ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The proposed Rural Connectivity Improvement Project involves upgrading existing fair-weather earthen tracks to all-weather bituminous surfaced roads to provide all-year access to the rural communities in 16 districts of Nepal. The poor road network and closure of roads for 60–90 days per year because of rains significantly inhibits the rural community's ability to improve agricultural production and integration with other sectors and value addition, especially in the hills and mountains. The poor access adds to the other weaknesses in the system resulting in low agricultural productivity, limited commercialization of farm and off-farm enterprises, and low efficiency of markets and marketing, and all these place strong brakes on progress. The main output of the proposed project is upgrading of 27 rural roads (388 kilometers [km]) in 16 districts to improve quality of life with better access to health and education, provide increased economic opportunities, improve access to social services, and reduce the incidence of poverty in these rural communities.

B. Macroeconomic Context

2. The agriculture sector contributes about 35% of Nepal's gross domestic product (GDP) and supports two-thirds of the population and is therefore very important for employment and income and poverty reduction in Nepal. Nepal's economy, growing at 4.0%–5.0% annually, was disrupted by the April–May 2015 earthquakes and growth fell to 3.4% in 2014–2015 and to 0.8% in 2016. The economic growth outlook indicates robust economic growth of 5.6% in 2017 and 5.4% in 2018 and is expected to continue in the 5.0%–6.0% range in the medium term. Annual agriculture sector growth, although much more variable than national economic growth, has averaged about 2.5% with annual growth rates varying from 0.8% to 4.6%.[1] Since much of the cultivated area has no irrigation facilities, annual outputs are, in many places, highly weather dependent. Nepal's agriculture suffers generally from low productivity. There is potential to increase productivity but several factors constrain increasing productivity, and one of the main ones is poor accessibility. Nepal has made significant progress in achieving the Millennium Development Goals. Over 90% of Nepal's poverty reduction since 2008 has occurred in rural areas, and growth of rural incomes will continue to be the main driver of poverty reduction in coming years, provided that agricultural productivity improves and rural households meet market demand, selling more of their produce in the market. Raising agricultural factor productivity, increasing connectivity, promoting agribusiness, and increasing commercialization across the sector are essential for achieving these goals. Nepal is benefitting from a large skilled work force employed abroad and the remittance income forms almost 32% of GDP. The remittance income has been increasing at an annual growth rate of 21.8% from 2012-2016 which explains the high vehicle growth rate in the country, including in rural areas. The vehicle growth from 2012-2016 has been much higher in rural areas of Nepal—more than 18.0% compared to 10.2% in the Kathmandu Valley.[2] The government's development strategy of harnessing remittance incomes in productive sectors and improving rural accessibility will help in achieving poverty reduction.

C. Demand Analysis

3. Road connectivity of smallholder farmers, scattered around the interior parts of the country, is at a level far from what is needed for them to engage in diversification and commercial

[1] ADB. 2017. *Asian Development Outlook 2017*. Manila.
[2] The Kathmandu Valley (Bagmati Zone) accounted for 40% of total vehicles in Nepal in 2016.

agriculture. An average household needs to spend more than 3.5 hours to reach the nearest bus stop, and more than 2.0 hours to reach the nearest market center. Nearly 40% of rural households live more than 2 hours from paved roads, more than 25% live 2 hours away from the nearest bus stop or telephone booth, while a little less than 33% live 2 hours away from a market center. The terrain and transportation constrict the market circulation of bulky products. Nepal has the lowest road density[3] in South Asia, with around 22% of the population still disconnected from road access. The local road network (LRN), which connects rural households to the market centers, consists of 57,632 km, of which only 27% are all-weather roads and the remainder are fair-weather roads;[4] only about 3.5% of the LRN is black-topped, 22.2% is gravel, and the remaining 74.3% is earthen. The LRN, which provides the basic access to the rural population, needs substantial investments to make it accessible all year. The poor road network also results in poor public transport services and high rates charged for passenger and freight transport, restricting agricultural inputs and agricultural products marketing and thus economic opportunities for the rural population.

D. Project Rationale

4. The Government of Nepal initiated the implementation of the Agriculture Development Strategy in 2015[5] with a goal of raising the agriculture sector's long-term annual growth rate from below 3% to the government's goal of 5%. The strategy recognizes lack of all-weather access as one major constraint on developing commercial agriculture value chains. Nepal's geology and topography, combined with its rural population distribution, restricts and complicates efforts to provide all-weather road connectivity to rural communities. The project aims to improve access in rural areas through the upgrading of selected rural roads.

E. Project Alternatives

5. The selected roads are part of the district core road network selected for development based on the district transport master plans. From a long list of alternative roads that could be upgraded, roads were prioritized based on project impact variables such as population benefited, district agricultural potential, and commercial farming potential. Twenty seven road sections from 16 districts were selected for the project. A total of 52 initial roads were considered for prioritization. Impact variables were assessed using district-level data available from district master plans and socio-economic survey in the project area. Variables were chosen and weighted and roads were prioritized through the process of factor analysis.[6]

F. Methodology and Data

6. **Economic analysis assumptions.** The economic analysis was carried out following Asian Development Bank (ADB) guidelines[7] and using the highway development and management (HDM)-4 model by comparing transport costs for road agency and transport users in with- and without-project scenarios. The analysis used domestic price numeraire, and a

[3] Road density in Nepal is about 44.4 kilometers (km) per 100 square km (km^2), and that of all-weather roads is about 16 km per 100 km^2, which is well below the rates in other countries in the region.

[4] Government of Nepal, Department of Local Infrastructure Development and Agricultural Roads. 2016. *Statistics of Local Road Network 2016*. Kathmandu.

[5] Ministry of Agricultural Development. 2015. *Agriculture Development Strategy 2015 to 2035*. Kathmandu.

[6] The selection criteria took into consideration the population size, each district's agricultural potential, the number of agricultural farms and commercial establishments, economic potential, and access to education facilities, aligned with the Agriculture Development Strategy in 2015.

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

discount rate of 9% was used. Project costs and benefits were valued at 2017 prices using an exchange rate of $1 = NRs102.65. A shadow exchange rate factor of 1.084[8] (estimated based on import and export trade data for Nepal for 2014–2016) for traded goods and shadow wage rate factor of 0.7 for unskilled laborer generally adopted in Nepal were used. A 3-year construction period starting in 2018 and operational period of 20 years following the construction was used for the analysis. A straight-line depreciation method was used to calculate the salvage value of project elements at the end of the analysis period. Among the project elements, bituminous components are assumed to have a life of 20 years with periodic renewal as needed and with no salvage value. The pavement structure below the bituminous layer is assumed to have a 40-year life for salvage value calculation. Cross-drainage structures and retaining structures can have a life of more than 40 years, but a 40-year life is assumed for all structures. Based on these assumptions, salvage value was calculated in the analysis. The data required for the analysis, including existing road characteristics and project design, have been obtained from the detailed project reports.

7. The selected project road sections have an operational single lane earthen track in poor condition at present and most road sections become nonmotorable during the rainy season. Without reconstruction to an engineered road, maintaining accessibility throughout the year is not feasible and road conditions continue to deteriorate to very poor condition. With no intervention, project road maintenance will involve earthworks to allow vehicle access at least during fair weather conditions with low travel speeds and high vehicle operating costs. With the high cost of transportation and seasonal access, the project area will continue to have low agricultural productivity and subsistence farming and the goals of the Agriculture Development Strategy will not be met. The improvement alternative to achieve the minimum required level of service on project road sections will be to reconstruct the project road sections. In the with-project scenario, the project road sections will be reconstructed with granular base, asphalt concrete surfacing, and cross-drainage works along the existing alignment with minimum required geometric improvement and all engineering features for safe operation. The carriageway will be widened to single carriageway width with shoulders as per standard for hill roads and roads in plain and rolling terrain. The engineering designs adopted have measures to improve the road safety and control speed at locations such as curves and commercial areas. The engineering designs have been optimized for economy and construction efficiency in accordance with applicable design standards. The proposed improvement to the selected road sections will provide all-year access and acceptable travel speeds in the hilly and *terai* region and allow sustainable maintenance over the design period and thus maintain the improved speeds over the analysis period.

8. **Vehicle characteristics and costs**. The HDM model takes as input the vehicle technical and operational characteristics, vehicle prices, tire prices, fuel prices, and maintenance and vehicle operation staff costs. The technical and vehicle operating characteristics are adopted from the HDM-4 calibration for Nepal. The vehicle and tire price, excluding taxes and labor cost for vehicle maintenance and operation, collected from dealers in the country has been adopted. Economic fuel price has also been derived excluding taxes and duties from the details published by the Nepal Oil Corporation and adopting a medium-term crude oil price of $60 per barrel.

9. **Value of time for passengers and freight**. For passenger-carrying vehicles, the value of passengers' working and nonworking times were calculated based on a survey of income level of

[8] A. Lagman-Martin. 2004. *Shadow Exchange Rates for Project Economic Analysis: Towards Improving Practice at the Asian Development Bank.* Manila: Asian Development Bank.

vehicle users from a previous study[9] as well as skilled and unskilled laborer rates in project areas. The value of work time was derived from the monthly income by assuming 2,080 working hours per year in case of motorcycle and car passengers, and based on laborer rates for bus passengers. The proportion of work trips is taken from previous studies and ranges from 10% to 20%. The value of time for nonwork travel of income-earning persons is taken as 25% of the value of work time. No value of time is considered for travel by non-income-earning persons. The value of bus passenger time was modified applying the shadow wage rate factor. The values were updated to 2017 values based on increases in per capita income. A summary of the calculated values of time for each passenger-carrying vehicles is presented in Table 1.

Table 1: Adopted Values of Passenger Work and Nonwork Time
(NRs/hour)

Vehicle Type	Value of Work Time	Value of Nonwork Time
Motorcycle	108	27
Car/4-wheel drive	180	45
Bus	83	21

Source: Asian Development Bank estimates.

10. **Traffic estimation and forecast**. Traffic volume was obtained from the classified traffic counts carried out on project road sections during the dry season as most road sections are nonmotorable during the rainy season. Traffic counts were carried out for feasibility and detailed design studies for 1, 3, or 7 days. Summary features of project road sections grouped based on traffic are given in Table 2. The low traffic level roads are in the hilly and mountainous districts and the higher traffic levels are observed in the plains (*terai*) districts. The base-year traffic obtained from the traffic surveys constitutes the normal traffic for the dry season. The wet season traffic reduction and number of days roads are not motorable were assessed based on local enquiries. In addition to the normal traffic, generated or induced traffic is also considered. The proposed improvement creates a drastic change in the accessibility for the project area with all-weather road in the hilly and mountainous sections and reduces the travel cost by 40%–50% during the fair-weather period. Generated traffic elasticities are assumed in the range of –0.5 to –1.5 and considering the large cost reduction and accessibility improvement, an elasticity of –1.0 is considered, i.e., a traffic generation of 40% of base traffic is considered. In the *terai* region, with higher road density, more alternative routes are available and hence a traffic generation of 20% is considered. The benefits of generated traffic have been quantified at half the benefits of normal traffic and this is in-built in the HDM-4 model.

11. In the absence of historical traffic growth data on these road sections, traffic growth on other rural roads, vehicle growth, and growth forecast of both economy and population are used in traffic projections. The before and after studies on some of the roads[10] indicate a more than doubling of traffic in 5 years with similar upgrading. Data on vehicle registration growth and economic parameters such as GDP, per capita income, and population were analyzed to estimate vehicle growth elasticity in relation to these parameters and were adopted for traffic projection.

[9] ADB. 2016. *Transport Project Preparatory Facility*. Draft Feasibility Study Report. Canada (Grant 0227-NEP, Project Preparatory Consultant [PPC-2 Road], MMM Group).

[10] ADB. 2017. *Subregional Transport Enhancement Project.* Consultants Final Report*.* Manila (Loan 2685-NEP/Grant 0225-NEP, Intercontinental Consultants and Technocrats Pvt. Ltd., India in association with Full Bright Consultancy, Pvt. Ltd.).

Table 2: Summary Details of Base-Year Traffic on Project Road Sections

Traffic Level (motorized vehicles)	Number of Roads	Length (km)	Dry Season Traffic (motorized vehicles)	Passenger Vehicles (%)	Freight Vehicles (%)	Dry Season Traffic (nonmotorized vehicles)
<50	8	127.16	32–49	68	32	Negligible
50–100	10	142.76	50–80	75	25	40–120
>100	9	112.19	108–448	85	15	60–150

km = kilometer.
Source: Detailed project reports.

12. Nepal has observed a very high vehicle growth from 2012 to 2016 at more than 15% per annum.[11] The vehicle growth by category indicate annual growth of 15.6% for motorcycles, 10.2% for cars and utility vehicles, 12.0% for buses, 7.2% for trucks, and 11.5% for tractors. The overall vehicle growth in the rural areas is expected to be more than 10% in the short to medium term from the trend observed. A conservative 8% overall growth in traffic on project road sections is assumed for the analysis for the first 5 years and reducing every 5 years and stabilizing at about 4%. Based on the overall traffic growth assumed, traffic growth rates adopted for different vehicle categories are given in Table 3.

Table 3: Adopted Traffic Growth Rates

(%)

Vehicle Type	2016–2021	2021–2026	2026–2031	Beyond 2031
Car/van/jeep	8.0	6.5	5.0	4.0
Two-wheeler	9.0	7.5	6.0	5.0
Bus	6.0	5.0	4.0	3.0
Goods vehicles	6.0	5.0	4.0	3.0

Source: Asian Development Bank estimates.

13. **Project benefits.** The benefits of upgrading the project roads are an increase in vehicle speeds to normal vehicle speeds on a rural single-lane road in good condition compared to very low speeds with poor condition of the roads. 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 scenario are 8–10 km per hour (km/h) in the hilly region and 15–17 km/h in the *terai* region for all vehicles during fair weather. In the with-project scenario, the average speeds estimated with the HDM-4 model are 25 km/h in the hilly region and up to 35 km/h in the *terai* region for all vehicles throughout the year.

14. The other major benefit will be the all-weather access. Currently during the rainy season most of the road sections are not motorable and passengers have to walk and porters are used for transport of goods in the hilly and mountainous region. The transport cost thus becomes many fold during rainy season. About 30–60 days of closure is assumed based on local enquiries in the analysis, and transport costs (passenger time and porter costs) are calculated in the without-project case compared to motorized transport, and the cost savings are estimated separately and included in the analysis. In the case of *terai* roads, increased travel cost is considered during the rainy season as roads are observed to be kept open. The traffic during the rainy season will reduce because of higher travel times and costs, and for the analysis a one-third to one-half reduction is considered.

[11] Government of Nepal, Central Bureau of Statistics. 2016. *Statistical Year Book 2016*. Kathmandu; Government of Nepal, Ministry of Finance. *Economic Survey 2015/16*. Kathmandu.

15. The improved roads will also reduce greenhouse gas emissions but the value of savings in monetary terms is not large because of low traffic levels and therefore not included in the analysis. Also, the roads after improvement will provide better riding quality and be safer. The road upgrading will support agricultural productivity increase and crop diversification as well as reduced loss of agricultural produce with timely and safe transport of perishable produce, thus generating consumer surplus in addition to transport costs savings. The access will also encourage more areas to be brought under cultivation. These are additional economic benefits but are not included in the analysis because of difficulty in their estimation and to avoid double counting of benefits.

16. **Project costs**. The construction cost estimate for the project option is derived based on detailed design and bill of quantities. The cost estimate 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 the shadow exchange rate factor and shadow wage rate factor for the unskilled labor component. The estimated unit cost range from NRs14.1 million to NRs26.2 million. The routine and periodic maintenance unit costs adopted are based on the unit cost estimates for the project.

G. Results of Economic Analysis

17. An economic analysis has been carried out for the project road sections, and results are summarized in Table 4. The results indicate that the project development option has a rate of return well above the opportunity cost of 9%. The cash flow streams for the overall project are given in Table 8.

Table 4: Results of Economic Analysis

Project	**EIRR** (%)	**NPV** (NRs million)
All roads	13.4 (10.0–20.5)*	2,712.6

EIRR = economic internal rate of return, NPV = net present value.
* gives the range of EIRR for individual roads.
Source: Asian Development Bank estimates.

18. Sensitivity analyses were carried out to investigate the robustness of the economic viability of the project to cost overruns and benefit reductions. The cases analyzed are (i) Case I: base cost and base benefits; (ii) Case 2: increase capital costs by 10% and base benefits; (iii) Case 3: base cost and decrease benefits by 10%; (iv) Case 4: 2-year construction delay; (v) Case 5: rainy season traffic reduced to 50%; (vi) Case 6: increase capital costs by 10% and decrease benefits by 10%. The results of the sensitivity analyses for the project are given in Table 5. As shown, with an increase in capital costs of 10% and a reduction in benefits of 10%, the project still has an economic internal rate of return (EIRR) of 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

	Sensitivity Scenario (EIRR [%])					
Project	**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**	**Case 6**
All Roads	13.4	12.2 (+46%)	12.1 (–31%)	12.0	10.9(–85%)	11.0(+/–18.6%)

Note: Figures in brackets give the switching value for the variable(s) considered. In Case 6, the +/– indicates the percentage by which cost increases and benefit decreases result in a net present value 0.

EIRR = economic internal rate of return.
Source: Asian Development Bank estimates.

H. Distribution and Poverty Analysis

19. The project costs and benefits are shared among the project stakeholders including government, laborers, vehicle operators, and vehicle passengers. The poverty headcount ratio for Nepal was at 23.8% in 2014. The project roads are located in 16 districts that have about 28.5% of the country's population. In addition to the population living below the poverty line, it is assumed an equal proportion of the population in the project area remains vulnerable. The analysis assumes that 50% of vehicle operating cost savings will be passed on to the users by the operators in case of public transport and freight vehicles. It is also assumed that about 33% of two-wheeler owners are in the vulnerable group. The project will increase the net income by an estimated NRs2,957 million, of which NRs1,779 million accrues to poor and vulnerable people. The poverty impact ratio is estimated to be 60.2% (Table 6).

Table 6: Poverty Impact Assessment

Item	Vehicle Owners	Vehicle Passengers	Unskilled Laborers	Government	Total
NPV (NRs million)	1,947.8	8,242.2	199.4	(7,432.8)	**2,956.7**
Share of costs and benefits accruing to the poor and vulnerable (%)	6.1	31.9	100	15.7	
Costs and benefits accruing to the poor and vulnerable (NRs million)	118.8	2,628.6	199.4	(1,167.5)	**1,779.3**
Poverty impact ratio (%)					**60.2**

( ) = negative, NPV = net present value.
Source: Detailed project reports

I. Financial Analysis

20. **Financial sustainability.** The budget allocation for the local road network (LRN) has increased significantly in recent years and several development partners are participating in improving the rural road maintenance and involving the rural communities in road maintenance through road maintenance groups. About half of the funding for the LRN comes from block grants provided to the local governments and local government revenue, and the balance comes through targeted projects funded by the Government of Nepal and development partners. The LRN budget allocation and expenditure is given in Table 7.[12]

Table 7: Local Road Network Construction and Maintenance Funding
($ million)

Year	2010	2011	2012	2013	2014	2015	2016	2017
Budget Allocation	212.4	235.8	271.9	198.2	264.1	317.1	413.4	546.0
Expenditure	184.3	215.2	218.5	176.6	215.9	247.4	335.6	

Source: Department of Local Infrastructure Development and Agricultural Roads

21. The budget available has more than doubled from 2013-2017 and overall expenditure has been about 85% of the budget allocation. The maintenance fund allocation is based on the annual road maintenance plans (ARMPs), and consultation with the Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR) has indicated that with the ARMPs,

[12] Funds allocated to local government is for all local infrastructure and maintenance expenditure.

maintenance needs of upgraded roads are fully met. In addition to the above, the LRN also receives funding from the Road Board of Nepal (RBN) and the allocation by the RBN in 2017 for LRN maintenance was $16.7 million. The proposed project will upgrade about 388 km of the LRN and will require an annualized maintenance budget of $2.6 million, which is less than 0.1% of the total LRN expenditure in 2016. DOLIDAR has the established system (ARMP) for maintenance planning and fund allocation and is currently meeting the maintenance funding as requested by the ARMPs. The additional maintenance expenditure required for the sustainable maintenance is a small fraction of the total expenditure for the LRN and is therefore financially sustainable. Further, the project will include performance-based maintenance in civil works contracts for 3 years to ensure better asset quality and improved maintenance. DOLIDAR has established a rural transport information and management system which incorporates improved asset management practices. The capacity of DOLIDAR on fund and asset management will be strengthened through the ADB technical assistance attached to the project.

Table 8: Cash Flow Stream for the Project

	Increase in Road Agency Costs		Decrease in Road User Costs			
Year	Capital Costs	Maintenance Costs	Vehicle Operating Costs	Time Costs	Rainy Season	Net Benefits
2017	0.0	0.0	0.0	0.0	0.0	0.0
2018	1,555.1	0.0	0.0	0.0	0.0	(1,555.1)
2019	3,107.5	0.0	0.0	0.0	0.0	(3,107.5)
2020	3,106.2	0.0	0.0	0.0	0.0	(3,106.2)
2021	0.0	37.3	375.2	225.9	375.6	939.5
2022	0.0	37.3	400.7	246.5	394.5	1,004.4
2023	0.0	37.3	425.1	267.3	414.4	1,069.5
2024	0.0	37.3	450.9	289.9	435.3	1,138.9
2025	0.0	37.3	478.3	314.5	457.2	1,212.8
2026	0.0	948.5	501.4	336.8	480.1	369.8
2027	0.0	37.3	542.3	361.8	504.4	1,371.2
2028	0.0	37.3	559.8	386.7	529.4	1,438.7
2029	0.0	37.3	584.8	414.0	555.9	1,517.5
2030	0.0	37.3	612.2	443.4	583.7	1,602.1
2031	0.0	37.3	635.3	470.6	584.4	1,653.0
2032	0.0	948.4	659.3	499.5	585.2	795.6
2033	0.0	37.3	685.7	530.2	586.1	1,764.7
2034	0.0	37.3	712.0	562.8	586.9	1,824.4
2035	0.0	37.3	739.3	597.4	587.8	1,887.2
2036	0.0	37.3	767.7	634.3	588.7	1,953.4
2037	0.0	37.3	797.2	673.4	589.6	2,023.0
2038	0.0	948.7	827.8	715.1	590.6	1,184.8
2039	0.0	37.3	861.4	759.3	591.7	2,175.2
2040	(2,097.6)	37.3	894.8	806.4	592.8	4,354.4
				EIRR (%)		**13.4**
				NPV @ 9%		**2712.6**

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