ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. **Economic rationale.** This analysis is prepared for processing Tranche 2 of the multitranche financing facility (MFF) using the time-slicing approach for the South Asia Subregional Economic Cooperation Dhaka–Northwest Corridor Road Project, Phase 2. It updated the analysis conducted during appraisal in 2017 for the MFF and Tranche 1. The updated economic and financial analysis reflects the latest exchange rate, the actual contract amounts for civil works (when available), and the prices based on constant 2019 prices.[1]

2. The proposed project primarily aims at capacity augmentation by upgrading the 190 kilometer (km) section of the Elenga–Hatikamrul–Rangpur road to four lanes for carriageways and two lanes for slow-moving vehicular traffic. The project also funds the cost increase of the Phase 1 project resulting from improving road safety and gender-responsiveness features and from the higher civil works costs.[2] The road is part of the Dhaka–Northwest international trade corridor to Bhutan and Nepal through India, and the main national highway connecting the northwest region of Bangladesh to Dhaka and Chattogram. The capacity augmentation of the Dhaka–Northwest international trade corridor under the Phase 2 project, 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 those countries. The Phase 1 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 Phase 2 project is therefore important in enhancing road network efficiency, the economic development of the northwest region of the country, and subregional trade and transport.

3. **Project design.** The existing road has a two-lane carriageway and the latest estimate indicates that it currently carries 12,000 to 16,000 vehicles per day. The traffic volume on the project road is at maximum or above the capacity of the two-lane carriageway, resulting in poor level of service and congestion in the built-up areas. To provide an acceptable level of service, it is therefore proposed that the road be widened to a four-lane divided carriageway with separated lanes for slow-moving traffic, which will significantly reduce the accident potential, especially fatal crashes. The project design also includes interchanges and flyovers 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, improvement of intersections with minor roads by channelization, reduction of impact of roadside activities and general encroachment, and treatment of geometric deficiencies along the corridor.

B. Demand Analysis

4. **Traffic demand.** The base-year traffic data derived from the feasibility study and the design reports for the project road sections are 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

[1] The exchange rate used in the analysis is $1 = Tk84.135 (ADB rate as of 11 April 2019).
[2] ADB. 2012. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Loan and Technical Assistance Grant to the People's Republic of Bangladesh for South Asia Subregional Economic Cooperation Road Connectivity Project*. Manila.

low vehicle ownership and heavy reliance on public transport. Two- and three-wheeler traffic are also low, except within the influence areas of the towns along the road corridor.

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

Section	Length (km)	Truck	Bus	Car and Utility	Motorcycle and Rickshaws	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: Asian Development Bank estimates and project feasibility study reports.

5. Future traffic is an aggregation of the normal, diverted, and generated traffic that will increase over time as a result of the socioeconomic development of the project area. However, the analysis did not assume a diversion of existing travel demand from competing corridors. Therefore, diverted traffic is not considered in the analysis. Generated traffic of about 7% has been considered, as per the design reports.

6. **Traffic growth.** The past traffic data from 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 traffic grew at an average rate of 6.9% per annum and passenger traffic at 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 the associate growth. The more recent 5-year growth trend indicates the long-term growth trend and is used for the traffic projection.

7. The increase in vehicle fleet is another indicator of traffic growth. The annual increase observed for Bangladesh during 2003 to 2010 was 4.5% for goods vehicles and 5.0% for passenger vehicles. From 2010 to 2016, the annual increase rate was 6.5% for goods, 5.9% for cars, and 4.8% buses. The traffic growth rate observed at the Jamuna Bridge compares well to the vehicle fleet growth. The growth rate observed in recent years at the Jamuna Bridge has been 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 traffic growth rates in Table 2 were adopted.

Table 2: Adopted Traffic Growth Rates

(%)

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

Source: Asian Development Bank estimates.

C. Economic Analysis

8. **Economic analysis.** The economic analysis of the project was carried out using the Highway Design and Management Version 4 (HDM-4) model and in accordance with Asian

Development Bank (ADB) guidelines.[3] The HDM-4 model requires input data on traffic, road geometry, pavement condition, maintenance and improvement costs, vehicle operating costs (VOC), and the value of time. The traffic estimates and other inputs required for the economic analysis have been taken from the design consultant's reports and from the updated data provided by the Government of Bangladesh.[4] The costs and benefits accruing to the road agency and to road users were estimated in the without- and with-project cases and were used to derive the net costs and benefits of the project and to calculate the economic viability of the project road sections.

9. The economic analysis was conducted using the domestic price numeraire. Physical contingencies are included but price contingencies are excluded in the project economic cost. A discount rate of 9% was used for calculating the net present value. Taxes are included in the project cost estimate but excluded in the economic analysis. A 3-year implementation period starting in 2018 is considered for the Phase 2 project roads. The analysis considers a 20-year period of operation after construction of all packages; benefits accruing for completed sections are starting in 2021.

10. **Project costs.** The project cost has been updated with the actual contract amounts of the works packages that have been awarded. The costs include 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 $1,127.64 million. The economic costs of construction were derived from the financial construction cost by removing transfer payment taxes and applying the shadow exchange and wage rate factors, and is estimated at $842.45 million. The project also finances cost overrun for Phase 1 and the additional consulting services necessary for those works. Hence, the economic analysis of the Phase 1 project has been revised based on the estimated additional costs (i.e., civil works, consulting services, land acquisition and resettlement, and utilities shifting) and considered here.

11. A shadow exchange rate factor of 1.055 was applied to traded goods in civil works costs, VOC, and emission costs, to convert the costs of traded goods into domestic prices. A shadow wage rate factor of 0.80, obtained from the feasibility study, is applied to unskilled labor cost. Land acquisition costs are accounted 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 cost resulting from congestion during construction is also considered.

12. **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 layers of pavement 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 layers 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%.

[3] ADB. 2017. *Guidelines for the Economic Analysis of Projects.* Manila.

[4] Roads and Highways Department. 2014. Final Feasibility Study Report, Subregional Transport Project Preparatory Facility; Roads and Highways Department. 2015. Final Design Report (Design Packages 2 and 7), Subregional Project Preparatory Facility; and ADB. 2011. Feasibility Study and Preliminary Design - Final Report 2011, Priorities Roads Project. Consultant's report. (TA 7383-BAN).

13. **Project benefits.** The quantified benefits of the project include travel time savings and VOC savings for motorized vehicles resulting from higher vehicle speeds and improved riding quality with the project. Reduced carbon dioxide emissions were also quantified as a potential benefit. Under the without-project scenario, speeds are significantly reduced as road capacities are reached earlier than under the with-project scenario, which in turn contribute to a higher rate of road degradation.

14. **Value of time for passengers and freight.** For passenger vehicles, passenger working time values and nonworking time values were calculated based on per capita income or wage rate in Bangladesh. 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 value of time was updated using growth in per capita income. The estimates from per capita income and wage rates were compared and lower values from the two estimates were adopted for the analysis. The value of bus passenger time was modified by applying the shadow wage rate factor assuming about 20% bus passenger work trips by unskilled labor. Non-work 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

(Tk/hour)

Vehicles	Values of Working Time	Values of Nonworking Time
Bus	91	30
Car	162	53
Motorcycles and rickshaws	68	22

Tk = taka.

Source: Asian Development Bank estimates.

15. 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.

16. **Economic analysis.** For the analysis, VOC and time savings as well as savings from reduced emissions are quantified and included.[5] 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. The results indicate that the Phase 1 and Phase 2 projects are economically viable, yielding an economic internal rate of return (EIRR) well above 9%, signifying the high economic rate of return of the proposed projects (Table 4). The annual cost benefit streams for Phase 2 project road sections are presented in Table 5. Due to the increase in costs, the EIRR for the Phase 1 project was reduced to 17.4% from the previous 19.9% obtained during Phase 2 project appraisal. However, it is still well above the threshold EIRR.[6] The environmental assessment indicates that the project will help reduce vehicle emissions by 40%–45%.

[5] The social cost of carbon reduction is valued at $36.3 per ton equivalent of CO_2 emission in 2016 values and increased at 2% per year in real terms.

[6] Economic internal rate of return without considering crash reduction benefits.

Table 4: Economic Analysis Results

Project Component	EIRR (%)	NPV (Tk Million)
Elenga–Hatikamrul-Rangpur Road (Phase 2)	19.5	108,183.06
Joydevpur to Elenga Road (Phase 1) with updated cost	17.4	51,166.62
Phase 1 and Phase 2 road sections combined	18.6	159,349.68

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

Table 5: Comparison of Cost Streams for Elenga–Hatikamrul–Rangpur Road
(Tk million)

Year	Increase in Agency Costs		Decrease in User Costs			
	Capital Costs	Maintenance Costs	Vehicle Operating Costs	Time Costs	Emissions	Net Benefits
2017	0.00					0.00
2018	3,684.73	0.00	(236.14)	(164.50)	(3.42)	(4,088.79)
2019	10,605.21	0.00	(812.42)	(608.66)	(4.46)	(12,030.74)
2020	15,330.79	0.00	(1,292.06)	(955.51)	(6.54)	(17,584.90)
2021	16,089.63	4.03	(472.71)	284.62	388.50	(15,893.25)
2022	16,176.84	4.03	(397.27)	393.20	784.24	(15,400.69)
2023	7,818.19	13.54	2,980.33	5,260.73	1,114.82	1,524.14
2024		23.72	3,547.64	7,783.74	2,067.48	13,375.13
2025		23.72	4,065.52	8,449.78	2,202.55	14,694.13
2026		23.72	4,724.41	9,202.55	2,342.20	16,245.44
2027		597.56	5,488.75	10,033.88	2,486.56	17,411.63
2028		23.72	6,489.29	11,157.15	2,635.75	20,258.47
2029		91.88	7,577.36	12,243.04	2,789.92	22,518.45
2030		1,437.45	5,920.30	12,309.22	2,949.20	19,741.26
2031		23.72	6,832.43	13,536.04	3,113.73	23,458.48
2032		23.72	7,809.72	14,643.06	3,283.67	25,712.73
2033		23.72	8,930.81	15,859.90	3,459.16	28,226.14
2034		597.56	10,231.86	17,211.56	3,641.04	30,486.90
2035		(1,219.64)	11,850.28	18,895.20	3,742.46	35,707.58
2036		1,335.21	9,498.15	18,575.72	3,910.42	30,649.08
2037		1,437.45	10,862.70	20,369.79	4,074.10	33,869.15
2038		23.72	12,535.56	22,365.61	4,234.05	39,111.49
2039		23.72	14,013.09	23,915.66	4,390.76	42,295.78
2040		23.72	15,916.72	25,915.57	4,544.70	46,353.27
2041		23.72	18,547.48	28,793.32	4,696.29	52,013.37
2042		23.72	16,942.69	30,283.33	4,845.94	52,048.24
2043	(14,297.24)	23.72	18,529.50	32,147.05	5,454.41	70,404.47
				EIRR (%)		**19.5%**
				NPV @ 9%		**108,183.06**

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

17. **Sensitivity analysis.** Sensitivity analysis was carried out over the base case with respect to adverse changes in the costs and benefits. The following cases were analyzed: (i) base case (Case 1); (ii) a 10% increase in cost (Case 2); (iii) a 10% decrease in total benefits (Case 3); (iv) a 10% increase in cost and a 10% decrease in benefits (Case 4); (v) traffic growth reduced by 50%,

no generated traffic, and no emissions benefits (case 5); and (vi) value of time reduced by 50% (case 6). The results of the sensitivity analysis are presented in Table 6.

Table 6: Results of Sensitivity Analysis

(%)

Project Component		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Elenga–Hatikamrul–Rangpur Road (Phase 2)	EIRR	19.5	18.4	18.2	17.2	13.1	5.7
	Switch Value		+179.9	-62.9	+48/-48	-66.2	-113.1
Joydevpur to Elenga Road (Phase 1) with updated cost	EIRR	17.4	16.3	16.1	15.0	7.0	13
	Switch Value		+128.0	-54.5	+38/-38	-43.4	-86.7

EIRR = economic internal rate of return.
Note: Switch value indicates percentage change in a variable required for the EIRR to go below 9%.
Source: Asian Development Bank estimates.

18. **Regional cooperation.** The project will facilitate the economic development of the northwest region of the country and subregional trade with Bhutan, India, and Nepal. The project will generate additional benefits which are not quantified in the economic analysis. First, the project will strengthen the cross-border transport network that boosts and generates intraregional trade and opens up trade opportunities with East and Southeast Asia. Improving this corridor will benefit the neighboring countries to access the land ports, resulting in enhanced linkages among those countries for increased cross-border trade, tourism, and investment. Second, the project will contribute in creating economies of scale to operate competitively and effectively. As a result, the project will potentially contribute to increased revenues of the land ports and growing demand for local commercial services, leading to an improved economic situation of the surrounding area. This will promote synergies between economic corridors and help optimize development gains in the subregion, including industrial growth and competitiveness, the creation of high-quality jobs, increased productivity, and strengthening existing value chains. Third, the project may attract private sector or external investment for upgrade or operation of the land ports or other infrastructure.

D. Financial Sustainability

19. The project will not generate revenue. In accordance with ADB guidelines, the financial sustainability of the project was therefore conducted by assessing the sustainability of incremental recurrent costs to be assumed by the Roads and Highways Department (RHD) and by the Bangladesh Bridge Authority (BBA).[7] The majority of the project roads are administered by RHD, except the approach roads to Jamuna (Bangabandhu) Bridge that come under the authority of BBA.

20. Every year, RHD carries out an international roughness index survey for paved roads. Based on that survey, the HDM-4 report is prepared, identifying the road segments that require maintenance and specifying the type of maintenance required, along with the estimated cost. The road condition and respective maintenance are kept in the HDM database after the HDM survey is completed. The Maintenance and Rehabilitation Needs Report is published on the RHD website after the completion of the international roughness index survey.

[7] ADB. 2005. *Financial Management and Analysis of Projects.* Manila.

21. RHD carries out periodic maintenance every 3 years and routine maintenance every year. With respect to the road maintenance system of BBA, periodic maintenance is carried out every 5 years, according to the Maintenance Manual through the Operation and Maintenance Operator and the maintenance is decided through regular or periodic inspection.

22. The projects will be implemented with the performance-based maintenance included in the contract for an extended period of 6 years after construction. The average annual incremental recurrent costs are estimated at 3.1% of the project cost (i.e., $47.9 million), which equals about 2.9% of the fiscal year (FY) 2018 annual maintenance budget for all roads under RHD. The Government of Bangladesh has substantially increased the allocation to RHD for maintenance over the last 5 years (from Tk12,396.4 million in FY2013–2014 to Tk23,500.0 million in FY2018–2019) and this has increased the proportion of roads in the good to fair category from 58% to 74% during this period (Table 7). With regards to BBA, the future estimate indicates a positive trend in the maintenance budget (Table 8). The maintenance budget requirement estimated for the project road sections is within limits of the proportionate maintenance budget allocation for these road sections. Therefore, it is reasonable to expect that RHD and BBA will be able to allocate sufficient budget to meet the maintenance costs for the project roads.

Table 7: Roads and Highways Department's Allocation and Use of Resources for Road Maintenance

(Tk million)

Year	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018	2018–2019
Funds received for road maintenance	12,396.40	14,441.40	14,684.50	14,900.00	23,343.80	23,500.00
Funds spent on road maintenance:						
Routine maintenance	3,582.10	3,846.20	5,207.30	4,335.50	7,316.20	2,326.30
Periodic maintenance	7,097.40	9,231.30	9,430.00	10,450.00	14,600.00	9,446.30
Others	4,649.40	1,237.10	62.40	72.50	1,390.00	-
Total	**12,376.80**	**14,314.60**	**14,699.70**	**14,858.00**	**23,306.20**	**11,772.60***

Tk = taka.
*up to March 2019.
Source: Roads and Highways Department.

Table 8: Bangladesh Bridge Authority 's Allocation of Resources for Road Maintenance

(Tk million)

	Past Performance					Future Estimates	
Year	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018	2018–2019	2019–2020
Funds received for road maintenance	892.44	964.80	1,566.00	759.90	558.80	-	-
Funds spent on road maintenance	701.12	383.11	1,367.08	547.51	403.84	731.24	989.60

Tk = taka.
Source: Bangladesh Bridge Authority.