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13. ECONOMIC ANALYSIS

13.1 Economic Analysis

13.1.1 Methodology

The economic evaluation has been carried out within the broad framework of social cost benefit. The objective is to determine the appropriate improvement Scheme out of several proposals that leads to minimizing total transport costs and maximizing benefits to the road users. The indicators for economic viability analysis are Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and NPV/Cost Ratio.

The costs considered comprise of road agency costs and costs to road users as follows:

Road Agency Costs	Road User Costs
• Construction Cost • Maintenance Cost	• Vehicle Operating Cost • Travel Time Cost • Congestion Cost • Accident Cost

The benefits accruing to society from the proposed improvement are as follows

Road User Benefits	Social Benefits
• Vehicle Operating Cost Savings • Value of Travel Time Savings • Value of Savings in Accident Costs • Savings in Maintenance Costs	• Improvements in administration, Law and order • Improvements in health and education • Improvements in agriculture, Industry, trade and mining • Improvements in environmental standards • Appreciation in value of Land adjacent to roads

At the present state of knowledge in the country, it is possible to monetarily quantify only the direct road user benefits. This report, therefore, restricts itself to only the direct road user benefits.

Road users experience different costs in the "With Project" and "Without Project" scenarios. The benefits to road users are constituted by the savings in costs. Increasing traffic volumes as a result of the project implies more vehicle kilometres and hence more vehicle operating costs and, possibly showing more saving in with project conditions viz. benefits as a result of the project.

Based on traffic, Road network and Socio-economic characteristics of the project road, two different improvement options(with project) have been considered. The Economic analysis is carried out for the following improvement options

· "Without project/ Do minimum" - Routine maintenance of the existing road

· "With Project"- 4 lane road with paved shoulder as per the warrants of traffic volumes.

The total transport costs for both the Options have been worked out on yearly basis for the entire analysis period of 15/20 Years. All costs and benefits considered in the study have been valued in monetary terms and expressed in economic prices for avoiding distortion in the input prices of labour, materials, equipment and foreign exchange due to market imperfections. The ratio of Economic and Financial costs is taken as 0.85.

Economic analysis is carried out with help of HDM-4 (version 1.3) developed by the World Bank. The HDM-4 Road User Effects (RUE) sub-model uses mechanistic principles for modeling of fuel and tyre consumption. The mechanistic forces comprise of the aerodynamic, gradient, rolling and inverted resistance. It calculates vehicle speeds and operating costs taking into account road roughness, geometry, together with the characteristics of representative vehicles and the traffic flow.

The new HDM-4 also makes use of the CRRI deterioration models for Indian asphalt mixes such as semi dense carpet and premix carpet and gives accurate predictions of roughness for various road maintenance related components.

This model provides for calibration of crucial input parameters to suit the local conditions and analysis of a number of alternatives and sections at relatively greater speed than is possible with HDM III. The Road user cost streams generated by HDM-4 are extracted and Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and sensitivity analysis have been carried out.

13.1.2 Measures of project Analysis

In order to quantify the economic viability of a project or projects three measures can be used. All of these use a discounting approach. These are:

* Net Present Value (NPV)
* Benefit Cost Ratio (BCR)
* Internal Rate of Return (IRR)

(1) Net Present Value (NPV)

$$\sum_{i=1}^{n} \frac{B_i}{(1+r)^i} - \sum_{i=1}^{n} \frac{C_i}{(1+r)^i}$$

NPV = Discounted Benefit – Discounted Cost

Where B_I = Benefit in the i^{th} year

C_I = Cost of the i^{th} year

(2) Benefit Cost Ratio (BCR)

$$\sum_{i=1}^{n} \frac{B_i}{(1+r)^i} \div \sum_{i=1}^{n} \frac{C_i}{(1+r)^i} \text{BCR} = \frac{\text{PresentValueofbenefts}}{\text{Presentvalueofcosts}}$$

(3) Internal Rate of Return (IRR)

$$\text{or}, \sum_{i=1}^{n} \frac{B_i - C_i}{(1+r)^i} = 0$$

The IRR is that discount rate which makes NPV = 0

IRR represents average earning power of the money used in the project over the project life.

13.1.3 Decision Criteria

The formal decision criterion is to accept all projects with a BCR of one or greater than one, NPV greater than Zero or IRR greater than opportunity cost of capital, since primary tangible returns are greater than primary tangible costs. If funds are limited, the magnitude of IRR or BCR can be used in ranking the order of priority of undertaking projects whose ratios are more than one. This assumes, of course, that the indirect tangible and intangible benefits and costs are of minor importance or are approximately the same for the various projects under consideration. Sometimes, however, the indirect tangible and intangible benefits may dictate over direct tangible benefits and so the projects with even less than one BCR may be selected for the overall intangible benefits of the society. In practice, there is really no single yardstick to measure the economic and financial viability of the project.

13.1.4 Price Elasticity of Demand and Traffic Forecasting

An important benefit of a capacity expansion project is the reduction in travel times for highway users. Travel time is a major component in overall price or cost to the user, which includes time as well as out-of-pocket costs. As with most goods and services, a lower price can be expected to lead to more quantity demanded – in this case, some additional travel.

Price elasticity of demand is an economic concept used to summarize how much more or less of something people will consume if its price changes. From the standpoint of estimating future traffic levels, elasticity represents how a change in the cost of driving, due to a reduction in travel time or implementation of a toll, may affect the volume of travel that will take place. These changes in volume result from some drivers' decisions to make more or fewer trips than they otherwise would have made.

Elasticity is stated in percentage change terms, e.g., an "*X*" percent reduction in travel time leads to a "*Y*" percent increase in travel Km or trips. An elasticity of zero implies that travel is unresponsive to a time change, no matter how large, while an infinite elasticity implies that even a one-second decrease in travel time will cause all capacity to be completely absorbed.

While price elasticity is a generally accepted tool in economics, there are differing opinions about how to apply it in a transportation context. The transportation economics literature reveals a wide range of measured elasticity values, reflecting different study methods, data, time periods, and locations. No studies, however, suggest that travel demand elasticity is either zero or infinite. When measured on a given facility, observed elasticity includes the effects of both diverted trips, which represent existing traffic that has simply shifted from other routes or time periods, and new travel taken as a consequence of the lower user cost. Additional research is needed to narrow the range of elasticity values that are applicable to a given set of circumstances – whether facility, corridor, or region – and to develop methods for better incorporating demand elasticity into traffic forecasting.

13.1.5 Road User Costs (RUC) Components

RUC consists of following three components:

- Vehicle operating costs (VOC), that is, the physical costs of operating a vehicle such as fuel, spare parts, depreciation, crew costs, etc;
- Travel time costs (TTC), that is, the value of time spent in travelling that could be used in other activities;
- Accident costs (ACC), that is, the physical costs of an accident and the value of injuries and fatalities.

The financial price is the retail market price to the consumer of the product. The economic price reflects the true value (that is, the real worth) as well as the scarcity premium of the resource to the economy. In the economic jargon, this is termed as a "shadow" or "accounting" price of the resource in the economy. The shadow price of unskilled labour, for instance, may well be lower than the wage to reflect its abundant supply, while that of a skilled professional may be higher than the salary given to him, if his opportunity cost is considered.

The economic price of a factor or a product also excludes all tax elements as they reflect mostly a transfer of resources from one sector of the economy to another. On the other hand, subsidy elements, if any, are included with the economic price.

Furthermore, market distortion or imperfection and government regulations or interventions are also taken into consideration while shadow-pricing a factor or a product. In case of imported inputs, economic costs were based on the border prices plus port handling, transportation, assembling and retail cost (profit margin) duly shadow priced. Local inputs of labour and materials were shadow priced using the Standard Conversion Factor of 0.85.

13.1.6 Inputs to the HDM-4 Model

13.1.6.1 Project Road Inputs

Project corridor length details mentioned in below table

Table 13-1: Project Length Details

Sections	Design Chainage (Km)			
	From	To	Length	Remarks
HS-III	0.020	14.380	14.360	4-laning of existing 2-lane stretch and Greenfield alignment

13.1.6.2 General Inputs

Analysis period - 20 & 30 years
Discount rate - 12 %
Construction Period - 3.0 Years
Construction Beginning Year - 2023
Opening year to Traffic - 2026
Standard Conversion factor - 0.85
Salvage value - 10 %

13.1.6.3 Pavement Characteristics

Road and pavement characteristics obtained from the Road Inventory Survey have been used as Model input. These include road length, carriageway width, width of paved shoulders, roughness of the existing road (IRI), structural number and cracking area.

The details of model inputs for road and pavement characteristics are presented below.

Table 13-2: Details of existing Pavement Conditions

S. No.	Item	Karimganj-Sutarkandi
01	Visual Riding Quality	Fair
02	Surface Type	Bitumen
03	Cracking (%)	15.00
04	Average Pot holes	10.00

S. No.	Item	Karimganj-Sutarkandi
	(No/Km)	
05	Average Ravelled Area (%)	3.00
06	Average Rut depth (mm)	4.5
07	Average Roughness	2.5
08	Shoulder Condition	Good
09	Road Length	14.250 Km
10	Carriageway Width	7.0m
11	Shoulder Width	1.5 to 2.0m

13.1.6.4 Traffic Composition and Growth Rates

The classified Traffic Volume Count Survey for both the directions have been carried out. The estimated ADT has been converted in to AADT, by applying the seasonal factor as applicable to the area. The summary of AADT is below and the details are presented in Traffic Report.

Table 13-3: AADT details

Survey Location No.	1
Name of Location	**Near Fakirabazar**
Two-Wheeler	1945
Three-Wheeler (Passenger)	2764
Car	649
Car (Y)	2
Tata Magic	1
RTC Bus	0
Private Bus	0

<table>
<tr><th colspan="2">Survey Location No.</th><th>1</th></tr>
<tr><th colspan="2">Name of Location</th><th>Near Fakirabazar</th></tr>
<tr><td colspan="2">Minibus</td><td>0</td></tr>
<tr><td colspan="2">School/ College Bus</td><td>0</td></tr>
<tr><td colspan="2">2 Axle</td><td>28</td></tr>
<tr><td colspan="2">3 Axle</td><td>68</td></tr>
<tr><td colspan="2">Multi Axle</td><td>5</td></tr>
<tr><td colspan="2">HEM</td><td>3</td></tr>
<tr><td colspan="2">LCV</td><td>29</td></tr>
<tr><td colspan="2">Mini LCV</td><td>155</td></tr>
<tr><td colspan="2">Tractor</td><td>0</td></tr>
<tr><td colspan="2">Tractor with Trailer</td><td>2</td></tr>
<tr><td colspan="2">Three-Wheeler (Goods)</td><td>20</td></tr>
<tr><td colspan="2">Bicycle</td><td>611</td></tr>
<tr><td colspan="2">Cycle Rickshaw</td><td>37</td></tr>
<tr><td colspan="2">Animal Drawn</td><td>1</td></tr>
<tr><td colspan="2" rowspan="3">Government Exempted</td><td>0</td></tr>
<tr><td>2</td></tr>
<tr><td>4</td></tr>
<tr><td colspan="2">Others</td><td>0</td></tr>
<tr><td rowspan="4">Vehicles</td><td>Motorized</td><td>5678</td></tr>
<tr><td>Non-Motorized</td><td>649</td></tr>
<tr><td>Total Traffic</td><td>6327</td></tr>
<tr><td>Tollable Traffic</td><td>942</td></tr>
<tr><td rowspan="3">PCUs</td><td>Motorized</td><td>4959</td></tr>
<tr><td>Non-Motorized</td><td>388</td></tr>
<tr><td>Total Traffic</td><td>5347</td></tr>
</table>

Survey Location No.		1
Name of Location		Near Fakirabazar
	Tollable Traffic	1178

The traffic growth rates have been worked out on the basis of present GDP and NSDP for the state of Assam. The growth rates for the 30 horizon years are tabulated below for the motorized traffic and for the non-motorized traffic a growth rate of 2% has been considered.

Based on the NHIDCL guidelines, the growth rates adopted to 5% along the project corridor for all modes of traffic.

Table 13-4: Traffic Growth Rates

Projected Growth Rates of Assam							
S. No	Period	2W	Car	Truck	Bus	Tractor	Tractor with trailoer
1	2023 - 2027	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
2	2028 – 2032	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
3	2033 – 2037	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
4	2038 - 2042	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
5	Beyond 2043	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%

13.1.6.5 Road Side Friction

Roadside friction has to be computed for each project road package considering the following:

- The road width
- Total traffic Volume and its Composition (Slow, Two & Three wheelers Traffic)
- Settlement pattern along the roadside
- Percentage of Built-up Area
- Number and location of Dabhas and Fuel Stations

The number of settlements along the roadside and especially the extensive ribbon development that takes place is a major factor influencing road performance. The maximum friction factor for the existing condition is taken as 0.7 and the minimum 0.6 amongst different sub projects. Following the improvements of package the roadside friction factor for the two/four lane has to be taken as 0.95.

Roadside friction factors have been incorporated into VOC as well as vehicle speeds for the given volumes and composition of traffic. Survey speed observations by the traffic planner have validated the speed assumption for the HDM-4 inputs. It is considered that the creation of free flow conditions will be a more important yardstick with which to measure the success of any project improvement rather than increase in vehicle speeds.

13.1.6.6 Base vehicle characteristics and Utilization data

The data as given in the table below have been obtained from manufacturer's literature and RUCS report and details are furnished in Appendix.

13.1.7 Capital cost of the Project

The capital costs (financial) of the project road have been converted into economic cost by using a standard conversion factor of 0.85, as suggested by the World Bank for highway projects in India. The conversion factor of 0.85 has been applied to all cost items except land acquisition cost and R&R cost. The economic cost excludes the cost of toll plazas and the proportionate design & supervision cost for the same. A salvage value of 15% of capital cost has been considered in the terminal year for flexible pavements. The project costs in financial and economic terms for different schemes are presented below:

Table 13-5: Capital Cost of the Project Road

Package	Financial Cost	Economic Cost
VII	268.04 Cr.	227.834 Cr.

13.1.8 Routine and Periodic Maintenance

Routine maintenance, Periodic maintenance costs have been considered as per the MORT&H guidelines 1997 prices. Routine maintenance, Periodic maintenance costs of 1997 prices have been escalated to 2018 prices with an inflation rate of 5%. The details of the maintenance costs and administration charges are given below:

Table 13-6: Routine and Periodic Maintenance

S. No.	Description	Amount (Rs. Lakhs/Km)
01	Routine maintenance in every year cost per km for the 6 lane	9.90
02	Periodic maintenance in every 7th year cost per km for the 6 lane.	99.00
03	Routine maintenance in every year cost per km for the four lanes with Paved Shoulders	6.60
04	Periodic maintenance in every 5th year cost per km the four lanes with Paved Shoulders	66.00

13.1.9 Project Benefits

The direct benefits of road improvement considered in the study include vehicle operating cost (VOC) savings for vehicular traffic using the project road and time savings for passengers and goods (carried) in transit. The benefit streams have been computed annually over the 20 year benefit period for all homogeneous sections.

13.1.9.1 VOC Savings:

The unit Vehicle Operating Cost (VOC) by vehicle type and VOC savings section-wise has been computed by the HDM model. The VOC computation takes into account capacity augmentation, pavement characteristics, roughness progression vis-à-vis intervening surface treatment and strengthening policies, traffic characteristics, geometric conditions and vehicle characteristics.

13.1.9.2 Time Savings:

The HDM Model has generated average speeds in km/hr by vehicle type, in the existing (without project) and the improved (with project) road conditions. The time savings for passengers and goods (in transit) vehicles have been derived separately. For computing time saving for passengers of cars and buses, a weighted average occupancy was used viz. Car – 4 persons and Bus – 40 persons. The average payloads considered for goods vehicles are: LCV – 6 tonnes, 2 Axle Truck-16.2 tonnes, 3 Axle Truck – 30 tonnes and MAV – 35 tonnes.

The value of time (VOT) for passengers and goods considered in this analysis has been based on earlier studies carried out in recent years. For the average car passenger, VOT has been taken as Rs. 68 per hour, and for the average bus passenger it was Rs. 47 per hour. The value placed on time is rather on the conservative side. For goods in transit, time value has been worked out using the inventory cost method, with a 15% interest rate considered as the opportunity cost of capital. The VOT for goods (Cargo) vehicle worked out to Rs. 3.43 per hour for LCV, Rs. 10.54 per hour for 2-axle trucks and Rs. 19.73 per hour for multi-axle vehicles.

13.1.9.3 Accident Cost Savings:

A distinction made between main cause of accident and the contributory factors of accident. It is usually difficult to identify the main cause of accidents, whereas several factors which could have contributed to accidents can be identified.

13.1.9.4 Contributory factors of Accidents:

Human Factors:	Manner of executions (Deficiency in actions & behavior)
	Perceptual errors
	Impairment
	Lack of Skill
Road Factors:	Adverse Road Design
	Adverse Environment
	Inadequate Furniture or Markings
	Obstacles
Vehicle Factors:	Tires

Brakes
Other defects due to poor maintenance
Unsuitable Designs

It is possible to predict the reduction in accidents on account of road improvements. The accidents costs collected from IRC-SP-30 (the values are in the year 1990 and escalated with 5% to get the values in the year 2018 are given below.

Accident Costs (Rs.)	1990	2018
Fatal	210000	746692
Serious injury	32000	113781
Minor injury	1130	3911
Damages to car	4700	16712
Damages to 2-wheeler	1100	3911
Damages to bus	15800	56179
Damages to truck	18100	64358

13.1.10 Economic Analysis

The annual cost and benefit streams are used to derive the net cash flow for the project. The EIRR and NPV @ 12% discount rate are determined using the discounted cash flow technique for all the Sections. The results for the improvement scheme are presented below and details are provided in Appendix.

Table 13-7: EIRR & NPV

Total Package	EIRR (%)		NPV (Cr.)	
	20 Year	30 Years	20 Year	30 Years
VII	12.7	14.7	156.24	848.37

13.1.11 Sensitivity Analysis

Sensitivity analysis has been carried out for the below mentioned four variations in costs and benefits. The sensitivity scenarios take into account possible construction cost overrun, traffic volume, revenue shortfalls, interest rate volatility, non-compliance or default by contractors, and political risks.

Case-I Base Cost and Base Benefits
Case-II Base Cost plus 15 % and Base Benefits
Case-III Base Cost and Base Benefits minus 15%
Case-IV Base cost plus 15% and Base Benefits minus 15%

Summary for the Sensitivity analysis for the three sections are given below:

Table 13-8: Sensitivity Analysis (20 years)

Case	EIRR	
	20yrs	30yrs
Case-I	12.7	14.7
Case-II	10.9	13.2
Case-III	9.0	11.6
Case-IV	10.7	12.9

13.1.12 Conclusion

From the results of the Economic Analysis, it can be seen that the improvement scheme, the EIRR is getting higher than minimum threshold value of 12%.

So, it can be concluded that the project of four lane with paved shoulder option is economically viable and recommended for implementation.

1