Economic Analysis of a New Road Infrastructure Project —A Case Study of West Bengal

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Abstract

The economic analysis of any infrastructure project indicates the seriousness of the project in terms of social needthe benefits, that society will reap from the project, if the project is implemented. In a developing country, like India, it is very important to evaluate the project in terms of economic benefits properly to prioritize the funds allocation and to reduce the opportunity cost. The prime objective of this analysis is to analyze the return of the investment to the society, which is measured in economic prices to capture the real impact on the society. The fundamental purpose of this paper is to show, how professional economists are evaluating highway infrastructure projects and discuss the key determining factors for that evaluation. This is typically a branch of mainstream economics, that is, Transport Economics, which is an assimilation of basic theories of economics and civil engineering. Good highway engineering is the key determinant factor of the economic benefits that the society will get from the project. For the simplicity of this paper, the use of engineering analysis and terminologies, of transport, pavement (roads) design and highway designing have been minimized intentionally. The whole analysis has been done with the help of The World Bank's Highway Development and Management Tool (HDM-4), which is developed by University of Birmingham and Transport Research Laboratory (TRL), United Kingdom and it is accepted by more than 130 countries all over the world including Government of India. This paper tries to capture the benefits of road users in terms of road user cost, which is a summation of vehicle operating cost, value to travel time and accidental cost over a specified time period. This paper is a part of economic analysis report of Kona Expressway (NH-117) which has been selected to be upgraded to four lanes configured elevated corridor as a segmental box type structure from Second Hooghly Bridge to NH-6. The sole purpose of this paper is only to share the knowledge and not for any commercial purpose.

Key words: infrastructure project, Kona Expressway, transport economics, highway designing.

1.0 Introduction

The demand for automobile has increased almost endlessly in last few years. Several world class automobile manufacturers are working to reduce the fuel consumption of their vehicles to increase fuel efficiency and to reduce air pollutions as well. Several Japanese, European and American automobile companies have revolutionized fuel consumption technology and redesigned their engine to meet the maximum fuel efficiency in a competitive market like India. Moreover, more fuel efficiency means greater greener technology which emits lesser Carbon-monoxide (CO), Carbon-dioxide (CO_2), Hydro-Carbons (HC) and Sulphur. However, only good quality of engine does not ensure lesser emission level but a congestion free road along with good pavement (road) condition is also responsible to ensure greener environment. A vehicle with new technology in a fully congested road with poor pavement condition will not behave like an efficient engine though the engine is new in terms of age and technology. In other words, society can reap the benefits of greener technology only if there is a congestion-free good quality road, which is only possible when there is an amalgamation of good Highway Engineering along with good Mechanical Engineering. It has been observed from the Statistical Abstract of West Bengal, 2012, that, the annual growth rate of all types of vehicles in West Bengal is more than 5%, which clearly indicates the alarming traffic condition of all the State Highways, District Highways and National Highways of West Bengal, vide Table 1.0. The threat lies in the negative externality of traffic congestion, that is, air pollution. In today's world, air pollution is fast becoming a threat in all metropolitan cities including all emerging economies and eventually it will be increasing overtime in a parallel positive path along with the economic growth rate of the society (The World Bank, 2019). Hence, neither good quality of engine nor congestion-free roads ensure greener environment; rather good quality of new roads and well-maintained existing roads are responsible as well as required for greener environment. Again, good quality of newly constructed roads is not only a necessary condition to eradicate excessive air pollutions but maintaining the existing roads network of the country is equally important. Therefore, a pre-planned road maintenance networking along with construction of new road network, both are very important to support a stable economic growth and reduced air pollution, simultaneously for the wellbeing of the society.

This chapter deals with the collation of traffic data and growth rates, cost of construction and maintenance and cost of other social and environmental parameters extracted from various sections of the report, followed by conversion to economic costs, working out the benefits, and economic and sensitivity analysis for the entire Kona Express Road project. The analysis was carried out through HDM-4 model Version 2.1.

The economic evaluation has been carried out within the broad framework of social cost-benefit analysis assuming a project life of 25 years including the construction period. The economic feasibility of the project has been sought to maximize the economic returns on investment. There will be a reduction in Road User Costs (RUC) for Motorized Traffic (MT) upon the new road. The accidental cost and Non-Motorized Traffic (NMT) have not been considered for this analysis. Economic savings at a significant level in the following areas are expected to occur due to construction of new elevated project road :

- Vehicle operating costs (VOC)
- Journey time of passengers and goods

2.0 Brief Description of the Project

The National Highway Authority of India (NHAI) and West Bengal Highway Development Corporation Limited (WBHDCL) have jointly decided to build an elevated corridor over the same alignment of existing Kona Expressway from Second Hooghly Setu to NH-6, which is almost 6.82 km long. The primary intention of the project to increase the smooth mobility of existing traffic condition (better Level of Service) including the generated traffic from Santragachi Railway Station.The analysis period of the project has been taken as 25 years including the period of construction. It has been considered that, expected construction start year is 2018 and end year is 2021.

2.1 Framework of Analysis

The following scenarios are considered for the economic analysis as per "Manual for Evaluation of Industrial Projects" by United Nations, 1980 :

- **"Without the proposed elevated corridor of Kona Expressway" (Base Strategy):**

This is the 'without project' situation where traffic will continue to travel on the existing road of 6.82 km from the end of Vidyasagar Setu up to NH-6 along Kona Expressway. In the analysis, this is the base strategy against which the new construction of proposed elevated corridor will be compared.

· **"With improvement of project road(proposed elevated corridor, along Kona Expressway) in same place with same distance":**

This is the "with project" situation. In this case the future traffic on the road is assumed to continue with a lower VOC and Travel Time. In the analysis, this alternative, that is, improved case will be compared against the base strategy.

· **Benefits Calculation**

The reductions in VOC and Travel Time lead to savings due to construction of the new elevated corridor against the existing one. The present traffic condition of existing Kona Expressway is miserable due to high traffic that leads to congestion. The proposed elevated corridor will be used as an alternative to the existing one, specifically for through traffic to NH-6 from Kolkata and vice-versa. The total savings expressed in quantitative terms are the total benefits arising from the new project road. The total quantitative benefits and costs at economic prices determine Economic Internal Rate of Return (EIRR) and Net Present Value(NPV) of the project road.

2.2 Process for Estimation of Benefits

The following process has been employed to estimate the aforesaid benefits :

1. Identification of sections used to travel 6.82 km.
2. Estimation of the local values for RUE and RD calibration.
3. Entry of data in the model and sub-models.

The model used for analysis is New Road as Bypass modules of HDM-4 and the above factors help to estimate total VOC, time cost, etc. EIRR and NPV estimation have taken the sum of benefits from

- VOC savings
- Time savings

When considered together, these give the total net benefits for the project. The total net benefits are considered against the economic cost of project to determine the EIRR and NPV at a discount rate of 12%, which has been used as Social Discount Rate (SDR) as per Government of India, World Bank and Asian Development Bank (ADB)(Cost Benefit Analysis for Development, ERD, ADB, 2013).

3.0 Conversion to Economic Prices

Economic costs are generally used in economic analysis to ascertain the economic viability of a road project. The financial prices are the market prices whereas economic prices are the market prices net of taxes, subsidies and transfers. To obtain economic prices shadow pricing is also used. The commodity price is adjusted by the shadow price factor to reflect the real scarcity value of the resources in the commodity. The shadow pricing is desirable but often the economic prices are quantified as net of taxes.

3.1 Economic Prices of Fuel

The economic prices of fuel like diesel and petrol have been estimated on the basis of data received from the petrol pump of Howrah, West Bengal near the project road as on 26th of May, 2016. The entire details have been furnished in the following table. However, the Economic Prices of petrol and diesel are Rs. 47.6 and Rs. 35.5 respectively in Howrah, West Bengal near the project road, vide Table 3.1.

3.2 Economic Prices of Various Components

1. Engine Oil: The price list of the lubricants of different multinational companies in India, have been collected from the desk studies and some from Indian Oil Corporation. The market prices are indicative to all India level. The average price has been taken after deduction of applicable GST of 35%, which has been found to be Rs. 300 per litre.

2. Vehicles and Tyre: Almost all the vehicle manufacturers in India, manufacture all their vehicles domestically other than super sports vehicles. The super cars or bikes are not included in this study. Moreover, all the commercial vehicles are produced domestically including their engine to chassis. Almost all the manufacturers have their own manufacturing units which produce all the parts domestically to avoid different import duties to sustain in the competitive market like India. Only a certain percentage of commercial tax is imposed by the central government and road tax by the respective state governments, where the vehicles are generally sold.

More precisely, the 'Ex-showroom Price' in India only includes the central government tax, transit cost and the shadow price of the vehicle. The central government tax can be eliminated but transit cost cannot be eliminated. The following tables show the Economic Price of different vehicles in Howrah & Kolkata, West Bengal. After introduction of Goods & Services Tax (GST) by the central Government the price of the vehicle has dropped down significantly and GST for different categories of vehicle ranges from 28% to 41%. As a result, an average value has been taken as 35% as tax of ex-showroom price to estimate the economic price of the vehicle. The mean price value has been considered for the analysis. The price of new Non-AC Bus is found to be Rs. 13.72 Lakh, Multi Axle Vehicle is Rs. 17.26 Lakh, Two Axle Truck is Rs. 8.37 Lakh, Light Commercial Vehicle 1.99 Lakh, Three-Wheeler is Rs. 1.33 Lakh, Car is Rs. 5.05 and Two-Wheeler is Rs. 0.5 Lakh. Similarly, the tyre price of Non-AC Bus, Multi Axle Vehicle andTwo Axle Truck is Rs. 13725, for Light Commercial Vehicle it is found to be Rs. 8865, for car and auto it is Rs. 2468 and tyre price of two-wheeler is Rs. 2333.

4.0 Project Civil Cost

The capital costs of the proposed elevated corridor along Kona Expressway include the phasing of investment during the construction period have been estimated. The components of costs include the following items:

- Construction cost
- Land acquisition and resettlement cost
- Rehabilitation cost
- Environment management cost during construction

The table 4.0 shows the average cost of the proposed elevated corridor at economic prices. The economic prices have been obtained with the help of the table below: Conversion Table from Financial Price to Economic Price. The economic cost per km at 2018 price has been considered for the project. The per km cost at 2018, economic price is Rs. 121 crores inclusive of civil construction and environmental management costs. This is the final cost of construction.

5.0 Road Maintenance Costs and Schedule

The maintenance works considered in the analysis comprise:

- Annual routine maintenance
- Periodic maintenance
- Overlaying

Details of the maintenance programme followed for the project roads under different situations along with the unit rates used in the analysis are summarized in Table 5.0. The maintenance works costs adopted in the analysis are those which have been established under long-standing practices. The financial costs pertaining to maintenance operations have been converted into economic costs by applying the Conversion Factor of 0.90 (Conversion to Economic Prices, ERD, ADB, 2009).

6.0 Maintenance Cost of Vehicles

The maintenance cost of vehicles includes labour cost, tool cost, average parts cost and workshop overhead where the cost of the spare parts is not at all included. The maintenance cost at market prices have been collected by making enquiry from formal authorized service centers of different vehicles manufactures like TATA Motors, Ashok Leyland, Eicher and Bharat Benz. The conversion has been done from market prices to economic prices with help of Shadow Wage Rate Factor (SWR) 0.75 (Conversion to Economic Prices, ERD, ADB, 2009). TheTable 6.0 shows the maintenance cost of different vehicles at economic prices of 2017.

6.1 Crew Cost

Crew costs have been estimated as perTable 6.1, on the basis of per hour shadow wage rate (SWR). The monthly salaries of drivers who are skilled workers and helpers who are unskilled workers have been collected separately from primary survey. Both the shadow wages have been estimated on the basis of market wage rate. The monthly working days have been considered as 24 days and each working hour per day has been taken as 8. The conversion has been done from market prices to economic prices with help of Shadow Wage Rate Factor (SWR) 0.75 (Conversion to Economic Prices, ERD, ADB, 2009).

6.2 Passenger Time Cost

Passenger time costs are estimated as shown in Table 6.2. The basic working time cost has been estimated with the help of NSDP, population, labour participation rate, household consumption parameters etc. of West Bengal. The economic data of West Bengal have been taken from the Statistical Abstract of West Bengal and employment data have been taken from Workforce Participation Rate by Planning Commission of India, 2011. The non-working time cost has been considered as 25%-30% of working time cost (Cost Benefit Analysis for Development, ERD, ADB, 2013). A weight has been applied to basic rate to derive different time costs of passengers using different categories of passenger vehicles.

6.3 Cargo Time Cost

HDM-4 Manual of volume 5 provides formula as shown in Table 6.3 to estimate the cargo time cost and this has been used to estimate the cargo time costs for different freight vehicles. The SCF is considered as 0.9 as ADB suggest that in case of tradable goods Conversion to Economic Prices, ERD, ADB, 2009. The characteristics of vehicle category are presented in Table 6.3.

6.4 Vehicle Characteristics

The Table 6.4 shows the vehicles related parameters used in the HDM-4 model to obtain the economic analysis for the specific project.

7.0 Traffic on the present roads

Based on traffic surveys on the project road, AADT has been worked out and presented in Table 7.0.A, which has been used for economic analysis. The total number of traffic on elevated corridor is given in Table 7.0.B.

7.1 Traffic Growth Rate

Table 7.1 shows the adopted traffic growth rates per annum on the project roads after simulating various scenarios. It summarizes recent estimates of normal traffic growth in project area. The per annum traffic growth rate has been taken from the traffic forecasting analysis. The table is exhibiting the consolidated traffic growth rate in the proposed project area.

7.2 Additional Diverted Traffic

The additional diverted traffic will be significantly impacting the project road due to upgradation of the Santraganchi Station by Indian Railways. The analysis of the future traffic demand is under process and the additional diverted traffic has not been included in this report.

8.0 Exogenous benefits

One of the most important benefits of the project is the reduction in air pollution significantly in the project locality. The congestion in existing Kona Expressway is significantly high in peak hour traffic. Sometimes the average speed during peak hour traffic reaches to 10-15 kmph. The average speed is significantly low and it is near about 20-30 kmph. The decongestion effect after implementation of the elevated corridor will promote new greener environment in the locality. The pollution effect has been analyzed by the HDM-4 model for this particular project road stretches for Hydro-carbon (HC), Carbon-monoxide (CO) & Carbon-dioxide (CO_2) over the years of analysis, which has been referred in Table 8.0.

8.1 Vehicle Operating Cost Savings

The model comprehensively predicts the performance and operating costs of motorized vehicles in the selected fleet. Motorized vehicle performance predictions include speeds (free flow and congested conditions) and consumptions. Predictions for vehicle operating costs include fuel, oil, tyre and parts costs, crew and maintenance labour costs, capital depreciation, borrowing costs, and overhead costs. HDM-4 was used to estimate the Vehicle Operating Costs (VOC) for traffic in each vehicle category on each selected road with and without new road. The model estimates VOC in both the with- and without-project situations taking into account the speed and travel time including surface quality and road congestion. The resulting VOC values for each road and section can be found in the HDM-4 results.

9.0 Model Inputs

Inputs of road networks used in the HDM-4 model version 2.1 are shown in Table 9.0.A and 9.0.B for both existing and proposed road network, respectively:

10.0 The Residual Value

Considering the remaining life of the construction items the residual value (salvage value) has been assessed at the end of the analysis period. For structures, the life is assumed to be 50 years. Values of the selected construction items such as land acquisition, structures, sub-base, social displacement cost etc. are included in the economic analysis as residual values at the end of the analysis periods. These residual values are considered, as benefits to the project in the analysis. The value has been taken as 30% of capital cost of construction and maintenance.

11.0 Economic Viability

The Economic Internal Rate of Return (EIRR) is calculated by the model applying a project discount rate of 12% to the annual undiscounted net differences of the economic elements considered in the analysis. The sum of these discounted values gives the economic Net Present Value (NPV) of the project which is generated and presented, together with the associated EIRR in the HDM-4 output sheets for sectional and project basis attached in last, respectively.

The results of the HDM-4 analysis are summarized below in Table 11.0 for original model generated sheets which have been attached herewith at the end of this analysis as "HDM-4 Output Sheet".

Table 11.0 : Results of the Economic Analysis

Road Code	Road	EIRR (%)	NPV at 12%(Rupees Million)
Kona Expressway (NH-117)	New Elevated Corridor	**25.2**	9308.97

Source: HDM-4 Output sheets

11.1 Sensitivity Analysis

A sensitivity analysis has been performed under the following scenarios and found that the project is economically viable in all scenarios of sensitivities with 15% variability in each possible scenario. The sensitivity analysis is presented in Table 11.1.

Table 11.1: Sensitivity Analysis of EIRR (%)

Scenarios	EIRR (%)	NPV (Rupees Million)
Base case	**25.2**	**9308.97**
1.15% increase in capital cost	22.8	8265.49
2.15% decrease in MT traffic volume	23.4	8501.44
3.15% decrease in MT VOC	24.8	8963.91
4.15% decrease in MT time	22.8	7214.44
5. All scenarios together	18.8	5139.53
Source: HDM-4 Output sheets		

12.0 Conclusion

The project is found economically viable, having EIRR well above 12%, under all possible scenarios including the worst one. The project has a strong benefit-generation capability, hence, strongly recommended for implementation under the current settings.

Table 2.0: Construction Program

Program Name	**Elevated Kona Expressway**
Cost estimation Year	2018
Estimated Cost @ 2018 price level	Rs. 1100 Cr.
Construction Start Year	2018
Construction End Year	2021
Open to Traffic	2022
Phasing of construction cost (%)	
Year 1	20
Year 2	30
Year 3	30
Year 4	20

Table 3.1: Fuel Price at Economic Prices

Prices as on 26th of May, 2016 (Rupees/litre)		
Item	**Petrol (s)**	**Diesel (Rs)**
Retail Pump Price	73.76	56.85
Total Tax including Direct and Indirect Taxes	55%	60%
Economic Price	**47.6**	**35.5**

Source: Business Standard, Dated: 15.3.2016

Table 4.0: Distribution and Conversion of Cost

Type of Works	CF	Labour	Materials: Non-tradable: Natural (Earth, Sand, Water)	Materials: Non-tradable: Processed (Stone Aggregates)	Materials: Tradable: Cement	Materials: Tradable: Steel	Materials: Tradable: Bitumen	Equipment	Transport	Total
		0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	
	Works Share									
Bituminous Layers	30%	15%	4%	6%	0%	0%	50%	12%	13%	100%
Granular Layers	25%	15%	5%	30%	0%	0%	0%	10%	40%	100%
Earth Works	10%	15%	25%	0%	0%	0%	0%	0%	60%	100%
Structures, Drainage, & Other Works	35%	15%	5%	5%	10%	50%	0%	5%	10%	100%

Type of Works		Labour	Materials: Non-tradable: Natural (Earth, Sand, Water)	Materials: Non-tradable: Processed (Stone Aggregates)	Materials: Tradable: Cement	Materials: Tradable: Steel	Materials: Tradable: Bitumen	Equipment	Transport	Total
	CF	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	
	Works Share									
	Distribution of Costs at Market Prices									
Bituminous Layers	3300000000.0	495000000	132000000	198000000	0	0	1650000000	396000000	429000000	330000000
Granular Layers	2750000000.0	412500000	137500000	825000000	0	0	0	275000000	1100000000	275000000
Earth Works	1100000000.0	165000000	275000000	0	0	0	0	0	660000000	110000000
Structures, Drianage, & Other Works	3850000000.0	577500000	192500000	192500000	385000000	1925000000	0	192500000	385000000	385000000
Total Market Price Rs. 1100 Cr		Distribution of Costs at Economic Prices								Total at Economic Price
		1237500000	552750000	911625000	288750000	1443750000	1237500000	647625000	1930500000	825000000

Per km Cost at Economic Prices
Rs. 1,209,677,419

Source: ADB (Calculation Procedure)

Table 5.0: Maintenance Costs

Maintenance Type	Interval (years)	Maintenance Work	Cost Rs. /m^2	Economic Price
Routine	3	Edge Repair	837	753.3
	1	Pothole Repair	1674.9	1507.5
	1	Crack sealing	127.8	114.3
Periodic	5	Overlay	1065.6	958.5

Source: The Author

Table 6.0: Vehicle Maintenance Cost

Vehicle Category	Hourly Rate at Market Price	Hourly Rate at Economic Price
Car	310	232
Two-Wheeler	160	120
Bus	350	262
Commercial Vehicles	350	262

Source: The Author

Table 6.1: Crew Cost (Rs.)

Vehicle Class	Salary of Driver	Shadow Wage of Driver	Per Hour Rate	Salary of Helper	Shadow Wage of Helper	Per Hour Rate	Final Crew Cost
Passenger car	9000	6750	28.13	NA	NA	NA	28.13
LCV	14000	10500	43.75	8000	6000	25.00	68.75
2W	NA	NA	NA	NA	NA	NA	NA
2 Axle	17000	12750	53.13	9000	6750	28.13	81.26
MAV	23000	17250	71.88	11000	8250	34.38	106.26
Bus-Standard	21000	15750	65.63	12000	9000	37.5	103.13

Source: The Author

Table 6.2: Passenger Time Cost Calculation

Passenger time Calculation		**Working Passenger time (Rs)**				-
Items	**Working time value per hour**	**Vehicle category**	**Working Passenger time**	**Non-working Passenger time**	**Working Passenger time (Rs)**	**Non-working Passenger time (Rs)**
NSDP (Rs, Crore)	496927	Two Wheelers	120.92	36.28	120.92	36.28
Population (Crore)	9.13	Car	161.23	48.37	161.23	48.37
NSDP(Rs)/capita	54428					
Employment ratio	**38.1%**	Micro/Mini Bus	120.92	36.28	120.92	36.28
Total No. of employed person (Crore)	3.48	Bus	104.80	31.44	104.80	31.44
NSDP(Rs)/employed person	142930	**At economic Prices (SWR= 0.75)**				
Household consumption Expenditure	94.0%	**2W/3W**			**90.69**	**27.21**
Income per employed person (Rs)	134355	**Car**			**120.92**	**36.28**
Others costs of employment @20%	26871					
Total income and employment cost (Rs)	161226	**Bus**			**78.60**	**23.58**
Working hour/year	2000					
Average Working Time Value (Rs)	80.61					
Value of non-working time@30%	30%					
Average non-working time value	24.18					

Source: ADB TA Project of Uttar Pradesh, Data Source: Statistical Abstract of West Bengal & Work Force Participation Rate by Planning Commission, 2011.

Table 6.3: Estimation Cargo Time Value (Rupees)

Estimation Cargo Time value (Rs)				
	CARGO =	(PCTCGT. OPC. VALCAR)/365X24		Economic prices
CARGO	Cargo time value (LCV)	62	LCV	**46**
	Cargo time value (2 Axle Truck)	267	2 Axle Truck	**200**
	Cargo time value (MAV)	308	MAV	**231**
PCTCGT	Fraction of vehicles whose cargo to be benefited	80%		
OPC	Opportunity cost of Cargo	15%		
		LCV	2 Axle Truck	MAV
VALCAR	Value of cargo (respective payload of each MT vehicle multiplied by average cost of commodity)	4,500,000	19,500,000	22,500,000
Average cost of Commodity (Rs)		1,500,000	**Conversion Factor 0.75**	
LCV		3		
2 Axle Truck		13		
MAV		15		

Source: ADB TA Project of Uttar Pradesh,

Table 6.4: Characteristics of Vehicles per Category

Vehicle Type	2W	3W	Car	Bus-Medium	Bus-Large	LCV	2 Axle	3 Axle	MAV
GVW, tons	0.2	1.6	2.7	3.2	12.6	5	12.3	·40	50
ESA/vehicle	0	0	0.01	0.1	2.4	0.03	4.3	4.6	13
No. Axles	2	2	2	2	2	2	2	3	4-6
No. Tyres	2	4	4	4	6	4	6	10	18
No. passengers	1	3	3	38	54	0	0	0	0
Service life in Years	10	8	12	7	12	8	12	12	12
Annual hours driven	600	720	912	1825	2286	1250	1429	1429	1700
Annual km	10000	30000	20000	70000	80000	30000	40000	50000	80000
Depreciation code	Constant life								
Annual interest rate, %	12	12	12	12	12	12	12	12	12

Source: Based on local informal Survey by author& HDM-4 Manual

Table 7.0.A: Base year (2017) traffic on Kona Expressway (AADT)

Vehicle Category	Kona Expressway
2W	2645
3W	25
Car	18882
Bus	3035
LCV	6793
2 Axle	5495
MAV	7150
Total	**44024**

Source: Traffic Survey by IIT—Kharagpur

Table 7.0.B: Total Traffic on Elevated Corridor (2017)

Vehicle Category	Elevated Corridor
2W	0
3W	0
Car	12836
Bus	1546
LCV	4716
2 Axle Truck	3814
MAV	4963
Total	**27,875**

Source: Traffic Surveyby *IIT—Kharagpur*

Table 7.1: Annual Traffic Growth Rates (%)

Vehicle Category	2017 - 20	2021 – 25	2026 - 30	2031-35	2036-40
Two-Wheeler	6.0	6.0	6.0	5.5	5.5
Three-Wheeler	6.0	6.0	6.0	5.5	5.5
Car	3.0	6.5	6.0	5.5	5.0
Bus-Large	5.0	6.5	6.0	5.5	5.0
LCV	3.0	4.5	4.5	4.0	4.0
2 Axle	3.0	4.5	4.5	4.0	4.0
MAV	3.0	4.5	4.5	4.0	4.0

Source: Traffic Forecast by IIT—Kharagpur

Table 8.0: Emission Summary on the Project Road with project scenario

HDM-4 Emissions Summary						
Study Name: **Kona Expressway**						
Run Date: 21-08-2018						
Annual Emission Quantities in tonnes						
Scenarios	**Elevated Corridor-Improved Case**			**Kona Expressway Base Case**		
Pollutants	**HC**	**CO**	**CO_2**	**HC**	**CO**	**CO_2**
2023	62	110	16,553	308	427	79,158
2024	65	115	17,108	314	441	80,469
2025	67	122	17,684	319	452	81,168
2026	70	128	18,284	323	464	82,000
2027	73	136	18,977	324	472	81,975
2028	77	144	19,626	329	484	82,846
2029	80	152	20,296	326	485	81,505
2030	83	161	20,996	327	493	81,374
2031	87	170	21,727	328	502	81,247
2032	91	179	22,468	330	511	81,113
2033	94	189	23,186	329	516	80,327
2034	99	199	24,016	330	525	80,127
2035	103	210	24,886	331	534	79,928
2036	108	222	25,833	333	544	79,725
2037	113	236	26,935	335	554	79,520
2038	119	252	28,324	336	564	79,304
2039	127	270	29,856	336	572	78,642
2040	135	291	31,688	338	583	78,380
2041	148	324	34,782	340	594	78,117
2042	158	349	36,837	342	605	77,848
2043	169	379	39,288	344	617	77,577
2044	184	415	42,765	346	630	77,293
2045	189	428	43,676	347	640	76,676
2046	195	446	44,689	349	653	76,354

Table 9.0.A: HDM Inputs for Existing Road Sections (NH-117)

Parameters	Existing Sections
Length (km)	6.8
Carriageway width (m)	14
Paved Shoulder width (m)	1.0
Earthen Shoulder width (m)	1-1.5
Surface class	Bitumen
Flow direction	2 Ways
Road Class	NH
Geometry	
Rise and Fall (m/km)	2.5
No. of R and Fall	40
Super-elevation (%)	4
Average Horz. Curvature	54
Speed limit (km/h)	20
Speed Reduction Factor	1.1
XNMT	1
Road side friction	1
XMT	1
Pavement	
Pavement type	Flexible
Most recent surface thickness (mm)	400
Previous/old surfacing thickness (mm)	50
Last construction /reconstruction (yr)	2010
Last rehabilitation (overlay) yr	2015
Last resurfacing (resealing) yr	2015
Last preventive treatment yr	2015
SNP (dry)	1.6
DEF (mm)	3.06
Sub-grade CBR (%)	5
Structural No.	0.55
Condition	
Year	2017
Roughness (IRI)	6
All Structural cracking area (%)	30
Wide crack area (%)	10
Thermal crack area (%)	0
Ravelled area (%)	20
No of potholes (no /km)	2
Edge break area (m^2/km)	10
Mean rut depth (mm)	25
Rut depth Standard deviation	0.5
Skid resistance (SCRIM 50km/hr)	0.45
Texture depth (mm)	0.4
Drainage condition (excellent/good/bad)	Bad
Relative compaction (%)	85

Source: The Author

Table 9.0.B: HDM Inputs for new Elevated Corridor

Parameters	Elevated Corridor
Existing surface class	Concrete with BT Coating
Length (km)	6.82
New width (m)	24
New Pavement	Rigid
Duration (yr)	4
Intervention year	2018
Cost (2017)	Rs. 1100 Crore
Annual cost stream (%)	20, 30, 30 & 20
Salvage value (%)	30
Bituminous surfacing, CDS	1
Base CDB	1
Geometry	
Rise and Fall (m/km)	14
No. of R and Fall	
Super-elevation (%)	2.7
Average Horz. Curvature	
Speed limit (km/h)	65
Speed limit enforcement	1.1
XNMT	1
Road side friction	1
XMT	1
SNP (dry)	3.5
Surface thickness	50
Relative compaction (%)	98
Effect	
Roughness (IRI)	2.5
Mean rut depth (mm)	0
Rut depth Standard deviation	0
Skid resistance (SCRIM 50km/hr)	0.5
Surface Texture	0.7

Source: The Author

Table 11.0: Results of the Economic Analysis

Road Code	Road	EIRR (%)	NPV at 12% (Rupees Million)
Kona Expressway (NH-117)	New Elevated Corridor	**25.2**	9308.97

Source: HDM-4 Output sheets

Table 11.1: Sensitivity Analysis of EIRR (%)

Scenarios	EIRR (%)	NPV (Rupees Million)
Base case	**25.2**	**9308.97**
1. 15% increase in capital cost	22.8	8265.49
2. 15% decrease in MT traffic volume	23.4	8501.44
3. 15% decrease in MT VOC	24.8	8963.91
4. 15% decrease in MT time	22.8	7214.44
5. All scenarios together	18.8	5139.53

Source: HDM-4 Output sheets

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