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An Economic Analysis of Dhaka - Chittagong Strategic Road Corridor Maintenance and Improvement Project in Bangladesh

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Abstract:

A well-developed transportation network is vital to the economic development of the country. High quality road network increases the potential of any economic system and boost up economic growth. Shrinking road capacity is a bottleneck on major road corridors in Bangladesh. With increase in vehicle population commuters spends more time in traffic jam and loses precious time which could have been utilised in productive activities otherwise. It also causes wasteful fuel expenditure which directly affects the country's exchequer. Thus creation of new road infrastructures as well as periodic maintenance of the existing one has long term economic benefits. The economic benefits are calibrated by carrying out cost-benefit analysis of the expenditures incurred and benefits created vide Economic Internal Rate of Return (EIRR). Expansion of road capacity

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and maintenance of Dhaka Chittagong Road Corridor (DCRC) considered as the most important of the five major road corridors in Bangladesh was initially taken up during Fifth Five Years Plan (1997-2002) as part of Bangladesh's Road Maintenance and Improvement Programme. DCRC is frequented with heavy traffic jam due to ever increasing vehicle population and dilapidated road capacity. Bangladesh government had undertaken improvement of road corridors and maintenance work along DCRC with support of Asian Development Bank. Here an economic analysis was carried out to find out the benefits of this road improvement and maintenance works. SCF of 0.85 was considered to convert financial costs into economic costs. The EIRR for three Corridor Improvement Components were found out to be 32.91, 16.92, 12.22 and two Road Improvement Components were 29.80 and 26.95. The sensitivity analysis also proved the robustness of the project in changing cost conditions. Overall the proposed investment programmes were found to be economically viable.

Key words: EIRR, economic viability, sensitivity analysis, traffic congestion, VOC savings, time savings

JEL Classification: D6, R4, R42

1.0 INTRODUCTION

Chittagong is the most important port in Bangladesh which handled around 2 to 2.5 million TEUs (twenty feet equivalent unit containers) in 2016. Majority of Bangladesh imports and exports are carried out through Chittagong port and manages 85 to 95 percent of the country's international as well as domestic trade. In Bangladesh thirty per cent of the government revenue comes from Chittagong port and Custom House Chittagong (CHC).

However, the importance of the port is depends upon the efficient transport system. In this context the importance of Dhaka-Chittagong Corridor is paramount. It is a part of

country's development focus on road infrastructure development which was undertaken as part of its Fifth Five Years Plan, 1997-2002. It is one of the five major road corridors project aim to connect country's capital with main port. This corridor caters to 16 per cent of the land area, 30-35 per cent of the population and 50 per cent of the national GDP, and 85 per cent of international maritime trade of the country. Thus the expansion of the road corridor and establishment of an efficient transport system is expected to bring a boost to country's economic growth by 1 per cent especially the southeast region and contribute to poverty reduction.

Project Scope: Asian Development Bank (ADB) initially approved the Road Maintenance and Improvement Project (RMIP) work in November 2000 in response to the Bangladesh's focus on the development of the country's five major road corridors. Expanding the capacity of the Dhaka–Chittagong Corridor, which was one of the five corridors, was necessary to establish efficient transport between the country's capital and its main port helping to develop a satellite township. Improvement of the road network under the project was expected to lead to significant economic growth. It was further expected that such kind of project would introduce precise policy and institutional reforms in the road subsector to upkeep improvements in road maintenance, and allow a larger involvement by the private sector. The project was expected to complete in June 2005 but was actually completed after four years of actual target in April 2009. The project is considered as successful, highly relevant, effective, efficient, but less likely to be sustainable *(ADB, 2009)*[2].

2.0 LITERATURE REVIEW

[2] ADB, 2009, Project *Completion Report: Bangladesh: Road Maintenance and Improvement Project* (Loans 1789 and 1790). Manila.

Background: At the time of undertaking work for this project the road network conditions of Bangladesh was shabby. This was due to poor and inadequate maintenance that give rise to inefficient, costly and undependable transport services. This inhibited labour, goods, and services movements. Large vehicles population, poor road safety measures, and absence of traffic regulations implementations create high level of road accidents. Further total expenditure on periodic maintenance was always less than the desired level to maintain road assets sustainability. This hampered the maintenance activities as well. Inadequate maintenance and rehabilitation of road network was also responsible in prolonged road congestion and traffic volume is larger than the capability road on major and strategic corridors. In this context, the capacity of the South-East Road Corridor from the country's capital (Dhaka) to its main port (Chittagong) required expansion to create employment opportunities, reducing poverty so as to boost up economic development. This requires transparent, effective maintenance system and private sector participation in road sector projects. In 2000, the Bangladesh government pursued the support and special fund assistance from Asian Development Bank (ADB) for improvement and reduction road maintenance backlog in the Southeast Road Corridor between Dhaka and Chittagong. There was private sector participation in this project to increase the economic efficiency and reduce the burden on public financing of road sector projects. Various feasibility studies such as reports on the environment, land acquisition and resettlement, and poverty reduction impacts were carried out beforehand.

The project aimed at expansion of road capacity and improving transport efficiency by upgradation of road maintenance work. This could be achieved through implementation of right policy elements and choosing an appropriate investment environment. Further, it aimed to speed up economic development and poverty reduction vide

upgrading strategic road corridors in the country. However, in order to achieve transport efficiency it vital to make sufficient provision for road maintenance along with expansion of road infrastructures. It was envisaged to make the programme successful by active participation of public and private participations.

There was a huge bottleneck in road capacity expansion in Bangladesh as the modal shares of traffic were increasing at a rapid rate. Analysis of past data revealed the demand for road transport increased at annual rate of 8% for passengers and 7% for freight in early 1990s to 72% and 65% respectively in 1998 to 88% of passenger kilometres (km) and 80% of freight-ton km in 2006 *(Bangladesh Sixth Five-Year Plan FY 2011 – 2015)* [3]. This resulted in congestion and reduced transport efficiency in major corridors. Thus it was obvious to expand the capacity of the Dhaka–Chittagong Corridor which served to the majority of freight and passenger traffic and one of the strategic sections with the highest traffic levels with utmost importance to the economy. The traffic movement was above 10,000 vehicles per day, with a huge proportion of trucks and buses with over 7% to 8% traffic growth per annum at the time of appraisal.

Roads and Highways Department (RHD) of Bangladesh administered about 20,850 km of roads network in 1999 *(Roads and Highways Department 2012 – 13)*.[4] The repairs and maintenance of these roads required a significant amount of money every year. But these funding remained resulting in premature deteriorations of these roads. Thus, there is an urgent need to make provision for a periodic maintenance so as to avoid the heavy cost at a latter date. Lack of strategic planning, financing, and execution has made periodic maintenance practices inadequate.

[3] Bangladesh Sixth Five-Year Plan FY 2011 – 2015 — *Accelerating Growth and Reducing Poverty*, Planning Commission, Ministry of Planning Government of the People's Republic of Bangladesh. July 2011.

[4] HDM Circle. Maintenance and Rehabilitation Needs Report of 2012–2013 for RHD Paved Roads, Roads and Highways Department.

Insufficient fund for road maintenance was a serious issue.[5] All the road maintenance work had been financed from the revenue budget and the Annual Development Plan (ADP). It was the RHD of the Ministry of Communications regularly used project funding in the ADP to supplement its budget for periodic maintenance. However this money always fell short of sustainable fund requirements. This also causes major hindrance for expansion of road network. Further this backlog fails to meet 13–16% growth demand as it gradually increases. Thus the government needed to access additional sources of external and domestic funding for maintenance to clear the maintenance backlog.

The maintenance backlog was gradually increasing, as the available funds could not meet the. To reduce the backlog, the government needed to access additional sources of external and domestic funding for maintenance.

The main objectives and outcomes of the project were such as follows:

(i) Upgradation of road conditions and increasing capacity Strategic Southeast Road Corridor so as to raise transport efficiency on the;

(ii) Establishment of enabling policy and legal environment and encouragement of private sector participation in the delivery of road infrastructure; and

(iii) Strengthening the governance of road maintenance,

(iv) Directing prioritized sections for periodic maintenance works, targeting areas with a high incidence of poverty

(v) Improving transport efficiency on existing roads nationwide.

[5] Road sector revenues were collected through (i) fuel taxes; (ii) customs, excise duties, and sales taxes on vehicle acquisition, spare parts, and tires; (iii) registration and annual vehicle license fees and other fees related to drivers' licenses and route permits percent; and (iv) tolls and charges on ferries and selected bridges.

The project framework indicated that the expected impacts were enhanced economic growth and reduced poverty in the project areas; the expected outcome was to realize improved transport efficiency.

The project had two components with separate investment and policy elements such as follow:

(i) The corridor improvement component (CIC) and
(ii) The road maintenance component (RMC).

Improvement of Southeast Road Corridor was intended to be carried out by CIC that includes instituting a policy and legal framework for bigger private sector involvement in the road subsector, and implementation of toll road demonstration project for the Chittagong Port access road (CPAR). However, the RMC was intended to address the policy, planning, implementation, and financing requirements for establishing adequate maintenance of the RHD road network. For the CIC, the outputs were construction of 111-km sections of road along the Southeast Road Corridor[6], and for the RMC, road maintenance, and periodic maintenance of an estimated 250–400 km for each of the 3 years from fiscal year (FY) 2002-03 to FY 2004-05.

Regarding initial project preparation was financed through a project preparatory technical assistance project at a total cost to ADB of $250,000, equivalent to 0.2% of the estimated project cost (ADB, 1996).[7] But at appraisal, the project's total cost was estimated at $160.2 million equivalent, of which the foreign exchange cost was $75.6 million, and the local currency cost was $84.6 million equivalent. At completion,

[6] The CIC comprised three parts: (i) overlay and widening of the Chandina, Comilla, and Feni bypasses (52km); (ii) upgrading and widening of the Feni–Chittagong section, including construction of local bypasses (47 km); and (iii) construction of the Chittagong Port access road, an access-controlled toll road (12 km).

[7] ADB. 1996. Technical Assistance to the People's Republic of Bangladesh for the Third Road Improvement Project (TA 2678-BAN, piggy-backed to Loan 1478-BAN). Manila.

the project's actual cost was $117.77 million equivalent, which was 27% lower than the appraisal estimates. Within this total, the actual cost for the CIC was $68.61 million equivalent, compared to the appraisal estimate of $100.83 million equivalent, an underspending of 31%. For the RMC, the actual cost was $26.8 million equivalent, compared to the estimate of $36.0 million equivalent at appraisal, an underspending of 26%. Offsetting these results, land costs increased from an estimate of $6.1 million to an actual cost of $9.6 million. ADB financed about 60% of estimated project costs, totalling $94.0 million equivalent, of which $22.0 million was sourced from the ordinary capital resources and $72.0 million equivalent was sourced from the Asian Development Fund (ADF).[8] The loan was denominated in a mix of US dollars and special drawing rights (SDR). As a result of the contract cost savings and deferral of maintenance under the RMC, the government requested four partial cancellations from the ADF loan, totalling 32% of the original loan amount, which ADB approved.[9]

3.0 OBJECTIVE:

The main objective of this paper is to carry out an economic evaluation in order to assess the viability of the project components in terms of the benefits likely to accrue to the economy as a whole, thereby justifying its implementation based on the benefits to the economy. The economic viability is commonly expressed in terms of Economic Internal Rate of

[8] This amount was equivalent to SDR 55,660,000.

[9] The PCR indicated that loan cancellation amounted to $31,360,929.61 million equivalent. Following the last disbursement of the ADF loan, ADB cancelled the remaining balance of $1,358,171.49 equivalent on loan closing, reducing the ADF loan amount to $51,513,601 equivalent. Following the last disbursement of the OCR loan, ADB cancelled the remaining balance of $5,904,928.72, reducing the loan amount to $16,095,071.28,

Return (EIRR). The robustness of the project is further tested by carrying out a sensitivity analysis.

4.0 METHODOLOGY AND APPROACH

The economic evaluation had been carried out within the broad framework of social cost-benefit analysis. In economic analysis, benefits and costs are computed for the economy as a whole rather than for an individual entity that has made investment. The analysis involves comparison of cost and benefit streams under both the "*without*" and "*with*" project conditions, over a fixed analysis period.

Results of economic analysis had been expressed in terms of economic internal rate of return (EIRR). The EIRR was obtained using discounted cash flow (DCF) technique to an annual stream of net cash flows, accruing during the time horizon of the study. The study period was taken as extending over 16 years, with a benefit period of 10 years after commissioning of the projects. Feasibility of the project was determined by comparing EIRR with the current accounting rate of 12 percent. This represents the opportunity cost of capital and is considered the appropriate minimum criterion for economic viability by both Government agencies and International Funding Agencies like World Bank (WB) and Asian Development Bank (ADB).

All costs and benefits considered in the study had been valued in monetary terms and expressed in economic prices to reflect the true resource cost to the economy. The economic analysis has been carried out using life cycle costing approach.

Project Components for Economic Analysis: The project envisaged improvement of the southeast corridor in Bangladesh, a strategic corridor linking Dhaka and Chittagong. The project components for which the following economic analysis had been carried out include:

- Corridor Improvement Component (CIC)

- Road Maintenance Component (RMC)

CIC has been executed through four contracts including road works (widening & overlay); bridges/culverts; road safety, widening, concrete pavement and footpath; Engineer's facilities.

CIC 1 : Chandina, Comilla & Feni existing bypasses (51.76 km)
CIC 2 : Feni-Chittagong Section 1 (25.44 km)
CIC 3 : Feni-Chittagong Section 2 (22.5 km)
CIC 4 : Port access road construction (13.6 km)

RMC was executed through five contracts, namely,

RMC1 : Dhaka Chittagong road from Daudkandi to start of Chandina bypass to start of Comilla bypass (41.65 km)
RMC2 : End of Comilla bypass to start of Feni bypass (34.62 km)
RMC3 : Sections of Comila-Chandpur, Raipur-Laxmipur and Raipur Chandpur (93.5 km)
RMC4 : Lalmai-Laksham
Sonaimuri road section, Miabazar -Ashinagar-Harischar section (89.5km)
RMC5 : Sections of Kalurghat - Manashartek, Manasrtek-Coxs bazaar, Cox bazar to Teknaf (110.5 km)

The economic analysis had been carried out individually for each of the CIC and RMC contracts for which traffic data was available[10]. The traffic forecast data are presented in *Annexure 1*.

(A) Project Costs:

[10] Traffic projections based on *Dhaka-Chittagong Expressway (PPP)Project, Draft Final Traffic Survey and Projection Report(Vol. II), 2008; Roads& Highways Department., Government of Bangladesh.*

The financial costs comprise, both, the capital costs and the maintenance costs over the time horizon of the study.

a) *Capital Costs:* Based on contract wise phased cost, the total capital cost (in financial terms) for each contract, was updated to 2008 prices using the prevailing inflation rate. Contract-wise capital cost in financial terms is presented in **Table 1**.

b) *Estimation of Economic Cost:* Economic analysis requires the conversion of financial costs into economic costs by removing distortions in prices due to the existence of market imperfections. Taxes & duties are removed from financial prices as they are not real costs to the economy, but are only transfer payments. A Standard Conversion Factor (SCF) of 0.85 had been used for conversion of all financial costs into economic costs.

Table 1: Capital Cost of the Project

(Tk in million at 2008 prices)

Sl. No.	*Contract Type*	*Financial Cost*	*Economic Cost*
1	CIC 1	1437.82	1222.15
2	CIC 2	992.91	843.97
3	CIC 3	1265.28	1075.49
4	CIC 4	1383.95	1176.36
5	RMC 1	510.93	434.29
6	RMC 2	381.36	324.07
7	RMC 3	368.17	312.94
8	RMC 4	78.95	67.11
9	RMC 5	411.48	349.76

(c) *Maintenance Cost:* The annual routine maintenance cost had been taken at Tk 200,000 per km. This has been converted into economic costs by applying the standard conversion factor of 0.85. The routine maintenance is to be incurred every year after commissioning of the project.

(B) Project Benefits:

VOC Savings: The direct benefits of road improvement considered include VOC savings to vehicular traffic. Unit VOCs have been calculated using VOC equations 1999[11] after application of inflation factor for updating unit VOCs to 2008 prices.

a) *VOC Savings:* Future streams of unit VOC by vehicle type under "*without project*" and "*with project*" situations were calculated using the VOC equation [VOC = X + (Y*IR) **1.12]. A roughness progression is assumed with each passing year and VOCs estimated for different roughness levels. The benefit streams had been computed annually over the 10-year benefit period for the changing traffic volume and composition. The VOC savings is presented in *Annexure 2.*

Economic Viability: The annual cost and benefit streams are used to derive the net cash flow for the individual projects for which traffic data was available. The EIRR was determined using the discounted cash-flow technique. The results are presented in **Table 2.**

Table 2: Results of Economic Analysis

Sl. No.	*Project*	*EIRR (%)*
1	CIC 1	32.91
2	CIC 2	16.92
3	CIC 3	12.22

[11] Refer PCR ROIP Validation RUC Report Economic Circle 1999-2000

NB:

(i) *Tk stands for Bangladesh currency Taka*
(ii) In April 2008 (during project feasibility study by consultants),1US$ = Tk68.653
(iii) In April 2009 (at program completion),1US$ = Tk71.23
(iv) In February 2013 (Project Evaluation by ADB), 1US$ = Tk78.35
(v) In April 2017, 1US$ = Tk81.10

4	RMC 1	29.80
5	RMC 2	26.95

The rate of return considered desirable for transport infrastructure projects is 12 percent. With an EIRR above 12 percent cut-off rate, all the contract projects are economically viable. The detailed net cash-flow statements are presented in **Table 3, 4, 5, 6 and 7** for CIC1, CIC2, CIC3, RMC1 and RMC2 respectively.

Table 3: Net Cash flow Statement – Corridor Improvement Component 1 (CIC1)

(In million Tk)

Year	Cost			VOC	Net
	Capital/Periodic Maintenance	Routine Maintenance	Total	Savings	Benefits
2008	1222.15	8.80	1230.95	224.66	-1006.29
2009		8.80	8.80	256.36	247.56
2010		8.80	8.80	291.59	282.79
2011		8.80	8.80	330.58	321.79
2012		8.80	8.80	372.92	364.12
2013		8.80	8.80	419.72	410.92
2014		8.80	8.80	471.41	462.61
2015		8.80	8.80	528.48	519.68
2016		8.80	8.80	591.47	582.67
2017		8.80	8.80	659.25	650.45
2018		8.80	8.80	733.76	724.96
			EIRR		***32.91%***

Table 4: Net Cash flow Statement – Corridor Improvement Component 2 (CIC2)

(In million Tk)

Year	Cost			VOC	Net
	Capital/Periodic Maintenance	Routine Maintenance	Total	Savings	Benefits
2008	843.97	4.32	848.30	92.91	-755.39
2009		4.32	4.32	106.00	101.67
2010		4.32	4.32	120.53	116.21
2011		4.32	4.32	136.65	132.32
2012		4.32	4.32	154.11	149.78
2013		4.32	4.32	173.43	169.10
2014		4.32	4.32	194.73	190.41
2015		4.32	4.32	218.27	213.95
2016		4.32	4.32	244.21	239.88
2017		4.32	4.32	272.14	267.82
2018		4.32	4.32	302.83	298.51

EIRR	***16.92%***

Table 5: Net Cash flow Statement – Corridor Improvement Component 3 (CIC3)

(In million Tk)

Year	Cost			VOC	Net
	Capital/Periodic Maintenance	Routine Maintenance	Total	Savings	Benefits
2008	1075.49		1075.49	96.16	-979.32
2009		3.82	3.82	109.75	105.93
2010		3.82	3.82	124.82	121.00
2011		3.82	3.82	141.55	137.73
2012		3.82	3.82	159.70	155.88
2013		3.82	3.82	179.76	175.94
2014		3.82	3.82	201.89	198.07
2015		3.82	3.82	226.34	222.53
2016		3.82	3.82	253.33	249.52
2017		3.82	3.82	282.36	278.55
2018		3.82	3.82	314.30	310.48
EIRR					***12.22%***

Table 6: Net Cash flow Statement – Road Maintenance Component 1 (RMC1)

(In million Tk)

Year	Cost			VOC	Net
	Capital/Periodic Maintenance	Routine Maintenance	Total	Savings	Benefits
2008	434.29		434.29	86.92	-347.37
2009		7.08	7.08	94.64	87.56
2010		7.08	7.08	102.94	95.86
2011		7.08	7.08	111.83	104.75
2012		7.08	7.08	121.08	114.00
2013		7.08	7.08	131.02	123.93
2014		7.08	7.08	141.68	134.60
2015		7.08	7.08	153.15	146.07
2016		7.08	7.08	165.48	158.40
2017		7.08	7.08	178.28	171.20
2018		7.08	7.08	192.01	184.93
EIRR					***29.80%***

Table 7: Net Cash flow Statement – Road Maintenance Component 2 (RMC2)

Year	Cost			VOC	Net
	Capital/Periodic Maintenance	Routine Maintenance	Total	Savings	Benefits
2008	324.07		324.07	60.79	-263.28

2009		5.89	5.89	66.18	60.29
2010		5.89	5.89	71.97	66.08
2011		5.89	5.89	78.17	72.29
2012		5.89	5.89	84.62	78.74
2013		5.89	5.89	91.55	85.67
2014		5.89	5.89	98.98	93.10
2015		5.89	5.89	106.97	101.09
2016		5.89	5.89	115.55	109.66
2017		5.89	5.89	124.46	118.58
2018		5.89	5.89	134.02	128.13
			EIRR		***26.95%***

5.0 SENSITIVITY ANALYSIS

The robustness of the project's viability is further demonstrated by the sensitivity analysis. Because of the uncertainties surrounding many of the variables like traffic forecasts, cost changes due to detailed designing, etc., a sensitivity analysis was carried out to test the economic strength of the project. The variations in the following parameters have been examined, considering them to be on the conservative side:

i) Increase in cost by 10 percent
ii) Decrease in benefits by 10 percent
iii) Increase in cost by 10 percent and decrease in benefits by 10 percent

The results of the sensitivity analysis are presented in **Table 8, 9, 10, 11 and 12.**

Table 8: Sensitivity Analysis – Corridor Improvement Component 1 (CIC1)

(In million Tk)

Year	Cost increase by 10%	Revenue decreases by 10%	Cost increases by 10% & revenue decreases by 10%
2008	-1129.38	-1028.75	-1151.85
2009	246.68	221.92	221.04
2010	281.91	253.63	252.75
2011	320.91	288.73	287.85
2012	363.24	326.83	325.95
2013	410.04	368.95	368.07
2014	461.73	415.47	414.59
2015	518.80	466.84	465.96
2016	581.79	523.52	522.64

2017	649.57	584.53	583.65
2018	724.08	651.59	650.71
EIRR	***29.32%***	***28.96%***	***25.71%***

Table 9: Sensitivity Analysis – Corridor Improvement Component 2 (CIC2)

(In million Tk)

Year	Cost increase by 10%	Revenue decreases by 10%	Cost increases by 10% & revenue decreases by 10%
2008	-840.22	-764.68	-849.51
2009	101.24	91.07	90.64
2010	115.78	104.16	103.72
2011	131.89	118.66	118.23
2012	149.35	134.37	133.94
2013	168.67	151.76	151.33
2014	189.98	170.94	170.50
2015	213.52	192.12	191.69
2016	239.45	215.46	215.03
2017	267.38	240.60	240.17
2018	298.07	268.22	267.79
EIRR	***14.53%***	***14.28%***	***12.05%***

Table 10: Sensitivity Analysis – Corridor Improvement Component 3 (CIC3)

(In million Tk)

Year	Cost increase by 10%	Revenue decreases by 10%	Cost increases by 10% & revenue decreases by 10%
2008	-1086.87	-988.94	-1096.49
2009	105.55	94.96	94.58
2010	120.62	108.52	108.14
2011	137.35	123.58	123.20
2012	155.50	139.91	139.53
2013	175.56	157.96	157.58
2014	197.69	177.88	177.50
2015	222.14	199.89	199.51
2016	249.13	224.18	223.80
2017	278.16	250.31	249.93
2018	310.10	279.05	278.67
EIRR	***10.12%***	***9.90%***	***7.91%***

Table 11: Sensitivity Analysis – Road Maintenance Component 1 (RMC1)

(In million Tk)

Year	Cost increase by 10%	Revenue decreases by 10%	Cost increases by 10% & revenue decreases by 10%
2008	-390.80	-356.06	-399.49
2009	86.85	78.10	77.39

2010	95.15	85.57	84.86
2011	104.04	93.56	92.85
2012	113.29	101.89	101.18
2013	123.23	110.83	110.13
2014	133.90	120.44	119.73
2015	145.36	130.75	130.05
2016	157.69	141.85	141.14
2017	170.49	153.37	152.66
2018	184.23	165.73	165.02
EIRR	***26.04%***	***25.66%***	***22.27%***

Table 12: Sensitivity Analysis – Road Maintenance Component 2 (RMC2)

(In million Tk)

Year	Cost increase by 10%	Revenue decreases by 10%	Cost increases by 10% & revenue decreases by 10%
2008	-295.69	-269.36	-301.77
2009	59.71	53.68	53.09
2010	65.49	58.88	58.30
2011	71.70	64.47	63.88
2012	78.15	70.27	69.68
2013	85.08	76.51	75.92
2014	92.51	83.20	82.61
2015	100.50	90.39	89.80
2016	109.07	98.11	97.52
2017	117.99	106.13	105.54
2018	127.55	114.73	114.14
EIRR	***23.42%***	***23.06%***	***19.86%***

6.0 CONCLUSION:

The rate of return considered desirable for transport infrastructure projects is 12 percent. With an EIRR above 12 percent cut-off rate, all the project components (CIC1, CIC2, CIC3 and RMP1, RMP2) found to be economically viable. The sensitivity analysis also proved the robustness of the project. Even in the worst case of increase in cost and decrease in benefits all the project components found to be economically viable. Thus the Dhaka-Chittagong corridor is vital for Bangladesh speedy transportation of goods and passengers.

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ANNEXURE 1: Traffic Forecasts CICs and RMCs

Traffic Projections CIC1

Year	Med/Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car
2007	7226	1511	2205	474	1427	340	780
2008	7768	1625	2293	493	1555	371	851
2009	8351	1747	2385	513	1695	404	927
2010	8978	1878	2480	534	1848	441	1011
2011	9651	2019	2579	555	2014	480	1101
2012	10350	2165	2678	576	2187	521	1196
2013	11101	2322	2781	598	2374	566	1298
2014	11905	2490	2888	621	2577	615	1410
2015	12769	2671	2999	645	2798	667	1530
2016	13694	2864	3114	670	3038	724	1662
2017	14653	3065	3229	695	3286	783	1797
2018	15679	3279	3348	720	3554	847	1944
2019	16776	3509	3472	747	3844	917	2102
2020	17950	3755	3600	775	4158	991	2274

Traffic Projections CIC2

Year	Med/Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car
2007	7115	714	1512	396	559	519	441
2008	7649	768	1572	412	609	566	481
2009	8222	825	1635	428	664	617	524
2010	8839	887	1701	445	724	673	571
2011	9502	954	1769	463	789	733	623
2012	10190	1023	1836	481	857	796	676
2013	10930	1097	1907	500	930	864	734
2014	11722	1176	1980	519	1010	938	797
2015	12572	1262	2056	539	1097	1019	865
2016	13483	1353	2135	559	1191	1106	939
2017	14427	1448	2214	580	1288	1196	1016
2018	15437	1549	2296	601	1393	1294	1099
2019	16518	1658	2380	624	1507	1400	1188
2020	17674	1774	2468	647	1629	1514	1285

Traffic Projections CIC3

Year	Med/Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car
2007	8051	690	1779	608	1100	232	804
2008	8655	741	1850	633	1199	253	876
2009	9304	797	1924	658	1307	276	955
2010	10002	857	2001	684	1424	300	1041
2011	10752	921	2081	712	1553	327	1135
2012	11531	988	2161	739	1686	356	1232
2013	12368	1060	2244	767	1830	386	1338

Year	Med/Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car
2014	13263	1136	2330	797	1987	419	1453
2015	14225	1219	2420	827	2157	455	1577
2016	15257	1307	2513	859	2342	494	1712
2017	16324	1399	2605	891	2533	534	1852
2018	17468	1496	2701	924	2740	578	2003
2019	18690	1601	2801	958	2963	625	2167
2020	19998	1713	2905	993	3205	676	2343

Traffic Projections RMC1

Year	Med/Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car
2007	7226	1511	2205	474	1427	340	780
2008	7768	1625	2293	493	1555	371	851
2009	8351	1747	2385	513	1695	404	927
2010	8978	1878	2480	534	1848	441	1011
2011	9651	2019	2579	555	2014	480	1101
2012	10350	2165	2678	576	2187	521	1196
2013	11101	2322	2781	598	2374	566	1298
2014	11905	2490	2888	621	2577	615	1410
2015	12769	2671	2999	645	2798	667	1530
2016	13694	2864	3114	670	3038	724	1662
2017	14653	3065	3229	695	3286	783	1797
2018	15679	3279	3348	720	3554	847	1944
2019	16776	3509	3472	747	3844	917	2102
2020	17950	3755	3600	775	4158	991	2274

Traffic Projections RMC2

Year	Med/Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car
2007	7115	714	1512	396	559	519	441
2008	7649	768	1572	412	609	566	481
2009	8222	825	1635	428	664	617	524
2010	8839	887	1701	445	724	673	571
2011	9502	954	1769	463	789	733	623
2012	10190	1023	1836	481	857	796	676
2013	10930	1097	1907	500	930	864	734
2014	11722	1176	1980	519	1010	938	797
2015	12572	1262	2056	539	1097	1019	865
2016	13483	1353	2135	559	1191	1106	939
2017	14427	1448	2214	580	1288	1196	1016
2018	15437	1549	2296	601	1393	1294	1099
2019	16518	1658	2380	624	1507	1400	1188
2020	17674	1774	2468	647	1629	1514	1285

ANNEXURE 2: VOCs Savings

VOC Savings in million Tk: CIC1

Year	VOC Savings in million Tk: CIC1							
	Med / Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car	Total
2007	121.71	14.65	20.10	2.34	18.63	4.86	13.77	196.07

2008	139.59	16.81	22.30	2.60	21.66	5.66	16.03	224.66
2009	159.45	19.20	24.65	2.88	25.09	6.55	18.55	256.36
2010	181.48	21.85	27.14	3.17	28.96	7.57	21.42	291.59
2011	205.90	24.80	29.78	3.48	33.31	8.69	24.62	330.58
2012	232.43	27.99	32.55	3.80	38.07	9.93	28.15	372.92
2013	261.76	31.52	35.49	4.14	43.40	11.33	32.08	419.72
2014	294.11	35.41	38.62	4.50	49.35	12.89	36.51	471.41
2015	329.85	39.72	41.93	4.89	56.03	14.62	41.43	528.48
2016	369.22	44.45	45.45	5.30	63.50	16.57	46.97	591.47
2017	411.68	49.57	49.11	5.73	71.57	18.67	52.92	659.25
2018	458.32	55.18	52.97	6.18	80.54	21.01	59.56	733.76

VOC Savings in million Tk: CIC2

Year	VOC Savings in million Tk: CIC2							
	Med / Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car	Total
2007	58.90	3.40	6.78	0.96	3.59	3.65	3.83	81.10
2008	67.56	3.91	7.52	1.07	4.17	4.24	4.45	92.91
2009	77.16	4.46	8.31	1.18	4.83	4.91	5.15	106.00
2010	87.82	5.07	9.15	1.30	5.58	5.67	5.95	120.53
2011	99.64	5.76	10.04	1.43	6.41	6.52	6.85	136.65
2012	112.47	6.50	10.97	1.56	7.33	7.46	7.82	154.11
2013	126.67	7.32	11.96	1.70	8.36	8.50	8.92	173.43
2014	142.33	8.22	13.01	1.85	9.51	9.67	10.14	194.73
2015	159.62	9.22	14.13	2.01	10.80	10.98	11.51	218.27
2016	178.68	10.32	15.31	2.17	12.24	12.44	13.04	244.21
2017	199.22	11.51	16.55	2.35	13.79	14.02	14.71	272.14
2018	221.79	12.81	17.86	2.53	15.52	15.78	16.55	302.83

VOC Savings in million Tk: CIC3

Year	VOC Savings in million Tk: CIC3							
	Med / Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car	Total
2007	58.85	2.90	7.04	1.30	6.23	1.44	6.16	83.93
2008	67.50	3.33	7.81	1.45	7.25	1.67	7.16	96.16
2009	77.09	3.80	8.63	1.60	8.40	1.94	8.29	109.75
2010	87.74	4.33	9.50	1.76	9.68	2.23	9.57	124.82
2011	99.55	4.91	10.43	1.94	11.15	2.57	11.01	141.55
2012	112.37	5.54	11.40	2.11	12.74	2.94	12.58	159.70
2013	126.56	6.24	12.43	2.30	14.52	3.35	14.35	179.76
2014	142.19	7.01	13.52	2.51	16.51	3.81	16.33	201.89
2015	159.47	7.87	14.68	2.72	18.75	4.33	18.53	226.34
2016	178.52	8.80	15.92	2.95	21.24	4.91	21.00	253.33
2017	199.03	9.82	17.19	3.19	23.94	5.53	23.67	282.36
2018	221.59	10.93	18.55	3.44	26.95	6.22	26.63	314.30

VOC Savings in million Tk: RMC1

Year	VOC Savings in million Tk: RMC1							
	Med / Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car	Total
2007	49.46	5.95	8.17	0.95	7.57	1.97	5.60	79.68
2008	54.01	6.50	8.63	1.01	8.38	2.19	6.20	86.92
2009	58.86	7.09	9.10	1.06	9.26	2.42	6.85	94.64
2010	64.07	7.72	9.58	1.12	10.22	2.67	7.56	102.94
2011	69.65	8.39	10.07	1.18	11.27	2.94	8.33	111.83
2012	75.46	9.09	10.57	1.23	12.36	3.22	9.14	121.08

2013	81.71	9.84	11.08	1.29	13.55	3.54	10.01	131.02
2014	88.40	10.64	11.61	1.35	14.83	3.88	10.97	141.68
2015	95.59	11.51	12.15	1.42	16.24	4.24	12.01	153.15
2016	103.30	12.44	12.71	1.48	17.77	4.63	13.14	165.48
2017	111.33	13.41	13.28	1.55	19.35	5.05	14.31	178.28
2018	119.94	14.44	13.86	1.62	21.08	5.50	15.59	192.01

VOC Savings in million Tk: RMC2

Year	VOC Savings in million Tk: RMC2							
	Med / Heavy Truck	Small Truck	Large Bus	Mini Bus	Micro Bus	Utility	Car	Total
2007	40.48	2.34	4.66	0.66	2.47	2.51	2.63	55.74
2008	44.20	2.55	4.92	0.70	2.73	2.78	2.91	60.79
2009	48.17	2.78	5.19	0.74	3.02	3.07	3.22	66.18
2010	52.43	3.03	5.46	0.77	3.33	3.39	3.55	71.97
2011	57.00	3.29	5.74	0.82	3.67	3.73	3.92	78.17
2012	61.76	3.57	6.02	0.86	4.03	4.09	4.29	84.62
2013	66.87	3.86	6.32	0.90	4.41	4.49	4.71	91.55
2014	72.35	4.18	6.61	0.94	4.83	4.91	5.16	98.98
2015	78.23	4.52	6.92	0.98	5.29	5.38	5.64	106.97
2016	84.54	4.88	7.25	1.03	5.79	5.89	6.17	115.55
2017	91.11	5.26	7.57	1.08	6.31	6.41	6.73	124.46
2018	98.15	5.67	7.90	1.12	6.87	6.98	7.32	134.02