whereas 38.8 percent at rural and 18 percent at urban level in 2010. This was an improvement over the national level as well over 2005.

Table 80: Incidence of poverty (head count rate) by type and region

Poverty line/Division	HIES-2010 (%)			HIES-2016(%)		
	National	Rural	Urban	National	Rural	Urban
Upper Poverty line:						
National	31.5	35.2	21.3	24.3	26.4	18.9
Barisal	39.4	39.2	39.4	26.5	25.7	30.4
Chittagong	26.2	31.0	11.8	18.4	19.4	15.9
Dhaka	30.5	38.8	18.0	16.0	19.2	12.5
Khulna	32.1	31.0	35.8	27..5	27.3	28..3
Rajshahi	35.7	36.6	30.7	28.9	30.6	22.5
Rangpur	46.2	47.2	37.0	47.2	48.2	41.5
Mymansingh	-	-	-	-	-	-
Sylhet	28.1	30.5	15.0	16.2	15.6	19.5
Lower Poverty line:						
National	17.6	21.1	7.7	12.9	14.9	7.6
Barisal	26.7	27.3	24.2	14.5	14.9	12.2
Chittagong	13.1	16.2	4.0	8.7	9.6	6.5
Dhaka	15.6	23.5	3.8	7.2	10.7	3.3
Khulna	15.4	15.2	16.4	12.4	13.1	10.0
Rajshahi	21.6	22,7	15.6	16.8	17.7	13.2
Rangpur	30.1	30.8	24.2	30.5	31.3	26.3
Mymansingh	-	-	-	-	-	-
Sylhet	20.7	23.5	15.5	11.5	11.8	9.5

Source: BBS HIES for 2000, 2005, 2010 and 2016

Now we have results of HIES for 2016 and estimates for 2018, therefore we can compare poverty situation for 2010 and 2016. The table presented the poverty by type and region. In case of divisional dispersions of poverty reduction the table is self explanatory.

The head count rates (HCR) of incidence of poverty using lower poverty line was 17.6 percent at national level, 21.1 percent in rural areas and 7.7 percent in urban area of Bangladesh in 2010. In 2016 the corresponding figures are 12.9 percent, 14.9 percent and 7.6 percent. A substantial decrease marked in the level of lower poverty. In Dhaka division the head count rates (HCR) of incidences of poverty by using lower poverty line in 2010 was recorded 15.6 percent at national level, 23.5 percent at rural level and 3.8 percent at urban level. In 2016 corresponding figures were 7.2 percent, 10.7 percent and 3.3 percent respectively.

According to the Upper Poverty Line the head count rates (HCR) of incidence of poverty in 2010 was 31.5 percent at national level, 35.2 percent in rural level and 21.3 percent in urban level. The corresponding figures for 2016 are 24.3 percent, 26.4 percent and 18.9 percent respectively. It is seen that the moderate poverty situation has improved in 2016 than 2010. The corresponding figures for Dhaka division were 30.5 percent at national level, 38.8 percent at rural and 18 percent at urban level in 2010. The corresponding figures for 2016 are 16.0 percent at national level, 19.2 percent at rural level and 12.5 percent at urban level which is much declined than 2010.

Although incidence of poverty has been significantly reduced in the country but all divisions are not equally benefited from planning and investment. The Dhaka division and the metropolitan area the project influence zone is the fortunate to reduce the incidence of poverty both upper and lower poverty lines harnessing the opportunities available. The upper poverty has reduced from 30.5 percent at national level in 2010 to 16.0 percent in 2016 while the extreme poverty reduced to only 7.2 percent in 2016 from 15.6 percent in 2010.

The declining poverty incidence in Dhaka Division attributed to reduction of poverty in rural areas and transformation of rural centers into urban agglomeration. Savar, Keranigaanj and Dhamrai upazilas in the influence zone has almost completely became urbanized neighborhood.

9.9. Road Network of Project Area

RHD roads have been classified into three categories: National Highway, Regional Highway and Zila Roads. The total length of RHD road is 22,375.25 km, of which 3836.16 km is National, 4703.97 km is Regional and 13,835.12 km is Zila roads (RMMS). Number of concrete bridges on these roads are 3,548, bailey bridges 856 and culverts 14,814 (BMMS). All three types of road network are available in the project influence upazila of Savar and Dhamrai. Besides, RHD roads the upazila has rural roads network consist of upazila roads, union parishad roads and village rural roads under LGED. The table below describes the road network in the project district and Savar upazila.

Table 81: Road Network of Project district and influence Area

Road Agency	Road Type	Dhaka District (km)	Influence area (in km)
Roads and Highways Department (RHD):	National Highway	421.01	41.84
	Regional Highway	649.14	31.46
	Zila Roads	748.34	85.60
Local Government. Engineering Departt. (LGED):	Upazila road	489.65	42.82
	Union road	520.10	120.33
City Corporation and Municipality road:	Village roads-A	1200	347.00
	Village roads-B	2600	651.88
	Municipal roads	-	56.88
	City Streets	-	-

Source: *RHD, LGED, 2018*

The RHD within the Ministry of Communications is responsible for the management of approximately total 22,096.3 km of highway network comprising of three categories of road as mentioned earlier. In the project district RHD has 1818 km of network consists of 421 national highway, 649 km regional highway and 748 km zila roads. Specifically within the immediate influence zone RHD has 158 km of road network consisted of 41 km of national, 31 km of regional and 85 km of zila roads.

In parallel LGED has a very extensive rural road network consisting of upazila road, union road, village road-A and village road-B. Total network of LGED is more than 3 lakh km. In the project area LGED has 510 km of paved road network consisted of 42.82 km upazila road, 120.33 km union road and 344 km of village road.

Besides RHD and LGED there roads managed and maintained by City Corporations, RAJUK, Municipalities and Local Government Bodies. The Savar Upazila and Municipality has about road network of 1,147 km, of which 273 km is pucca, 114 km is semi pucca and 760 km is mud road. The upazila has 44 km perennial water way.

Existing road network Connecting N5 : At the starting of the Gabtali Bus Terminal the Mazar Road branched out from N5 on the north and meet the Embankment road N501 called Gabtali-Ashulia road at the Mazar area and proceed to meet Abdullahpur-Bipile N302 at Ashulia Bridge following alongside the Turag river. The road provides a shortcut route from Gazipur, Uttara, Ashulia, Jirabo, Jamgorah industrial area with Mirpur, Gabtali, Mohammadpur, Dhanmondi areas. This also serves an alternative to N5 when traffic congestion in Savar area build up in peak hours. On the south the embankment road continued up to Hazaribagh, Kamrangirchar, Lalbagh, Islampur, Sadarghat in the old city.

After Amin bazaar Salehpur Bridge a feeder/zila road Z5069 branched out from N5 on the left at 2+590 chain age serving the nearby PDB's Amin bazaar power plant a proceeds to south meeting Vakurta and Basila villages and finally meets the main road of Keraniganj upazila, a thickly populated suburban Municipality of Dhaka.

Until Hemayetpur no other major roads connect N5 except Municipal roads. From Hemayetpur intersection a RHD regional highway R504 originated at 6+940 chain age on the left to travel to Singair and Manikganj, a short cut road to Aricha and Paturia ferry crossings. From Hemayetpur till the PATC several Municipality roads have criss-crossed the project road at different places. From in front of PATC a branch of National highway N511 originated at 15+250 chain age to destined to Zirabo Bazar where the road meets Ashulia-Bipile road N302. Then at Nabinagar intersection project road meets the Nabinagar-Chandra regional highway R505 and follow the road until Bipile intersection where they meet N302 and proceeds further to Chandra where it meets N4 SASEC highway travellingto Bangabandhu Bridge. After Nabinagar N5 change the direction towards west and runs up to Aricha/ Paturia ferry. All the roads mentioned above belongs to RHD.

9.9.1. Other development projects in the area

The project Gabtoli – Savar – Nabinagar-Bipile section lies west to the city of Dhaka and is located within Dhaka district. The project commences from the western edge of Dhaka, at Gabtoli, and connects Hemayetpur, Savar, Nabinagar before terminating at Bipile intersection with Ashulia road. The project forms a crucial link in Dhaka's regional connectivity network. It is part of the first ring road, which encircles Dhaka city.

Following is a list of road projects under different stages of implementation, with the purpose of improving the regional connectivity of Dhaka:

Second Padma Bridge: Roads from Hemayetpur and Nabinagar merge at Manikganj and proceed towards Paturia. A second bridge over the river Padma shall connect Dhaka directly with Jessore and Benapole reduce travel time to Kolkata.

Joydebpur – Elenga: This project aims to expand the present road to 4 lanes and boost connectivity of Dhaka with Rajshahi and Rangpur divisions.

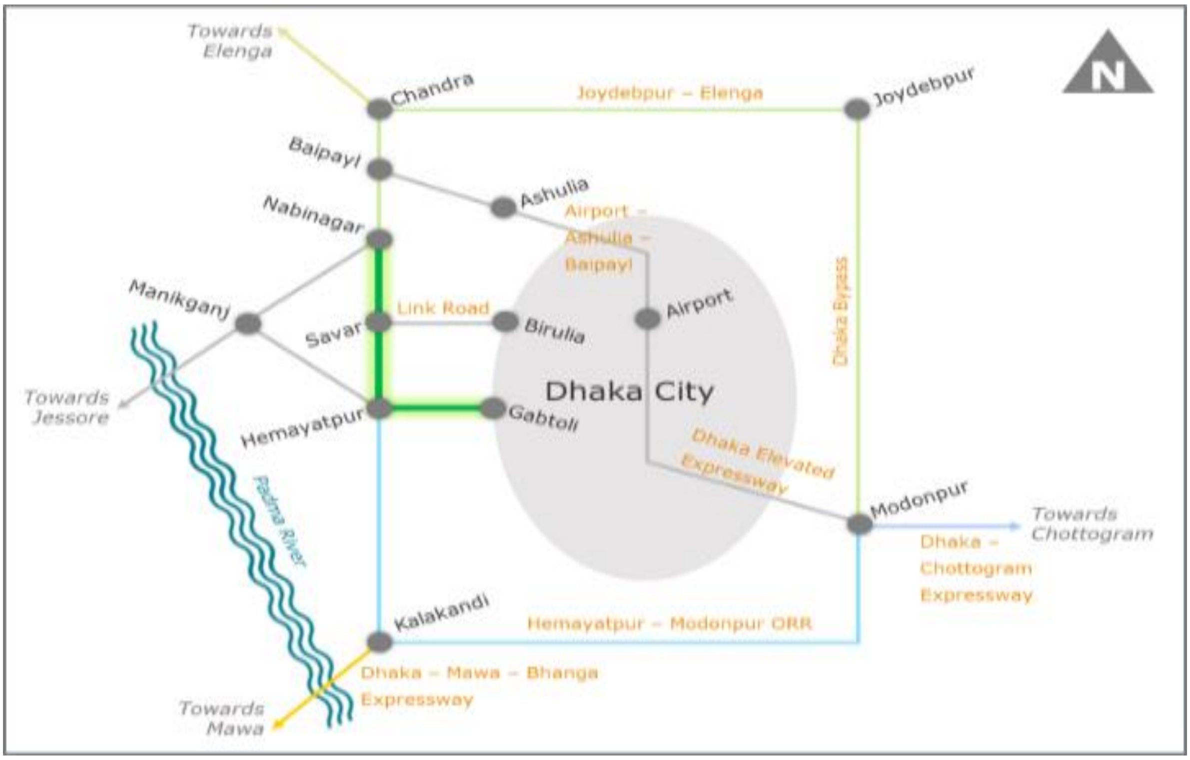
Birulia – Savar Link Road: This road connects the area of Birulia in Dhaka with Savar Bazaar through a new link road.

Airport – Ashulia – DEPZ Elevated Expressway: This project is envisioned as the northern extension of Dhaka Elevated Expressway and will connect the Airport to Dhaka Export Processing Zone (DEPZ) located in Bipile, north-west of Dhaka.

Dhaka Bypass: This project will connect Joydebpur to Modonpur via Debogram and Bhulta, thus acting as a bypass road to the east of Dhaka.

The projects described above have been captured in the schematic diagram below:

Figure 46 : Other development projects



9.9.2. Implications of listed projects on Gabtoli – Savar – Nabinagar- Bipile Expressway

The project section connects western Dhaka to Nabinagar. From Nabinagar the road splits and one road goes towards Elenga via Chandra while the other road goes towards Paturia via Manikganj. The Hemayatpur – Nabinagar section of the project will act as a crucial section of the inner ring road, with Dhaka Bypass, Modonpur – Hemayetpur, Joydebpur – Chandra, and Chandra – Bipile –Nabinagar being the other sections which, when combined, forms the inner ring road for Dhaka.

9.10. Regional Economy of Dhaka

Dhaka is the financial, commercial and cultural capital of Bangladesh. Regional economy of Dhaka is the backbone of country's economy as it contributes about 40 percent of the national GDP in value term. Sixty percent of manufacturing activities in industrial sector are performed in and around greater Dhaka including Narayanganj, Gazipur, and Narsingdi. It is the hub of all industrial processing whether be it in traditional jute and textile manufacturing, handloom weaving or modern export processing factories or software products. The city is home to the country's monetary authority, the Bangladesh Bank, and the largest stock market, the Dhaka Stock Exchange. The main commercial areas of the city include Gulshan, Banani, Kawran Bazar, Dhanmondi Motijheel, Mohakhali, and Dilkusha. Tejgaon, New Market and Hazaribagh are the major commercial and industrial areas. The city is having a growing rich entrepreneur and middle class population creating a market for market for modern consumer and luxury goods.

Narayanganj used to call Dundee of the Bengal specialized in jute baling, jute manufacturing, raw jute and jute product exporting and shipping. The city is pioneer in merchandising yarn and dying, cottage industry like handloom weaving in abundant, the finest of which is Muslin Zamdani fabrics. International trading of import and exports, readymade garments, knitwear factories, shipbuilding yards, vibrant transport sector activities have created employment opportunities which facilitate high per capita income to the household population. Small and medium industries of cotton textile and garments manufacturing expanded beyond the city areas creating opportunities for higher employment in the district/region.

Almost all large local conglomerates have their corporate offices located in Dhaka. Microcredit also began here and the offices of the Grameen Bank, ASHA and BRAC (the largest non-governmental development organization in the world) are based in Dhaka. Urban developments have sparked a widespread construction boom; new high-rise buildings and skyscrapers have changed the city's sky line and landscape. Growth has been especially strong in the finance, banking, manufacturing, telecommunications and services sectors, while tourism, hotels and restaurants continue as important elements of the Dhaka economy.

Adjoining Narsingdi district is part of greater Dhaka also having the higher concentration of textile industries and garment manufacturing. It can be called the capital of handloom weaving which gradually transformed to power loom weaving in medium scale operation. There are hundreds of them in Panchdona, Araihazar, Narsingdi and other places. Several number of jute twin mills, which play an important role in the economy are also located in this district. Babur haat, the biggest and renowned Clothes HAAT (Textile market) of Bangladesh is in this district. It Narsingdi gas field located in Shibpur Upazila has a total recoverable gas reserve of 215 billion cubic feet (6.1×109 m3). Commercial gas production was started in 1996. The largest power plant of Bangladesh is located in here.

9.11. Initial Consultation Meeting

Consultation Meeting:

To make the planning process inclusive, an initial consultation meeting was conducted on 26 Sep. 2019. The meeting venue was the conference room of Enam Medical College at Savar. Total 32 members of local stakeholders participated the meeting presided the Honorable State Minister for Disaster Management and Relief. The meeting was presented by nominated stakeholders across the government agencies, Chairmen of the 12 unions, UNO, Upazila Engineer, Community representatives and road users.

The Honorable State Minister for Disaster Management and Relief put forward his three point observations and suggested to consider them in the detailed design:

i) Provision for adequate number of foot-over bridges

ii) Provision for pedestrian walking and road crossing where bridge is absent

iii) Provision for access and exit to and from expressway to and from service road at Savar bazar.

All the above considerations shall be incorporated during development of the detailed design by the concessionaire.

10. Preliminary Project Cost

As per TOR of the project, the Consultants are required to prepare the Engineer's cost estimate based on preliminary engineering design and drawing in the transaction advisory phase of this study. In the subsequent phases, the PPP Concessionaire will have their cost estimates based on detailed engineering drawings prepared after completing all necessary investigations.

The purpose of producing this preliminary project cost estimate at feasibility study level is twofold;

- to indicate to the Client an approximate amount capital investment need for budgetary purposes, and
- to arrive at a cost to be used as input to the Economic and financial feasibility analyses of the project. The preliminary cost estimates are calculated mainly for the purpose of providing a probable per km economic cost and financial cost for the project.

Generally, at preliminary design stage, an accuracy of estimate of cost is considered to be plus or minus 20 percent of actual cost. This is because the estimates are based on preliminary level survey and investigations as well as preliminary level design drawings. The consultant has aimed for an accuracy of plus or minus 20 percent in this expressway road project.

The cost estimate produced here consists of principally project civil construction costs, including costs for land acquisition and compensation; resettlement; compliance with the environmental management plan during construction; re-location of utilities, and construction supervision and management costs. The unit rates used in the estimate are of mid-2019 prices.

The main elements of the construction cost estimate are; earthworks (mainly in road embankments); pavement and bituminous works; structures principally elevated expressway sections including covering major and minor river bridges; box culverts, roadside drainage and embankment protection works; highway overpasses, underpasses, elevated road sections; grade-separated intersections; road furniture and markings.

The quantification of works has been carried out based upon the preliminary alignment, pavement, drainage and structural designs produced by the Consultant, and cross-sections, typical cross-sections and typical details proposed for the road project.

For road furniture (including safety barriers) and road markings a Lump Sum has been assessed based upon the length of the road, frequency of junctions, etc.

Lump Sums have also been included, in the cost estimate, for re-location of utilities and consultancy fees for Construction Supervision and Management.

10.1. Basis and Components of Cost

The costs of following major elements have been estimated:

- General and Preliminary Items
- Embankment Earthworks
- Pavement Works
- Elevated structures and bridges
- Embankment Protection Works
- Road Safety Works
- Ancillary Works
- Road Marking

- Physical Contingency and Price Contingency (escalation)
- Relocation of Utilities
- Land acquisition and resettlement
- Environmental and Social Mitigation

Unit prices of work items have been calculated on the basis of current prices of locally available materials and labour, imported materials and expert consultants where required, plant and equipment obtained from international, regional or local sources, etc., constituting the work item and also including income taxes, VAT, contractor's profit and overhead at the approved rates. The basis provided due allowance for contractor's profit at 10% and overheads at 5% including provision of local Tax at 5% and VAT at 5.5%

These computed unit prices have been compared with the current unit prices of RHD as well as quoted unit prices of recently completed and ongoing RHD projects, and any necessary adjustments required have been made.

10.2. Construction Cost Estimate

10.2.1. General and Preliminary Items

The cost under this heading has been estimated to cover mainly the cost of establishment of Contractor's site facilities; establishment and maintenance of the Engineer's accommodation, office, site facilities and site laboratory; providing and maintaining office & laboratory staff & consumables; and transport for the Engineer and his staff. Also included is the cost for construction, repair and maintenance of temporary diversions and traffic management of the road for uninterrupted traffic movement during construction. Insurance cost is also included. Like other similar projects, it is assumed that government land can be made available for establishment of the above facilities.

10.2.2. Embankment and Earthworks

Investigations conducted by the Consultant, for the sourcing of construction materials locally, revealed that dredged sand suitable for embankment construction is available in abundant quantity along the project road. The unit price of dredged sand has been used in estimating the cost of earthworks for the road embankment. The required volume of earthworks for the project road has been calculated from preliminary highway design drawings.

10.2.3. Pavement Works

Standard typical profiles, for road pavement construction, have been developed for various sections of the project road as shown in the designs.

The flexible pavement works, for full depth reconstruction, consist of preparation of sub-grade, provision of improved sub-grade, sub-base, road base Type I and II, bituminous base course, and wearing course; and for partial reconstruction, profile correction course (base course material), base course type-I, bituminous base course, and wearing course.

In urban sections, rigid pavement has been proposed and is composed of improved sub-grade, sub-base, base type-I, lean concrete, rigid pavement type JRCP for full-depth reconstruction and profile correction course, lean concrete, rigid pavement type: JRCP for partial reconstruction. Quantities have been calculated on the basis of these profiles and the cost estimate prepared accordingly.

10.2.4. Elevated expressway Section and Other Structures

Standard drawings have been prepared for the common types of bridge for various spans, with deck width varying according to requirements: present 22m width of bridges may not be used as we need 44.6m of structures to carry three traffic lanes plus the one service lane at both sides of the 5m wide Median. The estimation of the construction cost of the structures has been based on bill of quantities calculated from the drawings.

Different types of RC box culverts for both new replacement, and for the extensions of existing culverts up to 46.7m were prepared and costs estimated to derive the unit costs per square meter of deck area. These unit costs have been used for estimation. Similarly, standard drawings for new elevated expressway structures of 6-lane and 4- lane options have been developed, with a deck width of 27.4m and a box girder flyover deck width of 20.0 m for service lanes are excluded from these structures. These drawings have been used to derive unit costs per linear meter length and hence establish overall costs for each structure.

The following elements of structures were considered in the cost analysis:

- Concrete
- Formwork
- Steel reinforcement
- Pre-stressing strands
- Foundations
- Protection works
- Miscellaneous items

The total length of each type of the above-mentioned structures and the total deck area of box culverts proposed for the project road, were provided by the Consultant's structural design team for the project. The estimated construction cost of each structure was calculated by using these unit costs and quantities appropriately.

10.2.5. Embankment Protection Works

The requirement for riverbank protective works depends mainly on the depth and flow pattern of the river, scouring regime and type of structure. A typical design has been adopted for riverbank protective works and a cost per linear meter of protective works along the river bank has been established. The quantities of protective works to be undertaken have been assessed through hydraulic investigation and design by the Consultant's river training specialist. Thus, the cost of this item has been estimated.

The requirement for river protection works is based on the depth and flow pattern of the river, the scouring regime and the type of structure. The cost analysis for protective works considered the following options:

- Geo textiles
- Brick Block
- Concrete Blocks
- Sand Cement Block

10.2.6. Road Safety Works

This component covers the cost for providing safety fences at vulnerable locations such as market places, townships, structures, road centre median, edge of high embankments, etc.; guard posts, lighting, traffic signs and signals, w-beams etc. On the basis of past experience and research on similar projects, a lump sum amount has been allocated to this item.

10.2.7. Ancillary Works

Dividers, footpaths, side drains, KM posts, turfing, and tree planting are grouped together in this item. A cost per linear meter of each item was calculated and aggregated to arrive at the cost per linear meter of road for the ancillary works.

10.2.8. Road Marking

The RHD Unit Price has been adopted. Quantities have been measured and assessed from the alignment and other design drawings.

10.2.9. Physical Contingency and Price Contingency (Escalation)

An amount equivalent to 2% of the estimated construction cost has been assumed for physical contingencies.

Price contingency is an allowance for price inflation based upon current and expected domestic and international inflation rates. A flat rate of 5.5% has been assumed for escalation.

10.2.10. Relocation of Utilities

A separate provisional lump sum amount has been allowed in the project cost estimate for the relocation of utility services such as high-pressure gas transmission pipelines, electricity transmission towers and posts, fiber optical cables and telephone lines.

10.3. Land Acquisition Cost for ROW

The preliminary design has aimed at minimizing the acquisition of land. However, at certain locations, additional land beyond the existing ROW is required for improvement of alignment as per design standard, for constructing new 6-lane expressway, 4-lane service road and shoulders. The land acquisition plan also included for toll plaza, bus bay, rest and parking area, toll offices, etc.

The quantity of land to be acquired was assessed by the Consultant's highway design team from the topographic survey results and alignment design drawings. The Consultant's socio-economic team for the project conducted field surveys and collected, along with other information, land prices along the road at different locations.

10.4. Resettlement and Compensation Costs

Assessment of resettlement cost is a complex task; it is more so when the road pass through urban areas. As it is related to the local people living along the entire length of project road. Successful resettlement leads to successful and peaceful implementation of the project. The components of resettlement cost are: compensation for loss of affected properties, cost of relocation of common properties, compensation for loss of business income and loss of income of their employees, compensation for loss of rental income, special grants to vulnerable households, compensation for loss of trees, cost of acquisitioned lands for resettlement purposes and all other potential losses. The Consultant's socio-economic team for the project conducted field surveys and estimated the resettlement costs for the project road.

10.5. Construction Supervision Cost/ PMC Costs

On the basis of past experience and research on similar projects, 1% of civil works cost has been assumed for this component.

10.6. Operations & Maintenance Cost

<u>Routine Maintenance</u>

Through an assessment of maintenance cost involved in similar PPP projects executed in Bangladesh and global practice, it was found that the routine maintenance cost for 6-lane expressway with 2-lane service roads on each side comes around 1% of the EPC cost.

However, according to the ongoing practice followed by RHD, the service lanes is handed back to the department after 3rd year of operations. Hence, the costs involved in routine maintenance of the remaining 6-lane main-carriageway comes around 0.6% of Total Direct Civil Cost.

Hence in conclusion, the following costs has been assumed –

Routine Maintenance until 3rd year – 1% of the Total Direct Civil cost

Routine Maintenance from 4th year – 0.6% of the Total Direct Civil cost

Periodic Maintenance

Periodic maintenance or the major maintenance of roads is undertaken in every five year and the cost involved in major maintenance is, in general, 5.5 times the routine maintenance cost. Hence, Periodic Maintenance cost has been assumed as 5.5 x 0.6% = 3.3% of the Total Direct Civil cost every 5 years.

10.7. Environmental Monitoring Costs

The Consultant's team for environmental assessment estimated this cost, which has been adopted for preliminary cost estimation.

10.8. Social Benefit Monitoring Costs

The Consultant's team for social safety assessment has estimated this cost, which has been adopted for preliminary cost estimation.

10.9. Other project development Costs

Other project development costs assumed include SPV incorporation, cost of bank guarantee (1.5%), Bid security (1.5% of TPC), Performance security (5% of TPC) and Financing Fee (1.5%)

10.10. Total Direct Civil Costs

The total of direct civil costs amounts to 4398.98 BDT Crores. A summary of which is presented in the table below. The schedule of rates mentioned against each item has been considered after VAT exemptions.

Table 82 : Summary of Total Direct Civil Costs

Item of Works	Unit	Quantity	Unit Rate (SOR) *(excluding VAT and Tax)*	Amount (BDT Crores)
General and Site Facilities				**4.25**
Administrative cost and overheads	L.S.			4.25
Earthworks in Road Embankment				**94.81**
Embankment filling from riverbed materials supplied by the contractor/ borrow pit	Cum.	38,91,292.00	208.25	81.04
Sand filling with compaction from contractor's own source	Cum.	3,89,129.20	348.50	13.56

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Item of Works	Unit	Quantity	Unit Rate (SOR) *(excluding VAT and Tax)*	Amount (BDT Crores)
Embankment fill from cutting materials in all sorts soil	Cum.	9,239.20	225.25	0.21
Pavement Works				**534.69**
Construction of Bituminous Flexible pavement: Full width	km	16.39	270,959,941	444.10
Construction of elevated Bituminous Flexible pavement (6 lane carriageway): DBM+BC	km	15.10	59,990,216	90.59
Structures				**3,620.66**
Rehabilitation and widening of PSC Bridges to 6-lane	meter	510.00	2,283,617.85	116.46
Construction of 4 service lanes adjoining PSC Bridges	meter	510.00	2,283,617.85	116.46
Construction of Overpass (Hemayetpur, Savar & Jahangirnagar University): I Girder	meter	9,920.00	2,328,593.91	2,309.97
Construction of Overpass PSC Box Girder (Dhaka - Chandra)	meter	1,700.00	2,766,240.00	470.26
Construction of Boxtype Tunnel (Paturia to Dhaka)	meter	1,060.00	4,270,876.00	452.71
Widening of Box Culvert	sqm	260.00	68,988.55	1.79
Construction of Road Underpass	meter	1,500.00	680,000.00	102.00
Construction of Retaining Wall at ROW	sqm	300.00	-	-
Construction of Toll Plaza	Nos	2.00	255,000,000	51.00
Road Safety and Security Works				**49.87**
Safety Fence, Armco Guard rail/ Post, Lighting, Median Fencing	meter	48,890.00	10,200.00	49.87
Ancillary Works				**62.33**
Divider, Footpath, Side/slope drain, Km post, Turfing, Plantation	meter	48,890.00	12,750.00	62.33
Road Markings	sqm	24,000.00	893.35	**2.14**
Riverbank Protective works	meter	1,000.00	302,305.05	**30.23**
Total Direct Civil cost (BDT Crores)				**4,398.98**

The inputs estimated above have been included for undertaking financial and VFM analysis for the project proponent in the following chapters.

11. Financial Analysis

This chapter discusses the financial viability assessment to undertake the upgradation of Gabtoli –Savar – Nabinagar - Bipile into 6-Lane Expressway through Public Procurement Partnership (PPP) mode.

Key aspects that affect the financial viability of the project include:

1. Estimated Capital Expenditure for construction
2. Projected Operations and Maintenance expenses
3. Projected revenues from the operation of the project facility

Financial viability assessment has been undertaken under two business scenarios, one from the government's perspective and others being from the investor/ developer perspective. These scenarios have been defined as below:

1. Base Case – Government perspective: The base case has been formulated to assess the financial viability of the project to be undertaken in the BOT – Toll mode and has been assessed from the government perspective.
2. Additional Cases – Investor perspective: To provide optimum returns to the investors and the concessionaire, multiple PPP options such as BOT – Toll plus VGF, Availability Payments/ Annuity payments, HAM and HAM plus toll methods have been evaluated. These PPP Options have been evaluated to assess the financial viability of the project in each of the PPP modes/ method and provide requisite return on investment to the private investors.

11.1. Option 1 : BOT – Toll (Base Case)

The indicators used to assess the financial viability assessment of the project include estimation of the Internal Rate of Return (IRR), the Return on Equity (ROE), Debt Service Coverage Ratio (DSCR) Net Present Value (NPV) of the project. While a positive NPV shows that the project is viable, the IRR helps in assessing if the returns are adequately above the market rates prevailing in the region.

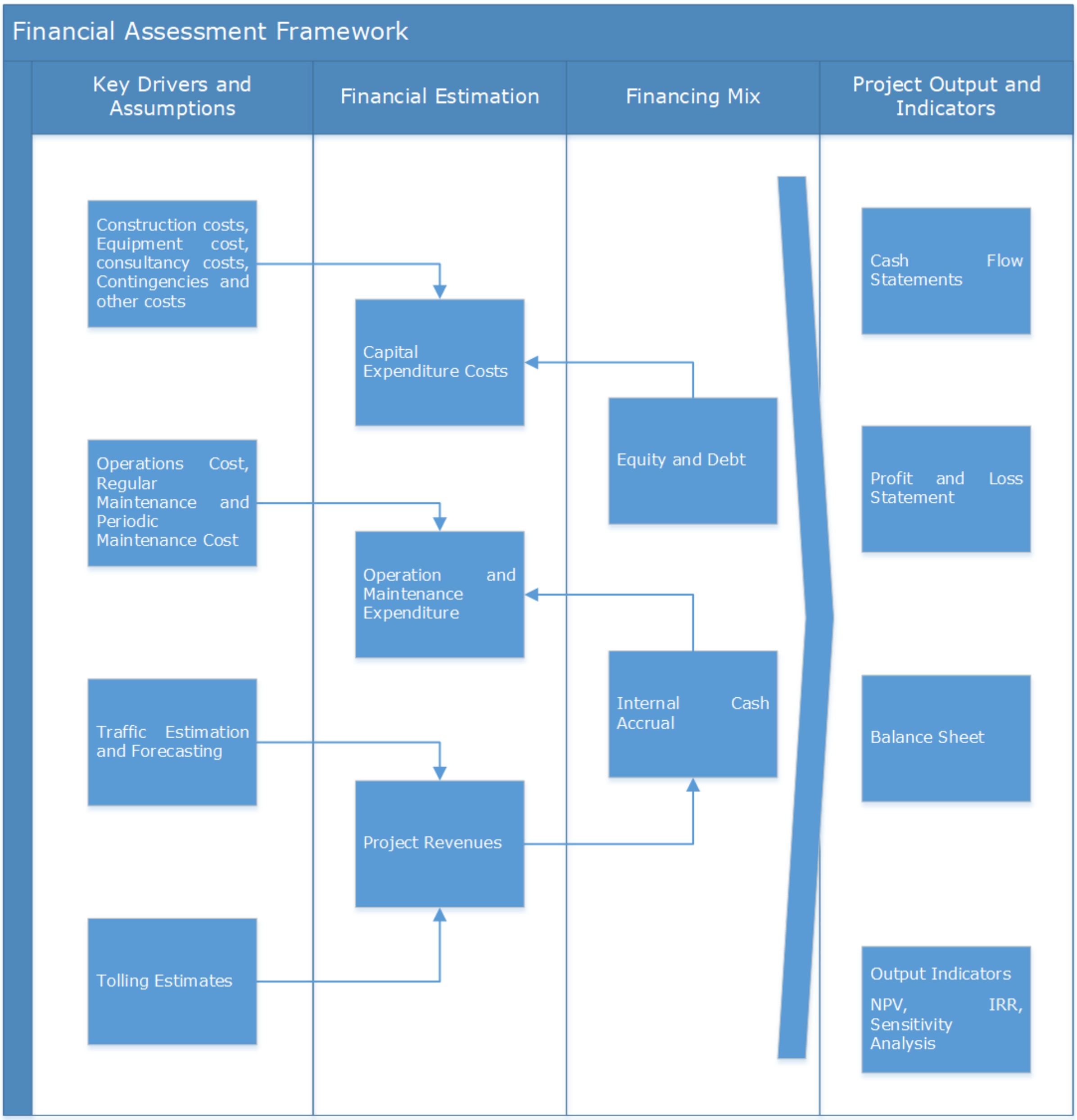
11.1.1. Key Assumptions and Approach

This section presents the key assumptions for the financial viability assessment of the project w.r.t the base case. These assumptions have been finalized based on Feasibility Study report, market interaction, interactions with financial institutions and industry benchmarks.

The project costs have been considered based on the technical feasibility assessment for the project, costs provided in the Schedule of Rates (SOR) 2019 and an analysis of related projects recently undertaken by RHD in the recent past. The revenue for financial analysis has been computed based on the projected traffic and toll rates in accordance with the prevailing rates in the country.

The financial projections for the project include estimation of yearly capital investments for development and construction, projected operation and maintenance expenses and the projected tolling revenues from the project. The approach behind the development of a financial model to assess the viability has been presented in the diagram below:

Table 83 : Approach for Financial Analysis



11.1.2. Project Cost Analysis

This section details out the estimated capital expenditure for development and construction of the project, projected operations and maintenance expenses during the operations period, and the taxes and depreciation that shall affect the project costs and structuring. The Project cost analysis have been undertaken for the base case.

11.1.2.1. Capital Expenditure

This includes the construction cost, equipment cost, project management cost, investment consultancy cost, other costs, contingencies and interest during construction. The details of the Capital Expenditure have been provided in previous chapter of this report and the same has been summarised as below:

Table 84 : Overall Capital Expenditure for BOT – Toll Model

#	Description of task	Phasing	Computation	Total Amount (BDT Crores)
1	Construction cost	To be incurred during construction period	Basic design volume and unit price (Roads, bridges, tunnels, tollbooth, misc.)	4398.98
2	Price Escalation /Inflation on base cost	To be applied on base Construction Cost for FY 2019	@ 5.50% per annum on construction cost (until FY 2026, construction period)	1,548.39
	Cost incl. inflation			**5,947.38**
3	Contingency costs	For construction cost	2% of Base Cost	118.95
	Total Base Cost incl. inflation and contingency			**6,066.32**
4	Project Management cost	In proportion to direct civil cost; to be incurred during construction period	1% of total base cost	60.66
5	Other costs	Upfront; to be apportioned in the first construction year	SPV incorporation costs, Bid Security and Performance Security costs	6.55
6	Financing Fees	Upfront; to be apportioned in the first year	1.5% of Debt	70.55
	Sub – Total			**6204.08**
7	Interest During Construction (IDC)	To be apportioned during entire construction period in line with disbursement	Interest at 8% p.a. on the cumulative drawdown during the construction period	514.57
	Total Project Cost			**6,718.65**

It is pertinent to mention that the responsibility of final design for construction lies with the investor (private) and the costs may change upon finalization of technical design. The above stated construction cost is based on the basic design as per the feasibility study.

The construction cost has been added and termed as total base cost (EPC cost) for the project. The total project cost has been estimated at BDT 6,718.65 crores.

*For the purpose of financial analysis as a PPP project from the private sector perspective, the Land Acquisition and Resettlement Costs have not been considered as this cost will be borne by RHD.

11.1.2.2. Operation and Maintenance Expenses

This includes the cost for operation and maintenance of the project during the operations period. These costs include the operations cost (cost of management, operation and other costs), regular maintenance costs, major (periodic) maintenance costs, replacement costs and toll plaza expenses. It is also assumed that the concession period is 25 years which can be bifurcated as 3 years for construction and 22 years for operation and maintenance. Accordingly, the estimated maintenance cost has been summarised as below.

Table 85 : Summary and Schedule of OPEX Expenditure

Sl.	Description of task	Phasing	Computation	Cumulative Annual Amount (BDT Crores)
1	Maintenance cost			
1a	Regular Maintenance	Yearly basis during operations period	1% of Total Direct Civil Cost for first three years and 0.6% from 4th year onwards	1,427.31
1b	Major (Periodic) Maintenance	Every 5th year of operation period	3.3% of Total Direct Civil Cost	1,724.28
	Sub Total	**-**	**-**	**3,151.59**
2	Toll plaza costs and expenses	Yearly basis	1.50% of toll revenue	210.26
3	SPV operation cost (includes admin, transport, utility and misc. costs)			125.43 *(operations period)*
	Total OPEX	-	-	**3,487.28**

Note: It is assumed that the toll plaza expenses would be borne by the party which is handling/collecting the toll revenues. Since the modelling exercise has been carried out form the private player's perspective, these expenses have been included in total Opex in this Option wherein the toll is collected by the private player.

11.1.2.3. Taxes and Depreciation

This includes the taxes and depreciation applicable to various components of the project. The detail has been provided below:

Table 86: Summary of Tax and Depreciation in BOT (toll) Model

Sl.	Description of task	Phasing	Computation	Total Amount (BDT Crores)
1	Taxes			
1a	*Corporate Income Tax*	15% during operations period; initial 10 years exemption.	15% from 11^{th} year of operation.	610.95
1b	*Value Added Tax*	Exempted in PPP projects	-	-
2	Depreciation	During entire fund return (operations) period	Straight line method	6,718.65

11.1.2.4. Project Phasing and Milestones

The concession period has been considered as 25 years. For the purpose of the Business case, 3 years of construction period and 22 years of operations period has been considered. The milestones are as tabulated below:

Table 87 : Project Development Milestones

Sl.	Description of task	Start Date	End Date
1.	Project Duration	1^{st} July 2023	30^{th} June 2048
2.	Project construction	1^{st} July 2023	30^{th} June 2026
3.	Commercial Operation Date	1^{st} July 2026	30^{th} June 2048
4.	Termination of agreement	30^{th} June 2048	-

11.1.2.5. Inflation

The costs have been projected after adjusting them for inflation. The inflation has been computed at 5.50% for the entire concession period.

11.1.3. Means of Finance Analysis

This section details out the means of finance to fund the project expenditures for the base case. As the project is envisaged to be undertaken under PPP (BOT – Toll) mode, the sources of capital shall include Investor's Capital and Toll Revenue to fund various Investor/Project Enterprises.

11.1.3.1. Investor Capital

Investor's Capital includes equity and debt/ market borrowings. The investor is expected to invest 30% of the Total Project Cost (TPC) in the form of equity. The remaining capital (70% of the TPC) shall be mobilized in the form of debt/ market borrowings.

a. Equity

Investor's Capital has been taken as 30% of the TPC and has been estimated at BDT 2,015.59 crores. The expected return on equity for the base case has been assumed at 15% annually.

b. Debt/Market Borrowing

Debt/ Market borrowing has been taken as 70% of the TPC and has been estimated at BDT 4,703.05 crores. The rate of interest for the base case has been assumed to be at 8% annually for loans.

The details of investor capital are as tabulated below:

Table 88 : Details of Investor Capital

Sl.	Description	Amount (BDT Crores)
1.	Equity	2,015.59
2.	Debt	4,703.05
	Total	**6718.65**

For the purpose of financial analysis, the land acquisition cost has not been considered.

11.1.3.2. Toll Revenue

As the project is being undertaken in PPP (BOT – Toll) mode, the primary sources of revenue will be the service fee (toll) charged from the users.

For the purpose of this Business Case – Base Case analysis, the revenue has been computed at Base Toll. Toll revenue has been computed for the Operations period of 22 years considering the base Toll Rate of BDT 6 per km for a car for the first year of operation. The total toll amount has been rounded off to the nearest BDT 5. The toll rate has been increased at the rate of 5.5% (CPI rate) per annum in the subsequent years. At each of the toll plazas, the toll will be charged for 50% of the distance travelled irrespective of the distance travelled. In case a vehicle crosses both the toll plazas, it will be charged 100% (i.e. 50% at each toll plaza). On the other hand, traffic initiated / crossing Toll Plaza – 1 only shall be charged for 50% of the total amount assuming that the distance travelled is equivalent of 50%. Similarly, traffic initiated after Toll Plaza – 1 and crossing Toll Plaza – 2 only shall also be charged for 50% of the total amount assuming that the distance travelled is equivalent of 50%.

It is imperative to note here that the number of toll-able vehicles entering the toll plaza 1 are not expected in entirety to exit at toll plaza 2. Multiple exit points for the vehicles (as discussed in Traffic Analysis chapter) would render the collection at the two toll booths to be different. The same has been accounted for while calculating toll revenues.

The calculations undertaken for estimation of tolling revenue is provided below –

TOLL RATE CALCULATION

In order to derive the most appropriate tolling rates for the Gabtoli-Nabinagar-Bipile Project, we first studied the Bangladesh's Tolling Policy 2014. It outlines the percentage wise distribution of the tolling rates for different vehicle types. The distribution is as mentioned below –

Vehicle Type	Vehicle Category	Ratio of Toll Rate	Multiplier
A	Trailer	**250%**	**10.0**
B	Heavy Truck	**200%**	**8.0**
C	Medium Truck	**100%**	**4.0**
D	Big Bus	**90%**	**3.6**
E	Mini Truck	**75%**	**3.0**
F	Agri Vehicle	**60%**	**2.4**
G	Minibus	**50%**	**2.0**
H	Micro Bus	**40%**	**1.6**
I	4 Wheel Vehicle	**40%**	**1.6**
J	Car	**25%**	**1.0**
K	3 Wheel Vehicle	**10%**	**0.4**
L	Motorcycle	**5%**	**0.2**
M	NMT	**2.5%**	**0.1**

The multipliers stipulated in the table above, were then compared with the toll rates collected for similar projects in neighboring countries (India and Sri Lanka) for establishing its coherence with Global norms.

Toll Rates in India

In India, the Ministry of Road Transport and Highways has issued a notification for standardizing the base rate of Toll Fees per km. These rates are as mentioned below –

Type of Vehicle	Base Rate of Fee per km (in INR)	Ratio (considering car as base)
Car Jeep Van or Light Motor Vehicle	0.65	1.0
Light Commercial Vehicle, Light Goods Vehicle or Minibus	1.05	1.6
Bus or Truck (Two Axles)	2.20	3.4
Three-axle commercial vehicles	2.40	3.7
Heavy Construction Machinery (HCM) or Earth Moving Equipment (EME) or Multi Axle Vehicle (MAV) (four to six axles)	3.45	5.3
Oversized Vehicles (seven or more axles)	4.20	6.5

In addition, the toll policy allows the operating agency to charge extra for an elevated corridor. The user fees for an elevated corridor can be extended upto 10 times the user fee for at-grade highways.

An analysis of toll rates/ user fees charged out in Mumbai – Pune, Mumbai – Lonavala and Delhi – Agra Expressways is mentioned below –

Vehicle Category	Mumbai Pune		Mumbai Lonavala		Delhi Agra		Avg. Multiplier
	Toll Rates	Multiplier	Toll Rates	Multiplier	Toll Rates	Multiplier	
Cars, SUVs, Vans	270	1.0	203	1.0	110	1.0	**1.0**
Mini-Bus	420	1.6	315	1.6	180	1.6	**1.6**
Trucks (2 axles)	580	2.1	435	2.1	375	3.4	**2.6**
Bus	797	3.0	597	2.9	375	3.4	**3.1**
Trucks (more than 2 axles)	1380	5.1	1035	5.1	590	5.4	**5.2**
Cranes, multi-axle vehicles	1835	6.8	1376	6.8	715	6.5	**6.7**

Toll Rates in Sri Lanka

Sri Lanka has a dedicated Expressway Operation Maintenance and Management Division under Road Development Authority that determines the toll rates/ user fees for different vehicle categories. The Toll rates for some select expressways is provided below –

Vehicle Category	Katunayake to Hambantota		Peliyagoda to Hambantota		Kadawatha to Hambantota		Average Multiplier
	Toll Rates	Multiplier	Toll Rates	Multiplier	Toll Rates	Multiplier	
Vehicles with 2 axles and four wheels (includes Car, Jeep, Light truck, etc.)	1000	1.0	950	1.0	900	1.0	**1.0**
Vehicles with 2 axles and six wheels (includes Buses, Lorries, Trucks having 2 axles and 6 wheels)	1900	1.9	1650	1.7	1600	1.8	**1.8**
Vehicles with more than 2 axles (includes HCM, Heavy Trucks)	3150	3.2	3000	3.2	2800	3.1	**3.2**
Trailers	4000	4.0	3800	4.0	3600	4.0	**4.0**

Comparator Analysis of Toll Rates

On comparing the ratio of rates/ multipliers followed in India, Sri Lanka and Bangladesh across different vehicle types, it was found that the rates charged in Bangladesh are slightly higher than the user fees charged in India and Sri Lanka. The following table provides a clear comparison of these ratios –

Type of Vehicle	Multipliers in India	Multipliers in Sri Lanka	Multipliers in Bangladesh
Car Jeep Van or Light Motor Vehicle	1.0	1.0	1.0
Light Commercial Vehicle or Minibus	1.6	1.0	2.0
Bus or Truck (Two Axles)	**3.4**	**1.8**	**4.0**
Three-axle commercial vehicles	3.7	3.2	8.0
Trailers or HCM or Multi Axle Vehicle (four to six axles)	5.3	4.0	10.0

Now, considering that almost 60% of the traffic volume is accounted by cars and medium truck (i.e. 2-Axle commercial truck) alone (validated from the traffic analysis section), we can compare the ratio of rates for these vehicle types to determine the similarity. From the table above, it is noted that the multiplier for medium truck is 4.0 according to Bangladesh Toll Policy, 3.4 according to Indian Toll Policy and 1.8 in Sri Lanka. This justifies that the tolling rates followed in Bangladesh is in coherence with the Global Industry Practice and shall be considered for the purpose of this project as well.

Determination of Base Rates

For determining the base rates, we analyzed the tolling rates that were charged for some similar PPP projects currently running in Bangladesh. The comparison of the base rates provided below –

Vehicle Category	Dhaka Bypass Project		Rampura Amulia Demra Project		Average	
	Base Rate (BDT/km)	Multiplier	Base Rate (BDT/km)	Multiplier	Base Rate (BDT/km)	Multiplier
Trailer (at least 3+ axles)	33.06	7.7	30.81	5.7	**31.9**	**6.7**
Heavy Truck	26.45	6.1	23.19	4.3	**24.8**	**5.2**
Medium Truck	16.53	3.8	15.48	2.9	**16.0**	**3.3**
Small Truck	9.92	2.3	11.63	2.1	**10.8**	**2.2**
Large Bus	12.4	2.9	23.19	4.3	**17.8**	**3.6**
Minibus	7.44	1.7	15.48	2.9	**11.5**	**2.3**
Micro Bus	6.61	1.5	7.63	1.4	**7.1**	**1.5**
Utility Vehicle	5.79	1.3	0.96	0.2	**3.4**	**0.8**
Car	4.31	1.0	5.41	1.0	**4.9**	**1.0**

Based on the table mentioned above, we earlier considered BDT 5 per km as the base toll rate for Cars. However, in later discussions, it was suggested that the base toll rate should be increased slightly to ensure viability of the project. Considering this, the base rate is proposed to be revised to **BDT 6 per km** for the 1st year of Operation i.e. FY 2026. Subsequently, the Base Rate shall be annually increased @5.5% per annum (the total toll amount arrived after multiplication with the total project length shall be rounded off to the nearest BDT 5 in line with the toll policy).

Now considering the revised base rate of cars as **BDT 6 per km**, the revised base rates for different vehicle types is mentioned below –

Vehicle Category	Tolling Rates		Base Year Tolling Rate (in BDT)
	Base Rate (BDT/km)	Multiplier	
Trailer (at least 3+ axles)	**30.0**	**5.0**	**725.00**
Heavy Truck	**27.0**	**4.5**	**655.00**
Medium Truck	**20.0**	**3.33**	**485.00**
Small Truck	**15.0**	**2.5**	**365.00**
Large Bus	**18.0**	**3.0**	**435.00**
Minibus	**12.0**	**2.0**	**290.00**
Micro Bus	**12.0**	**2.0**	**290.00**
Utility Vehicle	**9.0**	**1.5**	**220.00**
Car	**6.0**	**1.0**	**145.00**

NOTE - In order to maintain a satisfactory willingness to pay ratio, the multipliers for Heavy Trucks and Trailers has been customized accordingly (reduced from 8.0 and 10.0 to 4.5 and 5.0 respectively).

Miscellaneous revenues:

In addition to the toll revenues, the project stretch is lucrative for advertisement and sign boards which is expected to fetch additional revenues. This revenue has been calculated basis the existing local rate and for a variety of sign boards such as digital screens, paint boards, etc. The revenues have been considered in principle to be adding to the profitability of the project and has thus been included as positive cash inflows for the developer. The Authority may, depending upon the existing local advertising rates and approvals from the local district governing bodies in Dhaka, offer to take these revenues itself or make it available to the private party. Net revenues from advertising (post adjustment of installation costs) has been assumed to be BDT 4.41 Crores per annum. The same have been inflated at 5.5% in subsequent years.

Accordingly, the revenues so computed have been tabulated below:

Table 89: Details of Toll Revenue

Sl.	Tolling Plaza	Revenue (BDT Crores)
1.	Toll Plaza – 1	7,556.29
2.	Toll Plaza – 2	6,460.99
3.	Other revenues (Advertisement and signage revenues)	180.31
	Total	**14,197.59**

11.1.4. Financial Analysis – Outputs – Base case

This section presents the analysis that shall help assess the viability of the project. This analysis has been conducted based on the project costs and means of finance, along with project revenues as has been detailed in the preceding sections for the base case.

Total Toll Revenue during the Operations Period of 22 years is BDT 14,017.28 crores as against the initial Capital Investment (CAPEX/ TPC) of BDT 6,718.65 crores and an Operations Cost (OPEX) of BDT 3,487.28 crores. **Overall, the Project is unviable on BOT Toll basis.**

11.1.4.1. Net Present Value (NPV)

The Net Present Value (NPV) is a measure of viability of the project. A positive NPV signifies that the project is viable. The Project NPV is estimated at BDT -2,760.64 crores (negative) which confirms that the project is unviable on BOT - Toll.

11.1.4.2. Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) signifies the return over the prevailing market rates. The project IRR has been estimated at 3.46%, which is well below the computed Weighted Average Cost of Capital (WACC) of 10.16%.

11.1.4.3. Debt Service Coverage Ratio (DSCR)

The Debt Service Coverage Ratio (DSCR) is a measure of ease of debt service. DSCR more than one signifies that the debt obligations for that period can be met with ease. The minimum DSCR has been estimated at 0.19 and the average DSCR at 0.55.

Thus, it is evident that the project is unviable in case the GoB/RHD decides to let out the concession in a simplistic model of only BOT – toll where the developer has to recover costs basis the toll collections.

11.2. Option-2: BOT – Availability Payments

In addition to the BOT – Toll model which was analysed in the previous section and found to be not feasible from the private player's perspective, another model of financing that constitutes the GoB/RHD providing the private player with annuity/availability payments was assessed. In this option of GoB providing the private player with annuity payments while collecting the toll itself, various financial parameters are listed below:

11.2.1. Project Cost Analysis in Option-2: BOT – Availability Payments

In this case, the development cost is estimated to be the same as in the base case i.e. at BDT 6,718.65 crores. The operation costs are pegged at BDT 3,277.02 crores (this excludes the toll plaza expenses). In addition to the capex and operational costs, the other proponents of tax rate, inflation and revenue assumptions have been kept the same as in the base case.

11.2.2. Means of Financing: Availability

In this case of BOT – the investor's capital (debt and equity) is used to fund the initial capex for construction, and the liabilities in the operational period are then supported by the availability payments made by the Government to the developer on an annuity basis. The toll revenues are collected by the GoB/RHD.

The debt and equity mix in the present case are similar to the base case with the debt required to be raised for funding being BDT 4,703.05 Crores and an equity contribution being BDT 2,015.59 Crores.

In this case, Toll revenues shall accrue to RHD/ Authority and are estimated to be the same as in the base case: BDT 14,017.28 Crores. This is not considered in the financials in Availability Payment mode of PPP.

11.2.3. Key Outputs – BOT – Availability

The financial returns from the project basis the above-mentioned mode of financing, costs and revenues are mentioned in the table below:

Table 90 : Key Outputs- BOT- Availability

Sl No	Key Parameters	Values
1.	Project IRR	11.85%
2.	Equity IRR	15%
3.	Project NPV	1,338.43
4.	Minimum and Average DSCR	1.15 and 1.45
5.	Availability payments Over the Concession Period (Outgo from the government)	BDT 29,021.83 Crores
6.	Tolling revenue (inflow for the GoB/RHD)	BDT 14,017.28 Crores

Thus, it is evident that in case the GoB decides to support the project via availability payments and keeps the toll revenue with itself, an amount of BDT 29,021.83 Crores will be required to make it feasible for a private player (equity IRR of 15%).

Such large quantum of annuity payments would entail a large commitment from the GoB. Therefore, further options for sustainable project financing were analysed.

11.3. Option 3: BOT – Toll plus Availability Payments

In addition to the base case, additional measures to improve the viability of the project with respect to private investors were considered. One of such measures is for the Government to provide annuity payments during the operations period of the concession together with the toll revenues to the developer. Such an arrangement is a step over and above the Option 2 discussed earlier. Toll along with annuity payments will help the developer recover the development costs and operational period expenses while collecting toll revenues as well.

11.3.1. Project Cost Analysis

In this case, the development cost is estimated to be the same as in the base case i.e. at BDT 6,718.65 crores. The operation costs are also similar to the base case at BDT 3,487.28 crores (this includes toll plaza expenses to be borne by the developer). In addition to the capex and operational costs, the other proponents of tax rate, inflation and revenue assumptions have been kept the same as in the base case.

11.3.2. Means of Financing: Toll Plus Availability

In this case of BOT – Toll plus availability payments, the investors capital (debt and equity) is used to fund the initial capex for construction and the liabilities in the operational period are then supported by toll revenue (from users) and availability payments by the Government to the developer on an annuity basis. The debt and equity mix in the present case are similar to the base case with the debt required to be raised for funding being BDT 4,703.05 Crores and an equity contribution being BDT 2,015.59 Crores.

Toll and other miscellaneous revenues are also considered to be the same as in the base case: BDT 14,197.59 Crores (Tolling Revenue – BDT 14,017.28 crore & other Miscellaneous Revenue – BDT 180.31 crore).

11.3.3. Toll plus Availability payments

In this mode of financing, the Government, in order to make the project viable for private sector participation, makes annuity/availability payments to the developer during the operational period. Such mode of financing is an added cost to the government to make the project feasible. This funding is over and above the tolling revenues that are taken by the developer.

11.3.4. Key Outputs – Toll Plus Availability

The financial returns from the project basis the above-mentioned mode of financing, costs and revenues are mentioned in the table below:

Table 91: Key Outputs- Toll Plus Availability

Sl No	Key Parameters	Values
1.	Project IRR	11.93%
2.	Equity IRR	15.00%
3.	Project NPV	1,428.63
4.	Minimum and Average DSCR	1.12 and 1.44
5.	Availability payments – Per Annum and Over the Concession Period (Outgo from the government)	BDT 398.80 Crores pa BDT 16,296.69 Crores
6.	Tolling revenue and other revenue from project (to the Developer)	BDT 14,197.59 Crores

Thus, it is evident that the provision of BDT 398.80 Crores for the first year increased by 5.5% annually as availability payments will help the private developer to garner an equity IRR of 15%. However, it should be noted here that the cost to government in this case is as high as ~BDT 16,296.69 Crores over the operation period of 22 years. Though this cost is less than in option 2, this might be significant cost to the exchequer. It was therefore imperative to analyse further options and combinations of project financing of this PPP project.

11.4. Option 4: BOT – Toll plus VGF Option

In addition to the base case, a case has also been formulated to assess the Project financial viability from the private (investor) perspective by providing VGF during the construction period.

It should be noted here that as per the Finance Division, PPP Unit of GoB, the definition of Total Estimated Project Cost (TEPC) is the aggregate of total capital cost plus the cost of operation including maintenance, consultancies, interest, contingencies, overheads, government charges and taxes. The provision for VGF allows for a maximum funding of up to 40% of this TEPC. This has been taken into consideration while analysing the project returns in this option of BOT – Toll plus VGF.

The analysis of Project cost in this option, along with means of finance are as below.

11.4.1. Project Cost Analysis

This section details out the estimated capital expenditure for development and construction of the project, projected operations and maintenance expenses during the operations period, and the taxes and depreciation that shall affect the project costs and structuring. The Project cost analysis have been undertaken for this option. The Capital Expenditure in this case is expected to be reduced due to reduction in Financing Cost and IDC costs which are based on Total Debt.

Overall, the Capital Expenditure will be as computed below:

11.4.1.1. Capital Expenditure

This includes the construction cost, equipment cost, project management cost, investment consultancy cost, other costs, contingencies and interest during construction. The Capital Expenditure will be moderately reduced owing to VGF contribution from GoB. Assuming that a VGF contribution of 40% is provided by the GoB, the capital expenditure in this case would be as provided below:

Table 92: Overall Capital Expenditure

#	Description of task	Phasing	Computation	Total Amount (BDT Crores)
1	Construction cost	To be incurred during construction period	Basic design volume and unit price (Roads, bridges, tunnels, tollbooth, misc.)	4398.98
2	Price Escalation /Inflation on base cost	To be applied on base Construction Cost for FY 2019	@ 5.50% per annum on construction cost (until FY 2025, construction period)	1,548.39
	Cost incl. inflation			**5,947.38**
3	Contingency costs	For construction cost	2% of Base Cost	118.95

#	Description of task	Phasing	Computation	Total Amount (BDT Crores)
	Total Base Cost incl. inflation and contingency			**6,066.32**
4	Project Management cost	In proportion to direct civil cost; to be incurred during construction period	1% of total base cost	60.66
5	Other costs	Upfront; to be apportioned in the first construction year	SPV incorporation costs, Bid Security and Performance Security costs	6.33
6	Financing Fees	Upfront; to be apportioned in the first year	1.5% of Debt	40.78
	Sub – Total			**6,174.09**
7	Interest During Construction (IDC)	To be apportioned during entire construction period in line with disbursement	Interest at 10% p.a. on the cumulative drawdown during the construction period	298.72
	Total Project Cost			**6,472.81**

It is pertinent to mention that the responsibility of final design for construction lies with the investor (private) and the costs may change upon finalization of technical design. The above stated construction cost is based on the basic design as per the feasibility study.

The construction cost has been added and termed as total base cost (EPC cost) for the project. The total project cost has been estimated at BDT 6,472.81 crores.

*For the purpose of financial analysis as a PPP project from the private sector perspective, the Land Acquisition and Resettlement Costs have not been considered as this cost will be borne by RHD.

11.4.1.2. Operation and Maintenance Expenses

This includes the cost for operation and maintenance of the project during the operations period. These costs include the operations cost (cost of management, operation and other costs), regular maintenance costs, major (periodic) maintenance costs, replacement costs and toll plaza expenses. The same has been summarised as below.

Table 93: Summary and Schedule of OPEX Expenditure

Sl.	Description of task	Phasing	Computation	Total Amount (BDT Crores)
1	Maintenance cost			
1a	*Regular Maintenance*	Yearly basis during operations period	1% of Total Direct Civil Cost for first three years and 0.6% from 4th year onwards	1,427.31
1b	Major (Periodic) Maintenance	Every 5th year of operation period	3.3% of Total Direct Civil Cost	1,724.28
2	SPV Operation costs (includes admin, transport, utility, Unknown)	Yearly basis during operations period	BDT 2 crores	125.43
	Sub Total			**3,277.02**
3	Toll plaza costs and expenses	Yearly basis	1.50% of toll revenue	210.26
	Total OPEX			***3,487.28***

11.4.1.3. Taxes and Depreciation

Similarly, tax computations will be on similar lines. However, the Depreciation shall not be available on VGF contribution made by GoB as the same is treated as Capital Grant to the Private Player and is reduced from the cost of Fixed Assets available for Depreciation. The detail has been provided below:

Table 94: Summary of Tax and Depreciation – Toll plus VGF

Sl.	Description of task	Phasing	Computation	Total Amount (BDT Crores)
1	Taxes			
1a	*Corporate Income Tax*	15% during operations period; initial 10 years exemption.	15% from 11th year of operation.	1193.10
1b	*Value Added Tax*	Exempted in PPP projects	-	-

Sl.	Description of task	Phasing	Computation	Total Amount (BDT Crores)
2	Depreciation	During entire fund return (operations) period	Straight line method	3,883.69

11.4.1.4. Project Phasing and Milestones

For equitable comparison, same concession period of 25 years has been considered. For the purpose of the Business case, 3 years of construction period and 22 years of operations period has been considered as in the previous cases.

11.4.1.5. Inflation

The costs have been projected after adjusting them for inflation. The same inflation of 5.50% has been considered for the entire concession period.

11.4.2. Means of Financing: Toll Plus VGF

This section details out the means of finance to fund the project expenditures for the Toll plus VGF option. As the project is envisaged to be undertaken under BOT – Toll plus VGF mode, the sources of capital shall include Investor's Capital, VGF contribution from RHD/ GoB and Toll Revenue to fund various Investor/Project Enterprises.

Now, according to the VGF guidelines issued by the PPP Authority, a VGF of max. 40% of TEPC can be provided by the GoB in this mode of PPP. This will reduce the Debt requirement and consequently the Financing Cost and IDC will also be reduced.

Max. VGF that can be provided by the GoB is provided below:

- 40% of initial construction cost
- 40% of operation and maintenance costs plus interest, taxes and depreciation.

11.4.2.1. Investor Capital

Investor's Capital (IC) includes equity and debt/ market borrowings. The investor is expected to invest 30% of the Investor Capital (i.e. Total Project Cost less VGF) in the form of equity. The remaining capital (70% of the Investor Capital) shall be mobilized in the form of debt/ market borrowings.

11.4.2.2. Toll Revenue

As the project is being undertaken in PPP (BOT – Toll) plus VGF mode, the primary sources of revenue will remain same i.e. service fee (toll) charged from the users and other miscellaneous revenues as mentioned in the previous options: BDT 14,017.28 Crores.

11.4.3. Key Outputs – Toll plus VGF

Targeting an EIRR of 15%, the financial returns from the project basis the above-mentioned mode of financing, costs and revenues are mentioned in the table below:

Table 95 : Key Output – Toll plus VGF

Sl No	Key Parameters	Values
1.	VGF contribution required	39.73%
2.	Total Capex	BDT 6,474.42 crores
3.	Project IRR	11.81%
4.	Equity IRR	15%
5.	NPV (project cash flows)	2,349.88
6.	Minimum and Average DSCR	1.18 and 1.43
7.	VGF – 39.73% of Total Direct Civil Cost during construction and 39.73% of OPEX during operations (Outgo from the government)	Const. Phase – BDT 2,572.29 Crores O&M Phase – BDT 4,123.82 Crores
8.	Tolling and other revenue from project	BDT 14,017.28 Crores

Thus, it can be seen that with a VGF contribution @39.73% would garner a return of 15% on the investor's equity that is attractive to any private party for a successful PPP bid.

Also, the VGF contribution required for target EIRR 15% is well under the capping of capital infusion permissible by RHD (i.e. 40%). Therefore, this option can be considered as a potential candidate for project execution.

11.5. Option 5: Hybrid Annuity Mode (HAM)

In this option, it is envisaged that the Toll Revenue shall be retained by the RHD/ GoB and the Private Investor/ Concessionaire will be compensated in the form of initial Capital Contribution during Construction Period and Availability Payments during the Operations Period. Accordingly, Hybrid Annuity Mode of PPP was evaluated as Option 5.

In this case, it is envisaged that the RHD/ GoB will provide 40% of EPC as initial contribution during the Construction Period and rest of the Project Cost shall be invested by the Private Player/ Concessionaire in the form of Debt and Equity.

The analysis of Project cost in this option, along with means of finance in HAM mode are as below.

11.5.1. Project Cost Analysis

This section details out the estimated capital expenditure for development and construction of the project, projected operations and maintenance expenses during the operations period, and the taxes and depreciation that shall affect the project costs and structuring. The Project cost analysis have been undertaken for the HAM option:

11.5.1.1. Capital Expenditure

An initial Capital Contribution of 40% of TPC is envisaged to be provided by the GoB in this mode of PPP, the Debt requirement will remain same and consequently the Financing Cost and IDC will also remain same as computed in earlier option. Overall, the Capital Expenditure will be as computed above: BDT 6,472.81 Crores.

It is pertinent to mention that the responsibility of final design for construction lies with the investor (private) and the costs may change upon finalization of technical design. The above stated construction cost is based on the basic design as per the feasibility study.

*For the purpose of financial analysis as a PPP project from the private sector perspective, the Land Acquisition and Resettlement Costs have not been considered as this cost will be borne by RHD.

11.5.2. Operation and Maintenance Expenses

In Option 5 also, Operations and Maintenance Expenses will remain same as in Base Case *except the toll plaza costs* (considered as 1.5% of toll revenue) which will be borne by the GoB since it will be handling and collecting the toll.

These Opex costs include the operations cost (cost of management, operation and other costs), regular maintenance costs, major (periodic) maintenance costs, replacement costs and SPV operations costs. The same has been summarised as below.

Table 96: Summary and Schedule of OPEX Expenditure

Sl.	Description of task	Phasing	Computation	Annual Amount (BDT Crores)
1	Maintenance cost			
1a	*Regular Maintenance*	Yearly basis during operations period	1% of Total Direct Civil Cost for first three years and 0.6% from 4th year onwards	1,427.31
1b	*Major (Periodic) Maintenance*	Every 5th year of operation period	3.3% of Total Direct Civil Cost	1,724.28
	Sub Total	**-**	**-**	**3,151.59**
2	Toll plaza costs and expenses	Yearly basis	1.50% of toll revenue	Nil
3	SPV Operation costs (includes admin, transport, utility, Unknown)	Yearly basis during operations period	BDT 2 crores	125.43
	Total OPEX	-	-	***3,277.02***

11.5.2.1. Taxes and Depreciation

In this case, the tax shall be payable after the completion of initial 10 years of exemption period @ 15%. However, similar to Option 4, Depreciation shall not be available on VGF contribution made by GoB as the same is treated as Capital Grant to the Private Player and is reduced from the cost of Fixed Assets available for Depreciation. The detail has been provided below:

Table 97: Summary of Tax and Depreciation

Sl.	Description of task	Phasing	Computation	Total Amount (BDT Crores)
1	Taxes			
1a	*Corporate Income Tax*	15% during operations period; initial 10 years exemption.	15% from 11th year of operation.	1155.04
1b	*Value Added Tax*	Exempted in PPP projects	-	-
2	Depreciation	During entire fund return (operations) period	Straight line method	3,883.69

11.5.2.2. Project Phasing and Milestones

For equitable comparison, same concession period of 25 years has been considered. For the purpose of the Business case, 3 years of construction period and 22 years of operations period has been considered as the previous options.

11.5.2.3. Inflation

The costs have been projected after adjusting them for inflation. The same inflation of 5.50% has been considered for the entire concession period.

11.5.3. Means of Financing: HAM

This section details out the means of finance to fund the project expenditures for HAM mode of PPP. As the project is envisaged to be undertaken under HAM mode, the sources of capital shall include Investor's Capital, Capital contribution of 40% of TPC from RHD/ GoB and Availability Payments shall be available during Operations Period to fund various Investor/Project Enterprises.

11.5.3.1. Capital Contribution

Similar to VGF, an initial Capital Contribution / Grant of 40% of TPC has been assumed from GoB as initial capital contribution. The initial Capital Contribution has been estimated at BDT 2,589.12 crores (i.e. 40% of TPC of BDT 6,472.81 crores).

This does not include land acquisition and resettlement cost, which need to be separately borne by the RHD/ GoB on actuals.

Out of the TPC of BDT 6,472.81 crores, 40% (i.e. BDT 2,589.12 crores) shall be the initial Capital Contribution or Grant from RHD/ GoB and the net amount of BDT 3.883.69 crores shall be the Investor's Capital.

11.5.3.2. Investor Capital

Investor's Capital (IC) includes equity and debt/ market borrowings. The investor is expected to invest 30% of the Investor Capital (i.e. Total Project Cost less Grant) in the form of equity. The remaining capital (70% of the Investor Capital) shall be mobilized in the form of debt/ market borrowings.

a. Equity

Investor's Capital has been taken as 30% of the IC and has been estimated at BDT 1,165.11 crores. The expected return on equity for the base case has been assumed at 15% annually.

b. Debt/Market Borrowing

Debt/ Market borrowing has been taken as 70% of the IC and has been estimated at BDT 2,718.58 crores. The rate of interest for the base case has been assumed to be at 8% annually for loans.

The details of investor capital are as tabulated below:

Table 98: Details of Investor Capital

Sl.	Description	Amount (BDT Crores)
1.	Equity	1,165.11
2.	Debt	2,718.58
	Total	**3,883.69**

For the purpose of financial analysis, the land acquisition cost has not been considered.

11.5.3.3. Toll Revenue

In this case, toll revenue shall be retained by the RHD/ GoB and shall be utilised to provide Availability Payments to the Private Player/ Concessionaire. The toll revenue is: BDT 14,017.28 Crores

11.5.4. Key Outputs – HAM

This section presents the analysis that shall help assess the viability of the project. This analysis has been conducted based on the project costs and means of finance, along with project revenues as has been detailed in the preceding sections for HAM mode of PPP.

Table 99: Key Indicators in HAM mode

Particulars	Details	Values
GoB initial Capital Contribution	Payable during the construction period of 3 years, in debt draw-down	BDT 2,589.12 crores
Availability Payments	Payable annually during 22 years of Operations Period with inflation @ 5.5% p.a.	Total: BDT 18,098.80 crores (First year availability payment - BDT 442.9 crores)
Equity IRR	Expected return on equity	15%
Project NPV		BDT 2,793.58 crores
Project IRR	Project Returns	11.85%
Min. DSCR		0.95 (due to first major maintenance in fifth year of operations which can be addressed through debt restructuring/ ballooning)
Avg. DSCR		1.45

In this case, toll revenue of BDT 14,017.28 crores shall be retained by the RHD/ GoB and shall be utilised to provide above Availability Payments to the Private Player/ Concessionaire. Hence, the net outgo of government would just be BDT 6,880.91 Crores.

In addition to this option of HAM, another variation that included HAM plus toll was also analysed to arrive at the best fit option for the project structuring. The same has been elaborated below.

11.6. Option 6: Hybrid Annuity Mode (HAM) plus Toll

In this case, it is envisaged that the RHD/ GoB will provide 40% of TPC as initial contribution during the Construction Period and rest of the Project Cost shall be invested by the Private Player/ Concessionaire in the form of Debt and Equity. Apart from the initial capital contribution, the RHD/GoB will also provide annuity payments to the private player over the operation period of the concession. Part form these upfront and annuity contributions, the private player would be allowed to keep the toll revenues as well.

The analysis of Project cost in this option, along with means of finance in HAM plus toll mode are as below.

11.6.1. Project Cost Analysis

This section details out the estimated capital expenditure for development and construction of the project, projected operations and maintenance expenses during the operations period, and the taxes and depreciation that shall affect the project costs and structuring. The Project cost analysis have been undertaken for the HAM plus toll option:

11.6.1.1. Capital Expenditure

The Capital Expenditure is expected to remain as in Option 5. Since an initial Capital Contribution of 40% of TPC is envisaged to be provided by the GoB in this mode of PPP, the Debt requirement will remain same and consequently the Financing Cost and IDC will also remain same as computed in Option-5. Overall, the Capital Expenditure will be as computed above: BDT 6,472.81 Crores.

It is pertinent to mention that the responsibility of final design for construction lies with the investor (private) and the costs may change upon finalization of technical design. The above stated construction cost is based on the basic design as per the feasibility study.

*For the purpose of financial analysis as a PPP project from the private sector perspective, the Land Acquisition and Resettlement Costs have not been considered as this cost will be borne by RHD.

11.6.2. Operation and Maintenance Expenses

In Option 6 also, Operations and Maintenance Expenses will remain same as in Base Case except that the toll plaza costs (considered as 1.5% of toll revenue) will be borne by the private player since it is collecting the toll.

These Opex costs include the operations cost (cost of management, operation and other costs), regular maintenance costs, major (periodic) maintenance costs, replacement costs and SPV operations costs: BDT 3,487.28 Crores.

11.6.2.1. Taxes and Depreciation

In this case, the tax shall be payable after the completion of initial 10 years of exemption period @ 15%. However, similar to Option 5, Depreciation shall not be available on VGF contribution made by GoB as the same is treated as Capital Grant to the Private Player and is reduced from the cost of Fixed Assets available for Depreciation. The detail has been provided below:

Table 100: Summary of Tax and Depreciation

Sl.	Description of task	Phasing	Computation	Total Amount (BDT Crores)
1	Taxes			
1a	*Corporate Income Tax*	15% during operations period; initial 10 years exemption.	15% from 11th year of operation.	1402.49
1b	*Value Added Tax*	Exempted in PPP projects	-	-
2	Depreciation	During entire fund return (operations) period	Straight line method	3,883.69

11.6.2.2. Project Phasing and Milestones

For equitable comparison, same concession period of 25 years has been considered. For the purpose of the Business case, 3 years of construction period and 22 years of operations period has been considered as the previous options.

11.6.2.3. Inflation

The costs have been projected after adjusting them for inflation. The same inflation of 5.50% has been considered for the entire concession period.

11.6.3. Means of Financing: HAM Plus Toll

This section details out the means of finance to fund the project expenditures for HAM plus toll mode of PPP. Financing will be similar as in HAM mode, the sources of capital shall include Investor's Capital, Capital contribution of 40% of TPC from RHD/ GoB and Availability Payments shall be available during Operations Period to fund various Investor/Project Enterprises along with the toll revenue which will also belong to the private player.

11.6.3.1. Capital Contribution

Similar to VGF, an initial Capital Contribution / Grant of 40% of TPC has been assumed from GoB as initial capital contribution. The initial Capital Contribution has been estimated at BDT 2,589.12 crores (i.e. 40% of TPC of BDT 6,472.81 crores).

This does not include land acquisition and resettlement cost, which need to be separately borne by the RHD/ GoB on actuals.

Out of the TPC of BDT 6,472.81 crores, 40% (i.e. BDT 2,589.12 crores) shall be the initial Capital Contribution or Grant from RHD/ GoB and the net amount of BDT 3,883.69 crores shall be the Investor's Capital.

11.6.3.2. Investor Capital

Investor's Capital (IC) includes equity and debt/ market borrowings. The investor is expected to invest 30% of the Investor Capital (i.e. Total Project Cost less Grant) in the form of equity. The remaining capital (70% of the Investor Capital) shall be mobilized in the form of debt/ market borrowings.

c. <u>Equity</u>

Investor's Capital has been taken as 30% of the IC and has been estimated at BDT 1,165.11 crores. The expected return on equity for the base case has been assumed at 15% annually.

d. <u>Debt/Market Borrowing</u>

Debt/ Market borrowing has been taken as 70% of the IC and has been estimated at BDT 2,718.58 crores. The rate of interest for the base case has been assumed to be at 8% annually for loans.

The details of investor capital are as tabulated below:

Table 101: Details of Investor Capital

Sl.	Description	Amount (BDT Crores)
1.	Equity	1,165.11
2.	Debt	2,718.58
	Total	**3,883.69**

For the purpose of financial analysis, the land acquisition cost has not been considered.

11.6.3.3. Toll Revenue

In this case, toll revenue shall be retained by the private player. The cumulative toll revenue amounts to BDT 14,017.28 Crores.

11.6.3.4. Availability payments

In this model, the GoB/RHD is expected to provide annuity payments of BDT 5,369.57 Crores to help the private player achieve an equity return rate of 15%. The table below shows the key indicators for this option:

11.6.4. Financial Analysis: HAM plus Toll

The key indicators for this option are as below:

Table 102: Key Indicators: HAM plus Toll

Particulars	Details	Values
GoB initial Capital Contribution	Payable during the construction period of 3 years, in debt draw-down	BDT 2,589.12 crores
Availability Payments	Payable annually during 22 years of Operations Period with inflation @ 5.5% p.a.	Total: BDT 5,369.57 crores (First year availability payment - BDT 131.40 crores)
Equity IRR	Expected return on equity	15%
Project NPV		BDT 3,033.76 crores
Project IRR	Project Returns	11.98%
Min. DSCR		0.90
Avg. DSCR		1.45

Thus, it is evident that the contribution by the GoB amounts to BDT 7,958.69 Crores in case HAM plus toll mode is adopted. This is more than the net outgo of GoB derived through HAM model.

The next section details out the comparative analysis across all the options mentioned above.

11.7. Conclusion

The aim of the financial viability assessment is to assess the financial viability of the Project for multiple scenarios and assess the potential of the Project for Government and investors/ developers alike.

Table 103 : Financial options analysis 1

Particulars	Option 1 – Toll	Option 3 – Toll Plus Availability/Annuity	Option 4 – Toll Plus VGF
Total Capex	BDT 6,718.65 Crores	BDT 6,718.65 Crores	BDT 6,474.42 Crores
Total Opex	BDT 3,487.28 Crores	BDT 3,487.28 Crores	BDT 3,487.28 Crores
GoB initial Capital Contribution/VGF	Nil	Nil	VGF – 39.73% VGF during Construction - BDT 2,572.29 Crores VGF during O&M – BDT 4,123.82 Crores
Availability Payments	Nil	BDT 16,296.69 Crores	Nil
Equity IRR	0.34%	15%	15%
Project NPV	-2,760.64	1,428.63	2,349.88
Project IRR	3.46%	11.93%	11.81%
Min. DSCR	0.19	1.12	1.18
Avg. DSCR	0.55	1.44	1.43
Toll ownership	Private	Private	Private
Total Funding required from GoB/RHD in terms of VGF + Availability	-	BDT 16,296.69 Crores	BDT 6,696.11 Crores
Toll earned by GoB	-	-	-
Net outgo for GoB	-	BDT 16,296.69 Crores	BDT 6,696.11 Crores

The above comparison lists the differentiating levels of project returns and GoB contribution for options involving toll ownership by private player (option 1), together with toll plus annuity (option 3) and toll plus VGF (option 4). An equity returns of 15% is achievable in option 4 for an VGF contribution of 39.73%. The outcomes of some other potential PPP options wherein the toll ownership remains with RHD are illustrated below:

Table 104: Financial Option Analysis-2

Particulars	Option 2 – Availability/Annuity only	Option 5 – Hybrid Annuity	Option 6 – Hybrid Annuity plus Toll
Total Capex	BDT 6,718.65 Crores	BDT 6,472.81 Crores	BDT 6,472.81 Crores
Total Opex	BDT 3,277.02 Crores	BDT 3,277.02 Crores	BDT 3,487.28 Crores
GoB initial Capital Contribution/VGF	Nil	BDT 2,589.12 Crores	BDT 2,589.12 Crores
Availability Payments	BDT 29,021.83 Crores	BDT 18,098.80 Crores	BDT 5,369.57 Crores
Equity IRR	15%	15%	15%
Project NPV	1,338.43	2,793.58	3,033.76
Project IRR	11.85%	11.85%	11.98%
Min. DSCR	1.15	0.95	0.90
Avg. DSCR	1.45	1.45	1.45
Toll ownership	RHD	RHD	Private
Total Funding required from GoB/RHD (VGF + Availability)	BDT 29,021.83 Crores	BDT 20,687.93 Crores	BDT 7,958.69 Crores
Toll earned by GoB	BDT 14,017.28 Crores	BDT 14,017.28 Crores	-
Toll Expenses by GoB	BDT 210.26 Crores	BDT 210.26 Crores	-
Net outgo for GoB	BDT 15,214.81 Crores	BDT 6,880.91 Crores	BDT 7,958.69 Crores

The above analysis clearly indicates that options 2 and 3 require similar levels of contribution from the GoB in terms of annuity payments (more than BDT 15,000 crores in each case). These payments are quite substantial and would cost the exchequer a substantial outflow. Thus, these modes of development are not suggested for a potential PPP structure.

The other options of toll plus VGF, HAM and HAM plus toll, entail a smaller contribution from the GoB than the above options. However, it can be noted that the contribution required in Option 6 is relatively more than the other Option 4 and 5. Whereas the contribution required in Option 4 and 5 are in the similar levels (around BDT 3900 crores in NPV terms).

Hence, the above tables demonstrate that Toll plus VGF and HAM model are both potential options for the PPP project and the authority can consider either of these two options in the implementation phase.

11.8. Sensitivity Analysis

The objective of the sensitivity analysis exercise is to examine the resilience of the project to changes in key assumptions in the above undertaken financial analysis. For the purpose of the present Project, key project indicators were examined for the HAM model.

The effect of changing parameters such as lending rate, project concession tenure was studied on the availability payments for a fixed equity return rate of 15%.

Table 105: Sensitivity Analysis-HAM -1

Debt rate	7%	8%	9%	10%
Availability payments pa	427.30	442.90	458.70	474.70
Equity	25%	**30%**	20%	27.5%
Availability payments pa	433.60	442.90	424.40	438.30

Table 106: Sensitivity Analysis-Toll plus VGF-2

Debt rate	7%	8%	9%	10%
VGF required	38.50%	39.73%	Over 40%	Over 40%
Equity	25%	**30%**	20%	27.5%
VGF required	38.17%	39.73%	36.57%	38.95%

The above sensitivity analysis shows that return on Equity in the project is sensitive in varying degrees to different risk parameters. It is clear from the chart that availability payments would reduce depending upon the lending rate which the developer is able to attract from the market. The lending rates in Bangladesh are primarily dependent on the good will of the private company and the credit worthiness of the parent organisation. The rates vary from 7-10% for a repayment period of 12 years.

In addition to the above sensitivity towards debt rate and varying equity contributions, the sensitivity of the internal return rate towards variation in capex and opex costs was also analysed as below:

Table 107 : Sensitivity Analysis HAM - 2

Opex	90%	100%	110%
Equity IRR	15.49%	15%	14.51%
Capex	90%	**100%**	110%

Equity IRR	17.95%	15%	12.53%
Toll Revenue	90%	**100%**	110%
Equity IRR	15%	15%	15%

Table 108: Sensitivity Analysis Toll plus VGF-2

Opex	**90%**	**100%**	**110%**
Equity IRR	15.32%	15%	14.67%
Capex	90%	**100%**	110%
Equity IRR	17.17%	15%	13.15%
Toll Revenue	90%	**100%**	110%
Equity IRR	13.91%	15%	16.07%

Thus, it is evident that variations in capex affect the equity return rate in a large way as compared to opex or the toll revenues for HAM plus toll model. Thus, it is prudent to revalidate the capex costs as per existing conditions upon project commencement. It is also therefore imperative to execute the project within laid down timelines to avoid cost inflations and reduced returns.

11.9. Minimum Revenue Guarantee (MRG)

Infrastructure PPP projects usually face substantial revenue risks during the operation phase. Hence, to avoid the downside risks of revenues, the government often provide a minimum revenue guarantee (MRG) to the concessionaire. MRG helps enhance the credit worthiness of a PPP project facing high revenue risks, since the guaranteed cash inflows can provide a minimum level of debt coverage.

In case of this project, the MRG amounts to a total of BDT 8,019.37 crores (i.e nearly 57% of the estimated Tolling Revenue) during the operations period. The rationale for MRG calculation is provided below –

Particulars	Value (in BDT crores)
Debt	2,731.49
Expenses	3,487.28
Interest	1,800.60
Total (MRG)	**8,019.37**

12. Value for Money Analysis

The Roads & Highways sector globally has been a front runner in terms of experimenting with various delivery models to arrive at the model which derives the maximum VFM for the government.

While exploring various PPP models, the key objective of the government in implementing PPP projects is to achieve optimal combination of benefits and costs in delivering user services. Many PPP programs require an assessment of whether a PPP is likely to offer better value for the public than traditional public procurement—often called VFM analysis.

According to the World Bank, VFM is defined as "the effective, efficient, and economic use of resources, which requires the evaluation of relevant costs and benefits, along with an assessment of risks, and of non-price attributes and/or life cycle costs, as appropriate"

A PPP project is considered to yield positive VFM where it results in a net positive benefit as compared to other procurement alternatives to the government.

12.1. Value for Money Framework

To decide whether a project is to be procured through Public Sector or Private Sector, VFM acts an important aspect of evaluation. It is assessed to arrive at the difference of the whole life-cycle costs (in terms of cost, price, quality, quantity, appropriate risk transfer or a combination thereof) of a publicly and a privately procured project.

The primary objective of the VFM analysis would be that the selected delivery model for the Project ensures:

- Financial viability & bankability from the private sector and lender perspective; and
- Maximum value for money and affordability from the government perspective

The VFM framework is used to compare costs with different PPP bid models in order to derive best value for money for implementing the project. The framework compares different modes of project delivery under common parameters in order to identify the appropriate and economical option. The broad comparisons of the models between Public procurement and PPP mode of development are made for the analysis which include:

1. **PPP Mode Development**: There are various PPP models that can be deployed for delivery for public infrastructure. In these models, the responsibility for design, construction, financing, operation and management, etc. is allocated between the public and private sectors in such a way that it ensures optimum risk allocation. The basis of such a partnership between the public and private sector would flow from the government and private sector allocating risks to the party which is best able to manage such risks. Sharing risk through such conscious reasoned allocation in this manner would result in optimization of VFM to taxpayers and users of the project.

2. **Pure Government Mode Development**: The traditional delivery models include publicly funded contracts such as Item Rate works contracts, Design-Build contracts, and Capital costs/Turnkey works. In these models, depending on the contractual arrangement, there is some degree of risk transfer to the private contractor. However, in general the public authority is responsible for financing the project, retains operations & maintenance, and attendant risks.

Based on the above comparison and estimation of costs and risks on various parameters, a Public Sector Comparator (PSC) is constructed.

12.2. Methodology for the VFM framework

To arrive at the cost of public sector undertaking the project for a quantitative VFM assessment, and to ensure that the analysis is comparable between alternatives, a PSC is constructed. PSC is used to estimate cost of a publicly procured project after adjusting for risks in an appropriate manner. PSC estimates the hypothetical rather than actual risk-adjusted cost if a project were to be financed, owned and implemented by government. It estimates full life-cycle risk adjusted cost to the government in order to achieve stated service delivery parameters of the project. The four important aspects of PSC are the following:

1. **Raw PSC Costs:** The Raw PSC provides a base costing under the procurement method where the underlying asset or service is owned by the public sector. This includes all capital and operating costs, both direct and indirect, associated with building, owning, maintaining and delivering the project over the project life cycle under the defined performance standards. The Raw PSC typically consists of direct costs and indirect costs with deduction of identifiable third-party revenues.

2. **Competitive Neutrality**: In order to eliminate the additional benefits availed by a publicly procured project as compared with PPP procurement, the value of such benefits are added to arrive at the full cost to government to ensure fair comparison. Competitive Neutrality removes the net competitive advantages that accrue to a government entity by virtue of its public sector ownership.

3. **Retained Risk**: An important aspect of PSC is the proposed risk allocation and its valuation. Retained risks are those risks that the government proposes to bear by itself. Value of risks retained by the government is added to the cost of the project. The risk is valued considering the probability of each risk and its financial impact.

4. **Transferable Risk** – These risks are likely to be transferred to private bidders. The value of this risk in a PSC measures the cost the government is expected to pay for that risk over the term of the project.

Figure 47 : Public Sector Comparator

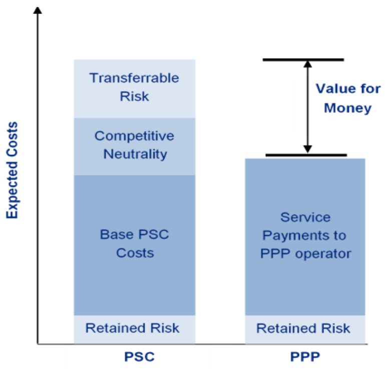
The PSC is developed in accordance with the required output specification; the proposed risk allocation, and is based on the most efficient form and means of government delivery. Once the PSC costs are ascertained, VFM framework is used to evaluate public mode of project delivery against PPP modes. VFM results are dependent on availability and reliability of data on possible performance by private sector, past track records of delays and cost escalations, identification and measurement of efficiencies etc.

As presented in the figure below, a VFM framework is used to compare PSC costs with PPP bid cost in order to get the best VFM for the project.

For the government, PPP costs can consist of service payments paid to the PPP operator. Apart from the cost of service payments, the government also assumes certain risk in privately procured projects. These risks are added to the cost. The sample VFM framework shows that the cost of PSC to the government is compared to cost of a PPP bid to the government. VFM is arrived at the difference in costs of these options.

In case of PPP bids, transferable risk need not be valued since these risks are borne by the private party. In assessing and delivering VFM, it is also important to note that VFM is a relative concept which requires comparison of the potential or actual outcomes of alternative procurement options. This requires a high degree of estimation; especially where experience and/or data on similar projects procured under different procurement routes is limited. The VFM analysis is contingent on the availability of quantitative data, especially as regards cost and time over-run precedents across similar projects.

Figure 48 : VFM Framework



12.3. VFM Analysis for the current engagement

During the development of the feasibility report, discussions were undertaken with PPPA and RHD regarding the VFM assessment based on the key considerations and assumptions arrived at during the financial analysis and assessment of different procurement options viz. Traditional and PPP procurement. Based on the discussions, the shortlisted PPP models finalized for the project are the HAM model and Toll+VGF model. A VFM analysis was conducted to assess if the PPP will generate higher net economic benefits to the GoB compared to a public procurement option. This was achieved by comparing the aggregate costs and benefits of a public procurement model with those of the selected PPP procurement model to determine which model provides the maximum net economic benefit.

12.3.1. Key Considerations and Assumptions

The key considerations and assumptions for VFM analysis are based on the financial assumptions and assessment of different procurement options viz. Traditional and PPP procurement earlier discussed in Chapter 11: Financial Analysis. The key components of the analysis include the following:

Table 109 : Key considerations and assumptions for VFM analysis

PPP Mode	Pure Government Mode (EPC)
Raw PSC Costs	
Base PSC cost for the PPP bid included the sum of the capital support and the service payments provided to the private player **PPP HAM:** The present value of capital contribution which is 40% of the total project cost and service payments/ availability payments are added to form the Base PSC costs to arrive at the outflow from the government under this mode for construction, operation and maintenance periods. **PPP Toll+VGF:** The present value of capital contribution which is 39.73% of the total project cost that will be paid out by the government in construction and O&M stages.	Base PSC costs for EPC mode consisted of three parts – total project costs, operational and maintenance costs and deduction of loss of revenue. The total sum of present value of the total project cost and the O&M expenses and the deduction of the present value of expected revenue represents the outflow from the government under the public procurement mode.
Assumptions :	

<table>
<tr><th>PPP Mode</th><th>Pure Government Mode (EPC)</th></tr>
<tr><td colspan="2">1. Total Project Cost: Total project cost is sum of base capital/civil cost of the project preoperative expenses, preliminary costs, project management expenses included independent expert costs, interest during construction (IDC) etc.
As during the construction period, the public authority has to appoint an independent expert (IE) for supervision of the project during operation. Cost of IE is added as part of the total project cost under the PMC expenses.
Cost of land and resettlement & rehabilitation costs have been excluded from computations as in all cases, it has been considered that the land and resettlement & rehabilitation costs would be borne by the government in both traditional and PPP procurement options. Thus, there is no net effect of land and resettlement & rehabilitation costs in calculation of VFM as VFM is the difference of the whole life cycle costs of a publicly and a privately procured project.
2. Expenses: O&M costs under the EPC mode for PSC calculation includes routine maintenance, periodic maintenance, facility management, office expenses and other system related operational expenses.
3. Project Duration: For maintaining parity with the private sector option, same period is considered for analysis. For this project, a period of 25 years is considered.</td></tr>
<tr><th colspan="2">Competitive Neutrality</th></tr>
<tr><td>No such measurable and exclusive benefits are available under the PPP contract.</td><td>In order to eliminate the exclusive benefits availed by a publicly procured project, their value is identified and added back to the PSC model in order to arrive at the full cost to the government to ensure better comparison.
Taxation benefits available to the government in case of public procurement (and paid by private developers in PPP approach) are added back to the PSC.</td></tr>
<tr><th colspan="2">Retained Risk</th></tr>
<tr><td>In PPP projects, most of the risks of cost overrun is borne by the concessionaire/ the private developer. Similarly the risks and costs associated with time overrun is also borne by the concessionaire.</td><td>Retained risks are those risks that the Government proposes to bear itself in self-development mode. Value of risk retained by the government in Public procurement contract is added to the PSC model. These comprise the following:
Cost Overruns: This aspect includes overrun in costs at construction stage in the Project, on account of change in quantities, escalation and others factors leading to cost overruns.
The estimation of cost overrun is based on the past data on completed government projects, as available nationally and internationally. The risk is valued considering the probability of each risk eventuating and its financial impact on the project lifecycle.</td></tr>
</table>

PPP Mode	Pure Government Mode (EPC)
	Time Overrun: The cost incurred on account of time overrun would entail a rise in expenditure. The cost incurred on account of time overrun can results in rise in expenditure and the cost of working capital which is added to the PSC model. **Operational losses**: Due to time overrun, there would also be a loss in toll revenues for the delay period. The average time overrun has been estimated based on the primary data for past similar projects which is added to the PSC model. Value of the risks such as increase in capital expenditure due to delays in construction, loss of toll revenue due to delays in construction, economic costs due to delays in construction and non-quantifiable risk (on estimated basis) are added to the PSC model.

Estimating time delays and cost overruns

Typically, publicly funded projects are prone to cost overruns and time delays owing to various inefficiencies plaguing decisions making, the appraisal process and construction management.

The tendency of government funded procurements to suffer significant time and cost overruns as compared to other procurement methods is corroborated from experience from around the world. A UK study of 50, PPP and Publicly funded projects, concluded that PPP projects were completed within time whereas there was a 17% time overrun for conventional public projects; capital expenditure for PPP projects was largely within budget as against an average cost over-run of 47% for conventional public projects. Another UK study undertaken by the UK National Audit Office (NAO) showed 76% of PPP project were delivered on time vs. 30% for publicly funded projects, with just 27% of conventional public projects being within budget as compared to 78% for PPP projects.

In addition to the above, the study undertaken by the European Investment Bank (EIB) also noted time overruns for over 60% of traditional public funded projects with delay of over a year. Comparatively, in India, over 57 National Highway EPC projects analyzed show average time overruns of 15 months.

For the Gabtoli-Nabinagar-Bipile project, data provided by RHD for a sample of public procurement projects has been considered. As per the data provided, for the purpose of VfM assessment 69%-time delay and 13% cost overrun has been considered for the public procurement model.

The key assumptions considered for undertaking the VFM analysis are listed below. It may be noted here that there are certain assumptions which are different under Pure Government led development as compared to PPP mode development. However, there also exist certain assumptions that are similar for both modes of development:

Table 110 : VFM Analysis- Key Assumptions for project VFM

Component	Public procurement- EPC Mode	PPP Model
Financing & Taxation Assumptions		
Financing	Market Borrowings (100%)	**Debt: Equity (70:30)**
Bond / Debt Tenor	3 years (construction period) and working capital for O&M expenses	**12 years**
Upfront Capital Contribution	-	**Toll+VGF: 39.73% of TEPC** **HAM: 40% of TPC**
Interest Rate on Financing Costs	8%	**8%**
Taxation	-	**Corporate Tax of 15%**
Retained Risks Assumptions		
Avg. Duration of Time Over-Run	69 %	**Nil**
Average Cost Over-Run	13%	**Nil**
Operational losses	Toll Revenue for time overruns- No. of years	**None**
Other Assumptions		
Assessment / Concession Period	**25 years**	
Discount Rate for NPV Calculation	**8%**	

12.3.2. Analysis

Based on these assumptions and the methodology suggested above, VFM analysis has been carried out for Government only- EPC mode vis-à-vis PPP options - HAM model and Toll + VGF model for project development. In assessing and delivering VFM following the financial analysis in Chapter 11: Financial Analysis, it is important to note that VFM is a relative concept which requires comparison of the potential or actual outcomes of alternative procurement options. The assessment has been undertaken keeping in view of the past precedents and inputs from the stakeholder discussions.

Based on our analysis, the output indicators have been listed below:

Table 111 : VFM Analysis Outputs – Indicators

Indicator	Toll+VGF	HAM
Raw PSC - PPP Mode	**(BDT Cr)**	
PV of VGF during construction/ upfront contribution	2,191.15	2,205.50
PV of VGF during O&M/ Availability Payments	1,493.91	5,662.63

Indicator	Toll+VGF	HAM
Total	**3,685.06**	**5,491.09**
Raw PSC - EPC Mode	**(BDT Cr)**	
PV of Capex	5,957.67	5,957.67
PV of O&M Expenses	1,028.21	1,028.21
Loss of Revenue		
PV of loss of tolling revenue	-4,205.09	-
Total	**2,780.79**	**6,985.88**
Retained Risk	**(BDT Cr)**	
Retained Risk - Cost overruns	774.50	774.50
Retained Risk - Operational inefficiencies (*cost escalation*)	168.38	133.67
Retained Risk - Operational inefficiencies (*working capital – time escalation*)	71.50	56.76
Operational Losses	-	415.60
Total	**1,014.38**	**1,380.52**
Competitive neutrality	**(BDT Cr)**	
Taxes in P&L (CIT)	255.31	265.54
Total	**255.31**	**265.54**

Bases on the above indicators, the following table gives a detailed breakup of the comparison between the two models in order to assess the model with the VFM for the project:

Table 112 : Output Comparison between Toll+VGF and EPC

Output	PPP Mode- Toll+VGF	EPC Mode
Raw PSC (A)	3,685.06	2,780.79
Competitive Neutrality (B)	-	255.31
Retained Risk (C)	-	1,014.38
Total Costs (A+B+C)	**3,685.06**	**4,050.48**
Value for Money (TC of EPC – TC of PPP)		**365.42**
% of PSC Cost		**9.02%**

Figure 49: VFM Analysis-Output for Toll+VGF and EPC

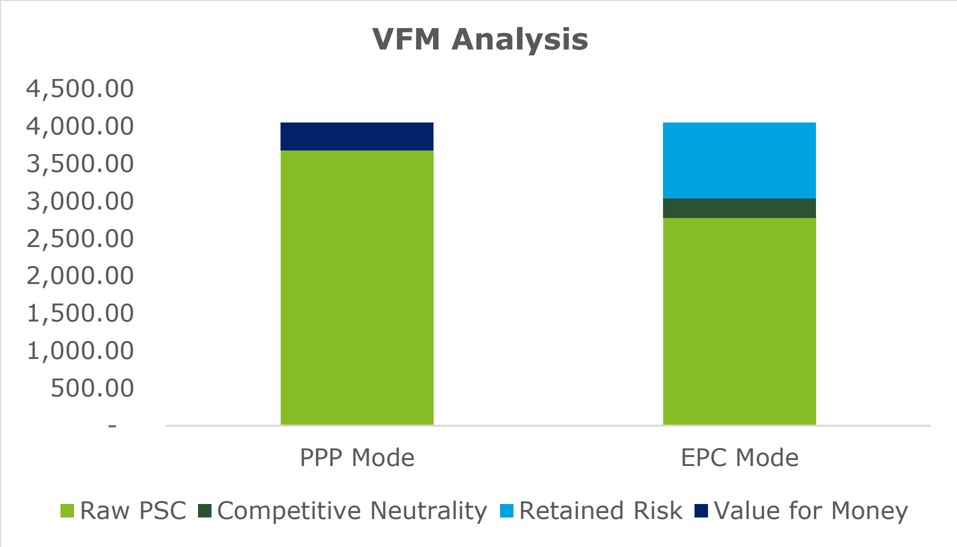
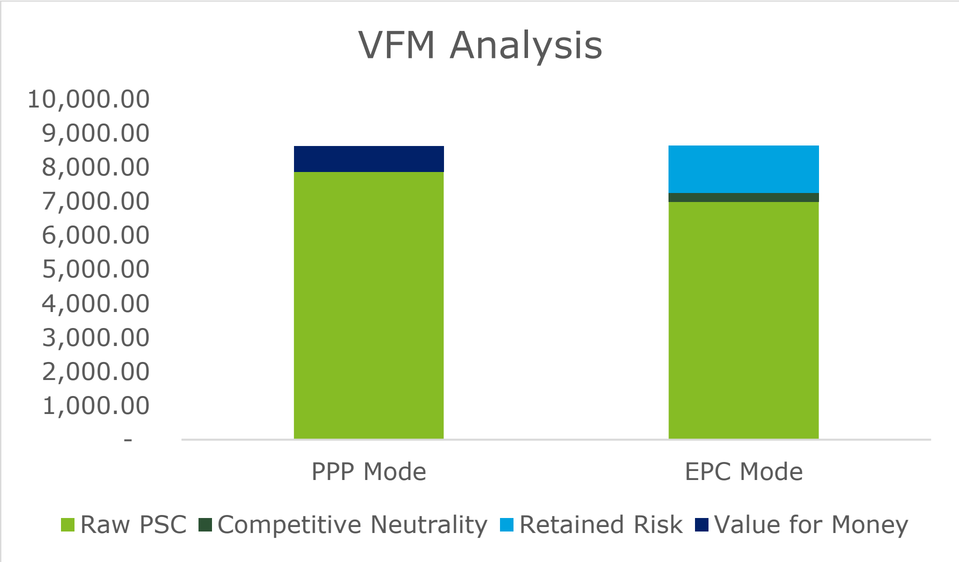


Table 113 : Output Comparison between HAM and EPC

Output	PPP Mode- HAM	EPC Mode
Raw PSC (A)	7,868.13	6,985.88
Competitive Neutrality (B)	-	265.54
Retained Risk (C)	-	1,380.52
Total Costs (A+B+C)	**7,868.13**	**8,631.94**
Value for Money (TC of EPC – TC of PPP)		**763.81**
% of PSC Cost		**8.85%**

Figure 50: VFM Analysis-Output for HAM and EPC



12.3.3. Recommended Procurement Option

As it is evident from the aforementioned analysis, the VFM analysis yield a net positive benefit of around 9% for both Toll+VGF and HAM models. Hence, the government can execute the project under either HAM or Toll+VGF models.

13. Economic Analysis

13.1. General Approach and Methodology

The objective of the economic evaluation of Gabtali (Amin bazaar)- Hemayetpur- Savar-Nabinagar- Bipile 6-lane Expressway is to assess the economic feasibility of the expressway comparing the life cycle costs and benefits of the identified alternatives, Base Alternative (no intervention) and Investment Alternative (project intervention) i.e. "with" and "without" the project case. The 6-Lane expressway will follow the alignment of existing N5 (Dhaka-Aricha- Nagarbari-Bogra-Dinajpur) from Aminbazar up to Nabinagar and then after R505 (Nabinagar- Chandra) from Nabinagarintersection to Bipile junction with Abdullahpur-Ashulia- Bipile highway N302. Both sections are ordinary 4-lane highway without service lanes and continuous hard shoulders. The expressway construction is assumed to be funded under PPP arrangement. The feasibility study, preliminary design and economic analysis was carried out during 2019- 2020. Necessary investigations and surveys mostly carried out during second half of 2019. The Study project is being implemented by PPP Authority of Bangladesh while Roads and Highways Department (RHD) is the Executing Agency.

The economic analysis was done for the entire highway section of 24.445 kmas wellas for each of 4road segments i.e. (i) Aminbazar- Hemayetpur, (ii) Hemayetpur- Savar, (iii) Savar-Nabinagar and (iv) Nabinagar- Bipile. For convenience the above road was sub-divided into 4 segments to produce homogeneous road sections in respect of traffic volume and other characteristics. The following are the segments with length in km for which economic evaluation was performed:

Table 114 : Length of the project segment

Serial No	Segment Name	Length
1	N5 Aminbazar-Hemayetpur	8.8
2	N5Hemayetpur -Savar	5.7
3	N5Savar - Nabinagar	7.0
4	R 505 Nabinagar –Bipile	2.945
Total		**24.445**

13.1.1. Background and Rationale

The Government of Bangladesh has planned to upgrade national highway network (Vision 2021) and improve sub-regional transport connectivity between Bangladesh, Northeastern States of India, Nepal and Bhutan for promotion of economic cooperation through enhanced trade, transit and transport development. To realize the planned goals various road improvement and transport projects have been undertaken according to the recommendations of various international studies by regional cooperation agencies and associations such as SAARC, SASEC, BIMSTEC, and RETA supported by ADB. This project will integrate the ADB's Transport Logistic and Trade Facilitation Project: Road Component under South Asia Sub-regional Economic Cooperation (SASEC) I (Jodebpur- Tangail- Alenga approach of BangabandhuJamuna Bridge) and SASEC-II (Alenga- Hatikamrul- Bogra-Rangpur).

The stretch of the highway selected for PPP intervention is very important as this serves the entire traffic, passenger and freight from northern districts of the country including the Sona- Masjid, Hili, Banglabandha and Burimari land ports via N5 and N4 as well as traffic from southwestern districts including Mongla Sea Port and Benapole, Bomra and Darsana land ports with Dhaka via N5 and N7. The proposed stretch belongs to Dhaka Urban Agglomeration and subject to sever traffic congestion during long peak hours in day and night. In the light of addressing this issue in line with the GoB's strategy of creating an efficient road network, particularly in urban Dhaka and surrounding areas the current project aims to achieve the following objectives:

- To provide congestion free gateway to Dhaka city along the existing N5, N4 and N1 and N8
- To ensure better connectivity with Northwest and Southwest part of Bangladesh
- To achieve better economic growth target by providing a safe, reliable and access controlled highway.
- To improve quality of life and productivity of the people using this corridor

The rational for the intervention is definitely creating the enhanced road capacity for handling national and sub-regional traffic by identified corridors i.e. N4, N5 and N7.

13.1.2. Objectives of the Chapter

The main objective of this chapter is to carryout economic feasibility study of the project as a part of transaction advisory services using HDM-4 through comparing life cycle economic costs and benefits of the gateway improvement to establish its economic viability, the basic criteria for project approval.The appraisal procedure followed the ADB Guidelines for Economic Appraisal of Projects (1997) with reference to Road Sector Guidelines.

HDM4 methodology always compares life cycle costs of project infrastructure between different alternatives. The Gabtali- Nabinagar- Bipile expressway improvement project has identified 2 alternatives namely the Base Alternative called base case alternative and improvement case alternatives:

i. **Base case Alternative:** This defines minimum cost solution for operation and maintenance of existing infrastructure primarily by routine maintenance where capital investment is zero. Routine maintenance keeps the infrastructure serviceable at current LOS protecting the road surface from further deterioration**.**

ii. **Improvement Alternative**: This defines capital investment options for different improvements. This alternative is 6-lane expressway along with 2-lane service lane on both sides and hard shoulders. To avoid congested urban city sections, cantonment, national monument and suspected troubled sections for social violence and traffic disruption, 9 km flyover and 1km tunnel, pedestrian facilities, etc to be constructed.

Identification of costs of the project is an essential first step towards HDM-4 analysis which provides a vivid idea about the size of investment. Initially financial costs are identified and estimated with the requirement of foreign exchange components. Estimation of financial costs of construction involves road alignmentimprovement and embankments, improved pavement designs and construction, bridges, flyovers and other structures, pedestrian facilities, under passes, over passes, etc, including engineering and non-engineering cost components. Operation and maintenance costs have also to be estimated based on current organization (RHD) Operation and maintenance (O&M) strategy. These items comprise road agency costs. Identification and estimation of benefits of the transport project has always been a complex exercise as the benefits are comprised fromsavings in the life cycle costs of transport operators 'with' and 'without' the project as well as savings of the agency maintenance costs in the longrun.

All predicted costs and benefits are measured in terms of economic prices[13]. All costs are estimated in Bangladeshi Taka (BDT). For estimating economic costs of tradable items expressed in world market price (border price) plus transport costs. For non-tradable items costs are converted to domestic prices multiplied by a standard conversion factor (SCF). Costs and benefits include: (i) economic costs of construction of all project components; (ii) economic costs of maintenance of new infrastructure constructed; (iii) savings in vehicle operating cost (VOC) and road user time costs; (iv) savings in the economic cost of accidents; (v) an estimate of the benefits of generated traffic; and (vi) sub-regional economic benefits due to sub-regional connectivity.

However, the sub-regional economic benefits will be included in road user cost savings item. Benefits of Indian transit traffic due to huge reduction of distance may be analyzed separately. The main objective of the project is therefore, to generate objective benefits to the region and the nation in terms of providing direct, cheaper, faster, easier and more convenient transportation to the road user. Traffic is the main determinants of estimating the benefits of a transport project like SRTPP project. This includes assessing alternative traffic scenarios based on existing traffic, population growth, expected traffic generation and diversion, growth in economic activities in the region, realization of expected trade and transit traffic and impacts of on-going infrastructure projects.

13.1.3. Improvement options considered

Improvement alternative considered was for the up-gradation of sections of N5 and R505 from existing ordinary four-lane with narrow median to 6-lane expressway with 5 meter wide median as mentioned. Access to main expressway will be restricted to long haul speedy motorized transport vehicles subject to toll collection. Other traffic local motorized, non-motorized and slow moving vehicles (CNG auto-rickshaw, battery run autos, Auto-Tempo, easy bike, motor cycles and non-motorized rickshaw/van, etc.) will use the 7.3 meter wide service lanes on both sides of the expressway separated by barriers toll free (figure-2 road cross section). Appropriate width of hard shoulders will be provided on both sides of the road all through.

Other cost components included are construction of new bridges and structures, flyovers, over and under passes, pedestrian facilities, foot-over bridge, at grade and off grade turning facilities, safety barriers, river banks protection and environmental and social mitigation measures.

The improvement under the project will involve widening of existing right of way (ROW) from 22 meters to 55 meters through the growing urban agglomeration accommodating all components and structures.

[13] Economic prices measure the value of project inputs and outputs in terms of the consumption of real resources. These are derived from financial prices (market prices) deducting tax and subsidies in case of non-tradable goods and making adjustment where market prices do not reflect the value of resources consumed. In case of tradable goods use world market prices (border) and add transport cost.

13.1.4. Annual Cash flow Analysis

Annual cash flows both financial and economic will be prepared for both cases of base alternative and investment alternatives which will be compared for assumed economic life of the project say 20 years. Basis of comparison will be the exiting and forecasted AADT of traffic of the present road under current situation (without intervention) and improved road to 6-lane expressway when implemented (with investment). An object traffic projection has a crucial role to play in the assessment of economic evaluation of such an expensive project. Extensive knowledge of traffic growth, generation and diversion under various development scenarios particularly the impacts of several Mega Projects such as construction of the Padma Multipurpose Bridge, its railway connectivity, Dhaka-Mawa- Bhanga Expressway, Mass Transit system of Dhaka City, Dhaka-Ashulia Elevated Expressway, Several City Bypasses, and SASEC-I and II implementation.

13.1.5. Data Collection and Major Assumptions

HDM-4 version 3.1 was deployed to undertake the economic financial analysis of the project. The model obviously needs a huge collection of data and information to gather to feed the successful Model run to be collected from different sources primary, secondary and tertiary. The following sets of data and information are considered for HDM-4 analyses:

- Traffic volume data in AADT from traffic surveys, volume counts and origin-destination interview surveys;
- Representative vehicle categories, characteristics and configuration of vehicle fleets operating in the country, expected changes in the configuration of transport vehicles with particular interest in freight vehicles;
- Collect and make assessment of vehicle operating cost (VOC) estimated and used by RHD HDM Circle for the whole country as well as in the region of road location, updating and recent changes that affected the VOC due to volatility of imported fuel and oil market and price phenomenon;
- Value of travel times for passengers and freight, important indicators for assessment of travel time cost (TTC) savings;
- Technical specification and design of investment infrastructures for considered alternatives, Base Alternative and Project Alternative;
- Identification and estimation of cost streams for improvement and upgrading of road sections to expressway based on strategic and approved designs;
- Determine operation and maintenance (O&M) strategy for the investment projects and prepare cost estimated for alternative options;
- Current travel speed, design travel speed, effective travel speed and travel time savings exercise under different level of services (LOS);
- Speed flow and traffic volume relationships under different road surface and congestion scenarios;
- Review of national planning documents, Five Year Plans, Perspective Plans, Annual development Plans for projected and actual GDP growth, per capita GDP, economic sectors growth, foreign trade and export processing, foreign remittances and migrated labour situation;
- Study of consumer price index (CPI) for commodity prices, inflation and wage rates, fluctuation of foreign exchange rates;

- Road accident and traffic control and management mechanism, statistics and record keeping, research on accident prevention and damage control system, compensation mechanism and institutions;
- Preparation of traffic forecast considering all plausible factors and indicators under different economic development scenarios and traffic modalities; and
- Macroeconomic stability and growth under global recession and economic decline.

13.1.6. Evaluation Period and Residual Value

The analysis period is considered to be 22 years after the completion of construction and opening up of project roads to the traffic. The design standard of the flexible pavement considered initially for 10 years life which can be extended up to 22 years through periodic maintenance at 5 and 7 years interval after the stipulated initial economic life. Although the bridges and flyovers are long lasting structures tended to continue for 50-60 years, and rigid pavement in urban sections are normally designed for 30 years, but they were not evaluated separately but done jointly as essential components of the main project, the significant project cost involved in flexible pavement construction. The assumptions of 22 years economic life for evaluation of the integrated project is reasonable. The excess of 22 years components will be added to salvage value as a negative cost at the end of the evaluation period.

Project implementation period is assumed to be 3 years after contract agreement signed in 2021 and construction work starting in 2022 to complete in 2024. Project will be implemented under separate packages working simultaneously. The road and all segments will be opened to traffic in 2025.

To account for the value of project remaining at the end of the evaluation period, a salvage value was included in 2046 equivalent to the remaining unused portion of project life (residual value-RV). The weighted lives of the individual project components assumed at the range of 35-40 years, based on the following assumptions the lives of about land, earthwork, utility diversion, consultants services, etc is 50 years (20% of the total costs); structures 40 years (25% of total costs); pavement, riverbank protection works and safety features, etc. 22 years (40% of the total costs). After 22 years operation of an asset with expected life of 35 years should have economic salvage value of 40% of initial cost[14]. However, for a more conservative estimate 30% of initial value was adopted as salvage.

13.1.7. Discount Rates

The usual 12 percent discount rate is adopted as per recommendation of the Bangladesh Planning Authority, the Planning Commission and which is also well recommended by all major donors.

13.1.8. Pricing Assumptions

The economic evaluation of the project is based on economic costs and benefits of the project which are deduced from the financial estimates. Financial cost calculation used the price level of the current fiscal year 2019-2020 adjusted with rate schedules of RHD, PWD and LGED. Therefore, no inflation adjustment was considered for the current year. A cost escalation factor of 4% was assumed annually for construction year 2022-2024. Physical contingencies of 5% were assumed in the financial accounting system. This also included

[14]Priority road project: Economic Evaluation of the priority roads project, RHD-ADB, 2011

costs of utility relocations, land acquisition, resettlement of project affected persons and entities, environmental mitigation measures, etc as non-construction costs.

A standard conversion factor (SCF) of 0.8 is used as a general practice to convert the domestic market prices to international prices. Economists have been using a conversion factor from 0.85 to 0.9 in recent years in view of increased wages rate for skilled and semi-skilled labor to significant level and harmonization of duties and taxes internationally under WTO. But prevailing world wide affected Corona Pandemic called CIVID-19 has to change the international trade and exchange system in coming years. An unprecedented economic recession and acute unemployment situation globally can be apprehended for all types of skill and occupations.

13.1.9. Analysis Model HDM-4

For economic analysis of the road project and its components HDM-4 version 1.3 is used. The software was calibrated by an expert team from the World Bank commensurate to Bangladeshi environment for the Roads and Highways Department (RHD) which is being in use since 2001. The calibration was supervised by the Consultants from Birmingham University.

13.1.10. Technical Investigations and Options

The technical evaluations initially examined the feasibility of construction of a dual carriage way 4-lane expressway including service road on both sides of the main carriageway along with the required structures for bridges, culverts, flyovers, over and under passes, pedestrian facilities, at grade and off grade turning facilities, safety barriers, river banks protection and environmental mitigation measures. During a presentation of progress review 4-lane expressway was found inadequate after 5th year of operation. Then RHD and PPP Authority decided to plan and design for 6-lane expressway along with other components. The proposed improvement and up-gradation included construction of 9 km flyover at several points of the gateway, 3 river bridges of more than 200 meters long and 8-9 small culverts. Number of Technical investigations required to prepare adequate standard design of each individual component of the bridge were properly carried out. The basic structure of the road and bridges include pre-stressed box girder bridges, pre-stressed concrete bridge consists of steel pier and pier head steel box girder with RCC deck. Design details are presented in Chapter 6 of this Feasibility Study Report

13.2. Road Agency Costs: Construction and Maintenance

13.2.1. Financial Cost

The economic costs of the construction project are derived from the financial predicted costs by deducting items of taxes and subsidies. Financial cost are prepared for all necessary project components such as site preparation and office set up, earthwork and embankment, pavement works, bridges and structures including flyovers, road safety and security works, ancillary works and road marking, river bank protection works, land acquisition and resettlement, environmental mitigation, engineering services and project administration. The costs are expressed in mid -2019 prices. Basic assumptions preparing the cost structure of the project was: (i) collecting market price for all available materials and ingredients for 2019 and review the trend of cost escalation over the years; (ii) collect and review the RHD Cost Analysis Guidelines (Update up to May, 2011 available); (iii) collect unit costs of National Accounting Wing of BBS for construction materials and labor, 2012; and (iv) collected and reviewed the cost structure of 2 similar on-going road projects of RHD, namely

Dhaka-Tangail-Alenga4-laning Highway project (SASEC-I) and Alenga- Bangabandhu Bridge-Bogra-Ranngpur4-laning project (SASEC-II).

Review of available primary and secondary sources of data provided guidance for preparing cost estimates by the Cost Engineers and Procurement Specialists. The well known method of rate analysis was applied for calculation from first principles particularly identifying taxes and duties involved in market prices.

During the preparation of costs the consultants adjusted the RHD and BBS costs to 2018 prices for all materials and labour. For overseas items they have collected Fob prices, customs duties and charges and transportation costs to update the price to 2018 level.

Labour Issues: The Government of Bangladesh has envisaged policy of adopting labour intensive technology providing employment opportunities to the poor wherever possible may it be infrastructure construction and maintenance or manufacturing for poverty reduction and employment generation. The project road will also provide opportunities for labour employment both skilled (30%) and unskilled (70%) in construction jobs. Wage bill for labour will be 11.2% of the total expenditure of corridor project. Summary of Costs is presented in Table 135.

13.2.2. Economic Cost

The economic costs are derived from the financial costs deducting taxes and duties from the costs of imported equipment and materials and applying a conversion factor of 0.8 to non-traded items. This has followed the pricing assumptions described in preceding sections. All costs are estimated in local currency units for construction and maintenance. Construction costs included physical contingencies, land acquisition, environmental mitigation and resettlement excluding direct taxes, subsidies and VAT. Price and physical contingencies was not considered as economic cost component and omitted. For imported foreign materials economic price was obtained using international border price i.e. cif price plus economic transport costs. Shadow wage rate was applied for labour used. Summary of Economic cost is presented in Table-136

13.2.3. Operation and Maintenance Cost

The operation and maintenance of the gateway corridor will be performed according to the Road Maintenance Strategy of RHD after improvement. The strategy explained the intervention criteria based on road condition survey results. Unit price of each intervention routine or periodic has been recommended by RHD which is updated annually. However, the consultants estimated maintenance cost separately for road network and bridge and structure and other safety and protection works. Both routine and periodic maintenance was recommended. Routine maintenance will be applicable for every year as per schedule of maintenance including breakdown repairs and maintenance. For routine maintenance of road network 1% of construction cost should be allocated to routine maintenance including pedestrian facilities. The O&M cost of bridge and structure was estimated as 1.25% of the construction cost for 5 initial years. Thereafter the cost will be reduced to 0.75% of the construction cost for rest of the economic life with periodic overlays.

The RHD Maintenance Strategy and Intervention Criteria are presented in Table 130.

13.3. Project Benefits and Beneficiaries

13.3.1. Road User Cost Savings

The savings in road user costs (RUCs) comprise savings in vehicle operating costs (VOC) and user time costs (UTC). Direct and quantifiable benefits of the road widening are the mitigation of congestion in the first place and protection of road surface from deterioration in the second. The former is expected to dominate the RUC savings by way of savings in vehicle operating cost calculated for all types of vehicles. A total of 13 categories of vehicles identified by RHD for which traffic forecast is made are considered to be included in VOC calculation.Following categories of vehicles are considered for VOC saving:

(i) Heavy Trucks including truck-trailer, semi-trailer combination, multi-axle trucks, etc.

(ii) Medium Trucks usually 2-axle heavy goods vehicle

(iii) Small Trucks 2-axle light trucks, casketed medium trucks, heavy jeeps

(iv) Large buses including multi-axle luxury air conditioned buses

(v) Medium buses commonly known as Mini buses

(vi) Small buses commonly known as Micro buses

(vii) Utility vehicles including 4-wheels, vans, etc

(viii) Sedan Cars

(ix) Auto-rickshaw included CNG, Tempo, auto-rickshaw (baby taxi) and Easy Bike

(x) Motor Cycle

(xi) Cycle Rickshaw

(xii) Bicycle

(xiii) Animal Cart, push cart, etc.

13.3.2. Determination of Vehicle Operating Costs (VOC)

13.3.2.1. Representative Vehicles

Vehicle operating costs for representative motorized vehicles used are those prepared jointly by the Consolidation of Institutional Development Components-3 (CIDC3) funded by DFID, 2005 have been updated in 2011 and adjusted with 2013 prices. HDM-4 VOC model was used to calculate the VOC for Bangladeshi representative vehicles in respect to road surface condition of roughness i.e. following international roughness index (IRI), geometry and width, traffic volume and speed-flow, etc. Representative vehicles are selected by the consultants on the basis of popular brands commonly used in Bangladesh. Representative vehicles are Ashok Leyland, Tata, Eicher, Hino, Mitsubishi FJ, Toyota Hiace, Mitsubishi Pajero, Toyota Corolla and Honda respectively for chosen categories.

Table 117 represents Characteristics and configuration of representative vehicle in Bangladesh.

13.3.2.2. Economic Cost of Vehicle, Labour and Time

First step to determine the economic VOC is to know the economic prices of new vehicles, new or retreaded tires, labour and their time value for maintenance. In the second place it is required to know the import price, duties and taxes of new vehicles commensurate with technical configuration and characteristics of representative vehicles. Table 116 represents the financial and economic Value of Vehicles, values of maintenance Labor and maintenance Time for 2013.

In Bangladesh most of the vehicles are imported in completely built unit (CBU) condition particularly light vehicles including sedan/saloon cars. Large and commercial vehicles are imported in complete knocked down (CKD) condition particularly importing the engine and chassis. The body is built locally in local assembly plants or in roadside workshops. The automobile market is dominated by Japanese car, jeep, micro-bus, bus, and motorcycles while India dominates in truck, minibus and CNG auto rickshaw. Most of the Japanese cars and light vehicles imported are used vehicle called second hand vehicles. Chinese companies are trying to penetrate the automobile market introduced with motor cycle and battery run auto-rickshaw. European cars and light vehicles are also imported in CBU but their number is limited.

13.3.2.3. Import Duties and Taxes on Vehicles

Import of vehicles and tires are subject to complex system of duties and taxes. The tax rate depends on whether the import is in CBU or CKD, purpose of import, engine capacity, and type of fuel use. The amount of duties and taxes are to be paid according to the tariff rate (Tariff Schedule) fixed by the National Board of Revenue (NBR). Analysis of the schedule shows that the total tax incidence (TTI) on vehicle import ranges between 59 percent for mostly goods vehicle powered by diesel through 129 percent for a 1.0-1.5 liter car imported in CBU condition to 213 percent for station wagons with 2.0 to 2.75 liter engines. The economic cost of vehicles is retail prices less the appropriate TTI. Crew costs vary widely and employed on temporary contract basis. Overhead included insurance, renewal, registration, administration and training, etc. Financial cost of vehicle import therefore, including all applicable taxes and duties such as custom duties, development surcharge, supplementary duties, VAT, advance income tax and import permit fees, etc.

13.3.3. Fuel and Oil Price

To reduce the environmental pollution and save the cities as well as save foreign exchange bill of petroleum the Government through BRTA promoted conversion of petrol/diesel run vehicle into CNG for sustainable green transport system. The plan has been successful as more than 65% of the existing 1.96 million vehicles (2013) are now run by domestically produced CNG. However, CNG is not available in all regions of the country such as Barisal and many districts of Rajshahi division. Therefore, possibility of 100 percent conversion will not be achieved soon.

In terms of energy value 1m3 of CNG is equivalent to 1.1 liters of petrol. The fuel consumption per equivalent liter of CNG is slightly worse than it is for gasoline. Previously the difference between prices was greater such as per liter pump price for petrol was Tk. 74 while equivalent liter of CNG was TK 25 only. During 2012-13 the government has revised the energy prices several times to reduce the subsidies in the sector. The latest one was in July 2020 when CNG price was fixed at Tk.43 per cubic meter, diesel Tk. 65 and Octane Tk.89 per liter. Thus financial fuel cost per km in CNG is about a quarter of the using gasoline. The market of CNG as well as petroleum products are state controlled. BPC and Petro Bangla state won company controls the petroleum prices. Unlike the crude oil, there is no established world market price for natural gas or CNG. This situation makes it difficult to establish an economic cost of CNG. Therefore it is decided to use conventional fuels for HDM-4 analysis.

The road project adopted the same approach used in PRP[15] to calculate the economic cost of octane, petrol and diesel considering world market price for oil (taken as US$ 100 per barrel) and adds margins for refining, shipping cost from gulf, distribution and retail costs. Although Bangladesh has domestic facilities for refining crude oil in its Eastern Refinery in

[15]Economic analysis of priority road project, September, 2011

Chittagong but it supplies only a fraction (20 percent) of the total demand. Most of the refined products are imported from the Gulf. The calculation of economic price of fuel oil is shown in Table 121. The resulting economic prices are US$ 1.24 and US$ 0.88 for octane and diesel respectively. Diesel is given subsidy.

13.4. Road user Cost Savings: Travel Time Savings

13.4.1. Value of Time

Travel time costs (TTC) also referred to as value of time (VOT) for delays and waiting by vehicles and passengers on board. The value of time is an important parameter for economic analysis of transport projects where reduction of journey time is the main objective. Particularly for widening road, bridge constructions replacing ferries, elevated express motor ways, flyovers, light rail and other high-tech mass transit systems. The economic costs of passenger time are based on the findings of studies carried out by the Economic Circle, RHD with the assistance of CIDC3 from same reference period 2004-05 updated for 2013.

13.4.2. Value of Passenger Time

Passenger time value was calculated as Tk. per passenger hour. Value of passenger time, occupancy and per vehicle TTC is shown in the table below:

Table 115: Value of Passenger Time: (Tk. Per passenger hour)

Vehicle Categories	Occupancy (passenger)	Passenger (Tk./hr)	TTC Tk./ vehicle hr.
Heavy/Medium Truck	2	100	200
Small Truck	2	80	160
Bus (large/ medium)	40	88.3	3532.0
Medium Bus	30	79.2	2373.0
Micro Bus	8	75.0	600.0
Car/Utility	4	104.0	416.0
Tempo	8	60.6	484.8
Auto Rickshaw	4	83.0	332.0
Motor Cycle	2	85.3	85.5

Source: RHD Road User Cost, Annual Report for 2004-2005 and SRTPPF, 2013

The values placed by travelers on travel time savings are best established using revealed preference or stated preference survey. In the absence of such survey results there are two options to valuing time savings are:

- Use an empirical relationship between VOT and GDP per head derived using regression between pairs of values from stated and revealed preference studies; and
- Use appropriate income levels of passengers and crews.

The latter approach was used by RHD in their Road User Cost Annual Report for 2004-5. This study supplemented the report with updated passenger survey data 2013.

Table 116 : Financial and economic values of vehicles

Items	Units	Financial or Economic	Heavy Trucks	Medium Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car	Motor Cycle	Auto Rick
New Vehicle	Tk. '000	Financial	8474	3264	2222	6783	2256	3771	6156	3505	210	501
		Economic	6324	2428	1639	5757	1629	2536	2845	2138	125	299
New Tire	Tk. Per Tyre	Financial	44100	44100	16493	38462	23650	7071	11304	6364	1806	2848
		Economic	31046	31046	11613	27077	16650	4978	7963	4482	1270	2001
Maintenance Lab	Tk. Per hour	Financial	121	121	121	121	121	121	121	121	121	121
		Economic	97	97	97	97	97	97	97	97	97	97
Overhead	Tk. '000 per annum	Financial	515	515	231	2806	156	270	275	74	32	29
		Economic	413	413	186	2244	125	215	220	59	26	35
Crew wages	Tk. Per hour	Financial	73	73	42	73	50	42	44	49	0	39
		Economic	58	58	34	58	41	34	36	41	0	32
Fuel – Diesel	Tk. Per Litre	Financial	102	102	102	102	102	102	102	102	0	102
		Economic	84	84	84	84	84	84	84	84	0	84
		Financial	0	0	0	0	0	0	116	116	116	116

Items	Units	Financial or Economic	Heavy Trucks	Medium Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car	Motor Cycle	Auto Rick
Fuel – Petrol	Tk. Per Litre	Economic	0	0	0	0	0	0	95	95	95	95
Lubricants	Tk. Per Litre	Financial	365	365	365	365	365	365	365	365	365	365
		Economic	292	292	292	292	292	292	292	292	292	292

Table 117 : Vehicle Characteristics

Vehicle Characteristics	Heavy Trucks	Medium Truck	Small Truck	Large Bus	Minibus	Microbus	Utility	Car	Auto Rick	Motor Cycle
PCSE	2.50	1.49	1.40	2.14	2-07	1.48	1.27	1.00	0.98	0.47
Fuel Type	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel / Gas	Diesel /Gas	Petrol / Gas	Petrol / Gas	Petrol
No of Tyres	10	6	6	6	6	4	4	4	3	2
Tyre Type	Radial ply	Radial ply	Radial ply	Radial ply	Radial ply	Radial ply	Radial ply	Radial ply	Radial ply	Radial ply
No of Axles	3	2	2	2	2	2	2	2	2	2
Annual km (km)	86,000	80,720	74,317	129,796	66,737	56,780	21,932	49,848	46,148	13,085
Working hours (hrs)	2050	2036	1748	2864	2121	471	863	1276	1695	588

Vehicle Characteristics	Heavy Trucks	Medium Truck	Small Truck	Large Bus	Minibus	Microbus	Utility	Car	Auto Rick	Motor Cycle
Service Life (year)	14	9	8	5	5	6	7	5	5	5
Average no of Passengers	0	0	0	42	20	7	3	3	2	2
Private use (%)	0	0	0	0	0	50	100	100	100	100
Work Related Passenger Trip (%)	0	0	0	22	20	7	16	16	14	14
Gross Vehicle Weight (Kg)	13,000	15,660	5,200	12,500	9,000	2,150	2,800	1,510	320	186

Table 118 : Fuel and Oil Prices

Item	Petrol	Diesel
	US Cent/litre	
Crude oil al US$ 105/BBL (159L)	66.0	66.0
Refining cost : petrol US$ 1.50/ US gal (3.785l)	40.0	
Refining cost: diesel US$ 0.80/US gal(3.785l)		20.0
Sea transport from Gulf to Chittagong US$ 2.00/BBL	5.0	5.0
Chittagong-Dhaka by tanker , VOC say US$ 4.0/vec-km,550km round trip, 25,000l petrol/21,000l diesel	8.0	5.0
Bangladesh distribution and retail at US$ 0.05/liter	5.0	3.0
Total	124.0	99.0

***Source**: Market Statistics, Us Department of Transportation, GTZ: International Fuel Prices*

13.5. HDM-4 Calibration

13.5.1. Introduction

For economic analysis of the project road HDM-4 version 1.3 was employed. The software was configured and calibrated for Bangladesh environment by the Roads and Highways Department (RHD) and was in use since 2001. The calibration was done by the expatriate consultants from Birmingham University who implemented this version in Bangladesh for the first time. Calibration parameters of HDM-4 consisted of a long list of various techno-economic relations such as (i) coefficient of speeds; (ii) coefficient for maintenance cost; (iii) coefficient of tyre wear; coefficient for fuel consumption; (iv) factors for road deterioration; (v) speed-flow parameters; (vi) axle loading factors; (vii) speed limit and speed reduction factor. Calibration parameters are presented below:

13.5.2. Calibration Parameters of HDM-4

The tables below show the calibrated values of coefficients for speeds maintenance cost and tier wear used in HDM analysis.

Table 119: Calibration Factors for speed

Vehicle type	VDES2 km/h	Speed Beta	ARVMAX	Vcurve a0	Vcurve a1	Breaking Power(KW)
H-Truck	88.56	0.11	180	4.8	0.29	200
M-Truck	85.00	0.164	200	4.8	0.29	80.48
S-Truck	80.00	0.191	200	4.8	0.29	38.58
L-Bus	100.00	0.11	180	4.6	0.28	82.50
Minibus	90.00	0.191	200	4.8	0.29	48.72
Microbus	110.00	0.151	203	3.9	0.29	7.89
Utility	110.00	0.151	203	3.9	0.34	12.29
Cars	125.25	0.151	203	3.9	0.34	13.59
Auto-rick	71.85	0.151	203	3.9	0.34	8.43
M-Cycle	110.00	0.151	203	3.9	0.34	1.00

***Source**: HDM Calibration, RHD*

Table 120 : Maintenance Cost Coefficients

Vehicle Type	Labor hour Constant	Parts exponent of labor hour
H-Truck	301.46	0.52
M-Truck	242.3	0.52
S-Truck	242.03	0.52
L-Bus	293.44	0.52
Minibus	242.03	0.52
Microbus	77.14	0.55
Utility	77.14	0.55
Cars	77.14	0.55
Auto-rick	77.14	0.55
M-Cycle	77.14	0.55

***Source:** HDM Calibration, RHD*

Table 121: Fuel Consumption and Tyre Wear Coefficients

Vehicle type	Fuel Consumption		Tyre Wear	
	Idle Fuel ml/s	Kpea	Constant Term dm^3	Wear coefficient $dm^3/J\text{-}m$
H-Truck	1.12	1	0.03529	0.00275
M-Truck	0.37	1	0.02585	0.00201

Vehicle type	Fuel Consumption		Tyre Wear	
	Idle Fuel ml/s	Kpea	Constant Term dm^3	Wear coefficient $dm^3/J\text{-}m$
S-Truck	0.37	1	0.024	0.00187
L-Bus	1.12	1	0.03088	0.00241
Minibus	0.37	1	0.02173	0.00169
Microbus	0.48	1	0.024	0.00187
Utility	0.48	1	0.024	0.00187
Cars	0.36	1	0.02616	0.00204
Auto-rick	0.12	1	0.00639	0.0005
M-Cycle	0.12	1	0.00639	0.0005

Source: *HDM Calibration, RHD*

13.5.3. Road Deterioration Factors

In RHD, these factors were calibrated for Bangladesh by the expatriate consultants from Birmingham University, UK in 2000-2001. Since then RHD has been using these values without any change. Factors are shown in the table below :

Table 122 : Deterioration Factors

Items	Calibration Factors
1. Roughness-age-environment factor	1.100
2. Cracking initiation factor	0.800
3. Cracking progression factor	1.250
4. Rut depth progression factor	1.500
5. Roughness progression factor	1.100
6. Pothole progression factor	1.000
7. Raveling initiation factor	1.000

Source: *HDM Calibration, RHD*

13.5.4. Speed-Flow Parameters

The speed-flow types and their corresponding parameters are given below in the table below which was also calibrated for Bangladesh taken from the HDM Circle, RHD.

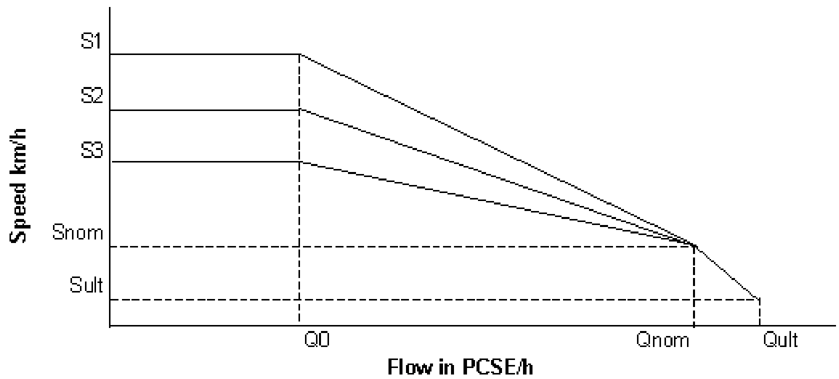
Table 123 : Speed-flow Types

Speed-flow type	Carriageway width	Mean Carriageway width	Shoulder width	Motorized AADT	Non-motorized AADT	Total AADT	% MT	%NMT
Single lane narrow	<3 m	2.66	1.00	532	846	1378	38.61	61.39
Single lane road	3 - 4 m	3.65	1.00	1025	1883	2908	35.25	64.75
Intermediate road	4 - 5.5 m	4.63	1.00	1410	2028	3438	41.01	58.99
Two-lane road	5.5 - 7 m	6.1	1.50	3231	2321	5552	58.20	41.80
Two-lane standard	7 - 9 m	7.66	1.50	4170	2667	6837	60.99	39.01
Two-lane wide	9 - 12 m	10.26	1.50	12175	7879	20054	60.71	39.29
4 lane road	> 12m	15.64	1.50	30731	2866	33597	91.47	8.53

Source: *HDM Calibration, RHD*

13.5.4.1. Three zone speed-flow Model

A three zone speed flow modal was established which demonstrates the speed effect under the volume of traffic flow as shown in figure below



Speed-flow model

13.5.4.2. Final Speed-Flow Model Parameters

Mr. Rodrigo Calio, member of the World Bank Expert Team suggested the following speed flow parameters presented in the table below to be used in HDM-4 analysis in Bangladesh.

Table 124 : Speed-flow model parameters

Speed-flow type	Carriageway width	Mean Carriage way width	% MT	%NMT	XQ1	XQ2	Qult	Actual Qult	Sult
Single Lane Road	<4 m	3.65	35.25	64.75	0.00	0.70	450	180	7.50
Intermediate Road	>4, <= 5.5 m	4.63	41.01	58.99	0.00	0.70	900	360	8.00
Two-lane road	>5.5, <=9 m	6.1	58.20	41.80	0.16	0.90	1050	630	8.78
Two-lane wide	>9, <=12 m	10.26	60.71	39.29	0.15	0.88	1450	950	14.40
4 lane road	> 12m	15.64	91.47	8.53	0.40	0.95	1800	1620	20.00

***Source**: HDM Calibration, RHD*

13.5.5. Equivalent Standard Axle Load Factor

The standard axles of vehicles suggested to be used in HDM run by the Pavement Engineers and Transport Economists are as follows:

Table 125 : ESA Factors used in Pavement Design

Vehicle Category	ESA Factor
Heavy Truck	4.80
Medium Truck	4.62
Light Truck	1.0
Large Bus	1.0
Mini Bus	0.5
Micro Bus	0.1
Utility	0.02
Car	0.00

***Source:** Consultants Assumption, RHD*

Following table shows the Million Equivalent Standard Axles per lane per year that has been used for the configuration setup of different speed-flow types. For each road width traffic volumes were calculated from the RHD Traffic Surveys and were multiplied by the factors mentioned above.

Table 126 : Equivalent Standard Axles

Speed-flow type	Road widths (m)	Both way ESAL	ESAL/Lane	Cum ESAL (MESAL/Lane/yr)
Single lane narrow	<3	311	311	0.11
Single lane road	3 – 4	615	615	0.22
Intermediate road	4 - 5.5	1527	1018	0.37
Two-lane road	5.5 – 7	3584	1792	0.65
Two-lane standard	7 – 9	5446	2723	0.99
Two-lane wide	9 – 12	5102	2551	0.93
4 lane road	> 12	20296	5074	1.85

Source*: HDM Calibration, RHD*

13.5.6. Speed Limits

The speed limit calculation for different speed-flow sections is a complicated process. However, the following formula was used to calculate the limiting speed for different widths.

Speed limit = 1.1*3.6*15.954* EXP (0.049*width)

Table below represents the limiting maximum speeds of vehicles for different road widths.

Table 127 : Limiting Speed of Vehicles

Speed-flow type	Carriageway width	Mean Carriageway width	Speed Limit (km/hr)
Single lane narrow	<3 m	2.66	71.97
Single lane road	3 - 4 m	3.65	75.55
Intermediate road	4 - 5.5 m	4.63	79.27
Two-lane road	5.5 - 7 m	6.1	85.19
Two-lane standard	7 - 9 m	7.66	91.95
Two-lane wide	9 - 12 m	10.26	104.45
4 lane road	> 12m	15.64	135.95

Source*: HDM Calibration, RHD*

13.5.7. Speed Reduction Factors

Under the mixed traffic situation the speed reduction factor is generally used. The reduction of speed of motorized vehicles due to interaction with non-motorized vehicles in the project road is zero, because the main carriageway does not carry any non-motorized vehicle. Only the interactions of motorized vehicles were considered. However, the speed reduction factors used in Bangladesh are as followings.

Table 128 : Speed Reduction Factors

Description	Factor
XNMT (reduction of speed due to NMT vehicles)	1.00
XMT (Reduction of speed due to interaction among MT)	0.95
XFRI (Reduction of speed due to road side friction)	1.00
Speed limit enforcement	1.10

13.5.8. Base Alternative: Routine Maintenance

Routine maintenance features are shown in tabular form below.

Table 129 : Routine Maintenance

Description of items	Intervention	Financial Cost (Tk.)
Routine (Per km/yr)	Scheduled	40,000
Patching (m^2)	Pothole >=1 no	843
Crack seal (m^2)	Cracking >= 25%	128
Edge rep (m^2)	Edge Br >= 1 m^2/km	843

Source: *HDM Calibration, RHD*

13.5.9. RHD Maintenance Strategy and Intervention Criteria

The improvement of the road will be carried out in three years so that the improved roads will be opened to traffic. Normal maintenance will be done afterwards for the whole lifecycle period of 20 years. Normal maintenance includes the following work categories and will be triggered by HDM-4 according to the RHD strategy of yearly condition survey.

Table 130 : RHD Road Maintenance Strategy and Intervention Criteria

Items of works	Intervention criteria	Cost of work item
Holding works	As detailed in the Base Alternative	

Items of works	Intervention criteria	Cost of work item
DBST 25mm @ 25% Cracks.	IRI <= 4, Traffic 100-10,000, Min interval 3 yrs.	Tk. 450/- per Sq. m
Overlay 50mm @ IRI= 4	Total Cracks >= 25% and IRI <=4, Traffic= 10,000 – 100,000, Min interval 5 yrs.	Tk.1111/-per sq. m
Overlay 50mm @ IRI= 4 – 7	IRI=4-7, Traffic= 6,000–10,000, Min interval 5 yrs.	Tk.1111/-per sq. m
Overlay 50mm @ IRI= 4-9	IRI=4-9, Traffic= 100-6000, Min interval 5 yrs.	Tk.1111/-per sq. m
Overlay 60mm @ IRI= 7-9	IRI=7-9, Traffic= 6000-10000, Min interval 5 yrs.	Tk.1325/-per sq. m
Overlay 80mm @ IRI= 4-9	IRI=4-9, Traffic= 10000-100000, Min interval 5 yrs.	Tk.1753/-per sq. m
Rehab 120mm @ IRI=9-12	IRI=9-12, Traffic= 100-2000.	Tk.4406/-per sq. m
Rehab 140mm @ IRI=9-12	IRI=9-12, Traffic=2000-4000.	Tk.5245/-per sq. m
Rehab 150mm @ IRI=9-12	IRI=9-12, Traffic=4000-6000.	Tk.5460/-per sq. m
Rehab 180mm @ IRI=9-12	IRI=9-12, Traffic=6000-10000.	Tk.6513/-per sq. m
Rehab 195mm @ IRI=9-12	IRI=9-12, Traffic=10000-100000.	Tk.6834/-per sq. m
Full Recon 120mm @ IRI>=12	IRI>=12, Traffic=100-2000.	Tk.6085/-per sq. m
Full Recon 140mm @ IRI>=12	IRI>=12, Traffic=2000-4000.	Tk.6924/-per sq. m
Full Recon 150mm @ IRI>=12	IRI>=12, Traffic=4000-6000.	Tk.7139/-per sq. m
Full Recon 180mm @ IRI>=12	IRI>=12, Traffic=6000-10000.	Tk.8192/-per sq. m
Full Recon 195mm @ IRI>=12	IRI>=12, Traffic=10000-100000.	Tk.8514/-per sq. m

Source: *HDM Calibration, RHD*

13.6. Benefits of Normal and Generated Traffic

13.6.1. Normal Traffic

Normal traffic is the existing traffic of the road without new improvement or new investment. It is also increasing overtime at a normal growth rate without project scenario. In case of project case the benefits from normal traffic forms the main benefit stream with higher growth rate. Benefits of normal traffic in a 'with project' scenario are:

Sn* d1* (VOC1-VOC2)

Where Sn is the number of vehicles (AADT), d1 is existing road length, VOC1 = vehicle operating costs 'without' project and VOC2= vehicle operating costs 'with' project.

13.6.2. Generated Traffic

Road improvements induces additional traffic called generated traffic due to cheaper travel costs that attract more journey trips by the existing users or from other routes, times and modes, and encourage longer and more frequent travel. This traffic could be avoided if costs were not reduced. Generated traffic is always referred to additional vehicle traffic on a particular road or corridor due to diversion from other routes and mode or induced traffic. The impact of diverted traffic is for short-term and for the induced traffic is longer term.

The benefit of generated traffic is calculated as 0.5*(T2-T1)*C1-C2) where T1 and T2 are the number of trips made without and with the improvement and C1 and C2 the road user costs without and with the improvement. The benefit of generated traffic is assumed half of the normal traffic's benefit for all four corridors.

13.7. Accident Cost Reduction

13.7.1. Road Accidents – General

Road accident rate per 1000 vehicles on road is the highest in Bangladesh compared to other countries. Accident rate is changing with the change in road geometry from dirt to paved and increase in the vehicle speed. But the new project proposed changes in road geometry which may reduce the rate of accident and associated costs significantly. The proposed gateway corridor includes separate service lanes on both side of the 6-lane dual carriageway expressway separated by barriers. This proposal also includes construction of: (i) flyovers at busy sections, politically sensitive areas such as Jahangir Nagar University, Cantonment area and major junctions; (ii) overpass and under pass to avoid cross vehicles at grade; (iii) pedestrian facilities and foot over bridges; and (iv) queuing lanes and bus bays at toll plazas.

For any given alternative HDM-4 calculates expected accident cost savings using accident frequencies per 100 vehicle km and average accident costs. A reduction in expected accident costs arises from a user-input drop in accident frequency. HDM-4 recognizes three accident types: (i) a fatal accident; (ii) an accident involving injuries but no death; (iii) an accident only causes damages.

13.7.1.1. Accident Statistics

The BRTA accumulates and published national accident statistics. The latest available statistics is for 2011. The ARC of BUET has compiled the accident black spot data along national highways 2007. Available data from both sources are summarized in the tables below:

Table 131 : National Accident Statistics: 2005-2011

Item	2005	2006	2007	2008	2009	2010
Accident:	3322	3549	3910	3662	4427	3381
Fatal	2424	2668	2893	2723		
Serious	631	610	679	658		
Slight	142	127	172	150		
Collision	125	144	166	131		
Casualties:						
Death					3765	2958
Serious injury					2720	2223
Slight injury					564	463
Total					**7049**	**5644**

Source: *BRTA Traffic accident Report, 2008 and ARC, 2011*

Table 132 : Selected National Highway Accident Statistic: 2007

Item	NH1	NH2	NH7
Accident:			
Fatal	179	236	157
Non-fatal	64	127	45
Total:	**243**	**363**	**202**
Casualties:			
Death	326	311	148
Serious injury	226	394	129
Slight injury			
Total	**552**	**705**	**277**

Source: *BUET ARC, 2007*

13.7.2. Accident Data Validity

Many of the compiled data lacks credibility when compared to daily News Paper Reports. In case of fatalities and deaths the country does not follow WHO definition and considers only the spot death. The international definition of a fatality is a death directly attributable to a road accident that takes place within 30 days of the accident. As a WHO suggests that Bangladesh fatality estimate should be increased by 30 percent (Global Status Report on Road safety, 2009).

13.7.3. Accident Severity and Frequency

From the above tables the consultants of PRP estimated the following rate of severity of road accidents in major roads in Bangladesh. Table below shows the accident severity rate in major highways of Bangladesh.

Table 133 : Accident Severity

Data source	Severity per average accident				
	Fatal accident		Non-fatal	All Accident	
	Fatalities	Injuries	Injuries	Fatalities	Injuries
National	1.3	4.0	1.7	0.2	2.1
N4 &N405	1.8	4.0	3.2	0.3	3.3
N5	1.3	4.0	2.9	0.1	3.0
N7	1.0	4.0	2.2	0.2	2.6

Source: *Economic Evaluation report, PRP, RHD, 2011*

From the above statistics of three national highways a country reference case was estimated. The project and reference case is presented in the table below

Table 134: Accident Severity in each category

Accident Category	Reference Case	Option 1 (four lane)	Option 2 (2-lane), GT and DA roads
	Accident per 100m vehicular km		
Fatal	58	46	52
Non-Fatal	319	255	287

Source: *Economic Evaluation report, PRP, RHD, 2011*

13.7.4. Accident Valuation

The capital approach is applied to estimating the value of statistical life (VSL) to estimate an appropriate part of income foregone because of accident al death or injury. The victims of road accident include all income groups. According to BRTA Annual Report, 2008 (latest available) 48% of fatalities were pedestrians. Pedestrians also include all across the income groups. The PRP of RHD, 2011 used the national GDP per head at PPP as a measurement of income foregone. This study adopted the same procedure for calculating accident losses due to death and injury. The assumption of effective working life is assumed 25 years and foregone income according to the age of victims. According to BRTA report the median age of the victims of fatality was in between 25-30. Considering the PPP per capita GDP of 2009-10 the PRP Study estimated the value of per fatality at $14,000 which looks rather low compared to international estimates.The International Road Assessment Program (IRAP) estimated of true cost of road crash was $46,000 in HC approach and $ 76,000 according to pay approach. Considering the HC approach and economy of Bangladesh the study decided to adopt $ 30,000 for income loss and adding 20% for damage and emergency services the ASL was $36,000.

Social cost of serious injury was estimated at 20-45% of fatality and for minor injury at 10% of the fatality i.e. $10000 for serious and $3000 for non-serious injury.

According to BRTA report average fatal road accident involves 1.8 deaths and 4 injuries while no-fatal accidents involve 3.2 persons. This gives the costs of a fatal and non-fatal accident as under:

- Fatal Accident: 1.8x $ 36,000 + 4 x$ 3000 = $ 76,000
- Non-fatal Accident: 3.2 x $3000 = $9600

These estimates are used in the economic analysis of the project road.

13.8. Economic Feasibility Analysis of the Project

13.8.1. Alternative Options in HDM-4

The major components of improvement alternative suggested for Gabtali- Hemayetpur- Savar- Nabinagar- Bipile N5 Highway into 6-lane expressway under PPP Transaction Advisory Services consisted of: (i) Improvement and construction of 24.445 kmexisting ordinary 4-lane highway into a 6-Lane expressway into dual carriageway with a median of 5m,along with 2-lane service road on each side of the expressway separated by barriers; (ii) Earthwork and widening of road embankment all through 24.445 km included; (iii) construction of flexible pavement in partial and full depth; (iv) construction of rigid RCC pavement in urban areas; (v) construction of 9 km of elevated flyover sections, 2 bridges of 100m and other structures needed; (vi) construction of service lanes on both sides of the main carriageway including hard shoulders; (vii) construction of foot over bridges, over passes, under passes, and pedestrian facilities; (vi) land acquisition, resettlement and environmental mitigation measures; (viii) road safety, road marking, ancillary and protective works; (ix); toll plazas and resting places; and (x) construction supervision and management consultants.

Feasibility study of the gateway corridor was carried out using HDM-4 model which considered only two different alternatives: Base Alternative case (zero investment case) and Improvement Alternative case (capital investment case). Base alternative case is called "do minimum option" i.e. only routine maintenance work. Improvement alternative is the project intervention for construction implementation. The results of economic analysis will adjudge the feasibility of such investment in macroeconomic perspective. Financial feasibility is important when private investment under PPP arrangement is sought. Profitability or return on investment for private parties must be sufficiently adequate to cover the risks of investment and protect their interest. This chapter only undertakes economic viability analysis.

13.8.2. Improvement Costs: Financial

Review and updating of project financial costs are being undertaken by the Consultants cost engineers and economist. It was found that costs were calculated meticulously collecting adequate amount of available data and information. They identified 14 items of works and cost centers for preparation of financial costs based on bill of quantities of works (Table 11.8.1). Costs items estimated are for mobilization, earthworks and embankment, pavement and bituminous works, elevated expressway section, bridges and drainage structure, road safety and security works, ancillary works, road marking, river bank protection, engineering services, land acquisition, resettlement, environmental mitigation, physical and price contingencies. They have prepared provisional cost estimate for feasibility level analysis. The final cost will be prepared when detailed and final design is prepared. Costs are prepared for 3 homogeneous traffic sections as well as for entire length of the gateway corridor. Following table presents the estimated cost of the project for feasibility level analysis.

It was found that financial costs including contingencies per km cost for first section Gabtali- Hemayetpur is Tk. 1,499.50 million. For the second section Hemayetpur – Savar per km cost is Tk.1915.03 million while for the third section Savar-Nabinagar-Bipile is Tk. 2,529.73 million. The total project financial cost for entire section is Tk.49,269.50 million including provisions and contingencies.

Table 135 : Financial Cost of Gabtali (Aminbazar) -Hemayetpur- Savar-Nabinagar (Bipile) Expressway

(Taka in Mn)

Items of Civil works and other Components		Gabtali - Aminbazar - Hemayetpur	Hemayetpur-Savar	Savar-Nabinagar-Bipile	Gabtali-Hemayetpur-Savar-Nabinagar (24.445 km)
1	Mobilization& site facilities	16.00	9.91	17.29	42.39
2	Earth work& road embankments	341.19	221.06	385.69	640.94
3	Pavement works Bituminous construction	2060.83	1198.20	2088.65	5347.68
4	Elevated structures & bridges	8831.83	7929.41	19445.36	36206.60
5	Road safety &security works	179.52	116.28	202.88	498.68
6	Ancillary works, divider, footpath, side drains, slope	224.40	145.35	253.59	623.34

Items of Civil works and other Components		Gabtali - Aminbazar - Hemayetpur	Hemayet pur-Savar	Savar-Nabinagar-Bipile	Gabtali-Hemayetpur-Savar-Nabinagar (24.445 km)
7	Road Marking, signs and signals	7.72	4.99	8.72	21.43
8	Riverbank Protective works	120.92	120.92	60.46	302.30
9	Engineering Service and Consult	234.63	194.92	449.25	879.80
10	Physical Contingency misc. etc (10%)	235.63	194.92	449.25	879.80
11	Price Escalation @5.5% for 2 years	942.54	779.69	1797.01	3501.24
12	Relocation utilities	110	39.6	44.75	194.35
13	Land Acquisition (Including 200% Premium) & Resettlement	11019.88	7138.43	12452.47	30610.8
14	EMP& social SP	36.00	23.32	40.68	100.00
16	Total Tk. million	13196.26	10915.68	25155.16	49266.95
17	Total US $ mill	155.25	128.41	295.94	579.61
18	Per km. Tk. Mill	1499.50	1915.03	2529.42	2015.42
19	Per km. US $ mill	17.64	22.52	29.57	23.71

***Source**: PPP Advisory Consultants Estimate, 2020*

Among the total costs 21% comes from physical and price contingencies which are accounting provisions not real costs, therefore are excluded from the economic and financial analysis. Moreover the costs of land acquisition and PAP resettlement is transfer payments for properties used in beneficial purposes made by the government to the public and not concerned the private concessionaire can be omitted from the analysis. However the government obligation is identified to provide land acquisition, resettlement, relocation of utilities and environmental management. Total cost considered is project construction cost and does not include cost of RAP and other miscellaneous cost.

13.8.3. Improvement Costs: Economic

The economic costs are derived from the financial costs deducting taxes and duties from the costs of imported equipment and materials and applying a conversion factor of 0.8 to non-traded items. This has followed the pricing assumptions described in preceding sections. All costs are estimated in local currency units for construction and maintenance. Construction costs included physical contingencies, land acquisition, environmental mitigation and resettlement excluding direct taxes and VAT. Price contingencies was not considered as economic cost component and omitted. For imported foreign materials economic price was obtained using international border price i.e. fob price plus economic transport costs. Shadow wage rate has to be applied for labour used. When the financial costs are still being confirmed the economic cost was based on 0.80 social conversion rate.

Table 136 : Economic Improvement Costs

Road Segments	Financial Cost (Tk. mill)	Economic Cost (Tk. mill)	Financial Cost per km (Tk. mill)	Economic Cost per km (US$ mill)
Gabtali (Aminbazar)-Hemayetpur	13196.26	11612.70	1499.50	1,319.56
Hemayetpur- Savar	10915.68	9,605.79	1915.03	1,685.22
Savar-Nabinagar-Bipile	25155.16	22,136.54	2529.42	2,225.88
Gateway Corridor: Total	**49,267.10**	**43,355.03**	**1981.31**	**1,743.55**

Source: *PPP Advisory Consultants Estimate, 2020*

13.8.4. Maintenance Costs: Financial and Economic

HDM-4 Calibration in Bangladesh followed the RHD formulated Road Maintenance Strategy in 2008-09. The strategy enlisted potential interventions after improvement and unit price for each alternative intervention is estimated and adopted. All maintenance routine or periodic including overlay, DBST, improvement and rehabilitation has been described with criteria of intervention. Provision of annual cost escalation was suggested. Economic maintenance costs have been estimated for routine and periodic maintenance. Table below presents the economic maintenance costs of RHD strategy used in the review calibration and run:

Table 137 : Maintenance Cost

Works	Economic Cost	Intervention Criteria
Routine maintenance beyond carriageway	Tk.62790/per km	Annually
Pothole patching	Tk.1255/per m2	At ≥ 2km (time lag of 6 months)
Crack sealing	Tk.269/per m2	All structural cracking ≥ 10%
50mm overlay	Tk.897/m2	IRI≤ 6 and interval ≥ 5 years
Reconstruction 120mm	Tk.4485/m2	IRI≥ 8

Source: *RHD, PPP Advisory Consultants, 2020*

13.8.5. Investment Scheduling

The assumption of investment scheduling considered 3 year construction period as standard timing for medium type project after the contract and issuing proceed to work order. The starting year of improvements now uncertain due to Covid-19 pandemic, hopefully this will end soon and project work can start from year 2021 with having year-wise costs splits as scheduled. The cost composition of feasibility study shows that highest allocation was for elevated expressway section including other structures at 61% followed by the pavement construction 15%.

13.8.6. Economic Analysis of Gabtali (Aminbazar)-Nabinagar- Bipile Gateway Corridor

Economic analyses are carried out for all three segments of Gabtali- Savar- Nabinagar-BipileN5expressway employing the HDM-4. The summary results of programme run are presented in Tables 11.8.5. However, the programme run was made with provisional feasibility level costs as many of the cost items were not finalized due to changes in design and finalization of resettlement costs.

For economic evaluation all relevant costs and benefits are expressed in economic terms. Life cycle cost 'without project' involved road repair and maintenance cost, vehicle operation cost, vehicle delay time cost and passenger time cost. The life cycle cost with project involved construction and maintenance cost, reduced vehicle operating costs, reduced vehicle time costs and reduced passenger time costs and reduced accident costs. Economic analysis was done to calculate net present value (NPV) and economic internal rate of returns (EIRR) for adjudging economic viability of the project. HDM-4 was run for the base case first then for proposed improvement project case. This has compared the streams of costs and benefits under 'with' and 'without' the project scenarios.

13.8.7. Results of Economic Analysis

The results of the review and updating of the feasibility can be presented in the table below:

Table 138 : Summary of Economic Evaluation Results

Road Segments	EIRR (%)	Net Present Value (NPV) (Tk. mill)	NPV/Cost Ratio (agency)	Benefit/ Cost Ratio (capital)
Gabtali-Hemayetpur	38.5	8513.69	0.908	1.823
Hemmayetpur-Savar Bazar	28.8	4335.21	0.559	1.492
Savar- Nabinagar-Bipile	19.8	5440.22	0.304	1.225
Total: Gateway Corridor	**24.44**	**17,487.11**	**0.500**	**1.436**

***Source**: PPP Advisory Consultants Estimate, 2020*

The study shows that the economic internal rate of return (EIRR) for overall gateway corridor is 24.44% while the NPV is Tk.17,487.11 million, NPV/RAC ratio is 0.500 and BCR is 1.436. The results of different traffic section showed that the economic internal rates of return (EIRR) for all three are above 12 percent of cut off rate for viability. The NPVs are positive and robust with Tk. 8,513.69 million, Tk. 4,335.21 million, and 5,440.22 million respectively. The BC ratios are also positive and greater than one at 1.823, 1.492 and 1.225 respectively. The results in general are robust therefore the project is economically viable. Among the sections Gabtali- Hemayetpur has the highest EIRR at 38.5% and with higher values of other indicators resulted in lowest per km cost. On the contrary the EIRR of Savar-Nabinagar-Bipile is the lowest at 19.8% but much above the cut off rate. Other indicators are also lower compared to previous two sections although they are positive and robust. Therefore, the project as well as individual sections are economically viable.

13.8.8. Sensitivity Tests

Sensitivity tests are "litmus tests" of viability indicators of a project, if successful, can be implemented beyond doubt. A sensitivity analysis has been carried out and compared with the base case economic indicators determined by the analysis. Sensitivity tests were done as routine for project risk analysis in order to adjudge the tenacity of the economic viability in case of vulnerability of assumed parameters which may come up during or after the implementation. Two sensitive parameters are usually tested for risks and vulnerability are increasing capital cost and decreasing benefits due to less than expected traffic or other benefits. Three tests are carried out for see the impact of their changes such as (i) increasing cost by 15%; (ii) reducing traffic benefits by 15% and (iii) combined impact of both costs and benefits. The summary results of sensitivity analysis are presented in table below:

Table 139 : Summary Results of Sensitivity Analysis

SL No.	Road Segments	Base case			Sensitivity 15% increase in cost and decrease in benefit		
					Cost	Benefit	Combined
		EIRR (%)	NPV (Tk. Mill)	NPV/ RAC	EIRR (%)	EIRR (%)	EIRR (%)
1	Gabtoli-Hemayetpur	38.5	8,513.69	0.908	33.1	32.2	27.0
2	Hemayetpur-Savar	28.8	4,335.21	0.559	23.8	23.1	18.2
3	Savar-Nabinagar-Baipayl	19.8	5,440.22	0.304	15.8	15.2	11.3
Overall Corridor		**24.44**	**17,487.11**	**0.500**	**22.3**	**21.5**	**16.7**

Source: *PPP Advisory Consultants Estimate, 2020*

The above results are self-explanatory in case of all three tests. The results of sensitivity tests are also robust for all three tests except for combined impacts of Savar-Nabinnagar-Bipile section. The results show that the project will generate sufficient economic returns to stand viable even the capital and construction cost goes up to 15% and traffic benefits reduce by 15%. In those cases, EIRRs are above 12% return on investment. In case of combined joint adverse effects, most of the EIRRs are above 12% except Savar-Nabnagar-Bipile section. The EIRR comes at 11.3% slight below usual cut off rate but above the infrastructure cut off rate of 10% (ADB). This is because of high construction cost per km due to construction of long elevated section along PATC, Jahangir Nagar University, Savar Cantonment, Golf Club and National Monument with a proposed tunnel at Nabinagar. But when we consider over all corridor results of sensitivity tests are found combined EIRR at 16.7% robust and positive. Therefore, even the cost for one section is higher still the project is satisfactorily viable.

However, in the analysis it is found that impacts of cost escalation are more sensitive than changes in the traffic benefits. The authorities should therefore, be more vigilant toward financial control and management to keep the costs within the budget

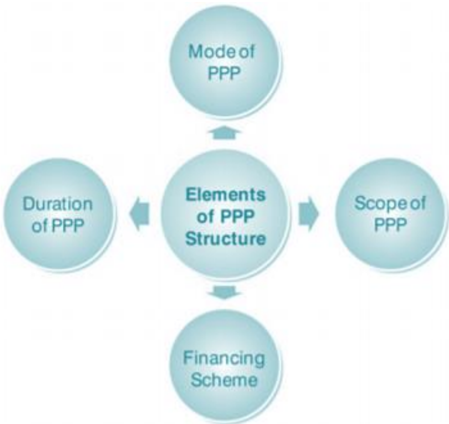
13.8.9. Summary and Conclusions

The project gateway corridor is very important for the road transport network development around the capital city Dhaka and surrounding urban agglomerations connecting rest of the country. The project linking with ongoing SASEC-I and II projects, Padma Bridge, Dhaka Eastern Bypass will facilitate sub-regional connectivity of Bangladesh with neighbouring landlocked SAARC countries of Nepal, Bhutan and Eastern States of India. A great potential for expanding sub-regional and bi-lateral trade, transit and transport to be explored to the interest of economic development of the member countries and the beneficiary communities in the region. The review of the results of base cases and sensitivity tests shows that all segments of the road are economically viable with robust rates of return. The summary of HDM-4 analysis is presented in Table 11.9.10. The project can be recommended for proceeding to the next step of preparation towards the implementation.

14. PPP Project Structuring

Infrastructure development through PPP mode is usually more complex as opposed to the development of infrastructure through traditional public sector procurement route. A PPP project has several stakeholders representing diverse interests.

Figure 51 : Elements of PPP Structure



A well-structured project ensures that the relationship between the various components is complementary leading to the achievement of the desired outcomes optimally. Project structuring for a project involves the process of configuring a particular project in a manner that comprehensively addresses the various facets of project development and implementation economically and sustainably.

For arriving at an optimal project structure for this engagement, the consultant has analyzed the PPP environment in Bangladesh for undertaking similar projects along with the study of the international practices to arrive at a bankable project structure for Upgradation of Gabtoli-Savar-Nabinagar into 4-Lane Expressway on PPP.

To design a project structure under a PPP framework, different options are analysed to ensure that the sharing of risks between the parties is done in a manner that creates a win-win situation for both the public and private partners and also provides maximum value for delivering public infrastructure in a country.

14.1. Assessment of PPP Models in the Infrastructure Sector of Bangladesh

PPPs can be categorized into various models encompassing different roles, ownership arrangements, and allocations of risks between the private and public partners. There are a range of service delivery models that allocate responsibilities and risks between the public and private partners in different ways, which need be considered while analysing the development of PPP projects.

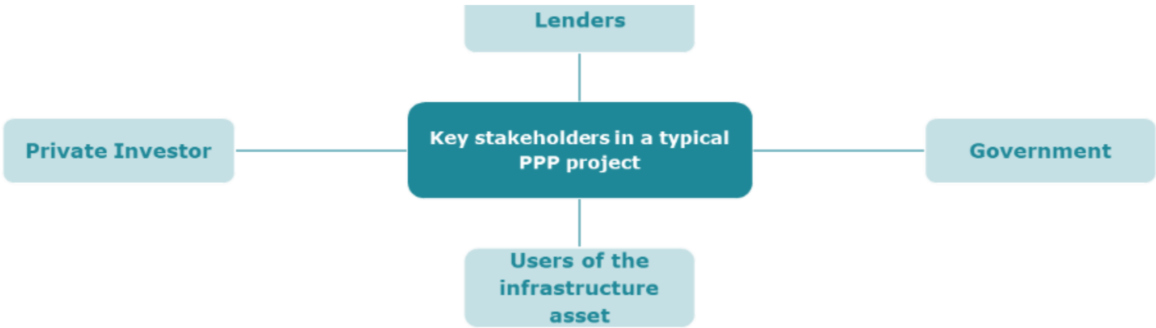
As per "Your Guide to PPP in Bangladesh" and " PPP Program Update of 2017" published by PPPA- Bangladesh, the various PPP contractual models prevalent in Bangladesh under the PPP framework for infrastructure development have been defined as the following :

a) BOT/DBFOM/BTL
b) BOO/BOOT
c) Management and operating contracts
d) Lease and affermages
e) Joint venture and partial divestiture

14.1.1. Key Stakeholders in a PPP Project

The following diagram represents different stakeholders in a typical PPP infrastructure project. In the case of the current project, the Government Agency shall be PPPA and implementing Agency – RHD of Bangladesh which represents public interests followed by the private investor and the lenders who fund the project and the in the end , the users of the infrastructure asset. Every PPP project must balance these diverse interests in order to ensure the success of the project on PPP.

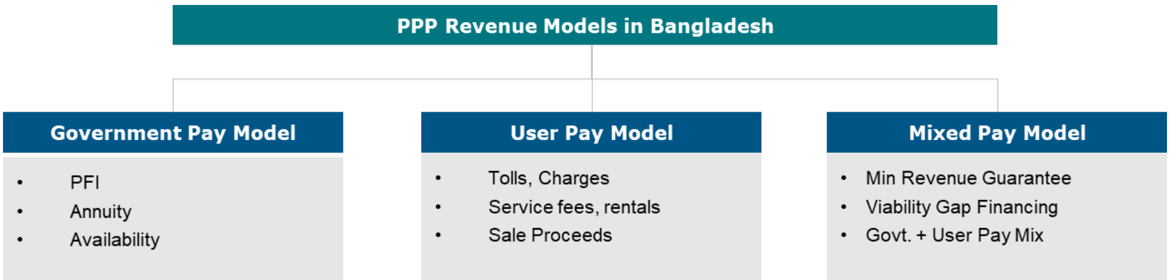
Figure 52 : Key Stakeholders in a PPP Project



14.1.2. PPP Revenue Models in Bangladesh

As per the " PPP Program Update of 2017" published by PPPA- Bangladesh, the PPP revenue models explored for various sectors in Bangladesh for the PPP models defined above have been categorized into the following:

Figure 53 : PPP Revenue Models in Bangladesh



14.1.3. PPPs in the Road Sector of Bangladesh

In the case of Bangladesh, while the PPPA acts as the nodal agency in finalizing and approving the project structure for undertaking any PPP project in the country, RHD plays the key role in designing the structure for undertaking PPP projects in the road sector.

The project durations for Road sector PPP projects usually range between 15-30 years to to enable the Concessionaire to make acceptable returns on the investments made. This is where it becomes imperative to ensure that the project is governed by an efficient contract and risk allocation mechanism. A well-structured PPP contract enables all stakeholders to better deploy resources, promote efficiency and transparency, as well as deliver the intended project benefits. One of the key tenants of an appropriate project structure is the idea that risk must be allocated to the party best suited to manage, minimise and mitigate the said risk.

From the procurement perspective, the project structure and contracting mechanism must be robust enough to ensure sufficient market interest and acceptability from the private sector and at the same time minimize the impact on government resources.

With the above context, this chapter outlines the assessment of various PPP structuring models for undertaking a road project for arriving at the optimum project structure. The framework and the key considerations involved in the assessment are:

1. Assessment of relevant PPP models for engaging private sectors in the road sector
2. Risk Assessment across identified PPP models and selection of a preferred model
3. Developing a risk allocation matrix for the identified model for development

Based on the above defined models, prevent practice and past precedents in Bangladesh road sector PPPs and the existing trends in undertaking Road sector PPP projects internationally, we have undertaken an assessment to arrive at the required model for development.

Before weighing the relative pros and cons of different PPP models, it is imperative to understand the development of road sector projects typically involve granting a concession to the private party to develop and operate the asset. The different types of concessions, their nuances and differentiating features followed across internationally in the road sector are presented below:

BOT Models			Hybrid Model
Toll	Annuity/ Availability Payments	Shadow Payments	HAM

14.1.3.1. BOT models

In case of BOT the private entity undertakes the construction, operation and maintenance for a specified time under a contract or franchise agreement with the public entity where the modality adopted pertaining to road sector development involves the DBFOT (Design-Build-Finance-Operate-Transfer) mode where the private entity is responsible for Design, Building, Financing and operating of the facility, which after the specified duration of the concession is transferred by to the public entity.

The Roads and Highways sector globally has been a front-runner in experimenting with various delivery models and considering the prevalent models, which have been deployed for delivering similar projects. While BOT has been the preferred mode, various BOT models with different approaches to financing and revenue mechanisms have been implemented successfully. The key BOT models followed across PPPs in the road sector internationally involves the following:

1. BOT-Toll

Under this model, the Concessionaire after the construction of the asset, is allowed to charge facility users appropriate fees, rentals, and charges, and then transfers the facility to the public entity at the end of the specified period.

In such a BOT arrangement, the Concessionaire would provide a service or ensure availability directly to the Expressway users in return for which it is allowed to charge and collect approved tariffs. Further, there are two PPP modes that could be explored under BOT (Toll), namely:

a. BOT - Toll + Capital Grant: The support from the government in such a case is in the form of an upfront grant payment during the construction period.

b. BOT – Toll + Availability payments: The support from the government in such a case is in the form of availability payments spread over the years during O&M period.

2. BOT-Annuity/ Availability Based Payments:

These contracts are seen as a hybrid of BOT and Management Contract. BOT-Annuity limits the rights of the concessionaire in terms of retention of collected user charges of the concessionaire. In this case, user charges are retained by the public entity while the private entity is compensated in the form of annual / semi-annual payments for the duration of the project.

In such a structure, the Concessionaire would provide the service or ensure availability directly to the Expressway users and shall be compensated by the Authority. The compensation would be in the form of pre-determined payments with deductions for service failures or unavailability of the Project facility.

3. BOT- Shadow Payments:

In such a BOT arrangement, the Concessionaire would provide the service or ensure its availability directly to the Expressway users and shall be compensated by the Authority for the number of the users using the Project.

In this model, the Concessionaire will retain the demand risk; however, the price risk will be borne by public sector. Such an arrangement will not provide any additional financial or affordability related benefit to the Authority as no revenue will be collected by the public sector through tolls and thus, will not yield an incremental benefit for them over other option

> BOT Annuity/Availability payments is the emerging model across the road sector in Bangladesh where in major ongoing projects, a Minimum Revenue Guarantee or a Currency Risk Mitigation Mechanism is proposed by the Government in order to provide comfort to the Concessionaires to cover traffic risks and currency fluctuation risks.

Other than the BOT models that act as a successful precedent for Road sector PPPs across countries , there are other innovative models being explored by developing counties in the recent years where the HAM is importance in these countries.

14.1.3.2. HAM

Other than the BOT model, another PPP mode that is being experimented recently is the Hybrid model wherein external assistance is used to provide upfront grant during construction period and with Annuity payments are made during the operations period where the authority of revenue collection lies with the Government. If external assistance is taken for upfront grant contribution during construction period, it also segregates debt service obligation of Road Development Agency from Annuity payment obligations.

The HAM model typically attracts a different profile of developer. Such developers would be interested in taking long-term risk and maintenance obligations. When compared to Annuity projects, such model provides lower NPV of overall payments from Road Development Agency and reduces equity requirements from developers as well as risk perception and thus possible reduction in return expectations. Such projects also have good bankability from lender perspective.

While there are different payment mechanism defined under the BOT models, as a combination of the BOT Annuity and Management contract, the HAM model defines financing of the project by the Government with 40% during the construction period and the remaining 60% during the operations period linked to the revenue collection on the project stretch by Government.

14.1.3.3. HAM + Toll

Based on the HAM model, another variant which can be explored is the is the Hybrid + Toll model wherein the public sector provides upfront grant during construction period and Annuity payments are made during the operations period. The authority of toll collection in this case is handed over to the concessionaire to introduce a safeguard mechanism of revenue flow to the concessionaire.

14.2. Risk Assessment

For arriving at an optimal project structure, appropriate risk sharing between the parties in a contract is key to determining selection of the preferred model for development and arriving at the bankable project structure.

A risk assessment of the Project section is based on the understanding of international Highway and Expressway PPP projects as well as the legal and institutional framework of the country. As part of the risk assessment, the broad level risks would first need to be identified to understand the allocation between different PPP models for development.

Section 26(2) of the PPP Act 2015 allows the inclusion of terms relating to risk sharing in the contract. The PPP Screening Manual 2013, Criteria 8.1., provides that in order to assess the level of compliance with this criterion, the PPP Proposal needs to include a tentative risk allocation matrix, which is to be in accordance with internationally accepted risk allocation schemes.

Well-developed projects identify risks up front to understand the allocation to decide on the final model, and accordingly design the institutional arrangements, the financing package, and the contractual agreements to best mitigate and manage those risks.

Based on arriving at the shortlisted model for development, the risks than shall be identified in details and will be allocated, managed and mitigated efficiently to ensure the success of the Project which have been detailed out in the subsequent sections. For arriving at the risk analysis for this project, the key aspects that are considered include:

- Identification of key risks for the Project
- Basis for allocation, management and mitigation of key risks impacting road sector projects in general
- Inputs from initial market sounding, past precedents and international benchmarking

The project structure emanates from an iterative process of role, responsibility and risk allocation to the various parties. The financing and revenue mechanism and the associated risks for a PPP project is crucial for arriving at the preferred model for development. Principally, the revenue mechanism for road sector PPP projects can be user pays or government pays. The payment mechanisms – Availability Payments, Shadow Toll and Toll linked payments– vary in terms of allocation of revenue risk comprising of demand or traffic risk as well as collection and price risk and Government payment risk. The broad risk allocation for the PPP models in the road sector has been illustrated below:

Table 140 : Risk Allocation for the Concessionaire

Mode	Source of Funding	Risks borne by the Concessionaire		
		Revenue Risk	O&M Risk	Regulatory Risk
BOT Annuity/ Availability Based Payments)	Funded by Concessionaire- Government periodically reimburses through annuity payments from the budget	No	Yes	Yes
BOT-Toll	Funded by developer through equity and debt	Yes	Yes	Yes
HAM	Funded by both budgetary allocation and the developer	No	Yes	Yes
HAM- Toll	Funded by both budgetary allocation and the developer	Yes	Yes	Yes

In a PPP model, the test of how the private sector can handle a particular risk is the cost that it would assign to managing it. BOT (Toll) mode has proven to be more suited for implementation where there is a possibility of established traffic while Availability Payment and Shadow Toll mode are better suited where there is uncertainty in traffic regime.

Further, HAM model is preferred to safeguard the concessionaire in terms of financing of the project and ensuring availability of payments for project development. The risk allocation for the Concessionaire in terms of financing and revenue for the different models have been detailed out. Further, based on the financial assessment undertaken for this project, it can be seen from the tabulated financial assessment; the HAM mode will have a lower financial impact on Government resources and would be viable for undertaking this project:

Table 141 : Financial Assessment of impact of PPP Modality

Sl.	Description	Project NPV
		BDT Cr
1.	BOT Toll + Annuity	1,428.63
2.	BOT Toll	-2,760.64
3.	HAM	2,793.58
4.	HAM + Toll	3,033.76

In terms of International Best Practices, Road Development Agencies in various countries are in the process of experimenting and selecting optimal PPP models for various projects using a programmatic approach. Basic premise of such programmatic approach is that tolling, wherever feasible, is considered as the most preferred source of financing.

In view of current scenario of budgetary constraints with respect to project requirements, it can be assumed that tolling would continue to be most preferred source of funding for some time in the emerging PPPs in the road sector and shall act as a foundation for future projects in the country like Bangladesh. While developing programmatic approach for identified core networks / priority corridor, the underlying idea is to select PPP models which meet requirements of the project as well as which are in sync with the fund availability profile for selected model shall be the optimal choice for the project stretch.

Preferred Model for Development – HAM Modality

The advantage of HAM model is that it gives enough liquidity to the concessionaire and the financial risk is shared by the government. While the private partner continues to bear the construction and maintenance risks as in the case of BOT (toll) model, he is required only to partly bear the financing risk.

While countries like India has explored this Model and is gaining momentum in its adoption for many more future projects with its acceptance in the market. This model shall be the suitable option for this project to provide a valuable proposition to GoB with the emerging PPPs in the country and to create a sustainable model in the long run.

The broad list of roles and responsibilities have been detailed out below:

Table 142 : Roles and Responsibilities under the HAM and HAM+ Toll Model

Sl.	Key Activity	Primary Responsibility	Remarks
1	**Project Design**		
1a	Basic Design	Public	The basic design will be finalized on behalf of the government by the technical consultant
1b	Technical Design	Private	The technical design will be finalized by the government after design proposed by the concessionaire
1c	Construction Design	Private	To be undertaken by Concessionaire and approved by the government agency prior to commencement of the construction
2	**Build/ Construct**	Private	To be undertaken by the concessionaire in accordance with the approved design
3	**Finance**		
3a	BOT Capital	Private	To be raised by the Concessionaire
	Equity	Private	To be added
	Debt	Private	To be added
3b	Govt's Contribution	Public	40% of the Project Cost as Upfront Capital Contribution 60% of Project Cost during Operation Period linked to Availability Payments/ Annuity
4	**Operate**	Public : HAM Private : HAM+Toll	**HAM**: Operation by the Authority in case of HAM Model. The Authority will be responsible for collection of toll for the purpose of revenue generation. The Concessionaire will be responsible for the maintenance.

Sl.	Key Activity	Primary Responsibility	Remarks
			HAM + Toll: The Concessionaire will be responsible for operation and maintenance. The Concessionaire will be responsible for collection of toll for the purpose of revenue generation
5	**Transfer**	Shared	Primary responsibility of the concessionaire to transfer the asset back to the government agency as per the conditions stipulated in the Project Agreement. The government agency to ensure smooth transfer of asset and hence bear secondary responsibility.

14.3. Risk Allocation Matrix

Based on the initial level of risk assessment for the PPP models for arriving at the preferred model for development, there is a need to detail out the risk allocation between the public and private entity which shall act as a guiding framework for designing the Project Development Agreement between both the parties. The following figure highlights the approach for risk assessment and allocation:

Figure 54 : Risk Allocation Matrix

Risk Identification
- Identify detailed risks associated with the Project section based on international experience and initial market sounding

Risk Allocation
- Allocation of the identified risks to parties best placed to manage such risks

Risk Management and Mitigation
- The next step involves defining measures to manage such risks for defining a Robust Project Agreement with clearly defined potential mitigation measures for respective stakeholders. This shall establish a project monitoring and evaluation mechanism while maintaining clear lines of accountability between stakeholders

14.3.1. Risk Identification

The broad list of risks associated with the Project can be broadly classified into four categories:

- **Project specific risks:** These risks are Project specific and to some extent are controllable by the Concessionaire.

- **Sponsor or counterparty risks:** The Authority and the sponsors can mitigate these risks to some extent.
- **Economic and Financing risks:** These risks affect the project financials and returns.
- **General and country risks:** These risks are associated with the political, economic and legal environment of the host country, over which the private Investor would have little or no control.

These have further been detailed out below:

1. Project Specific Risks

Project specific risks refer to risks that are generally within the control of the private Investor. These risks include design risks, site risks, construction risks, operation risks, insurance risks, etc.

a) Design risks

These risks are primarily associated with the design phase of the project life cycle and include risks pertaining to change in design standards, output specifications, failure of design, delays in design approvals, etc. The Concessionaire could mitigate most of these risks and the exposure to these risks depend upon the capability of the Concessionaire. In some cases, risks associated with the approvals required from the Authority would be allocated to the Authority and where approvals/consents are required from other Government bodies, the Authority may extend suitable support. However, the primary responsibility lies with the Concessionaire.

b) Site risks

These include risks pertaining to land acquisition, right of way, title claims, access rights, ground conditions, discovery of hazardous materials, etc. Delays in land acquisition are one of the major issues for Project delays or termination of infrastructure projects. The Authority has to play a significant role to ensure that land acquisition is smooth and the land free from encumbrances is provided to the Concessionaire timely.

c) Construction risks

These risks are associated with the construction phase of the project life cycle and include risks pertaining to time overruns, cost overruns, failure to meet technical specifications, etc. Most of these risks could be mitigated by the Concessionaire except in cases where the risks such as overruns are due to factors beyond the control of the Concessionaire.

d) Operation risks

The risks include performance risks, demand, tariff risks, etc. The Concessionaire is required to meet the performance standards for the Project. Such risks could be mitigated by ensuring selection of capable and efficient private Investor for the Project and formalising a criterion for penalties in case the Concessionaire does not meet the performance requirements. For the Project, the revenue and demand risks are very critical given the uncertainties. It is recommended that the Authority retain the revenue risks in case of HAM model.

e) Insurance risks

The Project must be suitably insured during both the construction and O&M phases. The insurance should ensure sufficient coverage of all Project assets.

2. Sponsor risks

The Authority can mitigate these risks, to some extent. For the Project, one of the major constraints for the bidders and financiers is the disbursement of Government Financial Support by the Government.

3. Economic and Financing Risks

These include the risks pertaining to inflation, foreign exchange and financial closure of the Project. These risks could have substantial impact on the project returns and financial viability of the Project. While inflation risks are to be assumed by the Concessionaire, it may not be possible for the Concessionaire to bear such risks beyond a certain level of increase in inflation. In such cases, there could be provision for indexation. The Project may also assume substantial financing from foreign debt market and is thus prone to foreign exchange risk.

4. Country Risks

These risks include the country risks, change in law, force majeure, etc. While generally such risks are unlikely to occur during the course of the Project, certain steps and measures have to be taken to assure the interest and active participation from the bidders.

14.3.2. Risk Allocation

Once the risks have been identified, they have to be allocated and managed efficiently to ensure the success of the Project. There are three overriding considerations when deciding the risk allocation for a PPP Project:

- Risks should be borne by the party most suited to deal with it, in terms of control or influence and costs.
- All substantial project risks that have been identified earlier should be allocated optimally between the parties and should be bound by contractual obligations.
- The risk structure has to be sufficiently sound to cope with a combination of pessimistic scenarios for the Project.

Risks involved in the Project have to be allocated and managed on a case-by-case basis. Normally, however, the private Investor will agree to bear the risks that they are familiar with, such as most development risks, construction and completion risks and operating risks.

14.3.3. Risk Management and mitigation

The basic allocation of risk would need to be defined in the Project Agreement between the Concessionaire and the Government Agency awarding the PPP project. This Agreement would need to define the commitments of each party, including how risks are to be allocated or shared between them. Subsequently, the private Investor will proceed to negotiate and sign a series of contracts with other Project participants and the mitigation mechanisms shall be designed and defined accordingly.

Addressing the key risks pointed out by the potential investors and the international experience of executing road sector PPPs across various developing economies, the following detailed risk allocation matrix lists down the allocation and mitigation mechanism for the identified risks:

Table 143 : Risk Mitigation Matrix

S. No	Risk Event	Description	Risk Significance and Allocation Govt. (G)/ Private (P)/ Shared (S)	Risk Mitigation Measures
Project Specific Risks				
1.	**Design Risk**			
1.1.	**Finalization and Approval of Construction Designs**	The Concessionaire will prepare the detailed construction design for the Projects. Given that the technical design shall be provided by the Government Agency, there is risk that: • The technical design of the Project is not adequate for the purpose • the construction design is not in alignment with the applicable standards and specifications • change in design may be required to improve project performance	P/G*	This risk will be allocated to the Concessionaire, who will be responsible for undertaking its own due diligence of the adequacy of the technical design and its compliance with the output/performance specifications. In case, a change in design is required in a rare instance, the risk would be allocated as: • Risk shall be borne by the Concessionaire for any discrepancy in the construction design. • * Risk shall be borne by the Government Agency if they, have requested a change in the design, for reasons not attributable to the Concessionaire. To mitigate risk, the Concessionaire could be required to furnish a design warranty and design vetted by accrediting agency/ institution for the approved output specifications. *An Independent unit of the Government Agency or Government Agency itself shall determine if the proposed design meets the

S. No	Risk Event	Description	Risk Significance and Allocation Govt. (G)/ Private (P)/ Shared (S)	Risk Mitigation Measures
				approved specifications to avoid any risk of failure of construction design.
1.2.	**Delays in Design Approvals**	Delay in approvals by the Government Agency of the design submitted by the Concessionaire could lead to delays in the commencement of the construction.	P/G*	Getting approvals shall be the responsibility of the Concessionaire. *The responsibility of granting approval is vested in the Authority. It shall do so within a specified period and/or provide its observations, without which the approval would be deemed.
2.	**Site Risk**			
2.1	**Land acquisition**	This includes the risk of not acquiring and making requisite land available for the Project. The handover readiness includes ensuring that the land is free of encroachments and encumbrances. Acquiring legal status of the land could also be a potential risk, which may lead to Project delays and/or increase costs including the risk of adverse title claims	G	Land Acquisition including Right of Way is the Authority's responsibility and is the condition precedent for the Authority by a specified time, failing which it shall be liable to compensate the concessionaire The need for resettlement along the Project stretch should be evaluated as soon as Project preparation starts. The land titles related due diligence should also be undertaken, allowing time to make necessary arrangements for land acquisition.
2.2	**Environmental Risk**	The risk of the environmental conditions affecting the Project, leading to a risk of damaging the environment.	S	• The Concessionaire shall bear the primary responsibility to manage the environmental impact and shall prepare an Environmental Management Plan. The

S. No	Risk Event	Description	Risk Significance and Allocation Govt. (G)/ Private (P)/ Shared (S)	Risk Mitigation Measures
				EMP shall be reviewed by the Government Agency and shall be approved as per applicable Laws. • The pre-existing assessment of conditions and their impact, which cannot be adequately addressed or priced, may need to be retained by the Government Agency.
2.3	**Social Risk**	This covers the social risks affecting the Project, and resettlement and rehabilitation of affected persons. The subsequent risk of impact to indigenous people, communities and culture/heritage and gender risk	G	The Government Agency shall retain the responsibility of mitigating the social risks and duly account for the same as part of the Resettlement and Rehabilitation costs.
3.	**Construction Risk**			
3.1	**Cost Overruns – not Force Majeure**	Cost overruns caused by the Concessionaire's failure to properly account for the costs of the Project.	P	Sub-contracts of the Concessionaire for construction may be based on a fixed price and may limit variations within a specified limit of that price.
3.2	**Cost Overruns due to Variations**	It covers the risk of any change in the output requirements, scope and minimum performance specifications and standards of the Project after the commencement of construction, as requested by the Authority.	G	The Authority will pay for variations it initiates. The risk shall be mitigated by the finalization of design/output specifications before contract signing.

S. No	Risk Event	Description	Risk Significance and Allocation Govt. (G)/ Private (P)/ Shared (S)	Risk Mitigation Measures
		The Authority will be liable to bear the costs of any variations it causes to the Project's design after contract signing. Thus, the scope variation after contract signing could be costlier.		
3.3	**Cost Overruns – Force Majeure**	Force Majeure entitles the Concessionaire to be relieved of its obligations but not of additional costs. Force Majeure events can significantly affect Project returns. Further, cost overruns due to Force Majeure are difficult to determine.	S/ G*	• Force Majeure due to non-political events to be shared. • Force Majeure due to political events in the country shall be be borne by the Government.
3.4	**Requisite approvals, licenses and permits**	This covers the failure to obtain or maintain permits, licences and approvals required for constructing and operating.	P	Obtaining and maintaining of requisite approvals, licences and permits shall be the responsibility of the Concessionaire. The Authority can provide reasonable assistance to the Concessionaire for obtaining any approvals.
3.5	**Failure to meet Technical specifications**	Failure to meet technical standards/ specifications leading to assets not being fit for usage could affect the level of	P	It is the responsibility of the Concessionaire to meet all the technical specifications/standards. In order to ensure compliance,

S. No	Risk Event	Description	Risk Significance and Allocation Govt. (G)/ Private (P)/ Shared (S)	Risk Mitigation Measures
		service of the Project.		penalties may be defined for failure to adhere to the specifications.
3.6	**Relief Events**	Delays and increase in costs due to Relief Events could lead to significant Project delays and may affect the Project returns.	S	During a Relief Event, the Concessionaire shall be entitled to some incentives in accordance with the Project Agreement based on the impact of such an event on the Project and the Concessionaire shall not be subjected to deductions from the key performance indicators and shall not hold the Authority liable for any losses or claims arising directly from the Relief Event.
4.	**Operating Risks**			
4.1	**Inadequate O&M Performance**	It covers the risks arising when the O&M of the Project is not undertaken appropriately leading to failure in meeting the required level of service and effecting the end project users.	S	Concessionaire shall be responsible for the maintenance. The Authority shall be responsible for operation in the case of HAM model and the Concessionaire shall be responsible in the case of HAM+Toll model. Mitigation of this risk can be ensured by incorporating appropriate criteria for selection of experienced operators for the Project during the implementation of the Project
4.2	**Demand Risk**	It covers the risks pertaining to changes in the traffic volumes as well as traffic mix, which may affect the	G	The Authority shall bear the demand risk. The Authority should conduct an independent assessment of the demand risk and ensure that the Project Agreement

S. No	Risk Event	Description	Risk Significance and Allocation Govt. (G)/ Private (P)/ Shared (S)	Risk Mitigation Measures
		Project revenues and returns.		appropriately addresses and allocates the risks.
4.3	**Tariff Risk**	The risks pertaining to changes in the tariff structure may influence the revenues and returns of the Project.	S	• With the toll collection responsibility lying with the government authority, the tariff risk pertaining to toll rates will be retained by the government in the case of HAM model and it shall lie with the concessionaire in the case of HAM+Toll model
4.4	**Competition Risk**	Risks pertaining to similar competing facilities in the vicinity can affect the revenues and returns.	G	The Government can provide safeguards in the Project Agreement to mitigate the risks of competing facilities.
5.	**General Insurance**			
5.1	**Insurance Risk**	Uninsured risks can affect Project costs and operations.	P	Insurance policies for the Project are to subject to a review/due diligence by the lenders to ensure sufficient coverage of all Project assets during construction and O&M period.
Sponsor Risk				
6	**Sponsor Risk**			
6.1	**Sponsor and Counterparty Risk**	This covers the risk of the Authority or Sponsors defaulting on their payment and other obligations.	G	The Investor may choose to mitigate these through guarantees and other arrangements as agreed with the authority.

S. No	Risk Event	Description	Risk Significance and Allocation Govt. (G)/ Private (P)/ Shared (S)	Risk Mitigation Measures
Economic and Financing Risks				
7.	**Economic Risks**			
7.1	**Inflation**	A high increase in the inflation rate will lead to a correspondingly high increase in the operation costs. If the impact is significant, it shall be difficult for the private Investor to bear the complete risk.	S	• The Concessionaire shall bear the risk in case the inflation rate is as expected. However, the Government may share the risk for any unexpected increases in the inflation rates.
7.2	**Foreign Exchange Rate and Convertibility**	Significant capital cost and subsequent debt repayments would be in foreign currency. The risk comprises of two elements – Convertibility and exchange rate.	S	• The Foreign Currency Exchange risk, shall be born by the Concessionaire (in part or full). It shall explore mechanism to leverage favourable foreign exchange regulations • The risk related to convertibility of currency shall be borne by Government.
7.3	**Financing Risk – Availability and Interest Rate**	This covers the risk of availability of debt with long-term fixed interest rates in the local currency. The ability to financially close the transaction will determine the final success of the Project.	P	Financing risk can be mitigated through proper Project structuring. The GFS from the Government Agency (if applicable), shall be backed by the Ministry of Finance to improve bankability for the project.
General and country risks				
8.	**Change in Law**			
8.1	**Risk arising due to change in PPP law or any other**	The change in PPP Law or project specific regulations may result in	G	• The Authority shall be responsible for any additional costs arising due to the introduction of

S. No	Risk Event	Description	Risk Significance and Allocation Govt. (G)/ Private (P)/ Shared (S)	Risk Mitigation Measures
	regulation that has a direct or indirect bearing on the project	unenforceable obligations, invalidity of current provisions, or increase in expenses for the private Investor.		the new law after the signing of the Project Agreement, provided such change was not reasonably foreseeable before signing. • If the financial impact due to the promulgation of the new law is more than a pre-agreed threshold, the Authority may compensate the private Investor based on mutually agreed terms.
9.	**Force Majeure**			
9.1	**Force Majeure**	This covers the risk of the occurrence of unexpected events (Force Majeure) that are beyond the control of the parties. Force Majeure events may lead to significant Project delays, increase costs and may even lead to termination, in some cases.	S	The Force Majeure resulting due to political events shall be borne by the Government. Force Majeure resulting due to apolitical events shall be shared by the Government and the Investor. Insurances may be used to cover certain risks.
10.	**Dispute Resolution**			
10.1	**Dispute Resolution**	One of the key risks observed in PPP projects is the rise of potential disputes between the public and private party.	S	• The Government Agency shall be responsible for any commercial implications/resolution of disputes pertaining to any acts, omissions, prior to handover date and date of novation, whichever is later. • The Concessionaire shall be responsible for any commercial implications/

S. No	Risk Event	Description	Risk Significance and Allocation Govt. (G)/ Private (P)/ Shared (S)	Risk Mitigation Measures
				resolution of disputes pertaining to any acts, omissions subsequent to handover date and prior to the handback date. Appropriate resolution mechanism should be defined in the project development agreement for resolving disputes in an optimal manner.

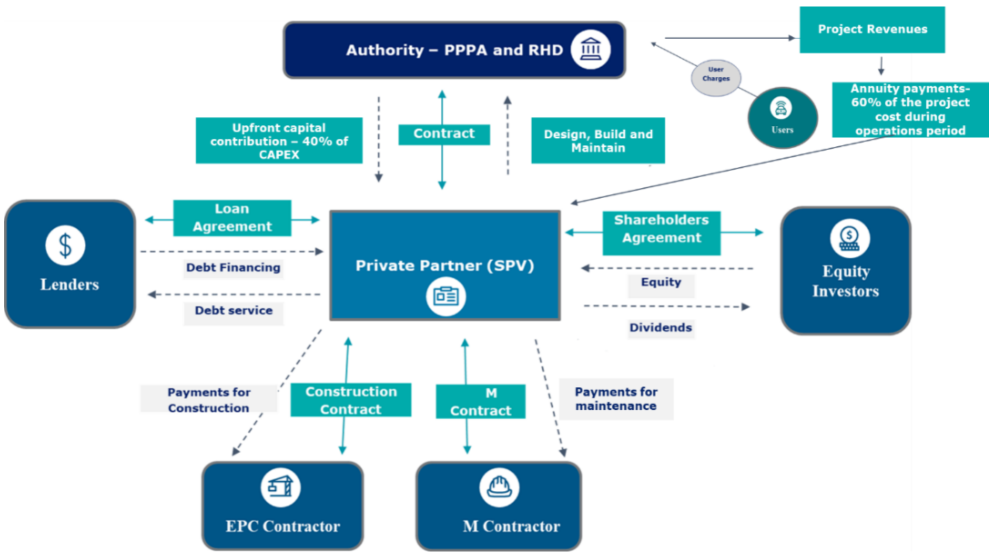
Low **Medium** **High**

14.4. PPP Structure for the Project

Project's viability and attractiveness is contingent on well-demonstrated revenue potential of the Project's sections. Based on the predictable traffic volume and the toll rates as per our traffic survey, the project shows a viable opportunity for upgradation of the expressway under this model. Based on our assessment, HAM has emerged as one of the preferred options for undertaking upgradation of Gabtoli-Savar-Nabinagar-Bipile into 6-Lane Expressway on PPP.

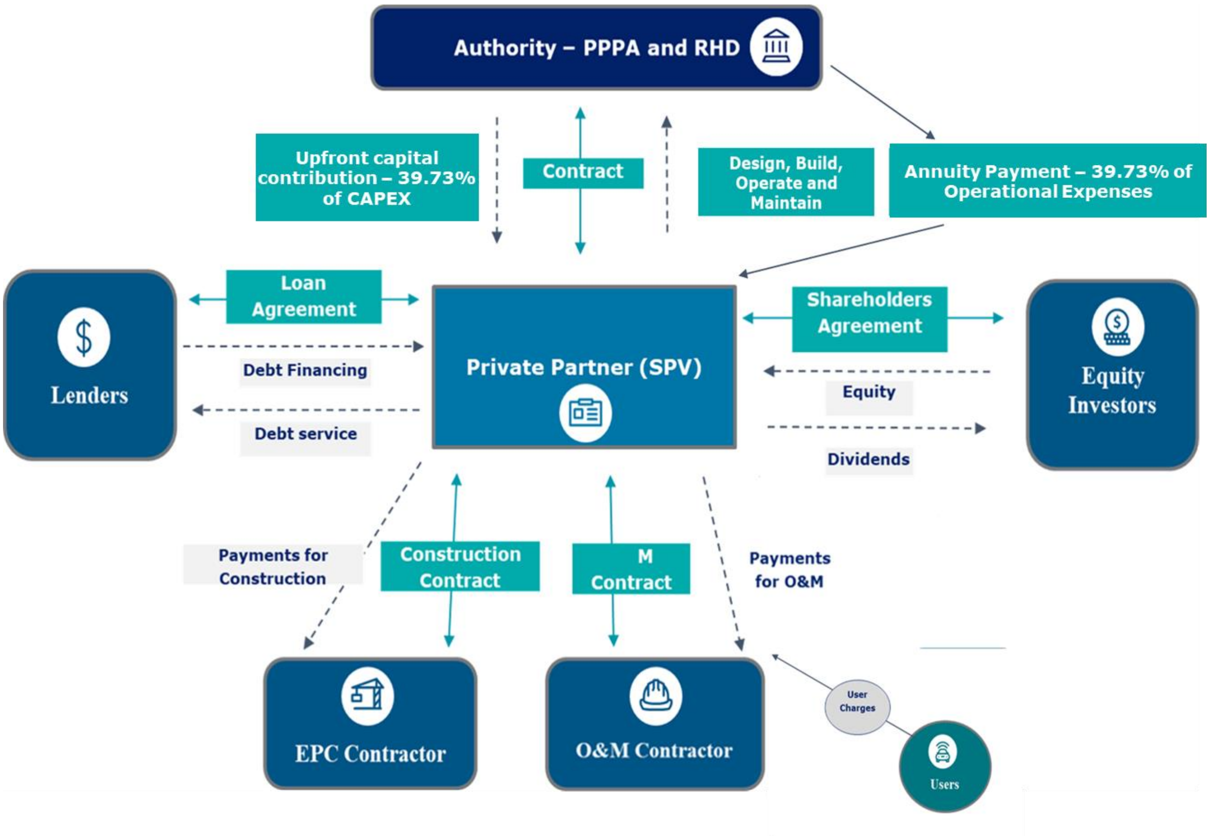
The following diagram represents the project structure for HAM that represents the architecture of contractual relationships and cash flows for this project:

Figure 55: PPP Structure for the project based on HAM model



The other preferred for undertaking this assignment is Toll+VGF model. The PPP structure for this model is illustrated below:

Figure 56 : PPP Structure for the project based on Toll+VGF Model



In order to finalize the contracting structure and clearly delineate the roles and responsibilities of each of the parties involved in the PPP process, it is important to ensure a standard interpretation of the terms and provisions covered under the Project Agreement. The framework of the project structure involves the following:

1. **Private Partner:** The Special Purpose Enterprise incorporated in Bangladesh in accordance with the appropriate laws and who is appointed to [build, finance, maintain and transfer] the Project also termed as the Concessionaire for the project
2. **Authority:** PPPA and RHD, Bangladesh who shall facilitate the development and implementation of the project
3. **EPC Contractor:** The third party appointed by the Private Partner to undertake the Construction Works pursuant to the Construction Contract.
4. **Construction Contract:** The agreement between the Private Partner and the EPC Contractor for the performance of the project's construction obligations under the Project Agreement.
5. **Financing/Loan Agreements:** The various Agreements between the Private Partner and its Lenders (of all levels) providing the funding for the construction works, to be repaid during the O&M Period.

6. **Maintenance Contractor in HAM:** The third party appointed by the Private Partner to undertake the Maintenance Services pursuant to the Maintenance Contract.
7. **Maintenance Contract in HAM:** The Agreement between the Private Partner and the Maintenance Contractor for the performance of the Project's maintenance obligations under the Project Agreement.
8. **Operations and Maintenance Contractor in Toll+VGF:** The third party appointed by the Private Partner to undertake the operations and maintenance services pursuant to the O&M Contract.
9. **Operations and Maintenance Contract in Toll+VGF:** The Agreement between the Private Partner and the O&M Contractor for the performance of the Project's operations and maintenance obligations under the Project Agreement.
10. **Users:** The users of the project asset who shall pay user charges for use of the project stretch as a toll fee. The Govt. can undertake by itself or appoint a tolling contractor through an operations contract to undertake the tolling services pursuant which shall be entered between the contracting authority and the Tolling Contractor for the performance of the tolling obligations under the Project Agreement.
11. **Shareholding Agreement:** The paid-up equity capital of the Project Cost and all conditions for equity contribution between the private partner and the equity investors.

The principal terms and conditions governing the transaction would be set out in the Project Agreement. It would also provide the obligations of the Contracting Authority and the Concessionaire in respect of the construction and operation of the project facilities, and other mutual undertakings, covenants and conditions to be performed or fulfilled by each of the parties.

14.5. Roles and Responsibilities

The broad roles and responsibilities under the PPP model involves the following:

Obligations of the RHD

The obligations of the RHD shall include:

- To procure and deliver in a timely manner the land/Right of Way, free from any encumbrances
- Prepare preliminary Technical Design for the project stretch
- Subject to Concessionaire compliance with pre-defined obligations, facilitate the project development
- Provide financial support in the form of upfront capital contribution/ VGF during the construction phase and availability payments in the operations and maintenance phase
- Assist the Concessionaire in securing and obtaining necessary approvals for project development

Obligations of Concessionaire

The Concessionaire for undertaking the Project shall comply with the following requirements:

- The project stretch is proposed to be implemented as on the HAM model with contractual arrangement wherein the concessionaire will be required to finalize design, construct, finance and maintain the project facilities
- Discharge rights and obligations under the signed Project Agreement and undertake project development as per the requirement stated in the Project Agreement. The Concessionaire may not be allowed transfer its rights and obligations, in part or full, until completion of construction and specified duration thereof

Based on the financial and VFM analysis and with an objective to arrive at the most feasible and beneficial option for development in the long run, Toll+VGF and HAM models have emerged as the preferred modes for undertaking this assignment. The Government can opt for either of these models for project execution.

15. Market Sounding

15.1. Market Sounding for Feasibility Assessment

Market sounding involves gathering knowledge with the purpose of testing the project viability and ensuring that it will attract bidders to reach financial closure. It involves active discussions, comments and feedback from several stakeholders (sponsors, financers, investors etc.) on some critical aspects of the project and gauging the stakeholders' perception of the risks that are being transferred from the public sector to the private sector.

It is envisaged that market sounding will facilitate a realistic understanding of project issues and about the general perception about the investment climate, financing challenges, project risks, etc

In particular, it focusses on gauging information with respect to:

- General appetite and interest in participating in the project
- Specific risks and concerns associated with the project.
- Applicable products and offerings for the project
- Manner and timetable for the conduct of the competitive tender process.

Therefore, market sounding has a two-fold objective. First, it aims to assist in assessing the market interest in the project from the view of the sponsors, investors and financiers who shall be involved with delivery of the project, and their capacity to deliver it. A

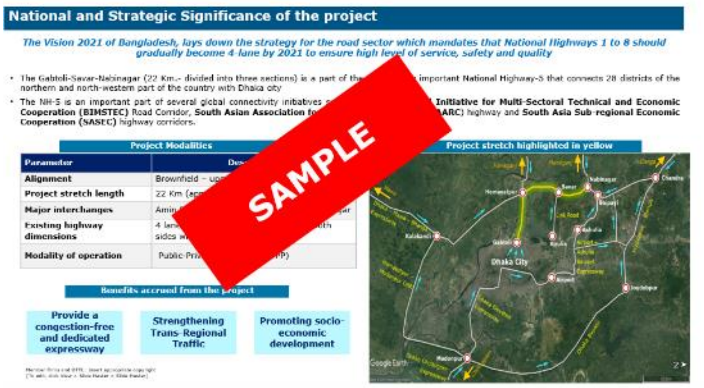
At the same time, the feedback from the market sounding and any subsequent consultations with investors will provide a useful guide to the client & its advisers on the structure and terms of the Transaction and the Project. The subsequent section presents an approach and methodology of the market sounding exercise.

15.2. Approach for the Market Sounding

Prior to any procurement exercise, it is necessary for the contracting authorities/advisors to gauge the market and likelihood of generating a competitive response to the project. Such a market sounding exercise in addition to providing feedback on project structuring also assist in developing a market knowledge and acceptability about the project.

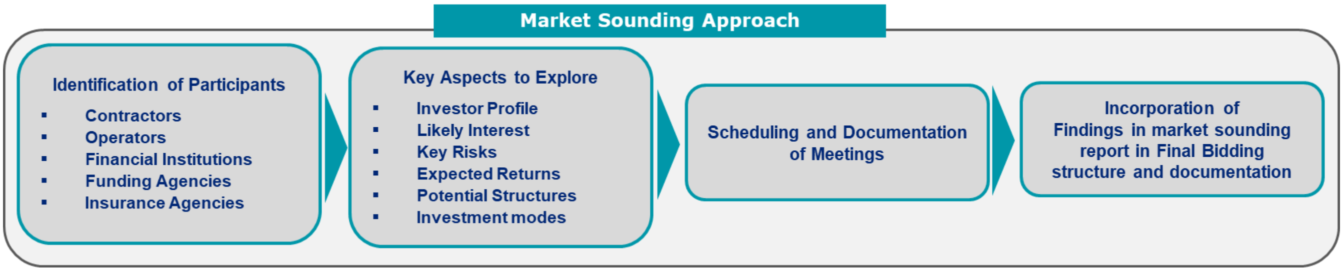
In a PPP project, the importance of market sounding exercise increases further because of augmented reliance on private sector for most of the project components and services. To accomplish that, a market sounding exercise will be undertaken prior to the procurement stage to gauge the perspective of the developers and investors.

To facilitate such market sounding exercise, our team will prepare a preliminary project memorandum (PPM), as shown, providing a summary of basic details of the project. This PPM shall be sent out to the comprehensive list of stakeholders to be consulted for market sounding.



Further details of the entire process is elaborated below:

15.3. Detailed approach



15.3.1. Identification of the participants

The first step involved identification of the participants during the market sounding exercise. Usually the participating stakeholders comprise contractors, investors, financial institutions such as Banks, Funding agencies, insurance agencies etc. Besides the type of participants, there is a need to consider the geography of the participants as well. It is imperative to reach out to both local investors, regional stakeholders and multi-national groups to ensure global coverage of the investors.

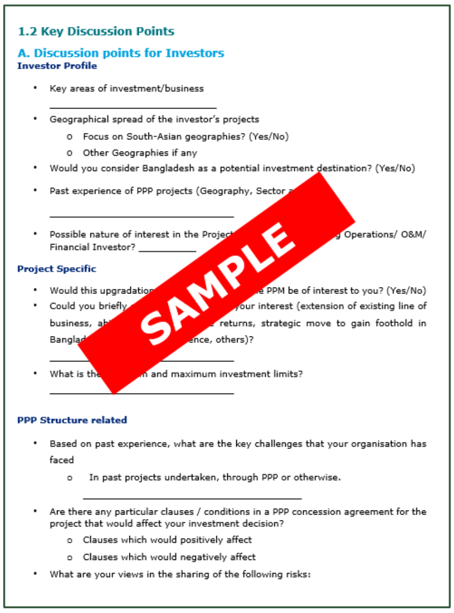
15.3.2. Key aspects to explore

Our team has conducted a preliminary market sounding exercise during the feasibility stage which shall further be conducted to reach out to prospective developers to understand the market expectations regarding the project prior to the procurement stage.

In addition to this and having chosen the comprehensive list of stakeholders after considering the right mix of type of stakeholders, type of investors and right mix of geographical representation, it is very important to ensure that the list of questionnaire shall cover all the crucial aspects of the project.

For this step, we shall develop a questionnaire, as shown, for discussing additional questions / topics, as per the type and geographical location of the stakeholders. These questions shall be specific to each type of stakeholder to gather insights from them in an objective format.

For instance, for the investors, the discussions shall revolve around project specifics such as PPP structuring, risk sharing, keenness to invest, tolling/demand risk etc. While for the financiers, the questions could revolve around mode of funding, challenges in financing such projects etc.


1.2 Key Discussion Points

A. Discussion points for Investors

Investor Profile

- Key areas of investment/business ______
- Geographical spread of the investor's projects
  - Focus on South-Asian geographies? (Yes/No)
  - Other Geographies if any
- Would you consider Bangladesh as a potential investment destination? (Yes/No)
- Past experience of PPP projects (Geography, Sector a ______
- Possible nature of interest in the Project ... Operations/ O&M/ Financial Investor? ______

Project Specific

- Would this upgradation ... e PPM be of interest to you? (Yes/No)
- Could you briefly ... your interest (extension of existing line of business, ab... returns, strategic move to gain foothold in Banglad... ence, others)? ______
- What is the ... n and maximum investment limits? ______

PPP Structure related

- Based on past experience, what are the key challenges that your organisation has faced
  - In past projects undertaken, through PPP or otherwise. ______
- Are there any particular clauses / conditions in a PPP concession agreement for the project that would affect your investment decision?
  - Clauses which would positively affect
  - Clauses which would negatively affect
- What are your views in the sharing of the following risks:

SAMPLE

15.3.3. Scheduling and documentation of meetings

It is imperative to schedule meetings to gather some details in-person as well. The participants shall include banks, investors, funding authorities etc. A combination of face-to-face and telephonic discussions will be conducted by our team as part of this exercise.

After discussions, we shall document all the findings and key considerations to structure and strengthen the project delivery.

15.3.4. Gathering insights and incorporation of findings

The final step in this process will be to compile all the findings and their analysis to provide useful insights on the market perception and attractiveness of the project. The relevant findings and issues will be kept in perspective and shall be documented in the Market Sounding report prior to the bidding stage.

Therefore, this entire exercise shall be fruitful in providing us with critical insights into the expectations of stakeholders from the PPP structure and key risks/issues perceived by them. The assessment of risk sharing and risk appetite of different stakeholders will enable better structuring of the project through appropriate risk allocation to the party most suitable to handle it.

Going forward post the current situation of Covid-19, our team shall conduct a market sounding exercise for capturing insights gathered from interacting with several stakeholders which will be compiled into the Market Sounding report. These findings shall enable us to get a conclusive idea of the market attractiveness of the project. It will also provide an estimate of the value and expected return vis-à-vis various risks perceived by the stakeholders to finalize the key parameters for undertaking this project.

16. Way Forward

The final project feasibility report captures the findings of the technical, financial, social, environmental and economic assessments undertaken for the engagement. The key terms and outputs of the report provides an overall picture of the development proposition in order to arrive at the suitable and beneficial PPP option for development which enhances the technical, financial viability and bankability of the project to both the Government and the private player.

Based on RHD and stakeholder approval, the key considerations of the feasibility assessment report shall be translated in the project bidding documents for approval and roll out for selection of concessionaire. The draft Head of Terms for the PPP project has been enclosed in Enclosure 2.

17. Enclosure 1: Response to RHD Queries

PAC Meeting – 29 April 2021

<table>
<tr><th>S. No.</th><th>Stakeholder Observations</th><th>Clarifications</th><th>Ref</th></tr>
<tr><td>1.</td><td>The Transaction Advisors to analyse/ review the implications of increasing the Concession Period to 23 or 25 years and accordingly revise the concession period to 25 years.</td><td rowspan="4">The Transaction Advisors undertook a detailed sensitivity assessment focussing on the following parameters –
a. Concession Period – 20 years, 23 years and 25 years
b. EIRR – 10%, 11%, 12%, 14% and 15%
c. Reduction in Civil Construction Cost – 10% and 15%
d. Discounted rate for NPV calculations – 6%, 7%, 8% and 9%
The returns against different procurement models considered in the feasibility report were compared and the results were then presented in the subsequent PAC meeting. Moreover, a separate note was submitted to the client that captured results of the sensitivity analysis.
Finally, based on the inputs provided by the PAC meeting, the following values were considered in the base case –
a. Concession Period – 25 years
b. EIRR – 15%
c. Reduction in Civil Construction Cost – Civil cost was estimated after considering VAT exemptions (reduced by 15%)
d. Discounted rate – 7% and 8%</td><td rowspan="4">Chapter 11 – Financial Analysis

Sensitivity Analysis Document shared with the client.</td></tr>
<tr><td>2.</td><td>The Transaction Advisors were requested to analyse the impact on government outgo in case of reduction in civil construction cost by 10% and/ or 15%.</td></tr>
<tr><td>3.</td><td>TAs were requested to analyse the government outgo in case the Equity IRR is considered at 12%, 11% and 10% as part of sensitivity analysis.</td></tr>
<tr><td>4.</td><td>The TAs were requested to compare the net outgo from Government of Bangladesh in net present value (NPV) terms.</td></tr>
</table>

PAC Meeting – 11 May 2021

S. No.	Stakeholder Observations	Clarifications	Ref
1.	TAs were requested to compare Civil Construction Cost of this project against Civil Construction Cost of similar projects executed in the Bangladesh.	A comprehensive comparative analysis of civil construction cost for similar projects executed in Bangladesh was undertaken. The similar projects included Rampura-Amulia-Demra Project, Dhaka Bypass Project, Dhaka Mawa Project and Dhaka Sylhet Project. The analysis included comparison of per km and per lane km costs involved in construction of pavement and structures along with other parameters. The results obtained from this analysis was document separately and shared with the client in a excel worksheet. The results were also presented to the client in subsequent meeting.	Comparison Matrix Excel Sheet shared with the client
2.	TAs were requested to revise the cost for O&M expenses and make necessary correction to ensure that the operational expenditure should not include maintenance expense of the service roads (since the service roads will be transferred to RHD after third year of operations).	The O&M cost was benchmarked against the maintenance cost considered under similar PPP projects executed in Bangladesh and maintenance cost for PPP projects in India. Accordingly, the maintenance cost for this project was revised as mentioned below – 1. Regular Maintenance (yearly basis) – 1% of Total Direct Civil Cost for first three years and 0.6% from 4th year onwards. 2. Major (Periodic) Maintenance (Every 5th year of operation period) – 3.3% of Total Direct Civil Cost Accordingly, the maintenance cost considered in the financial analysis was revised and returns under each model was updated.	Chapter 10– Preliminary Project Cost Chapter 11 – Financial Analysis
3.	TAs were requested to revise the toll rates in accordance with the Bangladesh Toll Policy. Also, TAs were requested to undertake a comparative analysis of toll rates	A detailed study was undertaken for determining the tolling cost for this project. The study involved analysis of Bangladesh Tolling Policy 2014, comparative assessment of tolling rates for similar PPP projects in India, Sri Lanka and Bangladesh. The revision in tolling rates resulted in an increase of annual tolling revenue for the base year by nearly 20%.	Chapter 11 – Financial Analysis

S. No.	Stakeholder Observations	Clarifications	Ref
	charged in neighboring countries.	The analysis was documented in a separate concept note that was shared with the client and was presented in the subsequent client meeting as well.	
4.	The TAs were requested to change the effective start date from July 2022 to at least July 2023 owing to the delays in finalization of feasibility report due to COVID-19.	The effective start date for the assignment was changed from July 2022 to July 2023. Accordingly, all the numbers were revised as the base year for the estimation of civil construction cost was taken as 2019.	Chapter 11 – Financial Analysis

Technical aspects – Project Configuration

S. No.	Stakeholder Observations	Clarifications	Ref
1.	The consultant to confirm whether while proposing the project configuration, various project options, innovation and cost optimization measures have been duly considered	The elevated Flyovers, 6-Lane Configurations and Service Roads have major contributions towards the cost. The design has been arrived at by ensuring a well balanced approach in respect of the project features. The consultant has analysed 4 alternative design options with respect to project configuration and arrived at the finalized model best suited for the project development further detailed out in the Chapter 6- Highway Engineering-Preliminary Designs. In order to ensure cost optimization and integrate innovation in the finalized design, we have considered the following measures: (i) By concentric widening of existing highway, which resulted only little strip widening on both sides and full use of existing highway. (ii) Rehabilitation of bridges instead of replacing with new constructions on either side is proposed to achieve the 6-Lane configurations (iii) There are no separate river/canal bridge proposed on the service roads. Instead, they have been proposed on the widened part of the main bridge with separating by "New Jersey Barriers". (iv) Service Roads are provided for the entire length of the proposed expressway. On elevated sections, the Service roads have been proposed to utilize the existing highway. (v) Flexible and Rigid Pavement structures are considered for optimizing projected traffic load over 25 years. (vi) The proposed tunnel is essential to cater to the futuristic traffic volume and un-signalised turning facility to substantially reduce traffic congestion at the Nabinagar intersection. Similarly, flyovers have been proposed at critical points and inter-sections to ensure smooth traffic flow.	Chapter 6- Highway Engineering-Preliminary Designs. Section 6.2 : Design Option Analysis

S. No.	Stakeholder Observations	Clarifications	Ref
2.	The consultant to provide rationale for proposing breakdown lane/ paved shoulder of 1.5m for the project. Further, breakdown lane has been considered on at-grade section only, consultant to provide rationale for not proposing the same for elevated sections	The features of the paved shoulder as break down lanes have been proposed based on international practices which shall act as a balance between the cost and the requirements of the expressway. The construction of break down lanes on the elevated structures is not a common practice followed in other countries. In order to address emergency exigencies, the break down vehicles or accident vehicles may be removed by towing using cranes on time which shall act as a robust emergency response system. Therefore, the usage of cranes is the most prevalent solution which can be applied to these structures on the proposed expressway to ensure normalisation of the traffic movements and operational efficiency.	NA
3.	Consultant to provide details of survey conducted to map the features of the project stretch, also stating whether drone survey has been conducted for the same	In order to ensure an overall picture for mapping the features of the project stretch during different time durations and to capture a larger area, we have applied the Satellite Imagery by using "Google Images" in order to propose an efficient upgradation for the stretch. In addition to this, we have also carried out an extensive topographic survey for 3 months to capture the on-ground scenario of the existing features in detail. Based on the combination of both these methods, the upgradation for the project stretch has been proposed. As the above method suffice the purpose, Drone survey has not been conducted and considered for the project.	NA
4.	Consultant to provide details of the proposed construction methodology and maintenance plan during construction for the project stretch, in order to minimise congestion/ interruptions during construction	It is the concessionaire's responsibility to develop and get approved the construction and management plans before commencement of construction. The Concession Agreement usually states that the concessionaire needs to maintain the current LOS and plans to maintain the same is required to be approved by the RHD. In general, the construction for brownfield projects is undertaken as below:	NA

S. No.	Stakeholder Observations	Clarifications	Ref
		For the construction methodology and maintenance plan with respect to pavement construction, the construction of the at-grade service roads and widening with break down lanes is envisaged to be constructed first. Following this, the overlay for resurfacing on the existing highway is envisaged to be undertaken. During widening of the expressway, the existing traffic shall use the old existing highway and during the second stage for undertaking overlay on the existing highway, the existing traffic shall be diverted to the widened new lanes with break down lanes and service roads. This staged construction approach assist the concessionaire to manage the traffic flow on the existing expressway. For the construction methodology and maintenance plan with respect to structures, the construction zone will be required to be frizzed on one-half and on the other half, the existing traffic shall be allowed on the highway to ensure hazard free traffic flow without changing the side at various structure locations. Besides the construction zone, a temporary diversion road will be required to be constructed for plying of the existing traffic. In addition to this, the pre-cast pre-stressed girders shall be brought to the site by trailers and be launched by cranes. Further, the deck slabs shall be cast by making staging and shuttering erected from the launched girders. This shall ensure accelerating the pace of the construction process by avoiding interruptions and minimizing the usage of the construction zone.	
5.	The design at the juncture of Nayarhat bridge (after Nabinagar and before Manikganj) and proposed tunnel has been provided or not?	We understand that this is beyond the scope of our designated project site for the current engagement and the upgradation of the stretch considering this junction and the tunnel is separately undertaken by RHD.	NA
6.	Consultant to clarify whether the project configuration seamlessly	The consultant has duly considered the significance of the proposed multi-modal hub during traffic projections and while highlighting the overall strategic	NA

S. No.	Stakeholder Observations	Clarifications	Ref
	integrates the project stretch with the multi-modal transport hub proposed at Gabtoli.	importance of the project corridor with connections to the major hubs in the vicinity. However, as the proposed transport hub at Gabtoli falls outside our designated project site, it has not been integrated in our project design.	
7.	Being an inter-urban stretch, Land Acquisition, Resettlement and Rehabilitation, and utility shifting are crucial to achieve project success. Consultant to provide plan to undertake these activities	While we have conducted a preliminary assessment of the current project features, a detailed land acquisition and resettlement plan along with a utility shifting plan will be developed has part of the additional scope envisaged for the consultant based on RHD and PPPA's approvals.	NA
8.	Consultant to provide proposed RoW for the project stretch, especially at the juncture of tunnel and flyover as proposed at Nabinagar intersection	The ROW details shall be included in the detailed Land Acquisition Plan, which is envisaged to be developed as part of the additional scope for the consultant.	NA
9.	Consultant to clarify whether it is possible to upgrade the 6-lane expressway into 8-lane expressway based on future traffic requirements	Based on the traffic projections undertaken by the consultant, the expressway has the potential for upgradation to 8-lanes to cater to the growing futuristic traffic. For the upgradation in terms of technical design, it is definitely possible by proposing additional pier or portal connected to the old structure in the future. No additional measures are required at present construction, as this will be independently constructed and will be joined with the old structure seamlessly.	NA
10.	Consultant to clarify whether proposed construction of MRT Line adjacent to the project stretch has	Yes. The consultant has considered the proposed MRT line adjacent to the project stretch in terms of assessing the expected shift in traffic and during development of the technical design for the project stretch.	NA

S. No.	Stakeholder Observations	Clarifications	Ref
	been considered while designing the project stretch	We have undertaken various stakeholder consultations in RHD and with MRT Authorities for arriving at the final project configuration for the corridor based on the current parameters. Nature and scope of our project has been changed because of 6-lane expressway design in place of 4-lane and half of the length designed for elevated section and flyovers. The foundation of these elevated sections will be on the median.	

Traffic Considerations

S.No.	Stakeholder Observations	Clarification	Ref
11.	The consultant to provide locations and methodology adopted for conducting O-D survey and analysis	The O-D survey was conducted for 3 days at three identified check points in order to capture the overall traffic : CP-01 : N5- Amin Bazar Bridge CP-02 : Hemayetpur Intersection CP-03: Nabinagar Intersection. The locations of the traffic surveys were selected based on the O-D patterns of the traffic between the key areas of the region as well as appropriate focal points for capturing the vehicle counts. The primary information collected was the origin and the destination of the vehicle, which provides insights into the traffic linkages of the region and the distribution of traffic to and from various regions surrounding the project corridor. Secondary data such as the purpose and frequency of the trip, the level of occupancy in the passenger vehicle, and the type and weight of commodity carried by freight vehicles were also captured to provide a picture of the traffic composition.	Chapter 5: Traffic Analysis and Tolling Mechanisms.

S.No.	Stakeholder Observations	Clarification	Ref
		In order to facilitate data analysis, the Project Influence Area was divided into Traffic Analysis Zones and have been demarcated based on a preliminary understanding of the area, demographic, and road network characteristics of the PIA. The O-D data analysis were captured in the questionnaire and a O-D matrix was prepared to present the quantity of trips between two zones to gather critical observations related to the travel patterns. The O-D survey is conducted to understand the usage of the proposed expressway by the commercial traffic, its expected duration during various times in the year, the expectation for improvements by the road users, the comparison of the project expressway with other alternative routes, time saving, saving in vehicle operating cost (VOC), facilities for emergency servicing and usage of related facilities. The findings of the survey have been captured in Chapter 5: Traffic Analysis and Tolling Mechanisms.	
12.	The consultant to provide rationale for undertaking traffic survey for 3 days, as against 7 days for forecasting and analysis	The consultant has duly considered a weekend and weekdays during the traffic survey to capture the overall scenario of the traffic on the corridor. For undertaking the TVC survey based on RHD manual, we have conducted the survey on three consecutive days comprising of weekday and weekend in between 27th July - 2nd August, 2019 on 16 hour and 24 hour bases counts at the respective locations. In addition to the TVC, we have duly considered seasonal correction factors to arrive at the AADT. In view of the above, the TVC survey captures relevant data of different scenarios for arriving at the traffic forecasting and analysis for the project corridor.	Chapter 5: Traffic Analysis and Tolling Mechanisms.

S.No.	Stakeholder Observations	Clarification	Ref
13.	The consultant to clarify whether the impact of proposed projects in the project influence zone including Inner Circular Ring Road, Outer Circular Ring Road and Ashulia Expressway have been duly considered for traffic forecasting and analysis	Yes. During our traffic analysis, the consultant duly considered all the existing and upcoming projects in the project influence zone including the mentioned projects to assess the expected shift in traffic/ diversion of traffic in the futuristic scenario for arriving at the envisaged traffic projections for our project corridor. Such projects have been categorized into two categories: competing and complementing projects. The related projects in the influence area have been covered in Chapter 5- Traffic Analysis and Tolling Mechanism of the final feasibility report.	Chapter 5: Traffic Analysis and Tolling Mechanisms. Section 5.5.1.4: Related Projects in the Influence Area 5.6.1.1 : Diverted Traffic
14.	The consultant to provide the basis for considering the proposed toll rate of BDT 5 per Km for the project stretch, and re-align the PCU values with the National Toll Policy 2014. Additionally, the consultant to consider proposing toll rates based on the metric of pavement damaging factor, and provide a comparative of toll rates and basis used in other similar projects in Bangladesh	The consultant has arrived at the toll rates based on National Toll Policy, 2014 and the precedence of similar projects being undertaken in Bangladesh. We have considered Rampura-Ashulia-Demra Expressway with BDT 5.4 per km. and Dhaka By Pass with BDT 4.3 per km. to assess the envisaged toll rates in the project. Based on the analysis of toll policy and other similar projects based on their planned year of operations, we have proposed the average toll rate of BDT 5 per km. by factoring all parameters. The toll analysis was conducted based on the PCU factors in the draft feasibility report. We have now incorporated the Pavement damaging factor to arrive at the finalized toll rates in the final feasibility report.	Note-1

S.No.	Stakeholder Observations	Clarification	Ref
		The benchmarking assessment has been presented as in Note-1 and attached with the clarifications.	
15.	The consultant to provide rationale for considering peak hour traffic at 10% of the daily traffic	With reference to the patterns observed during our traffic surveys on the project corridor, the peak hour traffic was estimated to be 10% of the total daily traffic.	NA

Cost Estimation

S.No.	Stakeholder Observations	Clarifications	Ref
16.	The consultant to update the cost estimates in accordance with the latest SoR-2019, as against the presently used SoR-2018 to arrive at project cost	The cost is estimated in accordance with the latest SOR-2019 and no change is envisaged.	NA
17.	The consultant to re-visit the maintenance cost, presently proposed at 1% of civil cost, which appears to be on a lower side. The consultant to also include other indirect costs including SPV costs during O&M period	The maintenance cost has been reviewed and found reasonable for the project. SPV costs during O&M period has been included in the financial assessment at a base cost of BDT 2 crore per annum and duly escalated with inflation.	Chapter 11 : Financial Analysis
18.	The consultant to provide the costs to the government w.r.t	The preliminary estimates for land acquisition (54.5 acres), resettlement and utility shifting i.e. government w.r.t amounts to be BDT 632 crores, which would be confirmed after detailed/ additional studies.	NA

S.No.	Stakeholder Observations	Clarifications	Ref
	Land Acquisition, Resettlement and Utility Shifting		

Financial and Economic Analysis

S.No.	Stakeholder Observations	Clarifications	Ref
19.	The consultant to provide a comparative of impact of different concession periods on the project viability, specifically by increasing the concession period to 25-30 years as against the currently assumed 20 years	The LOS of this project stretch is expected to be saturated to LOS 'C' in the next 20 years and would require lane addition in this project after 20 years. Additionally, the design life of pavement is envisaged as 20 years. Considering the above, if the concession period is increased beyond 20 years it will not only lead to increase in initial capital expenditure at this stage but also require re-investment after 20 years when lane addition is also required due to degraded LOS. Hence it is preferred and recommended that that pavement is upgraded after 20 years and design life is kept at 20 years only.	Chapter 11 : Financial Analysis Section 11.8 – Sensitivity Analysis
20.	The consultant to re-assess the assumed cost of debt at 10%, which appears to be on a higher side. Benchmarking with similar projects, the consultant may modify this assumption	Based on our analysis of similar projects being undertaken in Bangladesh and further stakeholder consultations with RHD, we have updated the base case analysis with a cost of debt at 8% in order to arrive at a more suitable project proposition. Sensitivity analysis for change in debt cost has also been provided in the report.	NA
21.	The consultant to update the current Debt Equity ratio assumed as 75:25. In accordance with the latest government guidelines, it is mandatory to	We have updated the financial analysis by incorporating 70:30 ratio to meet the prevailing guidelines.	Chapter 11 : Financial Analysis

S.No.	Stakeholder Observations	Clarifications	Ref
	keep the maximum Debt at 70% of investment.		
22.	The consultant to provide a comparative of PPP models evaluated for the project, including BOT-Annuity mode	The comparative analysis has been provided in the in Chapter 11 of the Final feasibility report.	Chapter 11 : Financial Analysis Section-11.7
23.	For the Hybrid Annuity Model, the consultant need to assess the gap between the availability payments (cost to government) and toll revenues (income to government) to identify additional funding requirements for the project.	An additional option of HAM plus Toll model has been included in the report to understand the gap and funding requirement.	Chapter 11 : Financial Analysis Section 11.5 : Option 5- Hybrid Annuity Mode
24.	The consultant to identify and assess the sources of non-tolling revenues for the project stretch	Advertising revenue has been considered and included in the financial analysis.	Chapter 11 : Financial Analysis
25.	The consultant to provide the basis, data and assumptions used for undertaking the economic analysis of the project	The updated economic analysis with the direct and indirect costs and benefits along with the basis, data and assumptions has been provided in the final feasibility report.	Chapter 13 : Economic Analysis

S.No.	Stakeholder Observations	Clarifications	Ref
26.	The consultant to assess the potential impact of Covid-19 on PPP financial structuring including an assessment of global financial market pertaining to PPP financing.	The Government's focus will now be on identifying options to safeguard the continued delivery of critical infrastructure services while managing fiscal impacts. Going forward, the governments need to proactively engage with private partners to plan and deliver infrastructure projects through more resilient contractual framework and delivery methods. One of the critical success factors for PPPs will be safeguarding revenues for the private sector. Accordingly, BOT (Toll) and similar/ allied modalities of PPPs may not be preferred by the private sector in the short to medium term due to its inherent nature of shifting the revenue risk to private sector. Accordingly, the Annuity mode/ Hybrid Annuity mode/ other assured revenue based models are likely to be the preferred options for private sector. The potential impact of Covid-19 on global infrastructure has been discussed in Note-2.	Note-2

Others

S.No.	Stakeholder Observations	Clarifications	Ref
27.	The consultant to assess the potential impact of Covid-19 on the project in terms of market appetite for PPP projects.	The Government's focus will now be on identifying options to safeguard the continued delivery of critical infrastructure services while managing fiscal impacts. Going forward, the governments need to proactively engage with private partners to plan and deliver infrastructure projects through more resilient contractual framework and delivery methods. The potential impact of Covid-19 has been discussed in Note-2.	Note-2
28.	The consultant to assess the impact of the condition in CCEA approval pertaining to median width for MRT Line on the project, if any	The consultant has arrived at a median of 3.5 m based on various stakeholder consultations in RHD and with MRT Authorities for arriving at the final design for the corridor based on the current parameters.	NA

Note 1 - Toll-regime benchmarking

The table below presents the toll rates proposed for three projects in the Dhaka region. It may be noted that the base toll per PCU i.e. 6 BDT per PCU per km proposed for Gabtoli-Nabinagar-Bipile (GNB) Expressway is within the range of toll rates proposed for similar projects in the region. Considering the strategic location of the GNB Expressway and its value within the Dhaka region, the proposed tolling rates are appropriate and justified. Further details are provided in feasibility report.

In addition, in order to account for the pavement damage factor, which is higher for heavier vehicles, we have proposed separate toll for heavy truck+trailer (3+ axles) which is the heaviest and largest vehicle category expected to use the Expressway. The toll multiplier for this category has been proposed with reference to similar projects.

	Gabtoli-Nabinagar-Bipile Expressway (2020)		Dhaka Bypass (2014)		Rampura-Amulia-Demra Road (2017)	
	10 km out of 25 km elevated		Majorly at-grade		8 km out of 13.5 km elevated	
Vehicle Category	**Toll (BDT/km)**	**Toll Multiplier Factor**	**Toll (BDT/km)**	**Toll Multiplier Factor**	**Toll (BDT/km)**	**Toll Multiplier Factor**
Heavy Truck+Trailer (at least 3+ axles)	30.0	5.0	33.06	7.7	30.81	5.7
Heavy Truck (2-3 axles)	27.0	4.5	26.45	6.1	23.19	4.3
Medium Truck	20.0	3.33	16.53	3.8	15.48	2.9
Small Truck	15.0	2.5	9.92	2.3	11.63	2.1
Large Bus	18.0	3.0	12.4	2.9	23.19	4.3
Mini Bus	12.0	2.0	7.44	1.7	15.48	2.9
Micro Bus	12.0	2.0	6.61	1.5	7.63	1.4
Utility Vehicle	9.0	1.5	5.79	1.3	0.96	0.2
Car	6.0	1.0	4.31	1.0	5.41	1.0
Base Toll (1 PCU)	5		4.31		5.41	

Note 2 – Impact of Covid-19 on PPP development

The novel coronavirus (COVID-19) pandemic is unprecedented and its impact continues to threaten economies globally. The Government might prioritize its spending commitment in light of the pandemic, focused more on recurrent expenditure, which could impact the annual gap in infrastructure investment in the short to medium term.

While the infrastructure financing will take a downward plunge in the short to medium term, once the pandemic is successfully contained, the focus will need to shift from crisis management to assisting to adequately invest in infrastructure for development, as well as preventing and mitigating the impact of future outbreaks contractually.

The Government’s focus will now be on identifying options to safeguard the continued delivery of critical infrastructure services while managing fiscal impacts. Going forward, the governments must proactively engage with private partners to plan and deliver infrastructure projects through more resilient contractual framework and delivery methods.

The focus on the governments now will be on recovery planning going forward. Focused actions to identify vulnerabilities, ascertain the scope of project impacts, monitor risks, adopt active risk management, and identify voluntary and mandatory recovery measures need to be embraced immediately. This includes engagement with all stakeholders to optimize recovery actions and explore more robust methods for risk allocation and mitigation in these projects. The impacts envisaged can be mitigated with measures through force majeure and compensation clauses, using bridge financing, capital injections, renegotiation of key project parameters, announcing blanket financial guarantees for lenders to critical infrastructure projects, and introduction of regulatory flexibility on performance indicators, among other measures. If the pandemic’s impacts are limited to the short or medium term, project credit risk and access to financing may not change substantially.

Because of these economic pressures and opportunities, government and industry will be incentivized to find new ways to innovate together for infrastructure. The appetite and urgency to deploy private investment into public assets will likely increase with the lowering of interest rates. Because of the low cost of debt, the ability for the private sector to benefit from enhanced equity opportunities may return. This creates a unique opportunity for many public-private partnership projects to become bankable.

One of the critical success factors for PPPs will be safeguarding revenues for the private sector. Accordingly, BOT (Toll) and similar/ allied modalities of PPPs may not be preferred by the private sector in the short to medium term due to its inherent nature of shifting the revenue risk to private sector. Accordingly, the Annuity mode/ Hybrid Annuity mode/ other assured revenue based models are likely to be the preferred options for private sector.

For the development of this project with the prevailing circumstances, the commencement of the construction is envisaged after 1.5 years. By this time, the overall market appetite is likely to improve with the government’s focus on infrastructure development. With the trends of growing economy of Bangladesh in the last few years, HAM is likely to secure and attract more investors in this project. Revenue protection and assurance will be the key to attract private sector in the projects. The project structuring has considered these aspects while designing this project during our feasibility assessment.

18. Enclosure 2: Head of Terms for the PPP Project

HEAD OF TERMS FOR PPP PROJECTS (draft)

Sl No.	Head of Terms	Particulars
1.	Title of the Project	Transaction Advisory Services for Upgrading of Gabtoli – Savar - Nabinagar into Expressway on PPP Basis
2.	Sector	Roads & Highways
3.	Name and address of the Contracting Authority	Roads and Highways Department Public Private Partnership Cell Address – Roads and Highways Department Sarak Bhaban, Tejgaon, Dhaka-1208 Bangladesh
4.	Escrow Account Required	Yes, to be opened by the Project Company
5.	Project Location	Dhaka, Bangladesh
6.	Project Site Area	24.445 Kms approx..
7.	Provide boundary of the Site (edged red)	The Gabtoli-Savar-Nabinagar stretch (24.445 Km, part of NH-5) starts from Gabtoli Bus Terminal on the mid-west boundary of the city area and passes through Aminbazar, Hemayetpur intersection and Savar Bazar and then passes Nabinagar intersection at National Monument Site followed by passing Nabinagar-Chandra R505 (a link between N5 and N4) and ends at Bipile intersection with Abdullahpur-Ashulia-EPZ Road.
8.	Description of the Project	The Government of Bangladesh through the Public Private Partnership Authority, Govt. of Bangladesh has identified the Gabtoli-Savar-Nabinagar stretch (24.445 Km, part of NH-5) for upgradation into 6 lane expressway on PPP basis.
9.	PPP Model	Hybrid Annuity Mode (HAM) of PPP or Toll plus VGF
10.	IFB or RFP	RFP
11.	Estimated Cost of the Project	The Estimated Civil Cost is estimated at BDT 4,398.98 Crores at present (year 2019) costs.

Sl No.	Head of Terms	Particulars
		The Total Project Cost (TPC) is estimated at BDT 6,472.81 crores in case of HAM and BDT 6,474.42 Crores in Toll+VGF mode. The operation and maintenance expenses for the operational period (including toll plaza expenses by GoB) for 22 years, including the effect of inflation, is estimated to be BDT 3,487.28 Crores.
12.	Total Contract Period	25 Years
13.	Construction Period	3 years
14.	Maintenance Period	22 years
15.	Minimum Development Obligations	Developing the identified stretch into 6-lane expressway
16.	Commercial Operation Date	1st July 2026 expected
17.	Project Development Fees	TBD
18.	Upfront Premium	Not Applicable
19.	First ACF Payment	During construction period
20.	Phasing	Construction Phasing Year -1 : 27% Year -2 : 34 % Year -3 : 39 %
21.	Bid Variable	Annuity amount during O&M period
22.	Bid Security	1% of Estimated Cost of the Project*
23.	Performance Security	5% of Estimated Cost of the Project*
24.	Construction Performance Security	as above (performance security)*
25.	Handback Security	28% of Estimated Cost of the Project*
26.	Handback of Service Roads	Service Roads will be handed back to the authority after third year of the operations period.
27.	CP to be fulfilled by Contracting Authority	The Contracting Authority will deliver or procure the delivery of the following Conditions Precedent to the Project Company on or before the Scheduled CP Satisfaction Date: (i) unencumbered access for the Project Company to the ROW in accordance with the Land Rights Agreement;

Sl No.	Head of Terms	Particulars
		(ii) the Land Rights Agreement, duly executed by the Contracting Authority; (iii) permission from the relevant Government Instrumentality; (iv) evidence that the transfer, demolition or removal from the Site of the applicable Utilities has been duly completed; (v) each Government Project Agreement duly executed by the relevant Government Instrumentality; (vi) the Substitution Agreement, duly executed by the Contracting Authority; (vii) the Collateral Warranties, duly executed by the Contracting Authority; and (viii) the Independent Engineer Contract, duly executed by the Contracting Authority* *others to be decided by the Contracting Authority
28.	CP to be fulfilled by Private Partner	The Project Company will fulfil the following Conditions Precedent on or before the Scheduled CP Satisfaction Date: (i) Government Project Agreement duly executed by the Project Company and any other party to it; (ii) the Substitution Agreement, duly executed by the Project Company and the Lenders Representative; (iii) the Collateral Warranties, duly executed by the Project Company and the relevant counterparties; (iv) evidence that all Applicable Permits, as may be necessary for the Works and Services, are in place and are in full force and effect; (v) evidence of the occurrence of Financial Close for the Project in the form of a certificate from the Lenders' Representative confirming that Financial Close has been achieved; (vi) certified true and complete copies of Financing Agreement; the Construction Contract; the Maintenance Agreement; the Independent Engineer Contract; Insurance and each Shareholders' Agreement; (vii) the Construction Security, duly issued; (viii) each of the Construction Management Plan, the Traffic Management Plan and Environmental Management Plan duly prepared by the Project Company (ix) Project Development Fee

Sl No.	Head of Terms	Particulars
		(x) evidence of the incorporation of the Project Company with Constitutional Documents of the Project Company; and all resolutions adopted by the directors and/or shareholders of the Project Company* *others to be decided by the Contracting Authority
29.	Selection of Private Partner (Stages)	Single stage (RFP)
30.	Payment Mechanism	Capital Contribution during construction period and Annuity Payments during O&M period.
31.	Support and guarantees by the Authority	In HAM model - An initial Capital Contribution / Grant of 40% of TPC from GoB. The initial Capital Contribution has been estimated at BDT 2,589.12 crores (i.e. 40% of TPC of BDT 6,472.81 crores); and Availability Payments (bidding parameter) during the operations period, is estimated at around BDT 18,098.80 crores. In Toll + VGF – A VGF of BDT 2,572.29 Crores shall be provided in the construction phase and BDT 4,123.82 Crores during operations and maintenance phase.
32.	Daily Rate for Liquidated Damages	Daily Rate payable by the Project Company : TBD*
33.	Cure Period	60 days for Project Company and the Contracting Authority *
34.	Change in Law Threshold	BDT 10 Crore *
35.	IE Payment Cap	Equal sharing between the Project Company and the Contracting Authority*
36.	Fees of Independent Panel	TBD*
37.	Independent Panel Payment made by	TBD*
38.	Force Majeure	Included: <u>Termination for prolonged Force Majeure Event or Project Company Relief Event</u>: If any Force Majeure Event is continuing or its consequence remains such that the Affected Party (in the case of a Force Majeure Event) is unable to comply with its obligations under this PPP Contract for a period of more than 180 days, then either Party may terminate this PPP Contract.

Sl No.	Head of Terms	Particulars
		The amount payable by the Contracting Authority to the Project Company on termination of this PPP Contract for a prolonged Force Majeure Event shall be equal to : (a) 100% of the Base Senior Debt Termination Amount; PLUS (b) Equity At Par in the case of a Force Majeure Event or Uninsurable Risk Event or 125% of Equity Compensation in the case of a Direct Political Event or Indirect Political Event; MINUS (c) the amount equal to insurance claims admitted and/or paid by the insurance companies (excluding any amounts paid in respect of any political risk insurance procured by the Project Company at its discretion).*
39.	Lease or license	License/ right to operate and maintain
40.	Any existing facilities on site	Yes, existing 4-lane highway along with structures such as Bridges, Flyovers, Underpass, Culverts and Tunnel.
41.	Any relocation required	Yes. Relocation of utilities
42.	Details of Construction Obligations	• Upgradation into 6-lane expressway • Intersections Amin Bazar, Hemayetpur, Savar and Nabinagar • Two toll plazas : One before Hemayetpur and other near Jahangirnagar University area • Four flyovers at Hemayetpur , Savar Bazar, Jahangirnagar University & Nabinagar Junction • 1 Tunnel from Paturia to Dhaka
43.	Details of O&M Services Required	Maintenance shall be undertaken by the Project Company during the 22-year O&M period.
44.	Any Other Term	-

*to be firmed up at the time of finalizing bidding documents.

DISCLAIMER

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