ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The proposed project primarily aims at capacity augmentation by upgrading the 190-kilometer (km) section of Elenga–Hatikumrul–Rangpur road (N5) to four lanes. The road is part of the Dhaka–Northwest road corridor and the trade corridor to Bhutan and Nepal through India. The project will also fund the cost increase of phase 1 resulting from improving road safety and traffic flow and from a higher bid price. The capacity augmentation of the Dhaka–Northwest corridor in phase 2, in continuation of phase 1, will aid the economic development of the northwest region of the country as well as subregional trade with Bhutan, India, and Nepal, since the project road provides the main trade route to Bhutan and Nepal. Phase 1 of the project also included improvements to the land port in Burimari to step up its transaction efficiency and in turn help boost import and export trade with Bhutan, India, and Nepal through Burimari. The proposed project is therefore important in boosting the road network efficiency, economic development of the northwest region of the country, and subregional trade and transport.

2. The project road under consideration now has two lanes and carries 11,000–14,000 vehicles per day. The traffic level is already at or above the capacity of a two-lane carriageway, resulting in poor levels of service and congestion in the built-up areas. It is the main national highway connecting the northwestern region of Bangladesh to Dhaka and Chittagong, and needs capacity augmentation. The proposed divided carriageway with separate lanes for slow-moving traffic will also reduce the potential for road accidents and improve road safety. The road geometry is generally good but will be improved nonetheless to achieve adequate road geometry along the entire corridor. Interchanges are also planned for the major intersections.

3. An economic evaluation of the proposed project components was undertaken using the Highway Development Model 4 (HDM-4), which requires input data on (i) traffic; (ii) geometry, condition, pavement structure, and material characteristics of the existing road; (iii) maintenance and improvement costs; and (iv) vehicle operating cost (VOC) parameters. The traffic estimates and other inputs required for the economic analysis have been taken from the design consultant's reports.[1] Upgrading the road corridor will result in savings for road users and society as a whole in the form of VOC reductions and less time needed for passengers and freight traffic. The improvements will also reduce road maintenance costs, vehicle emissions, and possibly road accidents. The costs to the road agency and users in the without-project and with-project cases were estimated and used to derive the project's net costs and benefits and to calculate the economic viability of the project road sections.

B. Demand Analysis

4. The base-year traffic data derived from the feasibility study and design reports for the project road sections is in Table 1. The traffic composition indicates a high percentage of truck traffic (37%– 55% of total traffic). The share of buses ranges from 23% to 33 % (of which 60%–80% are large buses). The share of cars and utility vehicles is 6%–9%, indicating low vehicle ownership and heavy reliance on public transport. Two- and three-wheeler traffic is also low, except within the influence areas of the towns along the corridor.

[1] (i) Final Feasibility Study Report, December 2014, and Final Design Report, March 2015 (Design Packages 2 and 7), Subregional Transport Project Preparatory Facility, Prepared by Snowy Mountains Engineering Corporation in association with Pyunghwa Engineering Corporation and ACE Consultants Ltd (ADB Loan 2688-BAN) and (ii) feasibility study and preliminary design – Final Report 2011, Priority Roads Project (ADB Technical Assistance 7383-BAN), prepared by MMM Group Limited and BCL Associates Ltd.

Table 1: Base-Year Traffic on Elenga–Hatikumrul–Rangpur Road

Section	Length (km)	Truck	Bus	Car & Utility	Motorcycle & Rickshaw	AADT
Elenga–Hatikumrul	34.1	6,453	4,315	2,350	1,380	14,498
Hatikumrul–Mokamtala	76.4	6,973	4,075	728	803	12,579
Mokamtala–Palashbari	30.5	5,368	3,030	807	2,330	11,535
Palashbari–Rangpur	50.4	3,928	2,496	857	3,500	10,781

AADT = annual average daily traffic; km = kilometer.
Source: Project feasibility study reports and Asian Development Bank estimates.

5. The past traffic data from the Jamuna bridge toll plaza gives a good indication of the traffic growth on the project road. The analysis indicates that from 2011 to 2016, goods and passenger traffic grew at an average rate of 6.9% and 6.5% per annum. In the same period, Bangladesh's gross domestic product (GDP) grew at an average of 6.4%, indicating an implied elasticity of 1.08 for goods traffic, 1.15 for passenger car traffic, and 0.9 for bus traffic. The data for the 5-year period prior to 2011 indicated a much higher growth rate and implied elasticity of 1.7–1.8. This may be a result of the new connectivity provided by the bridge and associate growth. The more recent 5-year growth trend indicates the long-term growth trend and is used for the traffic projection.

6. The increase in vehicle fleets is another indicator of traffic growth. The annual increase observed for Bangladesh during 2003–2010 was 4.5% for goods and 5.0% for passenger vehicles. From 2010 to 2016, it was an annual 6.5% for goods, 5.9% for cars, and 4.8% buses, indicating higher vehicle growth in the last 5 years than in the previous 7 years. This is in line with GDP growth. The traffic growth rate observed on the Jamuna Bridge compares well with the vehicle fleet growth, so the growth rate observed at the Jamuna Bridge was taken as the basis for the traffic growth forecast. Based on the implied elasticities and GDP growth projections for the short term, and assumptions for the medium and long term, the following traffic growth rates were adopted (Table 2):

Table 2: Adopted Traffic Growth Rates (%)

Vehicle Type	Up to 2022	2022–2030	Beyond 2030
Passenger vehicle	7.5	6.5	5.5
Bus	6.0	5.0	4.0
Goods vehicle	7.0	6.0	5.0

Source: Asian Development Bank estimates.

C. Project Design

7. The traffic volume on the project road sections is at or above the capacity of the existing two-lane carriageway. To provide an acceptable level of service, it is therefore proposed to be widened to a four-lane, divided carriageway with a separate lane for slow-moving traffic, which will significantly reduce the accident potential, especially fatal crashes. The project design also includes interchanges at major intersections and railway overbridges along the corridor to relieve congestion and delays for through traffic, and to improve traffic safety. Other design elements include bus bays; well-demarcated pedestrian crossings, including pedestrian overpasses; improvements to intersections with minor roads by channelization; reduction of impacts from roadside activities and general encroachments; and rectification of geometric deficiencies along the corridor.

D. Economic Analysis

8. The economic analysis uses the domestic price numeraire. Taxes are included in the project cost estimate but are excluded in the economic analysis. Physical contingencies are included but price contingencies are excluded in the project economic cost. A shadow exchange rate factor of 1.055 based on Bangladesh's international trade data for 2013–2014 is applied to convert the costs of traded goods into domestic prices.[2] A shadow wage rate factor of 0.80, obtained from the feasibility study, is applied to unskilled labor cost. The construction will begin in 2018 for the first two packages, in 2019 for the next three packages, and in 2020 for the remaining packages. Completion of these packages is scheduled for 2020, 2022, and 2023. The analysis considers a 20-year period of operation after construction of all packages; benefits accruing for completed sections are starting in 2021.

9. **Value of time for passengers and freight.** For passenger vehicles, passenger working and nonworking time values were calculated based on per capita income or wage rates in the country. The per capita income per employed person was calculated, and average hourly income was derived by assuming 2,080 hours of work per year. The feasibility study report derived value of time from wage rates obtained from field surveys, which was updated to 2016 values using growth in per capita income. The estimates from per capita income and wage rates were compared, and the lower values from the two estimates were adopted for the analysis. The value of bus passenger time was modified by applying a shadow wage rate factor assuming about 20% bus passenger work trips by unskilled labor. Nonwork time was valued as one-third of work time. Table 3 summarizes the time values for each passenger-carrying vehicle.

Table 3: Adopted Values of Passenger Working and Nonworking Time

	Bus (Tk/hour)		Car (Tk/hour)		Motorcycle & Rickshaw (Tk/hour)	
Vehicle	**Working**	**Non-working**	**Working**	**Non-working**	**Working**	**Non-working**
Value of time	91	30	162	53	68	22

Source: Asian Development Bank estimates.

10. For goods-carrying vehicles, the cargo time value was calculated by taking the opportunity cost of cargo using the method suggested in the HDM manual. The time value of freight is calculated as the time value of goods in transit, i.e., the value of the goods carried times the commercial interest rate paid by the owners as an inventory cost. With regard to the main goods carried, a cargo value of Tk80,000 per ton is assumed, and the opportunity cost of cargo delay or time value is estimated by assuming that 80% of cargo will benefit and by assuming a real interest rate of 9%.

11. **Salvage value**. A straight-line depreciation method was used to calculate the salvage value of project elements at the end of the analysis period. Bituminous components are assumed to have a life of up to 20 years with periodic renewal as needed, and no salvage value. The pavement structure below the bituminous layer in the widened portion is assumed to have a 30-year life, while bridges and cross-drainage structures are assumed to have a 40-year life. The analysis used the detailed cost estimate with cost breakdown of each component and calculated the salvage value of the overall project at 22%.

[2] The World Bank. World Development Indicators. http://data.worldbank.org/country/bangladesh (accessed on 23 April 2017).

12. **Construction and maintenance alternatives.** The construction and maintenance alternatives for the HDM analysis were defined based on the project design. Construction cost estimates for the project options were derived from the bill of quantities based on detailed design. The cost estimate includes the costs of civil works, environmental impact mitigation, land acquisition and resettlement, utility shifting, relevant consulting services, and physical contingencies. The base financial cost of implementing the project is estimated at $1,235.7 million. The economic cost of construction was derived from the financial construction cost by removing transfer payments and applying the shadow exchange and wage rate factors, and is estimated at $950.3 million. Land acquisition costs are accounted for as equivalent to the economic loss of agricultural production over a 40-year period. The periodic maintenance unit costs adopted are based on the unit cost estimates for the project. Traffic congestion during construction will be minimized with an effective traffic management plan, and by scheduling the construction and utilizing both carriageways. A 5% increase in vehicle operating costs resulting from congestion during construction is also considered.

13. **Economic assessment.** An economic analysis was carried out for the project road sections included in phase 2. The economic analysis of phase 1 road sections was also updated (cost and scope changes).[3] The proposed project will improve the level of service to desirable levels for the design period, eliminate traffic congestion, and result in significant time and operating cost savings for the road users. Without the project, the level of service on project road sections will reach unacceptable levels and hurt mobility and economic growth. The proposed project design will also reduce traffic accidents thanks to divided lanes, and greatly improve overall safety for slow-moving and pedestrian traffic thanks to segregated lanes and flyovers in congested urban areas. The HDM 4 model was used to estimate the project benefits. The environmental assessment indicates that vehicle emissions will decline by 40%-45% thanks to the project. For the analysis, VOC and time savings as well as savings from reduced emissions are quantified and included.[4] Benefits that were not quantified and included in the analysis are fewer road crashes, positive impact on mobility and the economic growth of the region, and increased subregional trade through this corridor.

14. A 3-year implementation period starting in 2018 is considered for the phase 2 project roads. The analysis considers a 20-year operation period starting in 2021. A discount rate of 9% is used as acceptable economic rate of return. The economic evaluation of the project was carried out by comparing the societal cost of transportation “with” and “without” the project options, and the results are summarized in Table 4, which shows the economic internal rate of return (EIRR) and the net present value for the proposed project options. The annual cost benefit streams for the phase 2 project road sections are presented in Table 6. The results indicate that the proposed project interventions are economically viable, yielding an EIRR well above 9%. The EIRR for the phase 1 interventions was reduced to 19.9% from the original 25.7% because of an increase in costs, but it is still well above the threshold EIRR.[5]

[3] ADB. 2012. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Technical Assistance Grant to the People’s Republic of Bangladesh for South Asia Subregional Economic Cooperation Road Project*. Manila.

[4] The social cost of carbon reduction is valued at $ 36.3 per ton equivalent of carbon dioxide emission.

[5] EIRR without considering crash-reduction benefits.

Table 4: Economic Analysis Results

Project Component	**EIRR** (%)	**NPV** (Tk million)
Elenga–Hatikumrul-Rangpur Road (phase 2)	17.4	65,994.9
Joydevpur–Elenga Road (phase 1) with updated cost	19.9	37,289.4
Phase 1 and phase 2 road sections combined	18.4	97,913.7

EIRR = economic internal rate of return, NPV = net present value.
Source: Asian Development Bank.

15. Further, sensitivity analysis was carried out for the road sections over the base case with respect to adverse changes in the costs and benefits. The following cases were analyzed: (i) base case, (ii) a 10% increase in cost, (iii) a 10% decrease in total benefits, (iv) a 10% increase in cost and a 10% decrease in benefits, (v) traffic growth reduced by 50% and no generated traffic and no emissions benefit, and (vi) value of time reduced by 50%. In the case of phase 1 project road sections, no further cost change or delay is expected, since the project is now on schedule. The results of the sensitivity analysis are presented in Table 5. The analysis shows that the project has an EIRR of more than 9% in all sensitivity cases.

Table 5: Results of Sensitivity Analysis

	Economic Internal Rate of Return (%)					
Project Component	**Case I**	**Case II**	**Case III**	**Case IV**	**Case V**	**Case VI**
Elenga–Hatikumrul–Rangpur Road (phase 2)	17.4	16.3 (+232)	16.1 (-56)	15.2 (+41/-41)	11.5 (-70%)	13.6 (-95%)
Joydevpur to Elenga Road (phase 1) with updated cost	19.9	18.8 (+281)	18.5 (62)	17.4 (+46/-46)	10.1 (-55%)	15.1 (-98%)

Note: Values given in parentheses are switching values for variables. The switching value indicates the percentage change in a variable required for the economic internal rate of return to fall below 9%.
Source: Asian Development Bank.

Table 6: Elenga–Hatikumrul–Rangpur Road – Comparison of Cost Streams
(Tk million)

	Increase in Agency Costs		**Decrease in User Costs**			
Year	**Capital Costs**	**Maintenance Costs**	**Vehicle Operating Costs**	**Time Costs**	**Emissions**	**Net Benefits**
2017	0.0					0.0
2018	3,947.2	0.0	(217.7)	(151.6)	(3.0)	(4,319.5)
2019	11,360.6	0.0	(748.9)	(561.1)	(3.8)	(12,674.4)
2020	16,422.8	0.0	(1191.0)	(880.8)	(5.5)	(18,500.1)
2021	17,235.7	3.7	(435.7)	262.4	319.6	(17,093.2)
2022	17,329.1	3.7	(366.2)	362.5	632.4	(16,704.1)
2023	8,375.1	12.5	2747.3	4849.4	881.4	90.5
2024		21.9	3270.2	7175.1	1602.5	12,026.0
2025		21.9	3747.6	7789.0	1673.8	13,188.5
2026		21.9	4355.0	8482.9	1745.0	14,561.0
2027		636.6	5059.5	9249.3	1816.2	15,488.4
2028		21.9	5981.8	10284.7	1887.4	18,132.1
2029		94.9	6984.8	11285.7	1958.7	20,134.3
2030		1536.3	5457.3	11346.7	2029.9	17,297.6
2031		21.9	6298.2	12477.6	2101.1	20,855.0
2032		21.9	7199.0	13498.0	2172.3	22,847.5

Year	Increase in Agency Costs: Capital Costs	Increase in Agency Costs: Maintenance Costs	Decrease in User Costs: Vehicle Operating Costs	Decrease in User Costs: Time Costs	Decrease in User Costs: Emissions	Net Benefits
2033		21.9	8232.4	14619.7	2243.6	25,073.8
2034		636.6	9431.8	15865.7	2315.2	26,976.1
2035		(1310.1)	10923.6	17417.6	2379.7	32,031.0
2036		1426.8	8755.4	17123.2	2437.8	26,889.6
2037		1536.3	10013.3	18776.9	2490.0	29,743.9
2038		21.9	11555.3	20616.7	2537.0	34,687.1
2039		21.9	12917.3	22045.5	2579.3	37,520.3
2040		21.9	14672.1	23889.0	2617.4	41,156.7
2041		21.9	17097.1	26541.8	2651.7	46,268.7
2042		21.9	15617.8	27915.3	2682.5	46,193.7
2043	(15,315.6)	21.9	17080.5	29633.2	2960.2	64,967.7
				EIRR (%)		**17.4**
			NPV @ 9%			**65,994.9**

( ) = negative, EIRR = economic internal rate of return, NPV = net present value.
Source: Asian Development Bank.

16. **Financial sustainability**. The project will be implemented with performance-based maintenance included in the contract for an extended period of 6 years after construction. The Government of Bangladesh has substantially increased the allocation for maintenance over the last 5 years (from $88 million in FY2012 to $183 million in FY2016) and this has increased the proportion of roads in the good-to-fair category from 40% to 63% during this period. Upon completion of performance-based maintenance under the project for 6 years, incremental recurrent costs (annualized) associated with the project road sections are estimated to be 2.8% of the projected maintenance budget of the Roads and Highways Department (assuming a real annual maintenance budget increase of 5%). The maintenance budget requirement estimated for the project road sections is within the limits of proportionate maintenance budget allocation for these road sections, and therefore it is reasonable to expect that funds will be available to meet the maintenance costs of the project road sections beyond the maintenance period included in the project.