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GDP Impact & Economic Analysis of Dhaka Chittagong Expressway: The Case of Bangladesh

Shamema Akter*

Abstract

*This analysis has been undertaken to assess the economic viability of the project. Dhaka Chittagong National Highway (NH1) is considered to be the most important National Highway and lifeline of trade in Bangladesh and carries port traffic to Dhaka and others location in the country. Dhaka Chittagong Expressway (DCE) is a 199.3 km long 4 lane new expressway, connecting Dhaka with Comilla, Feni and Chittagong districts of Bangladesh. The traffic forecast emanating from the model results were then used in the economic analysis**. The economic analysis compares the costs and benefits of investing in the at-grade and elevated option, as compared with the 'without project' case where National Highway1 (NH1) remains the only road on the Dhaka–Chittagong corridor. All costs and benefits are expressed in economic terms, the actual resource costs to the Bangladesh economy.*

The economic analysis of the expressway project based on traffic projection and cost estimates of the routes has carried out. Dhaka Chittagong Expressway is the sole viable alternative from the economic point of view. Its EIRR is 20.3%, and NPV @ 12% is USD 2,243.4 million, largely driven by VOC saving as well as benefit and cost ratio is 2.26 (benefit: cost ratios>1). It was found that DCE is a robust project, as only very substantial cost increases (126%) or traffic reductions (56%) would affect the overall viability of the project.

Also, the objective of the study is to explore the relationship between the DCE and GDP. For this purpose, time series data from the World Bank (WB) and DCE project data are used for analyzing bivariate linear regression using SPSS. Thus, I have economic researched of DCE Project and from my research emphasizes that Bangladesh GDP growth will be increase for this project and this amount by 0.60% i.e. GDP would be 8.75% pa with the Project over the 30 years of the Expressway of Dhaka Chittagong Corridor.

* Senior Economist of BCL Associate Limited and life member of BEA, Bangladesh
shamema008@yahoo.com, shamema.mphilecon@gmail.com

** The engineering team (PPP DCE) provided input into the traffic modelling, which was reported separately.

This paper focuses to find out what will be impact of DCE on Bangladesh's economy specially on economic growth, and how Bangladesh will be benefited from this project, besides what steps Bangladesh government should be take it meaningful. It gives the more economic benefit with potential for intellectual transportation System and also gives the positive impact it will have on their economic growth.

Also, the expressway can be connected Chittagong and Cox's Bazar with Kolkata, Myanmar and China in the future and may create an economic corridor among Bangladesh-China-India-Myanmar (BCIM) countries and there is enormous economic potential of Chittagong District with an exclusive advantage of ports, roads and railways. Yet, Bangladesh is part of the proposed BCIM corridor. And, BCIM corridor is included with Belt and Road Initiative (BRI). Besides, Bangladesh has the geographical boost to connect itself to neighboring countries including China, the Association of Southeast Asian Nations (ASEAN), central Asia and west Asia and beyond using multimodal connectivity through road-rail-air and shipping. This DCE project is absolutely relative with the BCIM economic corridor. In addition, Dhaka-Chittagong Highway, which is part of the Asian Highway (AH) network, by widening it to four lanes and building the Dhaka-Chittagong Expressway.

The potential of the project area for economic growth will be increased and poverty reduction in the Bangladesh. No adverse socioeconomic effects on employment and income trends.

First time I have made a presentation of this paper on 49th ETC-2021 of AET. Now I am specifically requesting for publication in the journal.

Key words: GDP growth · EIRR · NPV · B : C ratio · VOC · DCE

Short abstract

This paper describes, 'there were five options were study under this project but option1 Dhaka Chittagong Expressway (at grade and elevated) has a positive impact on GDP of country and is being the sole viable alternative from the economic point of view. The construction of the 4-Lane expressway from Dhaka to Chittagong will bring in direct economic and social benefits to the people in districts of Dhaka and Chittagong Divisions and indirect benefits to other parts of the country as well. Therefore, this project has an appropriate road transport policy should be hold to boost transportation infrastructure and hence sustainable economic growth in Bangladesh.

1.1 Introduction

The People's Republic of Bangladesh lies in the north eastern part of south Asia and is bounded by India on the north and west, Myanmar on the south east and the Bay of Bengal on the south. The country cover 147,630 km^2 and consists mostly of low, flat and fertile land. There are hilly regions in the north east and south east and some areas of high lands in the north western part. A network of rivers, and

especially the Padma, the Jamuna, the Teesta, the Brahmaputra, the Surma, the Meghna and the Karnaphuli is important for navigation, drainage, water supply and as a source of sand for construction.

This is the most important national corridor ushering in high traffic demand. And, this report contains the economic evaluation of the proposed project. three alignments (and 5 options) were studied on the Project, and, alignment1 (option1, at grade + elevated) was recommended by the consultants and the same has been approved by the Government of Bangladesh. The expressway has considered to be 4 lanes throughout, and tolled with a closed toll system that charges traffic according to the length of the journey along the expressway. This requires toll plazas at all entry and exit points of the expressway. The Dhaka–Chittagong is the busiest road corridor in the country. The expressway links the country's two largest cities, Dhaka and Chittagong.

More than 166 million people were estimated to live in Bangladesh in 2019, making it one of the most densely populated countries of the world, with 1,272 persons per km^2. Men account for 50.4% of the population and women 49.6%. In 2019 the annual population growth rate was 1.1%. According to the UN (2019) its Human Development Index (HDI) score was 0.614. While poverty reduction in both urban and rural areas has been significant, 24.3% of the population live below the national poverty line of USD 2 per day. This proportion is higher in the rural areas where it is 35.2% compared to 21.3% for the urban population. Bangladesh's GDP has been estimated at USD 302.6 billion. According to BBS, GDP growth rate is expected to reach 8.15% in FY 2018/19 which was 7.86% in FY 2017/18. The economy has grown at an annual average of about 6.6% over the last two decades and the country reached World Bank lower-middle income status in 2015. The per capita national income touched USD 1,909 in FY 2018/19, up by USD 158 from a year earlier. The macroeconomic environment has remained stable with the continuance of fiscal prudence. The rate of inflation slightly increased to 5.47% in FY 2018/19 at national level.

This project crosses through Dhaka, Comilla, Feni, and Chittagong Districts of Bangladesh. These Districts are located in central eastern part of the country. The expressway between the two key centres of Dhaka and Chittagong will support the economic development of this area and also of the country. Dhaka and Chittagong are also linked by air, inland waterways, and railway; however, road and railway links handle the bulk of passenger and high-value cargo traffic in this corridor. Both of these modes of transport are facing serious capacity bottlenecks. There is a need for additional road capacity on this corridor. The Government is also concentrating their efforts on increasing the capacity of the road link. In order to address part of this effort, the Government of Bangladesh has received a loan (Loan 2856 BAN) from Asian Development Bank (ADB) for the Dhaka-Chittagong Expressway PPP Design Project for the preparation of the Feasibility Studies and Detailed Designs for a new access controlled Expressway between Dhaka and Chittagong.

1.2 Background

As the capital and commercial centre of Bangladesh, Dhaka must have good communication links with the principal sea port of Chittagong, which handles approximately 90% of the country's imported and exported goods. The two cities, the largest and second largest in Bangladesh, are approximately 250 km apart, and about one quarter of the nation's population lives in this area.

Dhaka to Chittagong Highway, which is part of the Asian Highway network, by widening it to four lanes and building the Dhaka-Chittagong Expressway. Road traffic between Dhaka and Chittagong is hampered by the lack of capacity of the existing 250 km highway and load restrictions on bridges. In general, a fully loaded container cannot be quickly transported by road to Dhaka. Road safety on the two lane highway is poor because it is overcrowded with different types of vehicles, including rickshaws, bicycles, motorcycles, cars, buses, and trucks. Also, it is demonstrated that uninterrupted faster traffic flow, safety and can appropriate more trips than 4 lane existing road. It is the major Economic corridor of Bangladesh and around 92% of all of country import and export by NH1(existing road) and average speed of NH1 is 35km/hr. On NH1 traffic congestion has hotspot and in 2018, there was 7,221 people killed and 15,466 others injured in 5,514 road crashes across the country.

Indeed, this economic analysis presents an economic of the benefit to the country of this Corridor. Dhaka-Chittagong Corridor to provide substantial economic and social benefits to south eastern region of Bangladesh. For this reason, this expressway should be given priority in a large extent.

1.2.1 Outline of Project Influence Area

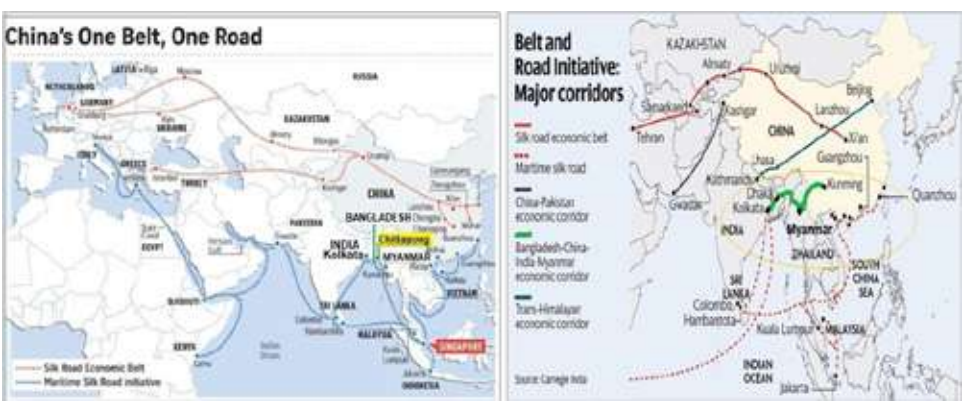
This Project is an important expressway for the connection to the north eastern part of the country to Dhaka and beyond. More than 85 million people of Dhaka, and Chittagong divisions comprising 28 Districts are connected to Dhaka through various corridors and the proposed DCE Project has a significant bearing from both improved connectivity and socio-economic point of view for a large number of people. The implementation of "the expressway (DCE)" of the Project will reduce travel times by improving the connectivity between the northern and southern regions.

The Project-influenced areas illustrate important road transport connectivity for the passenger, cargo traffics of the Bangladesh Roads and Highways. Chittagong port is the main foreign trade entry and exit point for the country, and is likely to stay that way. Mongla is important for vehicle imports and may have a growing role for Nepalese and Bhutanese traffic in the future, but this will not significantly affect growth at Chittagong port. There is a proposal for a new deep sea port at Matarbari, south of Chittagong. But such a port will also require use of the highway or expressway between Chittagong and Dhaka.

➢ Regional Road Connectivity Bangladesh Perspective

The present trade flows along the corridor, as found in the traffic surveys (DCE Traffic survey separate report) are thus likely to continue. These could be augmented in the future if proposals to open up Bangladesh as a transit route between the Indian states of Tripura and West Bengal are proceeded with. Such a corridor could gain further importance if Bangladesh and India support the 'BCIM' concept, initiated by China. BCIM (Bangladesh-India-China-Myanmar) would primarily be a land-based economic corridor from Kunming to Calcutta, passing through Bangladesh. Such ideas are conjectural at present, but they could potentially have a significant influence on trade flows and land transport. The road transport corridor is also important for establishing an improved transport link to Bangladesh-India-China-Myanmar (BCIM), thereby facilitating trade from Nepal, Bhutan and north eastern India to and through Bangladesh. The corridor plans are expected to further accelerate the associated economic growth in the region. Along the corridor, the land use pattern is largely dominated by industries including the largest export processing zone (EPZ) of Chittagong in Bangladesh, which demands improved transport facilities. Since the Chittagong Port is a major origin or destination of a large share of the freight traffic generated from the Dhaka EPZ and its adjoining areas, this Project will contribute to growth of the economic transport corridors. The implementation of the Project will improve journeys between Dhaka and Chittagong, and will also boost the economy because of efficient transportation of goods among the neighbouring countries.

Figure 1: Map -BCIM-Economic Corridor (that BRI)



Source: http://today.thefinancialexpress.com.bd/anniversary-issue-3/bcim-in-the-shadow-of-belt-and-road initiative

The expressway is essential for seamless movement of passenger and cargo transports within Bangladesh and for establishing regional connectivity with neighbouring countries under the southern corridor of the South Asian Association

for Regional Cooperation (SAARC), Bangladesh, China, India, Myanmar (BCIM) Forum for Regional Cooperation (BCIM) and Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC). The expressway is also an important aspect of the Bangladesh Roads and Highways Department Master Plan. Consideration to be made for projects that support regional and sub regional connectivity initiatives such as SAARC, BCIM corridors with BRI and BIMSTEC. The impact of BIMSTEC, BCIM Economic Corridor has many positive aspects. It will escalate regional trade through the developments of transit and transport facilities among boarders and World Bank Logistics performance index will also be improved.

South Asia is the least integrated region and the cost of trading across borders is one of the highest in the world. Co-operation with its neighboring countries offers benefits to Bangladeshi owned road, rail and water transport services and port services. There will be improved domestic and sub regional trade flow and passenger movement in Bangladesh. The consequence will be an improved road transport system in Bangladesh. For this reason, this Project will enable efficient and safe transport within the country in the Dhaka-Chittagong corridor and with India and, through India, with Bhutan and Nepal.

1.2.2 Need for the project

- **Benefit of the Project**

The construction of the 4 Lane expressway from Dhaka to Chittagong will bring in direct economic and social benefits to the people in districts of Dhaka and Chittagong Divisions and indirect benefits to other parts of the country as well. More than 37.1 million people of Dhaka, Feni Comilla and Chittagong Districts are comprising two Divisions are direct connecting from Dhaka to Chittagong via Comilla and the proposed this Project has a significant bearing from both improved connectivity and socio-economic point of view for a large number of people. The 4 Lane expressway will deliver better connectivity to the capital city of Dhaka and port city of Chittagong facilitating speedy and timely transportation of export and import of goods and services. In addition, cumulative advantageous impact of the project will result developed tourism, industries, employment as well as better economic integration of other cities within the country along with major economic & trade centers of the country.

- **Project Performance Indicators and Performance Targets**

The performance indicators should be geared to the objectives. The objectives of constructing a PPP expressway between Dhaka and Chittagong are not defined in the project Terms of Reference, but can reasonably be regarded as:

1 providing a faster and safer route between Dhaka and its main port that meets the traffic need at the lowest overall net public cost (by obtaining toll contributions from users)

2 to provide benefits to the road users that exceed the toll that they are required to pay (if this does not happen, they will not use it)

3 ensure the sustainability of the investment by making the investor responsible for its construction and life-cycle maintenance

4 providing relief from congestion, pollution and accidents to the inhabitants and remaining road users on NH1.

These may be regarded as the key objectives. Of course, secondary benefits follow from these, such as social benefits, better export competitiveness, lower consumer prices, etc. But these secondary gains will be harder to measure, and if objectives 1–4 above are achieved, the secondary benefits will follow. Thus, it is proposed that the monitoring is concentrated on these four aspects. **Table1** on the next page shows the key proposed indicators and some potential targets.

Table 1: Proposed Performance Indicators and Targets

Objective	Indicators	Targets
1. Reduced journey times and better safety between Dhaka and Chittagong, with good value for money	Use made of expressway (per cent of combined NH and expressway traffic that is using expressway between each interchange) Journey times and average speeds, by each vehicle class, between Dhaka (Kanchpur) and Chittagong (on NH and on expressway) Accidents per 100 million vehicle-km on NH and expressway, and overall Toll revenue Leakage (number of vehicles not paying toll, or toll revenue not accounted for) Average delay time at toll plazas Maximum delay time at toll plazas	To be taken from traffic model output To be taken from traffic model output 25 for NH and 13 for expressway assumed in HDM analysis. These should be verified and then target should be a progressive reduction of each As in PPP agreement Less than 0.5% Not more than one minute (20 seconds to slow down and start, 10 seconds per transaction, 30 seconds queuing) Not more than 5.5 minutes (maximum queue time in annual peaks to be 5 minutes)
2. Benefits to users that exceed the toll paid	Toll levels Value of time savings Value of vehicle operating cost savings (calculated from road roughness and HDM equations) Customer satisfaction with expressway experience	As in PPP agreement As assumed in traffic model Expressway IRI average of 2, and expressway market share at least as indicated in traffic model 99.5%

Objective	Indicators	Targets
3.Sustainability	Asset management (road roughness, lane availability, condition of structures, condition of assets at handover after end of concession period)	Expressway IRI 2 Lane availability each year average 98%, not less than 95% (allowing for 10-year periodic maintenance cycle) Other conditions to be set out in PPP agreement
4. Better conditions on NH1	Air quality and noise levels in populated areas along NH1 Pedestrian safety on NH1 (reduction in pedestrian casualties)	No specific targets for NH1 (beyond scope of project), but these trends should be monitored so that project benefit is understood

1.2.3 Distribution Analysis

This section considers the distribution of the costs and benefits among the different members of society. Being a new road project, the main beneficiary is the road user. The main road users who will benefit from the project are the travellers, cargo owners and transport companies that presently use NH1 between Dhaka and Chittagong. The main benefit will be time savings, as the HDM4 analysis shows that the vehicle operating costs (VOC) savings are not significant. This will be because vehicles consume more fuel at higher speeds. The time savings are substantial, however, and apply both to the users of the expressway, and to the remaining users on NH1, who suffer less traffic congestion. For the export products, such as ready-made garments, the time savings are also very significant. They will help the export industries retain and expand their markets, and thus help sustain and increase employment levels and net incomes in Dhaka.

The Project costs will be shared between the road users of the expressway (the tolls), the Government (in the support to the PPP) and the private investors (the equity). Ultimately the private investors will get their money back and it is the expressway users and the Government who fund the project. The expressway users will have a benefit (or they would not use it), while remaining NH1 users will have a benefit without having to contribute directly to the investment.

The Government contributions are either direct or by loan repayment and they are thus paid for by the general taxpayer - with a resulting redistribution of wealth from society as a whole to the beneficiaries. The expectation is of course that there is a resulting gain in economic activity, GDP and tax revenue in the future.

The contractors and labourers employed under the Project will also be beneficiaries and their skills should be enhanced as a result of the intended works.

Overall, the distribution of the benefits will be widespread throughout the region and society and proves to be justified when compared with the costs.

1.3 Objective of The Economic Assessment

The main purpose of economic analysis of the approved 4-Lane Dhaka- Chittagong Expressway (DCE) at grade and elevated is to present the economic wellbeing viewpoint and to estimate the economic benefits and EIRR of the resources invested to the proposed Expressway which would be reduced journey times, VOC and better safety between Dhaka and Chittagong.

Objective of this assessment was to perform economic analysis with economic parameters i.e. EIRR, ENPV, B/C (under reasonable postulates). The current and future development of trade, other future changes in the road transport network, regional and international connectivity of Bangladesh. Also, the benefits of the DCE for include enhanced transportation safety, positive environmental impacts, time savings, lower transport costs, poverty reduction, an increased standard of living and enhancement of trade and commercial activities and there is optimistic impact on Bangladesh GDP.

Figure 2: Project Area (map source: DCE Project)

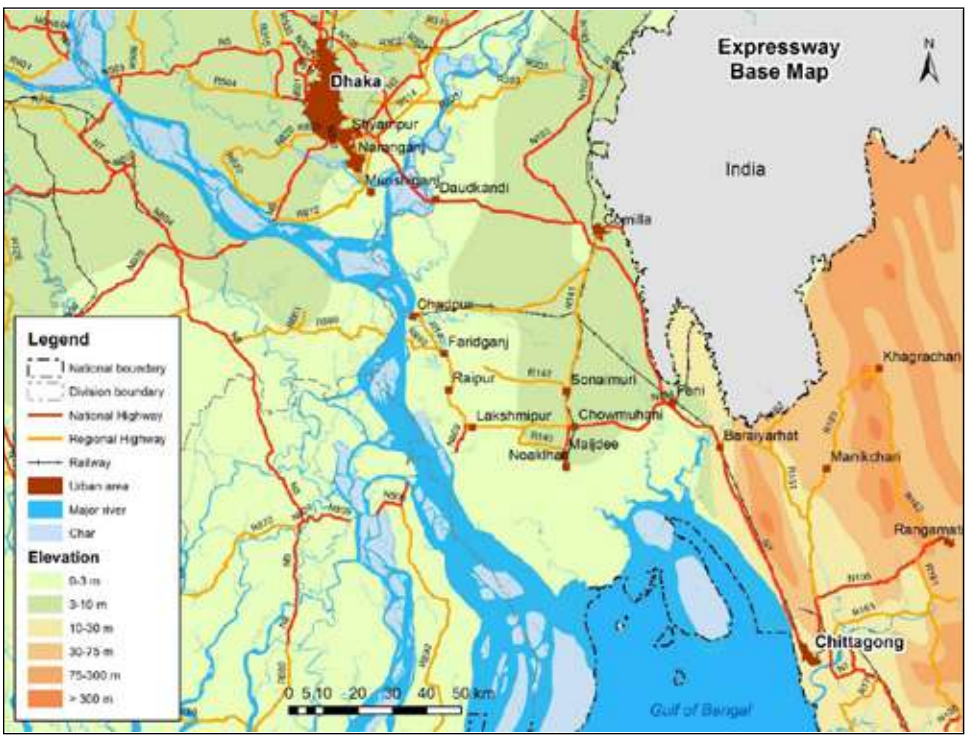
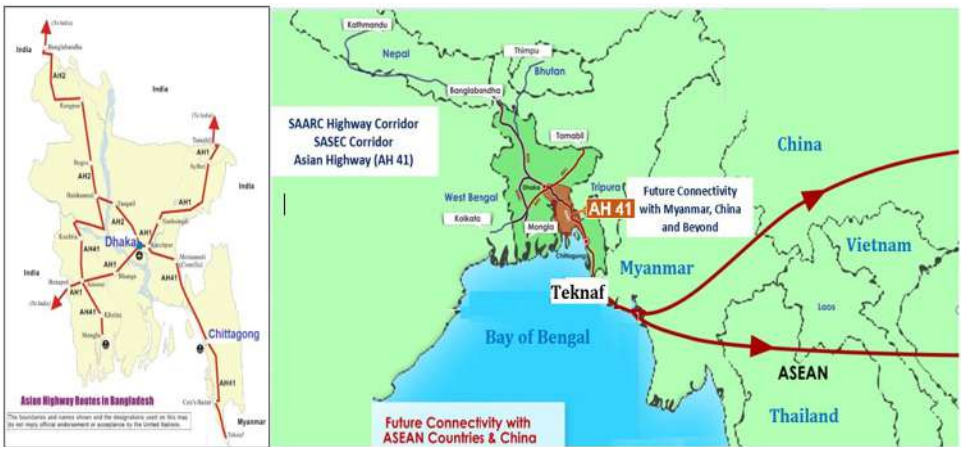


Figure 3: Asian Highway Routes in Bangladesh



1.4 Literature Review

RTHD (January 2016) study has conducted on Regional Road Connectivity: Bangladesh Perspective. From this report, Bangladesh has agreement to the Asian Highway Network on 8 November 2009 to connect the country with 28 countries. And in Bangladesh, there are three Asian Highway (AH) Routes namely AH1, AH2 and AH41. And AH41 routes could be connected with DCE. Of these three routes, AH41 remains within Bangladesh, but could be extended to neighboring countries. Total length of the AH routes in Bangladesh is 1771 kilometer. In this background, one of the options for BCIM corridor could be part of AH41 within Bangladesh. (see Figure 3). Kolkata (India) – Jessore (Bangladesh)–Dhaka (Bangladesh)-Chittagong (Bangladesh)-Cox'sBazar (Bangladesh) - Ghundum (Bangladesh) - Taungbro (Myanmar)- Bawlibazaar (Myanmar)- Kyauktaw (Myanmar). Likewise, in Bangladesh side, the condition of this route which is generally part of AH41 is well. In addition, the finance from ADB, the feasibility study and detailed design for upgrading Chittagong-Cox'sBazar-Ukhia-Balukhali-Ghundum expanse has been done. AH41 Route (Bangladesh): Mongla Port – Jessore –Bonpara – Hatikamrul-Katchpur-Comilla-Chittagong- Cox's Bazar-Teknaf -Myanmar Border. Total Length is 762 km (excluding common part of 162 km of AH2). Whatever, the investment will be needed to upgrade the route to AH Standard. Although, a number of projects has under prosses for upgrade and some projects have been upgrading almost completed with ADB finance. Also, some projects for feasibility study and detailed design for upgrading in this section have been completed.

RHD analyses and the study describes on 2nd 4-Laning of Dhaka-Chittagong National Highway (March 2010), the existing Dhaka-Chittagong National Highway (NH) was a 2-lane single carriageway except from the Mukti Sarani (Dhaka end) to Daudkandi section which has upgraded to a 4-lane carriageway. Considering

the importance of this road, the Government of Bangladesh (GoB) had decided to upgrade this highway from 2 lane to 4-lane carriageway to cater for the current traffic demand, capable of transporting heavy container traffic from the port of Chittagong to the capital city of Dhaka. This corridor is most important economic corridor of Bangladesh and within 21st century accompanying in high traffic demand. In general, a fully loaded container cannot be quickly transported by road to Dhaka. Road safety on the 2 lane highway was poor because it was overcrowded with different types of vehicles, including rickshaws, bicycles, motorcycles, cars, buses, and trucks. Therefore, according to the RHD's traffic count, the average motorized traffic volumes are around 27,000 of which 43% are trucks. This is consistent with the findings of the 2009 traffic study. But, after construction of 2nd Dhaka-Chittagong National Highway, it has been shown that it is not fulfil the transport needs between these two important cities of the country. Because poor road safety issue and frequently traffic congestions with different types of vehicles movements.

BBA Project Completion Report (April 2013), Feasibility Study for multi lane road tunnel under the Karnaphuli river, Chittagong, Bangladesh, the Karnaphuli river divides Chittagong city into two parts. One part is confined with the city and the port, the other part is the area of heavy industry. The current two bridges are not sufficient to accommodate the existing and increasing huge traffic flow. Due to river morphology, siltation on the bed of the Karnaphuli river is a big problem and the major threat for proper functioning of the Chittagong Port. To face the problem on siltation, Bangladesh government intends to construct a tunnel crossing the Karnaphuli river instead of another bridge over the same river. The focus of the KTP project is to carry out detailed economic and engineering investigation to examine the economic viability and technical feasibility for construction of tunnel under the Karnaphuli river. There were 3 alignment options (A, B and C) for detailed study in this feasibility stage and based on the traffic survey, analysis and forecast, demonstrated by expressway service level analysis, dual two lanes expressway standard with design speed of v=80km/h was recommended for Alignment C (Patenga-KAFCO crossing) with considerations of road network plan, traffic volume forecast, overall transportation system, and long term development of the project area. The Karnaphuli tunnel (KTP) is an under construction underwater expressway tunnel in the port city of Chittagong, under the Karnaphuli river. And, the tunnel length is 9.3 km (about 3.4km of which would be under the river) and width 10 metres. It is expected to complete the construction work by 2022 that would ease communication and boost trade and businesses along with industrialization of this area. And after accomplished construction of the tunnel project, it will be connect Chittagong City with planned development areas to the east of the Karnaphuli river and the existing port, airport reduced congestion in the Chittagong and on existing bridges, shorter journey times and travel time savings, direct connectivity with the new Deep Sea Port to be developed in Matarbari and catering to the additional traffic. The tunnel will connect Dhaka Chittagong expressway, Chittagong port

and Anwara upazila and is expected to make communication between Chittagong and Cox's Bazar easier. It will also ease traffic congestion on two bridges over the Karnaphuli river.

The Chittagong city is connected with Dhaka through Dhaka truck road in the north direction and in the south direction, it is connected with the proposed Asian Highway (AH41) through Cox's Bazar road, and will reach Myanmar through the Asian Highway (AH41). Furthermore, KTP, Chittagong City Outer Ring Road, Dhaka Chittagong Expressway (DCE) are also part of the Asian Highway Route (AH41, **Figure 3**) in Bangladesh. The transport corridor is important for establishing an improved transport link on the Trans-Asia highway, thereby facilitating trade from Nepal, Bhutan and northeastern India to and through Bangladesh. The corridor plans are expected to further accelerate the associated economic growth in the region. Along with the corridor, the land use pattern is largely dominated by industry including the largest export processing zone (EPZ) of Bangladesh, which demands improved transport facilities. Since the Chittagong port is a major origin or destination of a large share of the freight traffic generated from the Dhaka EPZ and its adjoining areas, the DCE and its future connections to the Chittagong City Outer Ring Road (CCORR) will contribute to the economic transport corridors. Major road works are presently taking place in Dhaka - Chittagong and are interrupting the normal traffic and creating congestion on NH1. In this regard, the DCE along with other ongoing road projects are expected to be a great reliever in providing diversion to the affected road users.

SMEC (April 2012) study reveal, according to the project report, the 14.7 KM Chittagong City Outer Ring Road (CCORR) comprising additional 5 km long two feeder roads and three approach roads will perform as a strong coastal embankment cum 4 lane highway stretching from Patenga Sea Beach to Sagorika Junction and considered to be the future main gateway to the port city. The arterial road connecting the city center with the port, airport, and EPZ was not well developed, which has resulted in chronic traffic congestion. Thus, it is required to improve the transportation network through the construction of a ring road. this road is under constructing.The main aim of constructing the this outer ring road is to save the people of coastal areas of Chittagong as well as resolve the alarming traffic congestions in the city and to mitigate damages caused by the natural disasters, such as cyclones and high flood tides etc., thereby contributing to the promotion of the city and country's economic development. it would be used as gateway the Karnaphuli Tunnel which would help to facilitate movement of vehicle from south Chittagong, Teknaf, Bandarban to enter in the Dhaka Chittagong expressway. As the connectivity of proposed Dhaka Chittagong expressway and communication through the Karnaphuli tunnel and ring road will be the most modern which would speed up the economic activity. A new city will be developed in the southern part of Chittagong.

1.5 Traffic Assessment and Forecast

For each road section, the traffic model was interrogated to ascertain the forecast traffic at the selected toll rate. Full details of the traffic on each section, for each future year in the analysis period (up to 2051) were entered into HDM4. HDM applies the annual traffic growth forecasts to these 2022 traffic flows. **Table 2** (reproduced from the traffic volume) shows the growth rates that were used.

The traffic model identified the remaining traffic on NH1, which differs for project alignment. Options1(at grade and elevated) give greatest relief to NH1 as they serve the important midway centre of Comilla. The difference between the traffic on NH1 when there is no project, and that remaining on NH1 when the alternative option-1 is considered, is the traffic diverted to the expressway.

The traffic model did not predict any generated traffic. This is considered a reasonable result since the expressway will be tolled. Payment of a toll will reduce the consumer surplus that the road users gain by the project, and thus reduce any propensity to make extra trips.

Table 2: Annual Traffic Growth Rates

Period	Passenger	Freight
2014–2020	3.0%	6.1%
20202030	5.99%	4.5%
From 2030	5.32%	4.0%

Source: DCE Traffic Survey and Analysis Report, March 2016

Table 3: Diverted traffic from NH1(existing road) to XW (expressway)

LINK TRAFFIC FLOWS			Vehicles/PCU			LV			Bus		GV				
			0.82	0.42	0.92	39%	10%	51%	25%	75%	13%	76%	11%		
			Alternative XW1: Alignment 1(with project)												
			PCU			Vehicles									
Link	Km	Code	LV	Bus	GV	PC	LDV	Micro8	SB	LB	LGV	MGV	HGV	AADT	Year
SECTION 1		XWDKC	6,986	6,914	22,569	2,869	1,105	3,307	1,729	5,186	2,954	17,152	2,488	36888	2014
Kanchpur - Daudkandi	53.8					2,995	1,204	3,587	1,884	5,652	3,911	20,421	2,954	43920	2017
						3,707	1,521	4,278	2,380	7,139	4,980	26,228	3,796	53530	2022
			Initial composition(%)			6.9%	2.8%	8.0%	4.4%	13.3%	8.4%	49.0%	7.1%	100.0%	2022
Daudkandi - Comilla	47.3		7,280	6,322	23,147	2,839	1,165	3,276	1,581	4,742	3,009	17,591	2,546	36749	2014
						3,095	1,270	3,571	1,723	5,169	3,581	20,834	3,030	42371	2017
						3,909	1,604	4,510	2,176	6,528	4,601	26,900	3,893	54121	2022
			Initial composition(%)			7.2%	3.0%	8.3%	4.0%	12.1%	8.5%	49.7%	7.2%	100.0%	2022
SECTION 2	55.9	XWDCF	5,183	5,844	22,334	2,021	829	2,332	1,461	4,383	2,902	16,966	2,456	33351	2014
Comilla - Feni						2,203	904	2,542	1,593	4,778	3,454	20,190	2,922	38585	2017
						2,783	1,142	3,211	2,011	6,034	4,438	25,944	3,755	49318	2022
			Initial composition(%)			5.6%	2.3%	6.5%	4.1%	12.2%	9.0%	52.6%	7.6%	100.0%	2022
SECTION 3	66.3	XWDFC	4,754	5,674	18,423	1,864	761	2,129	1,418	4,255	2,895	16,002	2,027	29851	2014
Feni - Chittagong						2,021	829	2,332	1,546	4,638	3,450	16,662	2,412	33280	2017
						2,552	1,047	2,945	1,953	5,858	3,962	21,411	3,099	42827	2022
			Initial composition(%)			6.0%	2.5%	6.9%	4.6%	13.8%	9.4%	50.3%	7.3%	100.0%	2022
Total	199.3														

Table 4: AADT at sections along the Project Road Alignment

				Vehicles/PCU			LV			Bus		GV			
				0.82	0.42	0.40	39%	16%	45%	25%	75%	13%	76%	11%	
				Alernative 0 (without project): NH only											
				PCU			Vehicles								
Link		Km	Code	LV	Bus	GV	PC	LDV	Micro8	SM	LB	LGV	MGV	HGV	AADT	Year
Kanchpur - Madanpur	Section 1	3.1		11,046	25,376	53,091	4,620	1,895	5,331	6,344	19,032	6,902	40,349	5,840	90,313	
Madanpur - Daudkandi		28.8		7,623	10,803	46,007	2,973	1,220	3,430	2,701	8,102	5,881	34,966	5,061	64,433	
Kanchpur - Daudkandi		31.9	NH0KD	8,033	12,219	46,696	3,133	1,285	3,615	3,055	9,164	6,070	35,489	5,137	66,948	2014
							3,415	1,401	3,940	3,330	9,989	7,224	42,232	6,112	77,643	2017
							4,313	1,769	4,977	4,205	12,616	9,293	54,268	7,855	99,286	2022
				initial composition(%)			4.3%	1.8%	5.0%	4.2%	12.7%	9.3%	54.7%	7.9%	100.0%	
Daudkandi - Bhairi	Section 2	25.7		6,026	3,202	45,846	3,130	1,204	3,612	2,301	6,902	5,860	34,043	5,043	63,074	
Bhairi - Mainamoti		21.2		7,227	8,666	46,364	2,819	1,156	3,252	2,166	6,499	6,027	35,236	5,100	62,256	
Mainamoti - Comilla		10.6		8,338	9,453	49,754	3,252	1,334	3,752	2,583	7,089	6,468	37,813	5,473	67,545	
Daudkandi - Comilla		57.5	NH0DC	7,789	9,050	46,758	3,038	1,246	3,505	2,263	6,788	6,078	35,536	5,143	63,596	2014
							3,311	1,358	3,820	2,466	7,399	7,233	42,287	6,121	73,996	2017
							4,102	1,716	4,825	3,115	9,344	9,295	54,339	7,865	94,681	2022
				initial composition(%)			4.4%	1.8%	5.1%	3.3%	9.9%	9.8%	57.4%	8.3%	100%	
Comilla - Chauddagram	Section 3	30.9		6,407	8,395	46,617	2,493	1,025	2,883	2,099	6,296	6,060	35,429	5,128	61,419	
Chauddagram - Feni		27.7		4,239	8,029	48,979	1,653	678	1,908	2,007	6,022	6,307	35,704	5,168	59,247	
Feni - South Feni		12.4		5,082	9,517	47,769	1,982	813	2,287	2,379	7,138	6,270	36,305	5,255	62,369	
Comilla - South Feni		71.0	NH0CF	5,329	8,448	46,960	2,078	853	2,398	2,112	6,336	6,105	35,689	5,166	60,737	2014
							2,265	929	2,614	2,302	6,906	7,265	42,470	6,147	70,899	2017
							2,861	1,174	3,301	2,908	8,723	9,335	54,574	7,899	90,775	2022
				initial composition(%)			3.2%	1.3%	3.6%	3.2%	9.6%	10.3%	60.1%	8.7%	100.0%	
South Feni - Barayarhat	Section 4	8.9		5,082	9,517	47,769	1,982	813	2,287	2,379	7,138	6,270	36,305	5,255	62,369	
Barayarhat - Mirzhurai		12.1		4,584	7,873	45,867	1,788	733	2,063	1,968	5,905	5,963	34,859	5,045	58,324	
Mirzhurai - Sitakunda		21.0		4,144	7,960	46,741	1,616	663	1,865	1,990	5,970	6,076	35,523	5,142	58,845	
Sitakunda - Chittagong		30.6		7,686	11,233	47,868	2,998	1,230	3,459	2,808	8,425	6,225	36,395	5,268	66,807	
South Feni - Chittagong		72.6	NH0FC	5,824	9,515	47,204	2,271	932	2,621	2,379	7,136	6,137	35,875	5,192	62,543	2014
							2,476	1,016	2,857	2,593	7,778	7,303	42,692	6,179	72,893	2017
							3,127	1,283	3,608	3,275	9,824	9,384	54,859	7,940	93,299	2022
				initial composition(%)			3.4%	1.4%	3.9%	3.5%	10.5%	10.1%	58.8%	8.5%	100%	
Total		233.0														

Note: here, the vehicle types adopted for the analysis of vehicle operating costs are such as PC= Passenger car, LDV= Light delivery vehicle (includes pickups and utility vehicles), MB= Microbus SB= Small bus, LB= Large bus, LGV= Light goods vehicle, MGV= Medium goods vehicle, HGV= Heavy goods vehicle. *Data source: DEC project traffic survey Oct./Nov. 2014 and calculation by Author*

1.6 Road Networks Characteristics of Section

NH1 and the proposed expressway alignment1 (option-1) have been divided into three Section, and the traffic forecast for each section is taken from the output of the traffic model. There are three Sections as follows:

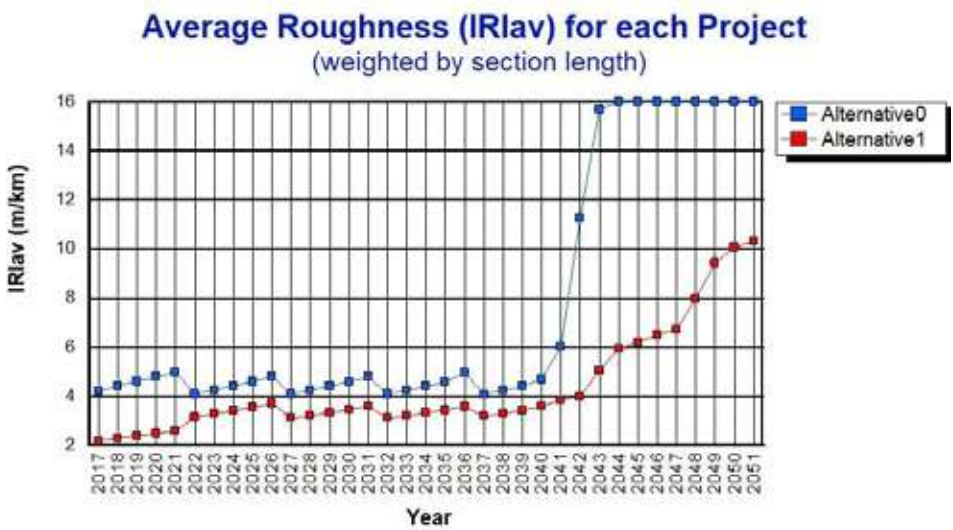
Section 1 Kanchpur (Dhaka) – Comilla = 78.1 km
Section 2 Comilla – Feni = 55.9 km
Section 3 Feni – Chittagong =65.3 km

The proposed expressway is divided into four hypothetical sections such as (i). For approved alignment1(at grade and elevated), the existing National Highway corridor from Dhaka to Chittagong Road link, HDM4 need specifics of road section and specifics of the vehicles fleet. Variables for each road sections are actual values. A number of parameters such as length of road section, carriageway width, shoulder width, effective number of lane, surface class, pavement type, traffic flow, speed flow type, traffic flow pattern, climate zone, road class, motorized (MT) and non-motorized(NMT) traffic, geometry, rise+fall, average horizontal curvature, speed limit, altitude, Drain type, Base thickness, surfacing thickness (mm), Resilient

Modulus thickness (Gpa), Relative compaction (%),Structural Number (SNP), Sub grade CBR (%).The roughness is the estimated IRI (international roughness index)(IRI- m/km), which expresses road roughness in terms of m/km. Total area of cracking, Ravelled area (%),Number of potholes (No/km), Edge break area (m2/km), Mean rut depth (mm), Texture depth (mm),surface texture ,superelevation (%).The value of parameters which has adopted for road.

This being a route choice study and not a detailed design (to which HDM can contribute), other more detailed aspects were left at the default values in the HDM program. These include such items as resilient modulus thickness, relative compaction, texture depth, surface texture, and other technical parameters. These default values are proposed by HDM in relation to the climatic conditions and other road attributes that are entered into the program, so they are appropriate for the study purposes. The initial roughness on the existing road alternative(A0) has been measured to average around 4 to 5m/km whereas the DCE (alternative A1) is expected to have an initial IRI of 2 m/km. (**see Figure 4**)

Figure 4: Roughness Development on Existing Road Section Alternatives and DCE



Source: by Author and HDM-4 Version 1.3

1.7 ECONOMIC ANALYSIS

1.7.1 Methodology

I have used the Highway Development and Management program, (HDM4, Version 1.3) for the project evaluation. This program, originally developed by the World Bank, takes into account the road standard and quality, and the effect of the traffic load and road maintenance on the road condition, for each future year of

the evaluation period (taken as 30 years), both for the national highway and for the approved expressway, in accordance with the traffic forecasts. The program automates many of the calculations needed for a realistic project appraisal and proper assessment of the option1.

1.7.2 Gather Data

The data has been obtained and research of the new Expressway by phasing in Dhaka-Chittagong corridor in assessment with the overall data of Bangladesh. The data inputs came from various sources. This economic analysis has been prepared based on site investigation (DCE Project), data collection from Bangladesh Roads and Highways Department (RHD), World Bank(WB), ADB, IMF, BBS, Chittagong Port (CPA), traffic and O-D surveys data (2015/16), from tunnel project under the Kurnapuly river, Chittagong outer ring road project and various sources for the economic analysis. This step was to gather the inputs required for the economic comparison. Information on capital costs, costs of operations, and time savings forms the core of the economic analysis. Also, I was collected data from engineering and traffic modelling teams of DCE Project. Data on the economy, population, vehicle operating costs(VOC), time values, and trends in all these values was compiled from desk research and provided to the traffic team for use in their model. The economic costs were provided, based on an analysis of the tax element of the project inputs (taxation accruing to Government not being a cost to the economy). This economic study report has been prepared based on site investigation, data collection, traffic and O-D surveys required as per terms of reference for the study for the alignment option selected.

The main steps in the economic evaluation have been as follows:

1. prepare basic economic parameters for the traffic forecasts, which are fed into the traffic model;
2. enter into HDM4 the relevant engineering information on standards and costs for each existing and proposed road section. This is done for NH1 and selected alignment of the expressway;
3. from the completed traffic model enter the existing and forecast traffic on each section;
4. enter details of the vehicle fleet and the costs of vehicles and major inputs such as fuel, tyres, maintenance and crew wages;
5. enter details of the value of time and the rate and cost of road accidents;
6. run the program and summarise and interpret the results, also running sensitivity tests and calculating switching values;
7. from the results, estimate the distribution of benefits and the poverty impact.

Each of these steps is explained in the following chapters.

Using the model, the total transport costs such as vehicle operating and time costs on the existing national highway and nominated alignment is compiled on a yearly basis for the proposed project operational period, i.e. 30 years starting from 2022, when it is assumed that the expressway will open to traffic. The benefit will be the reduced transport costs for each option when compared with the cost of the base case (Option 0) which is the 'without expressway' project situation. For this base case it is assumed that the four-lane of NH1 will be completed by 2020.

When the expressway is constrained a portion of the traffic will be diverted from NH1 to the new facility, giving faster speeds, time savings, reduced congestion and a better and safer travelling environment. The expressway is also designed to be stronger than NH1, to accommodate the heavy traffic loads expected.

The financial costs are converted to economic costs for the purpose of the evaluations. This is done by using 'shadow prices', which are the costs faced in the market place by the users adjusted to remove taxes or add subsidies. Taxes and subsidies are referred to as 'transfer payments' as they are not a cost or benefit to the national economy, they are simply transfers to or from the Government. Tax revenues are available to Governments for spending elsewhere in the economy.

Similarly, the toll revenues, which are fundamental for the financial analysis, are omitted in the economic analysis. They are paid from one part of the economy (the road users) to another (the toll road operator). It is from this flow of funds that the toll road operator meets his operating and maintenance costs – it is the latter costs that are part of the economic analysis, together with the road user costs, and in the economic analysis these costs are compared with the economic benefit, not with the financial revenue.

Economic indicators such as NPV and EIRR are calculated for approved alignment of option-1.

Many different variables have been collected from field survey data and secondary sources and can broadly be grouped as follows:

i. road network: existing (NH1) and expressway road sections (XW)
ii. vehicle fleet: vehicle operating costs (VOC) (economic costs) and vehicle specifications
iii. work standards: the routine and periodic maintenance and their economic costs
iv. the road configurations: speed-flow characteristics, traffic patterns, the climatic conditions, accident rates by road type
v. discount rates, traffic flows and growth rates, and travel time costs.

The new expressway will be constructed as well as the existing highway will be maintained. And when the expressway will be constrained then a portion of traffic will be diverted to new alternative route from existing highway for advantage of time saving, no congestion and faster speed, better and safe environment traveling,

reduce accident as well as emission. The expressway (XW) is stronger than existing highway (NH1) to take the load of heavier vehicles.

The economic review has been based on the economic costs for avoiding distortion, due to market imperfections in the input prices of several component of the project. It may be pertinent to carry out that that the investments in the elevated expressway also contribution a good consecutively surface to motorized traffic would main to an overall development in the transport system in the project region.

1.7.3 Cost components

The basic concept of the investment of the project roads is to minimize the total transport costs to the project road users by comparing the two scenarios i.e. 'With project' (new expressway) and 'without project' (existing National Highway). The total transport costs have two basic cost components as follows:

a) Capital, Operating and Maintenance (O & M) Costs: the cost of the intervention strategies being appraised including routine and periodic maintenance and the operational costs incurred by the expressway operator.
b) Road User Costs: vehicle operating costs and travel time costs, which are based on the future traffic levels and road conditions.

The economic construction and O&M costs were provided by the engineering team and are shown in **Table 5**. They have been compiled net of taxation, as the taxes are not an economic cost. Unlike in the financial assessment, the capital costs include the land acquisition and resettlement costs. The economic assessment has to consider all the costs (and benefits) to the economy, no matter who incurs (or receives) them. It does assume that the market price of the land and the resettlement is equivalent to the true economic value, which may not always be the case.

Table 5 also shows the calculation of the residual values of the investments estimated to apply at the end of the 30-year assumed 30-year project life. The concrete structures are assumed to have a 60-year life, so they retain their value. The embankment will still be in place, and the land acquisition and resettlement costs are assumed dot being sunk costs, as they need not be repeated. It is assumed that the expressway, after reconstruction, can continue to benefit from these assets during the following years.

1) Routine Maintenance

The routine maintenance activities included vegetation clearance, clearing of side ditches and culvert, bridge, and minor repair to the various elements of the cross section. A separate patching activity has been triggered based on the number of potholes /km.

2) Periodic Maintenance

To have the long term benefit s substantial capital investments in the project roads on one hand and the proper maintenance activities subsequent to the initial improvement on the another, the following periodic maintenance activities have.

Table 5: Summary of Cost Estimates for DCE Currency: US Dollar (million)

Project	(Dhaka - Comilla)	(Comilla - Feni)	(Feni - Chittagong)	(Dhaka-Chittagong)
At-Grade and elevated Section (A1)				
Economic cost	1,052	556	612	2,219
Length (km)	78.1	55.9	65.3	199.3
Economic cost/km	13.5	9.9	9.4	11.1
Earthworks	198	106	105	409
50% of structures	142	75	77	293
Resettlement and land acquisition	196	102	124	422
Residual value	536	283	305	1,123.8
Residual value as % of cost	50.9%	50.9%	49.9%	50.6%

calculation by the Author

Note:1. Foreign Exchange Rate is based on Bangladesh Bank/2017.Exchange Rate (USD 1 = BDT 78.5);
2. Data source: Costing data collection from our Engineering team of DCE Project-2017, Roads and Highway (2004/05), BBS, Bangladesh Bank, World Bank, ADB

Table 6: Annual Undiscounted Project Cash Flows of DCE (USD, million)

Year	Road Agency Costs (RAC)			Road User Costs (RUC)				Net Benefit
	Capital	**Recurrent**	**Total RAC**	MT Vehicle Operation	**MT Travel Time**	**Accidents**	**Total RUC**	
(1)	**(2)**	**(3)**	**(4)**	(5)	**(6)**	**(7)**	**(8)**	**(9)**
2017	421.7	0.0	**421.7**	0.0	0.0	0.0	**0.0**	**-421.7**
2018	288.5	0.0	**288.5**	0.0	0.0	0.0	**0.0**	**-288.5**
2019	532.6	0.0	**532.6**	0.0	0.0	0.0	**0.0**	**-532.6**
2020	621.4	0.0	**621.4**	0.0	0.0	0.0	**0.0**	**-621.4**
2021	355.1	0.0	**355.1**	0.0	0.0	0.0	**0.0**	**-355.1**
2022	0.0	0.5	**0.5**	428.9	79.7	1.0	**509.6**	**509.1**
2023	0.0	0.5	**0.5**	450.7	84.2	1.0	**535.8**	**535.3**
2024	0.0	0.5	**0.5**	473.3	88.8	1.1	**563.2**	**562.7**
2025	0.0	0.5	**0.5**	497.2	93.8	1.1	**592.1**	**591.5**
2026	40.7	0.5	**41.3**	522.4	99.0	1.2	**622.6**	**581.3**
2027	0.0	0.5	**0.5**	546.7	104.3	1.3	**652.2**	**651.7**
2028	0.0	0.5	**0.5**	574.1	110.0	1.3	**685.5**	**685.0**
2029	0.0	0.5	**0.5**	603.0	116.2	1.4	**720.6**	**720.1**

Year	Road Agency Costs (RAC)			Road User Costs (RUC)				Net Benefit
	Capital	**Recurrent**	**Total RAC**	MT Vehicle Operation	**MT Travel Time**	**Accidents**	**Total RUC**	
(1)	**(2)**	**(3)**	**(4)**	(5)	**(6)**	**(7)**	**(8)**	**(9)**
2030	0.0	0.5	**0.5**	630.2	121.9	1.4	**753.5**	**753.0**
2031	40.7	0.5	**41.3**	658.6	127.9	1.5	**788.0**	**746.7**
2032	0.0	0.5	**0.5**	686.2	134.1	1.6	**821.8**	**821.3**
2033	0.0	0.5	**0.5**	716.9	140.7	1.6	**859.3**	**858.8**
2034	0.0	0.5	**0.5**	749.2	147.7	1.7	**898.6**	**898.1**
2035	0.0	0.5	**0.5**	783.0	155.0	1.8	**939.8**	**939.3**
2036	24.8	0.5	**25.3**	818.4	162.7	1.9	**983.0**	**957.7**
2037	0.0	0.5	**0.5**	854.1	170.7	2.0	**1,026.8**	**1,026.2**
2038	0.0	0.5	**0.5**	892.8	179.2	2.1	**1,074.0**	**1,073.5**
2039	0.0	0.5	**0.5**	933.6	188.1	2.1	**1,123.8**	**1,123.3**
2040	0.0	0.5	**0.5**	977.4	197.6	2.2	**1,177.2**	**1,176.7**
2041	0.0	0.5	**0.5**	1,033.0	208.0	2.3	**1,243.4**	**1,242.9**
2042	0.0	0.5	**0.5**	1,098.2	227.9	2.5	**1,328.6**	**1,328.1**
2043	0.0	0.5	**0.5**	1,211.1	287.6	2.6	**1,501.2**	**1,500.7**
2044	0.0	0.5	**0.5**	1,339.4	302.0	2.7	**1,644.0**	**1,643.5**
2045	0.0	0.5	**0.5**	1,412.1	317.2	2.8	**1,732.0**	**1,731.5**
2046	0.0	0.5	**0.5**	1,491.9	333.9	2.9	**1,828.6**	**1,828.2**
2047	0.0	0.5	**0.5**	1,591.1	361.0	3.1	**1,955.2**	**1,954.7**
2048	0.0	0.5	**0.5**	1,730.6	454.5	3.2	**2,188.3**	**2,187.8**
2049	0.0	0.5	**0.5**	1,943.5	489.5	3.3	**2,436.4**	**2,435.9**
2050	0.0	0.5	**0.5**	2,085.3	513.9	3.5	**2,602.7**	**2,602.2**
2051	-1,122.9	0.5	**-1,122.5**	2,181.9	539.5	3.7	**2,725.0**	**3,847.5**
Total	1,202.6	15.3	1,217.8	29,914.9	6,536.3	61.9	36,513.0	35,295.2
HDM-4 Version 1.3						Economic NPV		2,243.4
						EIRR %pa		20.3%
						B:C Ratio		2.26

Calculation by Author

1. Note: The analysis period is 30 years
2. The project capital cost (USD 2,219 M economic cost) is spread over five years 2017 to 2021.
3. Physical contingencies are included but not financial contingencies. Cost inflation and price escalation during construction are not economic costs. Price escalation does not alter the materials used or the end result.
4. In keeping with previous road project analyses, economic costs are computed by multiplying financial costs by the standard conversion factor (SCF) 0.85 and financial costs converted to economic costs using a standard conversion factor of 0.85 and there

are is no tax or contingency included into economic costs. Residual value is 50.6% after 30 years.

1.7.4 Sensitivity Tests and Switching Values

Sensitivity tests have been carried out and switching values calculated. Up to 20% variation is tested. This **Table 7** shows the results of the analysis of sensitivity tests and switching values. In this table *the blue numbers represent the base case, the black numbers the sensitivity tests, and the red numbers the switching values.*

Table 7: Economic IRR, Sensitivity Tests and Switching Values for DCE

Inflation rate: 5.47%

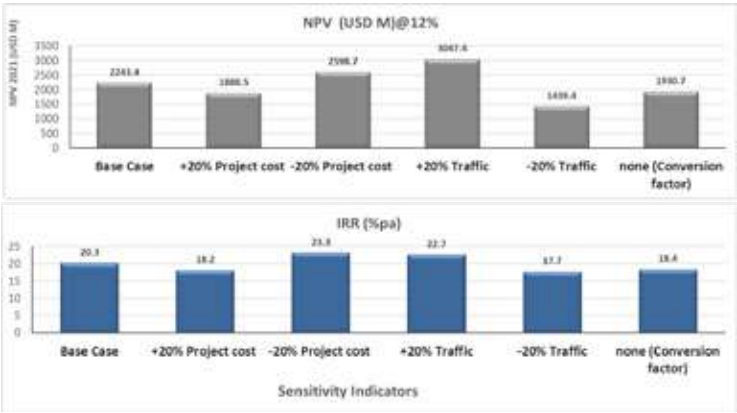
DCE Project	Net Present Values Discounted at 12%/year					Real 'Economic IRR	Nominal 'Economic IRR	Benefit: Cost Ratio*
	Project Costs	VOC savings	Time Savings	Accident Cost Savings	Net Benefit			
Option1: Alignment 1, At-Grade and Elevated	**1776.6**	**3345.0**	**667.6**	**7.5**	**2243.4**	**20.3%**	**25.8%**	**2.26**
Project cost +20%	**2131.9**	3345.0	667.6	7.5	**1888.1**			
Project cost -20%	**1421.3**	3345.0	667.6	7.5	**2598.7**			
Project cost +126%	**4020.0**	3345.0	667.6	7.5	**0.0**		12%	1.0
Traffic +20%	1776.6	**4013.9**	**801.1**	**9.0**	**3047.4**			
Traffic -20%	1776.6	**2676.0**	**534.0**	**6.0**	**1439.4**			
Traffic -56%	1776.6	**1478.2**	**295.0**	**3.3**	**0.0**		12%	1.0

Calculation by Author

Note1: EIRR=Economic Internal Rate of Return, NPV (USD million), *For ease of reading, only the benefit side of the ratio is shown, i.e. 2.26 is shown rather than 2.26 :1.

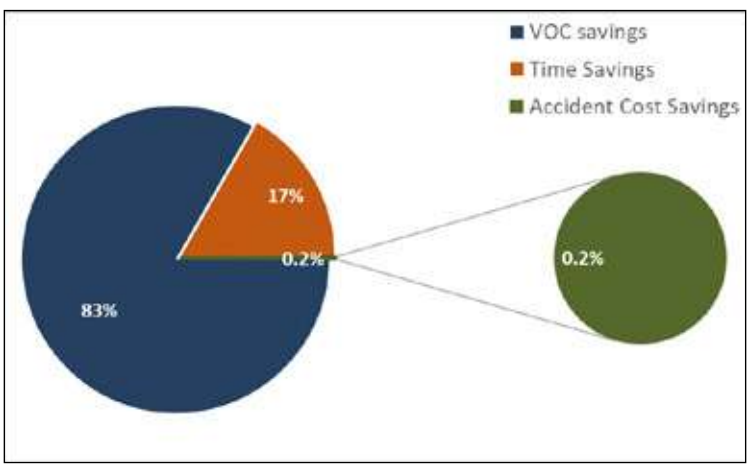
The result of sensitivity analysis has been summarized in above table. From analysis and above table has shown that DCE project is viable from the economic point of view. Its real economic internal rate of return (EIRR) is 20.3% as well as benefit and cost ratio are 2.26 (Benefit/cost ratio is greater than 1). It has found that DCE is a robust project, as sole very substantial cost increases (126%) or benefit reductions (56%) would affect the overall viability of the project. **Table 6, 7 and Figure 5** summarizes the result of sensitivity analysis.

Figure 5: Sensitivity Indicators & Switching Values



The main benefits generated by the DCE Project come from a combination of savings in vehicle operating costs for both passenger and freight traffic and travel time-savings. Reduced accident costs further contribute to the overall benefits. **Table 6,7, and figure 5, 6** shows the net present value (NPV) of the costs and benefits generated by the project. In addition are the distribution of benefits is illustrated graphically. Benefits from reduced vehicle operating costs represent the majority and correspond to 83% whereas benefits from travel time-savings represent 17%, reduced accident costs 0.2%.

Figure 6: Distribution of Benefits



1.7.5 Poverty Impact Analysis

The impact on poverty is hard to assess on a major project such as this, as it covers such an important area of the country and will touch the lives of almost everybody in the two cities and along the line of route. The main beneficiaries are

not poor, however. The transport operators and the cargo owners cannot, as a class, be regarded as poor. Nor can the users of private cars and privately-owned utility vehicles.

Thus, the poor who benefit from the project may broadly be classed as the following:

- The bus passengers – those that have low incomes – especially those who have dependents. In general, the poorest section of the community will not make much use of bus travel, but those who work for low incomes in the city, and need to go home to share their income with family members in the village, will be poor and will benefit from faster journeys and lower fares.
- The low-income workers such as those in the ready-made garment (RMG) industry. Even if they make no use of the corridor themselves, the benefits to the industry should help to preserve or expand their job opportunities and perhaps also create opportunities for the employers to pay higher wages.
- Other members of the poor who may benefit from an increase in employment opportunities due to the greater competitiveness of Dhaka in world markets, or due to lower costs of imports and consumer prices.
- Pedestrians along the route of NH1 will have a safer, cleaner and quieter environment, though NH1 will still be there and still be busy.

It has not proved possible, within the confines of the present study, to quantify this impact on poverty. The international definition of poverty is normally taken as earning less than $1.90/day at 2016/17 prices at purchasing power parity. The threshold for extreme poverty is regarded as $1.25 on the same basis. By that definition 31.5% of the population was regarded as extremely poor in 2010. For urban areas this figure was 21.3% and for rural areas 35.1%.

The national poverty line varies according to the price of food items (based on a daily consumption of 2122 calories per person) and selected non-food items. Those with a daily intake of less than 1805 calories are regarded as ultra-poor. The present value of these thresholds in monetary terms has not proved easy to find. In 2014, by these definitions, a quarter of the populations are regarded as poor, and half of these are ultra-poor.

The minimum wage, for example for garment workers, is now equivalent to $68/month in USD terms (BDT 78 =$1), or $2.27 (178 taka) a calendar day. Adjustments for purchasing power parity, however, use an exchange rate of 30 (a rate calculated in 2011), so the equivalent value in international terms becomes equivalent to 2.6 times more than this, or $5.90 in PPP terms.

Thus, such a worker would only be poor, by this definition, if he or she had more than one dependent. In practice, of course, most people would regard these workers as poor.

In the project area, about one-third of the population are regarded as poor under the $2/day (at 2019 PPP) definition. But it is not known how many of these

will gain significantly from the project.

Not much can be added to this discussion without more research, which is beyond the scope of this project. If the conclusion would be that not more than 15% of the project beneficiaries are defined as poor, and that these persons gain half the benefit each as compared with the non-poor, then the poverty impact.

1.7.6 Impact on GDP: Dhaka Chittagong Expressway (Option 1: Alignment 1, At-Grade and Elevated)

In terms of direct impact on GDP, it has found that the DCE project of Roads and Highways Department has only a slight impact on economic growth. I assumed a base case of 8.15% GDP growth, consequently benefit in the 2022-2032 period will be in the range of 0.25-0.40% and 2022-2051 period will be in the range 0.25-1.85% of 2051 GDP, it may say 0.60%. So, this project would increase this amount by 0.60% i.e. GDP would be 8.75% with the project over the 30 years of the project.

I have observed from the measures of central tendency of the variables used in my study and I have observed from the skewness and kurtosis values that data set is not normally distributed. Thus, I have used log values to solve this matter. Therefore, I can see from the histogram that after the log transformation the data set is normally distributed (**Figure 7 and Table 8**).

Table 8: Descriptive Statistics

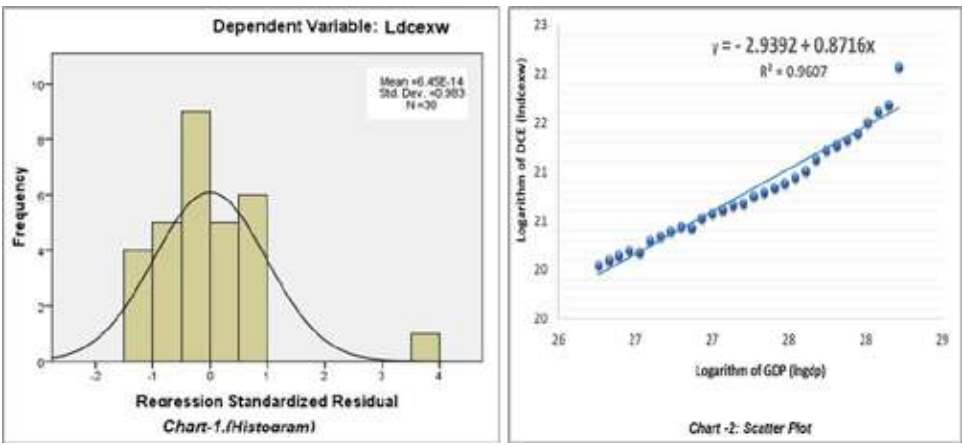
	GDP (Constant Market Price) USD	**Dhaka Chittagong Expressway Project (DCExw)*, USD***
Mean	27.239	20.802
Median	27.239	20.715
Standard Deviation	0.593	0.528
Sample Variance	0.3522	0.2785
Std. Error	0.108	0.096
Kurtosis	-1.200	-0.399
Skewness	0.000	0.559
Minimum	26.262	20.048
Maximum	28.216	22.071
Range	2	2
Count	30	30

Note: calculation by Author and SPSS

For GDP mean, median is 27.24 & 27.24 respectively. For DCExw mean, median is 20.80 & 20.71 respectively. And for GDP Std.Error, Kurtosis and Skewness are 0.108, -1.200 & 0.000 respectively. For DCExw Std.Error, Kurtosis and Skewness are 0.096, -0.399 & 0.559 respectively.

Using the log values, I have the following Histogram and scatter plot

Figure 7: Histogram (Chart -1) and Scatter Plot (Chart -2)



Here from the scatter plot I can observe a likely positive association between DCExw and GDP variables. The value of β is positive 0.871. This is also the slope term. The intercept term α has a value of -2.9392.

The coefficient of determination $r^2 = 0.961$. This is also high. Which states almost 96 percent of the total variation in Dhaka Chittagong Expressway Project (DCExw) explained by the regression model.

The coefficient of correlation r = ± 0.980. I can clearly see that there is strong positive correlation between GDP and Dhaka Chittagong expressway (DCExw).

In this analysis, time series data from the World Bank and others data from DCE project are taken and OLS linear regression has done.

Using SPSS data analysis software, I have derived linear regression analysis and the result is as followed (**section 1.7.6.1**).

1.7.6.1 Estimation of the Econometric Model

Regression analysis is the main tool used to obtain the estimates. Using this technique and the data given in Table 8, I obtain the following estimates of α and β, namely, −2.9392 and 0.871. Thus, the estimated Dhaka Chittagong expressway (DCExw) project function is:

$$Y\ (DCExw) = \alpha + \beta Xi\ (GDP) + \mu i \quad 0 < \beta < 1 \text{ ----------(1)}$$

$$Y = -2.9392 + 0.8716Xi \text{ ----------(2)}$$

$$R^2 = 0.961 \text{ ----------(3)}$$

The coefficient of determination (r^2) = 0.961. This is no higher. Which states almost 96%(percent) of the total variation in DCExy explained by the regression model.

The coefficient of correlation (r) = ± 0.980, it can clearly see that there is strong positive correlation between GDP and DCExy.

where, Yi = DCExw (dependent variable) and X_i = GDP at constant market

price (independent, or explanatory variable)

α = the intercept 2.9392(negative) this is a constant term and

β = the slope coefficient (the GDP coefficient is 0.871. It is a log-liner model)

μ_i= error term

From these results I see that GDP coefficient is positive + 0.871. Implying that for 1 percent increase in the GDP, the benefit of Dhaka Chittagong expressway (DCExw) on the average increases by about 0.871 percent. I can say that there is positive association between GDP and Dhaka Chittagong expressway (DCExw) project.

To find out if the parameters are statistically significant, I have used t-test, p value. Here the calculated t-values for both the variables are much higher that the critical t-values thus I can say the parameters are statistically significant. P-values are also very low thus I can say that variables are statistically significant.

The values of Standard error are also very low which stats statistically significant variables.

Observing the upper and lower values of confidence interval, so it can say zero is not included in this range. Thus, β cannot be zero ($\beta \neq 0$), this supports alternative hypothesis (H1).

As a consequence, I can see that findings are matching alternative hypothesis (H1). Moreover, there are a positive association between GDP and DCExw. If GDP increases by 1 percent then the benefit of Dhaka Chittagong expressway (DCExw) project on the average increases by about 0.871percent.

1.7.6.2 Findings

The value of this project (DCExw) is thus the benefit lost if this project is not undertaken. As a consequence, I can see that findings are matching alternative hypothesis (H1). Moreover, there are a positive association between GDP and Dhaka Chittagong expressway (DCExw) project.

Similarly, I have found, this infrastructure has a significant positive impact on GDP growth. It might well be the case that high GDP and high infrastructure investments are correlated. Therefore, this project would increase this amount by 0.60% that is GDP would be 8.75% with the project over the 30 years of the new Dhaka Chittagong expressway.

1.8 Results And Recommendation

The construction of the 4-Lane expressway from Dhaka to Chittagong will bring in direct economic and social benefits to the people in districts of Dhaka and Chittagong Divisions and indirect benefits to other parts of the country as well.

This paper recommends that development of road transport infrastructure with gross capital build will lead to robust growth of the Bangladesh economy. So, it is emphasizing, an appropriate transport policy should be hold to boost transportation infrastructure and hence sustainable economic growth in Bangladesh. On economic

criteria, therefore, the recommendation would be to proceed with Alignment 1 of the expressway, at-grade and as a tolled PPP project, as soon as possible. The economic analysis should take into account all on going and future road and transport infrastructure project and future development plans in the project area.

1.9 Conclusions of Economic Studies

In conclusion, this alignment at-grade and elevated, is the sole viable alternative from the economic point of view. Its Economic Internal Rate of Return is 20.3% as well as benefit and cost ratio are 2.26 (benefit cost ratios>1). It was found that Option 1 is a robust project, as only very substantial cost increases (126%) or traffic reductions (56%) would affect the overall viability of the project.

The benefits of the expressway will be widespread throughout the economy. Though the project is not directly aimed at poverty reduction, it will have knock-on effects on growth, incomes and employment that will benefit the poor.

The objective of the study is to explore the relationship between the DCExw project and GDP. For this purpose, time series data from the World Bank (WB) and DCE project data are used for analyzing bi-variant linear regression using SPSS. It is found that there is a positive linear relation of DCE project with the rise of GDP. Likewise, it has found that the DCE project of Roads and Highways Department has positive impact on economic growth.

Also, the expressway can be connected Chittagong and Cox's Bazar with Kolkata, Myanmar and China in the future and may create an economic corridor among Bangladesh-China-India-Myanmar (BCIM) countries and there is enormous economic potential of Chittagong District with an exclusive advantage of ports, roads and railways. Yet, Bangladesh is part of the proposed BCIM corridor. And, BCIM corridor is included with Belt and Road Initiative (BRI). Besides, Bangladesh has the geographical boost to connect itself to neighboring countries including China, the Association of Southeast Asian Nations (ASEAN), central Asia and west Asia and beyond using multimodal connectivity through road-rail-air and shipping. This DCE project is absolutely relative with the BCIM economic corridor. In addition, Dhaka-Chittagong Highway, which is part of the Asian Highway (AH)network, by widening it to four lanes and building the Dhaka-Chittagong Expressway.

The potential of the project area for economic growth will be increased and poverty reduction in the Bangladesh. No adverse socioeconomic effects on employment and income trends.

1.10 ACKNOWLEDGEMENT

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years. I am worked on several project i.e. water, roads, railways (MG, BG, DG and electric traction, also double stake and single stake container trains, passenger trains analysis, forecast, double track and single double, new and conversion railway line), port ICD forecast and analysis, road bridges, rail bridges, 4lane marine drive expressway, expressway, elevated expressway, and social development projects. And, Mr. Martin Kerridge (British), who is a Transport Economist/Advisor/ Director at LanXang International, Consultant (various and independent) UK. He had encouraged me for analysis on transportation. I'm thankful to him.

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