COST BENEFIT ANALYSIS

PARAMETERS FOR EVALUATION OF LOSS OF PROFITS.

Sl. No.	Parameter	Road, Tr. Lines.	Minor Irrigation projects, quarrying of stones/metals	Medium & Minor Irrigation, Hydroelectric, large mining & other misc. project.
1	2	3	4	5
1	Loss of value of timber, fuel wood & minor forest produce on annual basis, including loss of man hours per anum of peop e who diverted livelihood and wages from the harvest of their commo dities.	To be determined by Forest Department.		
2	Loss of animal husbandry productivity including loss of fodder.	N.A.		
3	Cost of human resettlement.	N.A.		
4	Loss of public facilities and adminis ration, infrastructures (roads, building, schools, dispensaries, electric line, ra lways etc.) on forest land if these facilities were diverted due to the project.	N.A.		
5	Environmental to soil erosion, effect on hyd ological cycle wild life habitat micro c imate upsetting of ecological balance	N.A. To be determined by Forest Department.		
6	Suffering of outages.	N.A.		

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COST BENEFIT ANALYSIS

PARAMETERS FOR EVALUATION OF LOSS OF PROFITS.

Sl. No.	Parameter	Road, Tr. Lines.	Minor Irrigation projects, quarrying of stones/metals	Medium & Minor Irrigation, Hydroelectric, large mining & other misc. project.
1	2	3	4	5
1	Loss of value of timber, fuel wood & minor forest produce on annual basis, including loss of man hours per anum of peop e who diverted livelihood and wages from the harvest of their commo lities.	To be determined by Forest Department.		
2	Loss of animal husbandry productivity including loss of fodder.	N.A.		
3	Cost of human resettlement.	N.A.		
4	Loss of public facilities and adminis ration, infrastructures (roads, building, schools, dispensaries, electric line, railways etc.) on forest land if these facilities were diverted due to the project.	N.A.		
5	Environmental to soil erosion, effect on hydi ological cycle wild life habitat micro c imate upsetting of ecological balance	N.A. To be determined by Forest Department.		
6	Suffering of outages.	N.A.		

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Manoharpur

ANNEXURE – VIII C

1.1 **Economic Analysis.**

An infrastructure project is subjected to economic appraisal to ensure the investment proposed would yield appropriate return to the national economy. It is therefore important that decisions about investments in roads are made on objective judgements and therefore, Economic appraisal has been carried out for different alternatives of entire Project road.

The basic purpose of the economic analysis is to enable the decision-makers in the Government to decide whether the project is worthy of investment keeping in view the benefits to the society. In order to assess the benefits accrued to the society, both the options of 'with project' and 'without project' have to be compared. For this purpose, the entire existing Road has been considered along with proposed maintenance and improvement proposals.

1.2 **Economic Analysis Approach.**

The economic evaluation has been carried out within the broad framework of social cost benefit analysis. The objective is to determine the best improvement scheme out of several proposals, which will lead to minimizing total transport costs and maximizing benefits to the road users.

The benefits accruing to society from the proposed improvement are mainly reduced vehicle operating cost, reduced travel time cost and reduced accident cost. Total transport costs comprise of two basic components as shown in **Table 1.1.**

Table 1.1

Total Transport Costs.

Road Supplier Costs.	Road User Costs.
1	2
Construction Costs.	Vehicle Operating Costs (VOC) both MT & NMT.
Maintenance Costs.	Travel Time Costs.
Replacement Costs: Cost of Environmental Impact Mitigation Measures, Costs of Rehabilitation and Resettlement (R&R) measures.	

These costs are generated using HDM – IV for every year of the analysis period (cost-benefit stream) from which economic indicator parameters that essential for viability of project namely Net Present Value (NPV), Economic Rate of Return (EIRR) and Benefit Cost Ratio (B/C) are the final economic outputs.

NPV is that the present value of Net Benefits (NB) during the project period. EIRR is the discount rate at which NPV of the Net Benefit (NB) is zero. Net Benefit is

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the cumulative sum of the difference between yearly benefit and yearly costs incurred after discounting.

$$NB = \sum_{n=1}^{m} (Benefit(n) - Cost(n)$$

Savings from vehicle emission reduction and less energy consumption due to improved facility are also important economic savings which are possible to calculate but these quantities are not converted to economic cost inside the software. So these benefits are not included.

The appraisal period (including the construction period) has been taken as 25 years after which a residual value of investment is assumed as 15 %.

1.3 Project Economic Evaluation using HDM-4

Economic evaluation for Gua – Salai Road from Km. 2.00 to Km.11.00
Road is carried out by consideration of two alternatives In HDM-4.

1.3.1 Alternative 1: Without Project

For without project consideration, project road will carry existing traffic on it without any improvement but maintenance is present condition that means No treatment is given to existing road for improving its capacity augmentation, functional and structural pavement quality and geometry standards however maintenance is done on the Project Road.

1.3.2 Alternative 2: with Project

Widening the existing road to two lane with 12 m roadway width including reconstruction, strengthening, bypasses and realignments to achieve the design speed of 60kmph in rolling area.

1.4 Project Cost and Scheduling

The project road is 9.000 km passes through Gua, Nuiya and meets at Salai Village at Manoharpur Saidal Road (SH-4, Now proposed for National Highway). Project road is being carried out as follows:

Table 1.2 : Alternative Details

Alternatives	Existing Chainage		Design Chainage		Improvement
	From	To	From	To	
Section	2+000	11+000	2+000	11+000	2lane

The project road with existing carriageway width of 3.05 m and is proposed for 2 lane facility which satisfies the project and traffic requirement.

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The Economic analysis was carried out for 25 year benefit period (2013-2037). For performing economic evaluation, a 'project' is formulated in which comparison is made between two scenarios namely (1) without any improvements.

1.4.1 Capital Cost.

Project costs have been worked out and given in Chapter-9. For economic evaluation base costs have been taken as factor cost of civil works and other cost related to land acquisition, R&R, environmental mitigation and utility relocations. That means capital cost is the total cost of civil work including cost of land acquisition, R&R, environmental mitigation and utility relocation for the project improvement.

The construction cost is tabulated in Table 1.3 for the year 2013 at which Project will start to implement The construction cost of project will be utilized in two phases i.e. 60% in first year and 40% in second year as construction period of 2 years.

The cost estimate is based on the quantities worked out for major items of work to be executed in the project on the basis of preliminary engineering design of roads, structures and the adopted rates .A conversion factor of 0.90 has been used to convert financial cost into economic costs.

The economic cost for each Alternative is as under:

Table 1.3 : Total Project Cost

Alternatives	Total Construction Cost Per km	Economical cost per km
Alternative-1	76733855	69060470

1.4.2 Maintenance Cost

For Two lane road

Routine maintenance cost – Rs. 0.25 lac per km per year (2013-14 prices)
Periodic maintenance cost- Rs. 25 lac per km (40mm BC) 2013-14 Prices)

1.5 Projects Benefits

Project Benefits mainly occurs due to Reduction in Vehicle operating cost and travel time savings.
The vehicle operating cost (VOC) components are

. Fuel

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- Lubricants
- Types
- Spare Parts
- Maintenance Labor
- Wages of Crew
- Fixed costs including overheads, administration, interest on borrowed capital
- Depreciations
- Travel time cost

1.5.1 vehicle Fleet

1.5.1.1 Fleet Utilization

Fleet utilization data adopted for the analysis is based on findings of Road User cost study in 2001, IRC SP: 30-2009. The adopted for the analysis is based on the findings of road User Cost study in 2001, IRC SP: 30-2009. The adopted values are summarized as shown in table below.

Table 1.4: Life Norms for Vehicles

Particulars	Km Driven	Life,Year	Working Hour	Passenger
2 axle Truck	90000	12	1950	-
Multi Axle truck	75000	12	2100	-
3 Axle Truck	75000	12	2100	-
LCV	45500	10	1050	-
Utility Car	45500	10	1500	-
Bus/Mini Bus	125000	10	2400	45
Car/Jeep/Van	87500	10	1750	5
Two Wheeler	28800	10	636	1.5

1.5.1.2 Vehicle and Tyre Cost

Economic costs of vehicle and tyre are derived from the market survey in Jharkhand. Ex-Show Room Price for each category of vehicle have been collected and elements of taxes, duties, freight, dealer's margin and incentives costs. The adopted economic costs are summarized as presented in table below.

Table 1.5: Prices of vehicles

Category	Vehicle	Tyre(Rs.)
2Axle Truck	900000	7075
3 Axle and Multi Axle	1000000	7075
LCV	500000	3500
Utility Car	600000	2250
Bus	850000	7500
Car/Jeep/Van	450000	2250
Two Wheeler	41000	750

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1.5.1.3 Fuel & lubricant

The details of fuel and lubricant prices for the state of Jharkhand have been Collected from the petrol pumps on the project road near Jharkhand. Information On Exise, Levy, Cess, Sales, Tax and Agency Charges has also been collected to arrive at economic cost for the analysis. Details of these are summarized in table below.

Table 1.6: Economic Cost of Fuel & Lubricants

Item	Rate	Present Economic Cost/ litre
Petrol	Rs./Litre	65.27
Diesel	Rs./Litre	53.42
Lubricants	Rs./Litre	248.96

1.5.1.4 Maintenance Labour and Crew Wages

Adopted values for Maintenance Labour and Crew Wages are based on the enquiries made by the Consultant with transport operators and workshops in and around the project Road. The adopted values are summarized vide in table below.

Table 1.7: Labor and Crew Wages
(Cost in Rs.per hour)

Category	Maint. Labour	Crew Wage
Truck	300	250
3 Axle and Multi Axle Truck	300	275
LCV	250	150
Utility Car	100	75
Bus	200	175
Car/Jeep/Van	100	75
Two wheeler	75	-

1.5.1.5 Annual Overhead

Recommended of the "Study for Uploading Road User Cost Data: 2001"and, IRC SP: 30-2009 are sun marized in table below:

Table 1.8: Annual Overheads

Category	Annual Overhead Cost (Rs.)
2 Axle Truck	292500
3 Axle and Multi Truck	358000

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Category	Annual Overhead Coast (Rs.)
LCV	228000
Utility Car	210000
Bus	255000
Car/Jeep/Van	180000
Two wheeler	8624

1.5.1.6 Annual Interest

An Economic Interest Rate of 12% has been adopted for the analysis.

1.5.1.7 Time Value of passengers

Time Value of Passenger (Work Trips and Non Work Trips) is arrived based on "Manual of Economic evaluation of Highway Projects in India ("IRC SP:30-2009)".The values of 2009 are upgraded by considering Whole Sale Price Index Ratio for the year 2009 and 2013. Non work time value of passenger is considered 85% of time value of passengers as suggested in IRC SP:30-2009". The adopted values are summarized as given in table below.

Table 1.9 Time Value of passenger

Mode of Travel	Unit	2 Wheeler	Car/Taxi	Bus
Travel time Value RUCS-March 2009	Rs/Hour	32.0	62.5	39.5
WPI Ratio 2013/2009	-	1.39	1.39	1.39
Travel time Value RUCS-May 2013	Rs/Hour	37.9	74.0	46.8
Eq. Non-work Time Value in May 2013	Rs/Hour	6.7	13.1	8.3

1.5.1.8 Time Value of Cargo

Average value of commodity is based on "Manual of Economic evaluation of Highway Projects in India("IRC SP:30- 2009)".Equivalent cost of commodity in 2013-2014 is determined using the WPI ratio (1.39 over 2009). Average payload for each category of freight vehicles is based on axle load survey. Time-delay cost is estimated with an economic interest rate of 12% and economic conversion factor of 0.90 and provided in table below:

Table 1.10: Time Value of Cargo

Vehicle Category	Average Payload (Tonnes)	Average Running Time (hour/Year)	Time –delay Cost (Rs./Hr)
2 Axle Truck	15	1950	38
3 Axle and Multi Axle Truck	17	2100	65
LCV	8.25	1050	23

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1.5.1.9 Accident Cost

In case of accidents The value of Rs.864,00,244,000 & 435,000 has been assumed on account of loss to the economy for the Fatal, Damage, Injury and All respectively.

1.5.1.10 HDM Traffic

Following category of fast moving and slow moving vehicles are considered for carrying out HDM 4 Analysis.

- 2 Axle Truck
- 3 Axle Truck
- Multi Axle Truck
- LCV
- Utility Car
- Bus
- Mini Bus
- Car/Jeep/Van
- Two Wheeler

As HDM-4 does not include 3 Wheeler and Agricultural Tractor Categories of Vehicle therefore these categories are not considered in the analysis. Percentage compositions of assigned traffic in AADT on the project road as on year 2013 and adopted for the analysis for the Project road are summarized as given in table below.

Table 1.11: Composition of Motorized Traffic assigned in Project road (MT)

Details	Project Road (Km 2.000-Km11.000)
MAV	95
3-Axle	375
2 Axle TRUCK	664
LCV	438
STANDARD BUS	78
MINI BUS	28
CARS	1172
2- WHEELERS	3837

Adopted traffic growth rates as per traffic analysis is Presented in Table 1.12

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Table 1.12 Traffic growth Rate of Motorized Traffic assigned on Project road (MT)%

Year	2012-2016	2017-2021	2022-2026	2027-2031	2032-2036	Beyond 2036
Car	7.79	7.01	6.31	5.68	5.11	5.00
2-W	7.17	6.45	5.81	5.23	5.00	5.00
Buses	5.00	5.00	5.00	5.00	5.00	5.00
LCV Passenger/3 W/Utility Van	6.39	5.75	5.18	5.00	5.00	5.00
LCV	5.01	5.00	5.00	5.00	5.00	5.00
2-Axle/3-Axle	5.62	5.06	5.00	5.00	5.00	5.00
MAV	5.95	5.35	5.00	5.00	5.00	5.00
Tractor	7.73	6.95	6.26	5.63	5.07	5.00
Others	6.22	5.60	5.04	5.00	5.00	5.00

1.6 Economic Internal Rate of Return

Economic Analysis has been carried out for construction option discussed above Variables considered in for economic analysis of the project are volatile and depend on various factors. In case of economic analysis is also recommended that analysis period should not be long as it may lead to erroneous results.

However, in order to be able to draw the conclusions on common platform Economic Analysis have also been carried out for 25 years of analysis period. The summary of Economic internal rate of return (EIRR) worked out , for construction option based on life cycle cost analysis is presented below.

Economic Analysis was carried out following the methodology and input data discussed in the preceding paragraphs of this chapter using HDM-4 software.

HDM-4 outputs on Annual Discounted Net Benefit Streams with time savings is presented vide **Appendix 1.1**

HDM-4 output on Benefit Cost Ration is presented vide **Appendix 1.2.**

The Economic Analysis Summary with time savings (By Alternative) is presented vide **Appendix 1.3.**

The EIRR and NPV at 12% discount rate for the construction package as worked out with and without benefits due to benefits due to travel time savings are summarized as under:

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Table 1-13: Results of Economic Analysis

Sr.no	Details	IRR
1)	Base Cost and Base Benefit	39.37%
2)	Base Cost Increase to 15% With Base benefit	35.89%
3)	Base Cost with Base Benefit Reduced to 15%	35.35%
4)	Base Cost Increase to 15% With Base Benefit Reduced to 15%	33.76%

1.7 Conclusion

The projected road is economically viable for normal case as well as sensitive cases in which EIRR is above 12%

2.0 Economic Analysis

An infrastructure project is subjected to economic appraisal to ensure that the investment proposed would yield appropriate return to the national economy. It is therefore important that decisions about investments in roads are made on objective judgments and therefore Economic appraisal has been carried out for different alternatives of entire Project.

The basic purpose of the economic analysis is to enable the decision-makers in the Government to decide whether the project is worthy of investment keeping in view the benefits to the society. In order to assess the benefits accrued to the society both the options of 'with project' and 'without project' have to be compared. For this purpose, the entire existing Road has been considered along with its proposed maintenance and improvement proposals.

3.0 Economic Analysis Approach

The economic evaluation has been carried out within the broad framework of social cost benefit analysis. The objective is to determine the best improvement scheme out of several proposals which will lead to minimizing total transport costs and maximizing benefits to the road users.

The benefits accruing to society from the proposed improvement are mainly reduced vehicle operating cost reduced travel time cost reduced travel time cost and reduced accident costs. Total transport costs comprise of two basic components as shown in Table 1.1

Table 1-1: Total Transport Costs

Road Supplier Costs	Road User Costs
Construction Costs	Vehicle operating Costs (VOC)both MT&NT
Maintenance Costs	Travel Time costs
Replacement Costs: costs of Environmental Impact Mitigation Measures, costs of Rehabilitation and Resettlement (R&R) measures	

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These costs are generated using HDM- IV for every year of the analysis period (cost-benefit stream) from which economic indicator parameters that essential for viability of project namely Net Present Value (NPV), Economic Rate of Return (EIRR) and Benefit Cost Ratio (B/C) are the final economic outputs.

NPV is the present value of Net Benefits (NB) is zero. Net Benefit is the cumulative sum of the difference between yearly benefit and yearly costs incurred after discounting.

$$NB = \sum_{n=1}^{m} (Benefit(n) - Cost(n)$$

The appraisal period (including the construction period) has been taken as 25 years after which a residual value of investment is assumed as 15%.

4.0 Project Economic Evaluation using HDM-4

Economic evaluation for Gua – Salai Road from Km. 2.00 to Km.11.00 road is carried out by consideration of two alternatives in HDM-4.

4.1.1 Alternative 1. Without Project

For without project consideratiop project consideration , project road will carry existing traffic on it without any improvement but maintenance is provided in present condition that means No treatment is given to existing road for improving its capacity augmentation, functional and structural payment quality and geometry standards however maintenance is done Road.

4.1.2 Alternative 2: with Project

Widening the existing road to two lane with 12m roadway width including reconstruction, strengthening, by passes and realignments to achieve the design speed of 80kmph in plain/rolling area and 50kmph in hilly area.

5.0 Project Cost and Scheduling

The project road is 9.00 km long and passes through Gua, Nuiya. Project road is proposed to undertake work of strengthening, rehabilitation the existing road. Accordingly, economic analysis of the project road is being carried out as follows:

Table 1-2: Alternative Details

Existing Chainage		Design Chainage		Improvement
From	To	From	To	
2+000	11+000	2+000	11+000	2 lane

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The project road with exiting carriageway width of 5.5 m is proposed for 2 lane facility which satisfies the project and traffic requirement.

The Economic analysis was carried out for 25 year benefit period (2012-2037). For performing economic evaluation, a 'project' is which comparison is made between two scenarios namely (1) without any improvements and (2) with different improvements.

6.0 Capital Cost

Project costs have been worked out and given in chapter-9. For economic evaluation base costs have been taken as factor cost of civil works and other cost related to land acquisition social environmental and utility relocations that mean capital cost is the total construction cost of civil works for the project improvement.

The construction cost is tabulated in Table 1-3 for the year 2013 at which Project will start to implement. The construction cost of project will be utilized in two phases i.e. 40% in first year and 60% in second year as construction period of 2 years.

The cost estimate is based on the quantities worked out for major items of work to be executed in the project on the basis of preliminary engineering design of roads, structures and the adopted rates. A conversion factor of 0.90 has been used to convert financial cost into ecc nomic costs.

The economic cost for each Alternative is as under:

Table 1-3: Total Project Cost

Alternatives	Capital Cost Per km	Economical Cost per km
Alternative-1	76733855	69060470

7.0 Maintenance Cost

For Two Lanes with Earthen shoulder road

Routine maintenance cost - Rs. 0.25 lac per km per year
Periodic maintenance - Rs. 25 lac per km (40mm BC)

8.0 Project Benefits

Project Benefits mainly occurs due to Reduction in vehicle operating cost and travel time savings.

The vehicle operating cost (voc) components are

- Fuel
- Lubricants
- Tires
- Spare Parts
- Maintenance Labor

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- Wages of Crew
- Fixed costs including overheads, administration, interest on borrowed capital
- Depreciations
- Travel time cost

9.0 Vehicle Fleet

11.8.1 Fleet Utilization

Fleet utilization data adopted for the analysis is based on the findings of Road User Cost study in 2001, IRC SP: 30-2009. The adopted values are summarized as shown in table below.

Table 1.4: Life Norms for Vehicles

Particulars	Km Driven	Life Year	Working Hour	Passenger
2 Axle Truck	90000	12	1950	-
Multi Axle Truck	75000	12	2100	-
3 Axle Truck	75000	12	2100	-
LCV	45500	10	1050	-
Utility Car	45500	10	1500	-
Bus/Mini Bus	125000	10	2400	45
Car/Jeep/Van	87500	10	1750	5
Two Wheeler	28800	10	636	1.5

10.0 Vehicle Resources

9.9.1 Vehicle and Tire Cost

Economic costs of vehicle and tire are derived from the market survey in Jharkhand. Ex – Show Room Price for each category of vehicle have been collected and elements of taxes, duties, freight, dealer's margin and incentives as applicable have been removed to arrive at the economic costs. The adopted economic costs are summarized as presented in table below.

Table 1.5: Prices of vehicles

Category	Vehicle (Rs)	Tyre (Rs)
2 Axle Truck	900000	7075
3 Axle and Multi Axle Truck	1000000	7075
LCV	500000	3500
Utility Car	600000	2250
Bus	850000	7500
Car/Jeep/Van	450000	2250
Two Wheeler	41000	750

9.9.2 Fuel & Lubricant

The details of fuel and lubricant prices for the state of Jharkhand have been collected from the petrol pumps on the project road near Jharkhand. Information on Excise, Levy, Cess, Sales Tax and Agency Charges has also been collected to arrive at economic cost for the

Analysis .Details of these are summarized in table below.

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Table 1.6: Economic Cost of Fuel & Lubricants

Item	Rate	Present Economic Cost/Litre
Petrol	Rs./Litre	65.27
Diesel	Rs./Litre	53.42
Lubricants	Rs./Litre	248.96

9.9.3 Maintenance Labor and Crew Wages

Adopted values for Maintenance Labor and crew wages are based on the enquiries made by the Consultants with transport operators and workshops in and around the project Road. The adopted values are summarized vide in table below.

Table 1.7 : Labour and Crew Wages

(Cost in Per Hour)

Category	Maint.Labor	Crew Wage
Truck	300	250
3 Axle and Multi axle truck	300	275
LCV	250	150
Utility Car	100	75
Bus	200	175
Car/Jeep/Van	100	75
Two Wheeler	75	-

9.9.4 Annual Overhead

Recommendations of the "study for Updating road User Cost Data: 2001"and. IRC SP: 30-2009 are considered to arrive ate annual overhead cost per vehicle and are summarized in table below:

Table 1.8 : annual Overheads

Category	Annual Overhead Coist (Rs.)
2 Axle truck	**192500**
3 Axle and Multi Axle Truck	**258000**
LCV	**128000**
Utility Car	**110000**
Bus	**155000**
Car/Jeep/Van	**80000**
Two Wheler	**6624**

9.9.5 Annual Interest

An Economic Interest rate of 12% has been adopted for the analysis.

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9.9.6 Time value of Passengers

Time value of Passenger (work Trips and non work Trips) is arrived based on "Manual of Economic evaluation of highway project in India ("IRC SP:30-2009)".The values of 2009 are upgraded by considering Whole sale Price Index ratio for the year 2009 and 2013. Non work time value of passenger is considered 15% and work time value of passenger is considered 85% of time value of passengers as suggested in IRC SP: 30-2009".The adopted values are summarized as given in table below.

Table 1.9: Time Value of Passengers

Model of Travel	Unit	2 Wheeler	Car/Taxi	Bus
Travel time Value RUCS-March2009	Rs/Hour	32.0	62.5	39.5
WPI ratio 2013/2009	-	1.39	1.39	1.39
Travel time Value RUCS-May 2013	37.9	74.0	46.8	
Eq. Non-work time Value in May2013	Rs./Hour	6.7	13.1	8.3

9.9:7 Time Value of Cargo

Average value of commodity is based on "manual of Economic evaluation of Highway projects in India ("IRC SP: 30-2009)".Equivalent cost of commodity in 2013-2014 is determined using the WPI ratio (1.39 over 2009). Average payload for each category of freight vehicles is based on axle load survey. Time –delay cost is estimated with an economic interest rate of 12% and economic conversion factor of 0.90 and provided in table below:

Table 1.10: time Value of Cargo

Vehicle category	Average Payload (Tonners)	Average Running Time (hour/year)	Time –delay Cost (Rs./hr)
2 Axle Truck	15	1950	38
3 Axle and multi Axle Truck	17	2100	65
LCV	8.25	1050	23

9.9.8 Accident cost

In case of accidents The value of Rs.864,000,244,000,198,000 & 435,000 has been assumed on account of loss to the Fatel, Damage, Injury and All respectively

9.9.9 Social benefits

Social benefit in terms of land development along the project road after improvement has been considered Rs. 5Cr. Per annum with growth rate of 5% for 10 years for entire road.

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11.0 HDM Traffic

Following category of fast moving and slow moving vechicles are considered for carrying out HDM 4 Analysis.

- 2 Axle Truck
- 3 Axle Truck
- Multi Axel Truck
- LCV
- Utility Car
- Bus
- Mini Bus
- Car/Jeep/Van
- Two Wheeler

As HDM-4 does not include 3 wheeler and Agricultural Tractor Categories of Vehicle therefore these categories are not considered in the analysis. Percentage compositions of assigned traffic in AADT on the project road as on year 2013 and adopted for the analysis for the Project road are summarized as given in table below.

Table 1.11: Composition of Motorized Traffic assigned on Project road (MT)

Details	Sec1 (0-9.8)	Sec2 (9.8-42.8)
MAV	0	14
3-Axle	5	25
2 Axle Truck	11	20
LCV	61	34
Standard Bus	8	24
Mini Bus	18	28
Cars	346	338
2-Wheelers	1667	2389

Adopted traffic growth rates as per traffic analysis is Presented in Table 1.12.

Table 1.12 Traffic growth rate of Motorized Traffic assigned on Project road (MT) (%)

	2012	2017	2022	2027	2032	3037
MAV	5.00	5.00	5.00	5.00	5.00	5.00
3-Axle	6.90	5.20	5.00	5.00	5.00	5.00
2 Axle truck	6.90	5.20	5.00	5.00	5.00	5.00
LCV	6.90	5.20	5.00	5.00	5.00	5.00
Standard Bus	5.00	5.00	5.00	5.00	5.00	5.00
Mini Bus	5.00	5.00	5.00	5.00	5.00	5.00
Cars	9.49	7.96	6.76	5.87	5.19	5.00
2-Wheelers	9.14	7.67	6.51	5.65	5.00	5.00

12.0 Economics Internal rate of Return

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Economic Analysis has been carried out for construction option discussed above. Variables considered in for economic analysis is also recommended that analysis period should not be long as it may lead to erroneous results.

However, in order to be able to draw the conclusions on common platform Economic Analysis have also been carried out for 25 years of analysis period. The summary of Economic internal rate of return (EIRR) worked out, for construction option based on life cycle cost analysis is presented below.

Economic Analysis was carried out following the methodology and input data discussed in the preceding paragraphs of this chapter using HDM-4 software.

HDM-4 outputs on Annual Discounted Net Benefit Streams with time savings is presented vide **Appendix 1-1 .**

HDM-4 output on Benefit Cost ratios presented vide **Appendix 1-2.**

The Economic Analysis Summary with time savings (By Alternative) is presented vide **Appendix 1-3.**

The EIRR and NPV at 12% discount rate for the construction package as worked out with and without benefits due to travel time savings are summarized as under:

Table 1-13: Results Of Economic Analysis

Sr no	Detail	IRR
1)	Base Cost and Base Benefit	16.18%
2)	Base Cost Increase to 15% With Base Benefit	14.47%
3)	Base Cost With Base Benefit Reduced to 15%	14.20%
4)	Base Cost Increase to 15% with Base Benefit Reduced to 15%	13.46%

13.0 Conclusion

The project road is economically viable for normal case as well as sensitive cases in which EIRR is above 12%.

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