ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The proposed additional financing for the Rural Connectivity Improvement Project will support rehabilitation and/or widening of approximately 930 kilometers (km) of rural road sections. The current project, approved in November 2018, will improve about 1,700 km of rural roads.[1] Sustained economic growth and an increase of more than 10% per year in vehicle registration have resulted in traffic exceeding the capacity of many single-lane carriageway rural roads; these roads have also been damaged by floods, and their riding quality is deteriorating to "poor". Rehabilitation and capacity augmentation of rural roads, where needed, are essential to sustain the country's achievement of self-sufficiency in cereal production, and to achieve Bangladesh's Seventh Five Year Plan, fiscal year (FY) 2016–FY2020 targets, which include crop diversification, increased productivity, and promoting agribusiness to increase rural incomes and economic development.[2] The additional financing aims to scale up the main output of the current project, and the economic context and project rationale remain the same as for the current project.

B. Project Alternatives

2. The selected roads are part of the main rural road network of *upazila* (subdistrict) roads and union roads, providing connectivity between district and subdistrict headquarters and market centers. The maintenance planning system of the Local Government Engineering Department (LGED) prioritizes rural roads for rehabilitation and maintenance. The roads proposed under the additional financing were selected from this prioritized list of roads, all of which require immediate intervention to sustain or improve the level of service. The roads were prioritized based on a rural road network parameter (based on socioeconomic factors, the location of market centers, and traffic levels) and their condition and a cost parameter (based on project design alternatives relating to maintenance, rehabilitation, and capacity augmentation and cost), with the goal of maximizing the overall benefit for the planned investment.

3. The selected project road sections have a single-lane bituminous paved surface in fair to poor condition. Traffic levels are well above the design capacity for many of the road sections. In the absence of rehabilitation and/or widening of these road sections, the level of service will deteriorate, increasing the cost of transportation to market centers and rural communities. With no intervention, project road maintenance will involve the patching of severely damaged areas, and will result in low travel speeds and high vehicle operating costs.

C. Economic Analysis

4. The economic analysis was carried out following the Asian Development Bank (ADB) guidelines, by comparing transport costs for road agency and transport users with and without project options.[3] The analysis used the domestic price numeraire and a discount rate of 9%. Project costs and benefits were valued in February 2020 prices using an exchange rate of $1 = Tk85.0. A shadow exchange rate factor of 1.058 (estimated based on import and export trade data for Bangladesh for 2014–2016) was used for traded goods,[4] with a shadow wage rate factor of 0.75 for unskilled labor (based on the average wage rates of construction and agricultural

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[1] ADB. 2018. *Report and Recommendations of the President to the Board of Directors: Proposed Loan and Technical Assistance Grant to the People's Republic of Bangladesh: Rural Connectivity Improvement Project*. Manila.

[2] Government of Bangladesh, Planning Commission. 2015. *The Seventh Five Year Plan: FY2016–FY2020*. Dhaka.

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

[4] A. Lagman-Martin. 2004. Shadow Exchange Rates for Project Economic Analysis: Toward Improving Practice at the Asian Development Bank. *Economics and Research Department Technical Note Series.* No. 11. Manila: ADB.

workers). Construction is planned to begin in 2020 and be completed by 2022, and the analysis considered a 20-year operational period following construction.

5. In the with-project alternative, the improvement will be either to rehabilitate the project road sections to the full cross-section of a single lane road or widen to an intermediate lane configuration based on the need for increased capacity. Improvements will include measures to improve road safety and control speed in some locations (e.g., bends and commercial areas). The proposed improvement will provide an acceptable level of service on the road sections, and thereby maintain improved speeds over the analysis period.

6. **Unit vehicle operating costs.** The Highway Development and Management (HDM-4) model was used to estimate unit vehicle operating costs for typical road conditions observed with and without the project over the analysis period. A spreadsheet was used to derive the road user cost streams. The technical and vehicle operating characteristics, inputs to the HDM-4 model, are adopted from the data collected by the project development technical assistance team.[5] The economic fuel price has also been derived, excluding taxes and duties, from details published by Bangladesh Petroleum Corporation, and adopting a medium-term crude oil price of $50 per barrel.

7. **Value of time for passengers.** For passenger vehicles, the value of passengers' working and nonworking time was calculated based on an income survey of vehicle users from a previous study, updated to 2020 using growth in per capita income.[6] The estimates were compared with values derived from per capita income, 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% of bus passenger work trips are by unskilled laborers. Nonwork time was valued as one third of work time. No value of time is considered for travel by non-income-earning persons. Table 1 summarizes the time values for each passenger-carrying vehicle.

Table 1: Adopted Values of Passenger Working and Nonworking Time
(Tk per hour)

Item	Bus		Car		Motorcycle and Auto Rickshaw	
	Working	Nonworking	Working	Nonworking	Working	Nonworking
Value of time	115	38	205	67	86	28

Source: Asian Development Bank estimates.

8. **Traffic estimation and forecast.** Traffic volume was obtained from the classified traffic counts carried out on the project road sections. The base year traffic obtained from the traffic surveys constitutes the normal traffic. The project road sections are existing roads that serve traffic, so the analysis does not consider generated traffic. In the absence of historical traffic growth data for these road sections, growth in vehicle numbers and the growth forecast for the economy and population are used in the traffic projections. Data on growth in vehicle registration and economic parameters (e.g., gross domestic product, per capita income, and population) were analyzed to estimate elasticity in growth in vehicle numbers in relation to these parameters, and were adopted for the traffic projections.

9. The number of registered vehicles in Bangladesh has been growing at 10.5% per year since 2011.[7] Motorcycles are the dominant vehicle type, accounting for 56.5% of registered vehicles. Passenger vehicle numbers grew at an overall annual rate of 10.8% and goods vehicles at 10.2%. The high rate of growth for goods vehicles numbers resulted from beginning at a low

[5] ADB. Bangladesh: Rural Infrastructure Maintenance Program.
[6] ADB. 2016. *Transport Project Preparatory Facility*. Draft Feasibility Study Report. Manila (Grant 0227-NEP).
[7] Government of Bangladesh, Bureau of Statistics. 2019. *Statistical Pocket Book, Bangladesh 2018*. Dhaka.

base and the increased economic growth during this period. The economic growth outlook indicates sustained economic growth prospects in the short to medium term. Overall vehicle growth in rural areas is expected to be more than 7% in the short to medium term. The analysis assumes a conservative 6% overall growth in traffic on project road sections for the first 7 years, which reduces every 5 years and stabilizes at about 4%. The traffic growth rates adopted for different vehicle categories for the traffic projection, based on the assumed overall traffic growth, are in Table 2.

Table 2: Adopted Traffic Growth Rates

Vehicle Type	2020–2027	2027–2032	Beyond 2032
Car, Van or Jeep	5.0%	4.0%	4.0%
Two-wheeler	7.5%	6.0%	5.0%
Bus	4.0%	3.0%	3.0%
Goods vehicle	5.0%	4.0%	3.0%

Source: Asian Development Bank estimates.

10. **Project benefits.** The benefits of upgrading the project roads are an increase in vehicle speeds to normal vehicle speeds on rural single lane or intermediate lane roads in good condition, compared with low speeds on roads in poor condition. The increased speed and improved road condition will result in significantly reduced travel time and vehicle operating costs during the analysis period. The travel speeds observed in the without-project option are 15–25 km per hour. In the with-project option, the average speeds estimated using the HDM-4 model are 35–45 km per hour for all vehicles throughout the year. The improved roads will also reduce greenhouse gas emissions, but the value of savings in monetary terms is not large because of the low traffic levels, and therefore not included in the analysis.

11. The road upgrading will support sustaining and increasing agricultural productivity and crop diversification, as it will have beneficial impacts on agribusiness and small-scale industries in rural communities, in addition to reducing transport costs.[8] These additional economic benefits are not included in the analysis because of the difficulty of estimating the contribution of transport savings alone, and to avoid double counting of benefits.

12. **Project costs**. The construction cost estimate for the project option is based on the project design and bill of quantities. It includes the civil works cost, social and environmental cost, utility shifting costs, and physical contingencies. The economic costs of construction were derived from the financial construction cost by removing taxes and applying a shadow exchange rate factor and shadow wage rate factor for the unskilled labor component. The estimated cost ranges from Tk6.5 million–Tk21.8 million per km.

D. Results of Economic Analysis

13. An economic analysis has been carried out for the project road packages included in the additional financing. The results of the economic analysis for additional financing, the current project, and the overall project (all updated to 2020 cost levels) are in Table 3. These indicate that the project development option has an economic rate of return of 16.4%–18.3%, well above the opportunity cost of 9%. The cash flow streams for all the road packages included in the additional financing are in Table 4.

[8] S. Liu. 2017. Transport and Agricultural Productivity: A Cross-national Analysis. *Research on Modern Higher Education*. 2: 79-84 concludes (p. 79) “that a country with better transport can produce more agricultural outputs given the same amounts of agricultural inputs and the same education level.”

Table 3: Results of Economic Analysis

Project	**EIRR** (%)	**ENPV** (Tk million)
All roads in additional financing	18.3	8,659.0
All roads in current project	16.4	10,891.0
Current project + additional financing	17.1	18,836.0

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

Table 4: Cash Flow Stream for the Additional Financing Project
(Tk million)

	Increase in Road Agency Costs		**Decrease in Road User Costs**		
Year	**Capital Costs**	**Maintenance Costs**	**Vehicle Operating Costs**	**Time Costs**	**Net Benefits**
2020	2,398.7	0.0	0.0	0.0	(2,398.7)
2021	4,797.4	0.0	0.0	0.0	(4,797.4)
2022	4,797.4	0.0	0.0	0.0	(4,797.4)
2023	0.0	(380.8)	1,665.7	834.8	2,881.3
2024	0.0	(387.1)	1,741.5	870.9	2,999.5
2025	0.0	(393.0)	1,820.4	908.4	3,121.9
2026	0.0	(397.4)	1,896.8	944.4	3,238.7
2027	0.0	1,707.5	1,970.4	978.8	1,241.7
2028	0.0	3,186.0	2,028.5	1,005.3	(152.2)
2029	0.0	738.4	2,086.2	1,031.4	2,379.3
2030	0.0	(413.5)	2,141.4	1,056.2	3,611.0
2031	0.0	(414.2)	2,193.0	1,079.0	3,686.2
2032	0.0	(415.0)	2,236.9	1,097.7	3,749.7
2033	0.0	1,692.8	2,277.3	1,117.5	1,701.9
2034	0.0	3,169.9	2,319.2	1,137.9	287.2
2035	0.0	725.1	2,361.4	1,158.6	2,794.8
2036	0.0	(426.4)	2,404.8	1,179.7	4,011.0
2037	0.0	(427.3)	2,449.9	1,201.7	4,078.9
2038	0.0	(427.3)	2,496.6	1,224.5	4,148.5
2039	0.0	1,679.4	2,545.0	1,248.2	2,113.8
2040	0.0	3,155.7	2,595.2	1,272.7	712.2
2041	0.0	688.8	2,647.3	1,298.2	3,256.7
2042	0.0	(431.9)	2,700.0	1,324.0	4,455.9
				EIRR (%)	**18.3**
				ENPV @ 9%	**8,659.2**

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

14. To determine the robustness of the analysis and how sensitive the project's economic viability is to cost overruns and benefit reductions, sensitivity analyses examined five cost and benefit cases: (i) base cost and base benefits; (ii) capital costs increased by 15%, with base benefits; (iii) base costs, with benefits decreased by 15%; (iv) fuel price reduced to $30; and (v) capital costs increased by 15% and benefits decreased by 15%. The results are in

15. Table 5. Also, with an increase in capital costs by 10% and a reduction in benefits by 10%, the project still has an economic internal rate of return above 9%. Based on the economic analysis of the project options, as well as on the engineering and traffic assessment, the proposed project is recommended for implementation.

Table 5: Sensitivity Analysis Results

Projects	Sensitivity Scenario (economic internal rate of return %)				
	Case I	Case II	Case III	Case IV	Case V
All roads	18.3	15.9 (costs +87%)	15.5 (benefits –46%)	17.2	15.9 (costs +30%, benefits –30%)

Note: Figures in parentheses give the switching value for the variable(s) considered.
Source: Asian Development Bank.

E. Financial Analysis

16. **Financial sustainability.** The rural road maintenance budget has increased each year since 2012 (Table 6), with an average annual increase in allocation of 15.6%. The allocation during 2012–2019 has averaged 15.6% of the estimated need, thus adding to the large maintenance backlog. The government budgetary allocation for rural road maintenance is inadequate, indicating that more investment is required to overcome the issue. Hence, it is unlikely that LGED will fully secure the funds required for sustainable maintenance, and the risk that the improved roads may not last for their entire expected economic life is substantial.

Table 6: Allocation of Funds from 2012–2019 [a]

Financial Year	Calculated Need (Tk million)	Allocated			Spent	
		Tk million	% of Need	% Increase	Tk million	% of Allocation
2011–2012		6,250				
2012–2013	57,210	7,600	13.28	21.60	7,600	100
2013–2014	52,630	8,350	15.87	9.87	8,350	100
2014–2015	48,040	9,750	20.30	16.77	9,750	100
2015–2016	97,040	10,750	11.08	10.26	10,750	100
2016–2017	76,220	12,580	16.51	17.02	12,580	100
2017–2018	112,590	17,300	15.37	37.52	17,300	100
2018–2019	120,000[b]	18,000	15.00	4.05	18,000	100

[a] District fund allocation for rural road and bridge maintenance, Road Maintenance and Road Safety Unit, Local Government Engineering Department.
[b] estimated
Source: Local Government Engineering Department.

17. ADB's road rehabilitation intervention will help reduce the maintenance backlog. Other development partners (the World Bank and the Japan International Cooperation Agency) are funding similar interventions, and together these will help sustain maintenance and prevent *upazila* and union roads—the backbone of the country's rural road network—from going into disrepair and requiring more costly reconstruction. The government needs to increase the rural road maintenance funding substantially. This may be possible given increased funding and sustained economic growth, and must be confirmed to ensure sustainable maintenance. The additional financing will increase the length of improved rural roads to approximately 2,630 km, and will require a maintenance budget of $23 million (annualized), or about 12% of total LGED road maintenance expenditure in 2018. LGED has a well-established maintenance planning and budget allocation system that can be used effectively to allocate funding for sustainable maintenance of the rehabilitated road network. The additional maintenance expenditure required is a significant share of the maintenance expenditure for rural roads managed by LGED. The budget increases the allocation for rural road maintenance (to 20% per year, from 15%), reflecting the government's commitment to improving rural road maintenance. The overall project will also include 5 years of maintenance through works contracts as a pilot, with the goal of ensuring better asset quality and improved maintenance. The technical assistance attached to the current project will strengthen the capacity of LGED on fund and asset management. For long-term sustainable maintenance of the rural road network, LGED should increasingly use performance-based maintenance or long-term maintenance contracts, increase the rural road maintenance budget allocation, and seek the continued support of development partners.