Traffic Congestion in Dhaka City and its Economic Impact

Sonjoy Chakraborty[*]

Abstract: *Dhaka is the capital and one of the oldest cities of Bangladesh. The history of Dhaka begins with urbanized settlements in the area that is now Dhaka since the 7th century. Dhaka is the heart of Bangladesh as the capital city as well as an economic & business hub of the economy. Bangladesh would enjoy the benefits of a huge economic boost by alleviating traffic congestion in the capital, the share of which alone in the country's GDP is 35%. In this study total congestion cost (TCC) consists of 5(five) components. These are TTC (Travel time cost), DWL (Dead-weight loss which is avoidable Social Cost), EC (Travel delay externality cost), VOC (Vehicle operating cost or excess fuel cost due to congestion), EC (Environmental externality cost or air/noise pollution) and RTAC (Road Traffic Accident Cost). The Total GDP of Bangladesh (in current value) is 173.8189 Billion USD in 2014 (WB Data-bank), while according to this study, it is estimated that the total economic loss of the traffic congestion is 12.561 Billion USD, which is around 7%. Certainly, this amount of congestion cost for the lower-middle of Bangladesh is very much higher compared to any other country of the world. If, there is no traffic congestion in Dhaka city, and if we calculate this economic loss from 1971, the GDP of Bangladesh might be much more larger than the present amount.*

1. Introduction

Increasing traffic congestion does impose costs not only on travelers but also on the whole economic activities and finally affects national income. It has been difficult to develop and apply empirical measures of the extent of those economic costs. This paper describes a modeling approach to estimate economic cost and how Dhaka City traffic congestion affects GDP. A number of studies on congestion have been carried out for Dhaka. But there is only a few studies on the economic impact of congestion in the city. Most studies on the issue were on estimation of the congestion cost. The effect of different types of vehicle on congestion has been captured on the basis of marginal congestion by Maitra et al. (2004). Using congestion models, the marginal congestions have been estimated for different road widths, traffic compositions and on-street parking levels.

[*]Sonjoy Chakraborty, MSS (Economics) PGD (Development Planning), Ph. D. (Econ.), Deputy Director, BIDA, Prime Minister's Office, Banhladesh

Mohammad R. A., Bhuiyan A. R. and Sultana S. (2013) attempted to explore the hidden causes of traffic congestion of Dhaka city as well as to shed light on its overall consequences. This study is based on the survey of 400 people directly associated with this problem. The researchers have also drawn information from the existing literature and various reports of the Government of Bangladesh to clarify the different causes of traffic congestion and its overall effects. The major finding of the study is that there are several factors liable for traffic congestion of Dhaka city and it has adverse effects on the different socio-economic aspects, but the study did not measure the overall traffic congestion cost and its economic cost. Singh & Sarkar, (2009) made an attempt to determine congestion pricing in central area of Delhi (Connaught Place) with a view to ensuring desired Level of Service. Two methods for the determination of optimal pricing were adopted. The first method was related to the Point of pricing where the external costs were met by the revenue generated by the pricing level while the second method was the Pricing level needed to maintain a level of service. By using these methods, pricing for car and two-wheeler motorized vehicles had been determined. Varmora and Gundaliya (2013) in their study in the city of Ahmadabad have shown that due to change in carriageway width and vehicle composition, the traffic stream speed and flow also encounter more congestion level along the length of link.

Rao & Rao (2012) discuss a novel and interesting way to detect the congestion on the urban arterials in India. They suggest using a Wi-Fi signal emitting device and a receiver across the road to identify the congestion. This method was found to be successful in terms of high accuracy of classifying the road as congested or free flowing. Sen et al. (2009) discussed the characteristics of the ITS techniques that needs to be developed to cater the traffic conditions and congestion in developing regions and presented a brief description of a few efforts being made in this direction. Shuichi and Hironao (2003) have shown in their study that by improving traffic signalling strategies the traffic situation of the street cars can be improved. According to them, their proposed signalling strategy improves the traffic situation of the street cars. Same signalling system can be implemented in Dhaka to improve the city's traffic system.

Litman, T. (2015) studied how traffic congestion can significantly affect transport planning decisions. This report describes various factors that affect congestion cost estimates and the evaluation of potential congestion reduction strategies, including analysis scope, baseline speeds, travel time valuation, accident and emission impact analysis, induced travel analysis, and consideration of co-benefits. It discusses how these factors influence planning decisions and describes best practices recommended by experts. It applies these methods to evaluate various congestion reduction strategies including roadway expansion, improve space efficient modes, pricing reforms, smart growth policies and demand management programs. Fioravante et al. 2009 studied the case of Brazil on environmental impact due to automobiles. Due to demographic changes

that have been occurred, the article projects the number and composition of households of Belo Horizonte (Brazil) by household size and marital status and age of reference person, using a multidimensional model developed by Yi (1991) that considers the interdependence between demographic events. However, the ambient impact did not occur with the same intensity, because some old vehicles were substituted by new ones that have lower emission of pollutants. Karim (1997) found that limited resources, invested for the development of transport facilities such as infrastructure and vehicles, coupled with the rapid rise in transport demand, existence of a huge number of non-motorized vehicles on roads, lack of application of adequate and proper traffic management schemes are producing severe transport problems in almost all the urban areas of Bangladesh. Worsening situation of traffic congestion in the streets and sufferings of the inhabitants from vehicle emissions demand extensive research in this field.

2. Background of the Study

Here is the experience of Michael Hobbes (a human rights consultant in Berlin), who visited Dhaka

"I am in a tiny steel cage attached to a motorcycle, stuttering through traffic in Dhaka, Bangladesh. In the last ten minutes, we have moved forward, maybe three feet, inch by inch, the driver twisting the wheel left and right, wriggling deeper into the block between a delivery truck and a rickshaw in front of us. Up ahead, the traffic is jammed so close together that pedestrians are climbing over pickup trucks and through empty rickshaws to cross the street. Two rows to my left is an ambulance, blue light spinning uselessly. The driver is on the road, smoking a cigarette, standing on his tiptoes, looking ahead to where the traffic clears. Every once in a while he reaches into the open door to blow his horn."

Dhaka has the distinct importance in the national and regional urban hierarchy. Administrative and most other policy and decision making functions are over concentrated in this capital city. The Dhaka traffic system is considered to be one of the most chaotic ones in the world. The residents are compelled to undergo physical stress and suffer financial losses in terms of man-hours lost on working days. The media, both print and electronic, have been constantly highlighting the sufferings of the commuters in Dhaka city because of the troublesome traffic problem. Though the government is trying its best, the city is yet to have sustainable permanent solution. As the Director General of Bangladesh Railway (BR) Abu Taher said, the government has taken a plan to bring dynamic changes in public transportation by setting a very planned and modern railway network. He said that the traffic congestion could be removed from the capital significantly by creating a metro rail network and running commuter trains after converting the Tongi-Dhaka route into three lanes and Dhaka-Narayanganj route into two lanes (The Financial Express, September 9, 2012). Various attempts were taken by the

government, including a special meeting with the agencies concerned to devise means to help reduce the intensity of traffic problem in Dhaka city. Some tangible improvements have been achieved, but the results are still far from the targets.

Daily trips in Dhaka city are estimated at 21 million, of which about only 5% are carried out by private cars, which use roughly 80% of the road space and are the main cause of traffic congestion. 28% of the total trips are carried out by buses which only use about 5% of the road space. 58% of the total trips are made by walking, bicycling, or riding on rickshaws, also called non-motorized transport modes (NMT). But these NMT modes barely have adequate road space. There are no dedicated bicycle or rickshaw lane on any road in Dhaka and less than 25% of roads have separated, paved sidewalks, most of which are either occupied by street veadors and parked cars or are damaged without proper maintenance. NMT users literally have to fight with vehicles for their right of way on roads and thus expose their lives to huge risks. Public transport and non-motorized transport, which meet mobility needs of 86% of the people in the city while only consuming a small portion of the road space and urban land (Source: http://blogs.worldbank.org/endpovertyinsouthasia/can-we-build-dhaka-out-traffic-congestion). DITS, (1993) study in metropolitan Dhaka revealed that of all trips the walk and rickshaw modes account for over 60 percent. Of the remaining trips, some 11 per cent included a significant walking component. Some 40 per cent or more of non-walk trips involved the use of pedal rickshaws. Only about 10 per cent of trips involved motorised public transport services.

Combating Dhaka’s traffic congestion requires short-term and long-term measures. Transportation engineers and urban sociologists need to analyze why people so compulsively rely on personal cars and what it would take to influence them to use public transport (provided there is one that is safe, efficient, and user-friendly). A comprehensive solution involves both infrastructure planning and measures like educating urban-dwellers about the benefits of using public transport, walking, and exercising civic responsibilities. Planning policies become viable only when they foster a culture of urban ethics. Many authors argue that “underdevelopment is a state of mind,” meaning that progress-resistant cultural habits cause the problems we are in, including traffic congestion. We want mobility without exercising our share of urban responsibilities.

MCCI & CMILT (2010) revealed that traffic jam was liable for the loss of people's 8.15 million working hours, 40 per cent of which are business hours. The loss is due to 3.2 million business hours wasted in congestion. Again, from another study of Dhaka Transport Coordination Board (DTCB), it has been found that against the speed capacity of 40 kilometers per hour (kph), motorized vehicles can run in the city on a speed of average 15 kph. In reality, the speed is much less now. In fact, the quality of life and

mental as well as physical stress remain uncountable which means the loss is much more than the calculated amount. Apart from the mentioned losses, motorists are burning extra liters of fuel or extra cubic metres of compressed natural gas as they crawl along in stop-start traffic on the obstructed roads. "Cars use four times more fuel on congested roads than when traffic is flowing at a normal speed. When a car is at a standstill, stopping and starting or moving slowly in heavy traffic, it uses 24.4 litres of fuel for every 100km driven. If the same car moves in free-flowing traffic, traveling at 50km/h or more, the fuel consumption drops to 6.4 litres per 100km" (Financial Express, August 4th, 2011).

Considering the above this paper aims to explore the causes of traffic congestion in Dhaka city, to estimate the cost of traffic congestion and finally, to measure the economic impact of traffic congestion.

3. Objectives of the Study

The main objective of the study is to estimate the impacts of traffic congestion in Dhaka city which embedded in the name of the article. The specific objectives of the study are:

a. To estimate the total traffic congestion cost of Dhaka city with the available data

b. To analyze the impact of traffic congestion

c. To develop recommendations for reducing traffic congestion in Dhaka city

4. Methodology and Data

The study is based mainly on literature survey i.e. content analysis from various published sources including books, online journals, newspapers, magazines, government/non-government organizations like Bangladesh Road Transport Authority (BRTA) and Accident Research Institute (ARI), previous works on the related issue and reports. The publication manual of APA (American Psychological Association, 2001) was used for citation of the sources of references that have been used in the study.

5. Limitation of the Study

To calculate the cost of TCC (Traffic congestion cost) the component TTC (Travel time cost), DWL (Dead-weight loss or Avoidable Social Cost), EC (Travel delay externality cost), VOC (Vehicle operating cost or excess fuel cost due to congestion), EC (Environmental externality cost such as, air/noise pollution), RTAC (Road Traffic Accident Cost) are considerd. But due to lack of time & data availability, we cannot calculate VOC (Vehicle operating cost or excess fuel cost) and its value was taken from the study of Khan & Rashidul (2013). On the other hand, there are a very few studies that measured the RTAC, which has 10 (ten) sub-components. Among the ten components, only one, Lost Labor Output is estimated in this study, which covers 72.9% of the cost of the RTAC. The other 9 components are computed from estimated component of Lost

Labor Output according to the share of the total RTAC studied by Richmund et al., (2005).

6. Estimating Cost of Traffic Congestion

In general, the total congestion cost is made up of different costs, primarily of travel time delay costs and vehicle operating (fuel) costs. Another very important part is the externality cost (i.e. costs imposed on others, not individual private costs) due to traffic congestion. Externality includes the effects on the individual groups, society or the environment resulting from the activities of some other groups of people. In terms of travel time delay, it measures the delay costs imposed on others due to an extra motorist entering in the road and therefore it is the difference between the average cost and marginal cost. Delay externality and the Dead-weight loss (DWL) are often measured as a part of the total travel time delay costs, which will be discussed later in this section. Other most pronounced relevant externalities are air pollution, noise pollution or environmental/climate damages. Road traffic accident cost due to traffic congestion may be a part of the total congestion cost, but it is not included in the total cost estimation of this study because of some reasons explained in the Discussions section. In general, the estimation of total congestion cost can be written mathematically as:

TCC= TTC+DWL+EC+VOC+RTAC----------(1)

Where, TCC = Traffic congestion cost, TTC = Travel time cost, DWL = Dead-weight loss (Avoidable Social Cost), EC = Travel delay externality cost, VOC = Vehicle operating cost (excess fuel cost due to congestion), EC = Environmental externality cost (air/noise pollution), RTAC= Road Traffic Accident Cost.

Of the components mentioned above, the study directly estimates TTC and VOC and for the remaining items, allowances are included which are estimated empirically.

The most pronounced and also the most familiar component of the traffic congestion cost is the travel time delay commonly known as the travel time costs. It is the economic concept that the time spent on travelling has an opportunity cost as it could be used for alternate activity which could produce some significant utility. The most widely used approach to estimate the associated cost is to impose the Value of Time (VOT) on the calculated delay due to congestion. By definition, VOT is the monetary value that a person will be ready to pay for a unit travel time reduction or it is the estimates of hours lost due to congestion in monetary terms, usually determined from "willingness-to-pay" (WTP) surveys. It certainly depends on many factors, such as the socioeconomic condition of the traveler, trip purpose, condition of travel or the mode types, time of travel and there are lots of estimates available in the literature on VOT and the various factors that affect it. Along with the travel time losses, there is another important cost

arising from the unreliability or the unpredictability of the journey times (mostly at peak periods of the day). This adds to the actual value of VOT.

Estimating Travel Time Cost (TTC)

Ideally, the model for computing TTC (for passenger travel) should be of the following form that includes all the effects of various factors:

$$TTC = \sum_{ijkm} (t \times TT \times VOT)_{ijkm} + TTV \quad \text{----------(2)}$$

Where, TTC = Travel time cost per vehicle-person per day; t = % Trips; TT = Travel Time; i = vehicle type; j = trip purpose (i.e. work trip, W.T. or non-work trip, N.W.T); k = Time factor (peak or off-peak hour) and m = allowance for short distance and/or less-time sensitive trips (L.T.S); VOT = Value of Time (varying according to travel condition, travel time, mode choice, travel purpose etc) TTV = Travel Time Variability Due to lack of specific detail data on different factors, i.e. the portion of trips in a particular mode for different trip purposes and for different travel times (peak/off-peak hours). The formula stated in (2) is modified according to the currently available data and shown in (3) below. But with specific necessary data, travel time cost can be computed from (2). Therefore, the modified model for estimating traffic congestion cost is:

$$\text{Total TTC per day} = \%WT \times [\Sigma_i (TT_{i,WT} \times VOT_{i,WT} \times O_i \times N_i] + \%NWT \times [\Sigma_i (TT_{i,NWT} \times VOT_{i,NWT} \times O_i \times N_i] \quad \text{--(3)}$$

Where, W.T. is the working trips (assumed to occur during peaks only) and N.W.T. is the non-working trips with different values of time (VOT) for a particular vehicle type i; TT is the travel time for mode i determined from average vehicular kilometers travelled VKT (km/day) and average speed. Speed is varied according to travel time condition (peaks/off-peaks). For a certain time condition (peak/off-peak), TTi (hr)=Average VKTi/Average speed; Oi is the passenger occupancy of the vehicle i and Ni is the number of vehicle i.

The major assumptions made for the estimation procedure of and relevant to the TTC are:

1. All commuter or work trips are assumed to occur at the peak hours only and similarly all non-work trips are assumed to occur at the off-peak hours only. 2. Average speed corresponding to economically efficient volume (discussed later) of traffic is assumed to be equal to 30 km/hr for all the vehicles and for buses 25 km/hr (MCCI & CMILT 2010). 3. Working and non-working trips are assumed to have a 50-50% split. 4. TTV, DWL, RTAC, FTC and delay externality costs are estimated approximately from previous observations, not using theoretical approach.

The VOT (Value of time) values for Dhaka city from willingness-to-pay survey regarding traffic congestion are collected from (MCCI and CMILT, 2010). After reviewing the literature, 1.5 times greater VOT is adopted for the peak hour than that for the off-peak hour or N.W.T. trips.

About TTV losses, it may sometimes be incorporated within the VOT itself implicitly. A reliable traffic system indicates that travelers can anticipate their travel times accurately before their trip, based on the experience gained from the past trips. In that sense, the measurement of reliability is: how stable rather than severe the congestion is from day to day. Therefore, travel time variability can be used for evaluating the reliability of transportation systems. A high degree of variability indicates that the travel time would be unpredictable and the traffic service is less reliable (Turochy and Smith, 2002). From the traveler's perspective, a decrease in travel time variability reduces the uncertainty in decision-making about departure time and route choice as well as the anxiety and stress caused by such uncertainty (Sun, et al. 2003). It may be computed separately and added to the total direct travel time loss (as in (2) or (3) or may be included within the VOT, knowing the precise values of variability and travel time, if possible. For this study, 25% allowances of the total travel time delay costs are assumed (BTRC, 2007). Table1 enlists all the data necessary for the computation of travel time costs.

BTRC (2007) has estimated that typically externality cost is 60-75% of the total delay cost with the average being 70%. The DWL is estimated to be around 50% of the total cost, typically ranging between about 30-55%. In this paper, these are estimated as being 70% and 50% respectively of the computed total TTC and are added with other costs to determine the total congestion cost from (1).

Table 1: Data for Travel Time Cost Estimation

Vehicle Type	Bus	Taxicab	Auto rickshaw	Auto-tempo	Private Passenger Car	Jeep (Hard/Soft)	Microbus	Minibus	Motor Cycle
No. of vehicle (N)	22680	36417	8082	1664	211425	26147	59946	9983	350543
Occupancy (O)	35	2	2	10	3	3	25	25	1
Daily VKT (Km/day)	150	200	150	150	60	60	150	150	50
Avg Speed (km/hr)	6	6	6	6	6	6	6	6	10
Desirable Speed (km/hr)	25	30	30	30	30	30	25	25	30
VOT (W.T.) - *BDT/hr	72	80	77	50	80	80	72	72	77
VOT (N.W.T.) - *BDT/hr	48	54	52	34	54	54	48	48	52

Note: Information on first four types of vehicles such as Bus, Taxi-cab, Auto-rickshaw, Auto-Tempo and Private Passenger Car is collected from BRTA, MCCI & CMILTA (2007) and Wadud & Khan(2011) Last 4 vehicle's information is inserted from assumption of the first four vehicle's information. We assumed that micro-bus and Mini-bus is the substitute of Bus, Jeep is the substitute of Private Passenger Car and Motor Cycle is the special types of vehicle. By considering the other vehicle's information, its information is considered.

7. Estimating Vehicle Operating Cost

Vehicle operating cost due to congestion consists of the cost of excess fuel burnt and the cost for the lubricants and additional maintenance for the vehicle. Fuel consumption rates vary depending on the type of vehicle (i.e. gasoline/diesel-powered automobile) and driving environment (i.e. urban versus freeway travel, un-congested versus congested travel). In Bangladesh, three types of fuels are used for vehicle operation: diesel, gasoline (octane/petrol) and CNG (Compressed Natural Gas). In the current study, first the fuel consumption cost is made for three types of fuel for all vehicle types and then the excess fuel burnt cost is determined with respect to congested and uncongested travel condition.

Total cost without congestion: for a specific type of vehicle

$$Cost\ Perday = \sum_{v,f}(N \times A \times EF \times FC) \quad \text{---------- (4)}$$

Where, N is the number of vehicle, v of a specific fuel type f; A is the average run per day; FE and FC stand for the corresponding fuel efficiency and fuel cost.

Total cost with congestion: A local survey estimated that the average additional cost due to the congestion is about 40% of the cost incurred in the congestion [MCCI (Metropolitan Chamber of Commerce and Industry) and CMILT (Chartered Institute of Logistics and Transport), "Traffic Congestion in Dhaka City: Its Impact on Business and Some Remedial Measures", July 2010]. So, for a specific type of vehicle, Total fuel cost/day with congestion = 1.4 times the Total fuel Cost without congestion in (4) Therefore, Lost Fuel Cost per day = Total fuel cost/day with congestion - Total fuel cost /day without congestion Hence, Annual Lost Fuel Cost = Lost Fuel Cost per day * 240 days (240 working days assumed instead of 365 days of a year).

Table 2: Traffic Congestion Cost Estimation

Vehicle Type	**Yearly TTC - (50%) W.T. (USD million)**	**Yearly TTC - (50%) N.W.T. (USD million)**
Bus	824.3308	549.5538
Taxi	89.6418	60.5082
Auto-rickshaw	14.3611	9.6984
Auto-tempo	9.6000	6.5280
Car	234.1938	158.0808
Jeep(Hard/Soft)	28.9628	19.5499
Microbus	1245.0323	830.0215
Minibus	165.8714	110.5809
Motor Cycle	83.0517	56.0869
Total TTC	2695.0458	1800.6086
Yearly Total TTC (USD million)		**4495.6544**
TTV losses (25% of TTC, USD million)		**1123.913598**
Total TTC including variability (USD million)		**5619.5680**
Delay Externality, Ed (70% of total TTC, USD million)		**3933.697595**
DWL (50% of total TTC, USD million)		**2809.783996**

Vehicle Operating Cost: This parameter has not been estimated in the study since Khan & Rashedul (2013) estimated it as excess fuel cost due to congestion in Dhaka City by using equation 4 above and according to the study, this cost is 178.55 million USD.

8. Estimation of Road Traffic Accident Cost (RTAC)

Road traffic accidents have now become a great social concern in Bangladesh and the situation is deteriorating. The safety problem is severe in Bangladesh by international standards with some 45 fatalities per 10,000 motor vehicles in Bangladesh compared to 2.0 in the USA and 1.4 in the UK (Hoque et al. 1997).

Dhaka Tribune (source: http://www.dhakatribune.com/long-form/2014/feb/03/death-road) mentions that in addition to the tragic loss of life, there are also economic costs to these accidents. In Bangladesh, the annual economic cost of road traffic accidents is estimated to be around 2% of its Tk. 151bn ($1.95bn) GDP. This is almost equal to the total foreign aid received in a fiscal year. The losses include direct and indirect expenses, such as medical costs, insurance loss, property damage, family income losses and traffic congestion.

A recent accident analysis shows that vulnerable road users are pedestrians, cyclist/motor cyclist and public vehicle passengers. Of the accident victims about 50% are pedestrians, one-third of the victims are adult males of age between 21-40 years, about 50% accident occur on National and Regional Highways and 20% on city roads. Accident on national highways is more severe - about 48% fatal and in city roads 14% accidents are fatal.

Human Capital Approach of Accident Costing: Cognizant of the magnitude of the ill effects of vast motorization, the United States with its National Highways Traffic Safety Administration (NHTSA) and the TRL pioneered in developing methodologies for costing accident. Since then, they have developed guidelines for use of developing countries after previous studies have noticed the vulnerability and greater effect of accidents on the poor. Their approach - the Human Capital Approach - has been adopted in this study.

Accident Cost Components: To simplify the process of identifying the sources costs, the Human Capital Approach, otherwise known as the Gross Output Method, classifies accident cost into three main components as shown in Table 3. Victim related costs are directly associated with the resources lost of the casualties. To be humane and considerate of the social impacts of accidents, a notional sum is also added to quantify the PGS (Pain, Grief, and Suffering) of the victim’s families. Property damage consists of vehicle repair, lost of the economic productivity of public utility vehicles and the cost of towing services. The first two components make the largest portion of property damage and are given due attention in this paper. The third and last component of accident cost consists of costs associated with police investigation, legal activities and insurance administration.

Table 3: Cost Components of Road Traffic Accident

Components of Costs	Sub- Components of Costs
Victim Related Cost	Funeral Cost
	Lost Labor Output
	Pain, Grief, and Suffering
	Medical Cost
Property Damage	Vehicle Damage Repair
	Lost Economic Output
	Towing Cost
Administration Cost	Police Investigation
	Legal Costs
	Insurance Administration

Table 4: Estimation Method of Cost Components

Cost Component	**Estimation**
Lost labor output	Calculated as the average daily wage rate of each person involved in the crash, multiplied by the number of days of work, then added up for all the people involved in the crash. For fatalities and permanent disabilities the calculation is performed over the rest of their expected productive working life and discounted to an equivalent present value
Vehicle damage	Calculated as the average cost of vehicle repairs multiplied by the average number of vehicles involved in the crash.
Administration cost	Calculated as a percentage of resource costs in line with ADB recommendations (0.2% for fatal accidents, 4% for serious injury accidents, 14% for minor injury accidents and 10% for property damage-only accidents)

Source: Richmund M. M. D., Primitivo C. C., Ricardo G. S., (2005)

Lost Labor Output: Potentially productive years of life lost as a result of an accident are also considered. Lost output is typically the largest casualty related cost incurred. A study by the police shows that the age group most vulnerable to road accidents, those between 21 to 35 years, comprises the core of the country's workforce (DMP, 1996) and from this report we can say that the average age of accident is 28 years. Using the compulsory retirement age of 59, we can deduct the average lost economic years of fatalities as 31 years.

The average income of people of Dhaka City is 1314 US dollars (according to per-capita income of the people of Bangladesh in 2014). Because of deaths by accidents, the country loses complete output which the deceased person would produce rest of the life. People

grievously injured lose 50% of their productivity for the rest of the lifetime and the people with simple injuries lose 10% productivity in their lifetime. For simplicity, I have considered the per-capita GDP as the yearly income of the people of Dhaka who have faced the accident.

Table 5: Calculation of Lost Labor Output

Type of Injury	Number (Average from 2006 t0 2014)*	Weight of Loss**	Average time of Rest of the Productive life in Years***	Average Yearly Income (Per-capita GDP of Bangladesh in 2014)****	Total Loss (USD)
Fatal	315	01	31	1314	11589480
Grievous	113	.50	31	1314	2078748
Simple	23	.10	31	1314	84621.6
Total					12969180

**Data Source is an Accident Research Institute (ARI) Data Bank, **Own Assumption, ***Accident Research Institute (ARI) shoes that from the age of 21 to 35 (average age is 28) is the mode value of accident (see table) ****Economic Review of Bangladesh, 2015*

As the loss of the labor output is equal to 14358735 USD which is 73.9% of the total accidental cost according to the study of Richmnd M. M. D., Primitivo C. C., Ricardo G. S., (2005), we can calculate the total accidental cost and it will be 19696841.48 USD or 19.6968 million USD. In this way we can calculate the sub-sectoral loss due to accident.

Table 6: Calculation of Sub-Components of Costs Road Traffic Accident Cost

Sub- Components of Costs	% of Total Expenditure* % of Total Accidental Cost*	Total Loss of Moneu Due to Traffic Accident
Funeral Cost	01.1	216665.2563
Lost Labor Output	72.9	14358997.44
Pain, Grief, and Suffering	14.6	2875738.856
Medical Cost	07.3	1437869.428
Vehicle Damage Repair	02.2	433330.5126
Lost Economic Output	01.6	315149.4637
Towing Cost	00.1	19696.84148
Police Investigation	00.2	39393.68296
Legal Costs		
Insurance Administration		
Total Road Traffic Accident Cost	100	19696841.48

**Studied by Richmund M. M. D., Primitivo C. C., Ricardo G. S., (2005)*

8. Freight Traffic Cost

The excess cost of freight traffic is mainly due to the average waiting time that the freight has to face for traffic congestion during peak hours. For Dhaka city, this is not a prime source of congestion cost because the freight traffic is only allowed to enter the city during off-peak hours at night in order to avoid the congestion. Hence this is majorly related to policy-making of government and not related to congestion particularly for Dhaka city currently. For this reason this cost is not considered in this study though it is an considerable component of raffic consideration.

9. Assessment of Total Cost

From equation (1) we get TCC= TTC+DWL+EC+VOC+RTAC, where, TCC = Traffic congestion cost, TTC = Travel time, cost, DWL = Dead-weight loss (Avoidable Social Cost), EC = Travel delay externality cost, VOC = Vehicle operating cost (excess fuel cost due to congestion), EC = Environmental externality cost (air/noise pollution), RTAC= Road Traffic Accident Cost.

According to the study referred to as the source for Table 6, the broad cost components of traffic congestion are as shown in Table 7.

Table 7: Broad Cost Component of Traffic Congestion

Component of the Cost of Traffic Jam	**Cost (in Million USD)**
Total TTC including variability (USD million)	5619.5680
Delay Externality, Ed (70% of total TTC, USD million)	3933.697595
DWL (50% of total TTC, USD million)	2809.783996
Vehicle operating cost (VOC)	178.55
Road Traffic Accident Cost (RATC)	19.6968
Grand Total	12561.296
Per capita Congestion Cost (Considering Countrie's Total Population)	(12561.296÷160)78.50
Per capita Congestion Cost (Considering Dhaka Citie's Population)	(12561.296÷16)785.00

10. Comparison of Congestion Cost per Person in Dhaka City with that in other Metropolitan Cities of the World

From the above estimation we see that total congestion cost for the Dhaka city is 12561.296 million USD. Considering the country's total population, per capita congestion cost is 78.50 USD and if we consider only Dhaka city's population, the per capita congestion cost stands 785.00 UD. From the table 9 and 10 we can see that the per

capita congestion cost in Dhaka city is larger than most other metropolitan cities in the world.

Table 8: Estimated Annual Congestion Costs of Large American Metropoliss, 2009

	Delay (000hours)	Excessfuel (000 gal)	Truckcon-gestion $ million	Totalcon-gestion $ m	Population (000)	Cost Perperson
Los Angeles-Long Beach-Santa Ana	514,955	406,587	3200	11,997	13,033	921
New York-Newark	454,443	348,326	3133	10,878	18,768	580
Chicago	372,755	276,883	3349	9476	8519	1112
Washington	180,976	148,212	945	4066	4454	913
Dallas-Fort Worth-Arlington	159,654	126,112	948	3649	5013	728
Houston	144,302	129,627	940	3403	3921	868
Philadelphia	136,429	106,000	967	3274	5337	613
Miami	140,972	109,281	883	3272	5350	612
San Francisco-Oakland	121,117	94,924	718	2791	4000	698
Atlanta	112,262	90,645	852	2727	4200	649
Boston	118,707	89,928	660	2691	4252	633
Phoenix	80,390	69,214	839	2161	3538	611
Seattle	86,549	68,703	659	2119	3187	665
Detroit	87,996	64,892	551	2032	3900	521
San Diego	71,034	60,057	450	1672	3048	549
Paris	Economic Congestion Cost (Only Dead Weight Loss)					250 Francs
Toronto						CAN$270

Source: Urban Mobility Report (Texas Transport Institute 2010) & NZ Transport Agency Research Report 489, p. 27

Table 9: Estimated Costs of Congestion 2005 (AUS$ Billion pa)

Area	**Total congestion (free flow)**	**Avoidable congestion (DWL)**
Sydney	3.9	2.09
Melbourne	3.6	1.79
Brisbane	1.44	0.71
Adelaide	0.78	0.36
Perth	1.05	0.54
Hobart	0.80	0.03
Darwin	0.27	0.01
Canberra	0.18	0.07
Total	11.06	5.6

Source: NZ Transport Agency Research Report 489, p. 27

11. Recommendation for Reducing Traffic Congestion

Two major strategies have to be taken to reduce the traffic congestion in the Dhaka city. First is to arrest the inflow of people in the Dhaka city and second is to take measures to reduce the existing traffic congestion in Dhaka city.

11.1 First Strategy : Arrest the follow of People in the Dhaka City

The main causes of population concentration in Dhaka city are employment, health, education and official purpose. If people get employment, health and education facility in their own location, the movement of people to Dhaka will reduce drastically. Because of the centralization of governmental activities, people from allover the country come to the Dhaka city and to address the problem, following recommendation can be taken into action.

11.1.1. Administrative decentralization: According to the article No.1 of Bangladesh Constitution, Bangladesh is a unitary, independent, sovereign republic, which has been recognized by the Supreme Judiciary as one of the basic features of the Constitution [*Anwar Hossain Chowdhury & Others v Bangladesh*, 41 DLR (AD) 165, paragraph 292]. According to the article 5. (1), The capital of the Republic is Dhaka. There is no provincial system. It speaks that the administration (all executive functions headed by Prime Minister, supreme judiciary headed by the Chief Justice, and legislative functions headed by the Speaker) of the country are highly concentrated in Dhaka. According to the article $7B^{1}$, there is no scope to change this provision. In such a situation, with the consultation of the supreme court, the government can establish circuit High Court Bench in the all divisional cities.

11.1.2. Work redistribution among ministries, department and divisional other sub-ordinate offices: Ministry will work only in policy preparation and monitoring. At present, not only policy preparation and monitoring but also the implementation, transfer, leaves, appointment, promotion, fund allocation and many other works are also done by the ministry. As a result, the ministry cannot give proper attention to the policy preparation. For this reason officers are attracted in the ministry as they can enjoy privileged positions in both the policy preparation and execution of the policy. This is one of the main problems of the development of economy. Since most of the works are centralized in the ministry and DG offices, people come the Dhaka city for postings, leaves, etc. but such jobs for health, education and many other cadres may be distributed to the divisional authority.

11.1.3. Abolition of vertical local government: Article 59 and 60 of the Bangladesh constitution has the provisions of the local government system. According to Article 59 (1), local government in every administrative unit of the Republic shall be entrusted to bodies, composed of persons elected in accordance with law. There are four tire

administrative units in Bangladesh: Divisional level, District level, Upazila level, the Union level. According the constitutional obligation, there should have four tire local governments. Besides, City Corporation and Municipalities are two types of horizontal urban local government. So many tires of local government system create complexity in administration and the local government as a single authority has no power to control or supervise or regulate lower local government bodies. The urban and rural, local governments may be reformed for coordination in administration, supervision and regulation by one organized in hieratical structure instead of having two many different parallel structures.

The Dhaka metropolitan city has a multiple number of authorities to take care of the same total area such as the Dhaka City Coroporation, the RAJUK and the Dhaka District Parishad. The land administration is under control of District Administration. City Corporation and District Parishad are simultaneously responsible for the development activities. It creates a serious mismanagement.

Although there is a three tire local government, very few amount of resource is generated by these individual tires while they have to carry unnecessary administrative cost. There is no coordination, arrangement between the vertically existing local governments due to the obligation of law (as every local government is a statutory body). So, most of the time, development projects overlapped and create distortion and misuse of resource and the economy achieved sub-optimal output. For this reason, growth centers are not developed in the center of the local government administrative unit. These local governments cannot create the center of economic activities within their administrative areas. Dhaka is growing without coordinated development of infrastructure and businesses expand haphazardly, people are moving to Dhaka from all corners and the city, which now has become the capital of traffic jam in the world.

11.1.4. Creation of metropolitan government: The name of the present local government in Dhaka city is called city corporation local government. The city corporation has no control over the traffic control, law and order, electricity system, water and sanitation, telephone, transport, or any other activities which is related to road maintenance, use and development. Only for traffic management, there are many agencies named DSCC, DNCC, DTCA, DMP, RHD, WASA, PDB, WDB, Gas, T&T, BRTA and many other departments and who are responsible for the management of the traffic system of Dhaka city along with RAJUK. The Dhaka Transport Co-ordination Authority is formed to co-ordinate these authorities, but the authority is not empowered due to the various legal obligations. Police and especially traffic police are mostly responsible for the traffic control, but, there is no control of Dhaka city corporation over the metropolitan police. So, without creation of metropolitan government, and complete control of the police department, traffic control will be very tough.

11.1.5. Empowering local government: Now the local government is empowered basically only to implement some development activities. They have no control over the law and order. In most developed countries local government is empowered to appoint police and to control law and order. Ethnic minorities in Bangladesh often feel insecure in rural areas due to inadequate law and order situation. So, they feel more comfortable to live in the mega cities. Local government administration does not have adequate funds to provide salaries to stuff including the law and order people and meet funding requirements from lump sum grant of the central. In every local government, there should be a representative of central government with some judicial power, who will be the eye of the central government and will be the independent from the local government. He will observe and advise the local government to follow the administrative and financial rule of the central government. These types of local government can create the growth center in the area of the local government by enhancing the economic activities which will reduce the pressure on the Dhaka city and will reduce the traffic congestion.

11.1.6. Introduction of judicial system in the local government level: Under the existing local government system, there is no judicial practice. If central government provides judicial officer under the judicial system in the every local government, it may not be economically viable. Under section 190 (1) (D) of the Cr. P. C., government can empower any executive magistrate to take the conigence of any offense. As every local government should have a representative of the central government, he may be empowered under section 190 (1) (D) of the Cr. P. C. It will enhance the empowerment of local government, will bring the judicial system in the near to the people, policing system will be empowered, increase the economic activities in the rural area, arrest the movement of the people to the mega-city, especially in the Dhaka city and finally will reduce the traffic congestion of Dhaka.

11.1.7 Introduction of e-governance: The government of Bangladesh has already introduced an e-governance system requiring that all meetings, and the tasks like sending letters, conference, official services should be carried out with use of electronic communications. It will reduce the movement of the people, reduce cost, would save time and will reduce the traffic congestion.

11.1.8 Adoption of family planing in the ueban area: Still there is no family planning policy in the urban area. A total of 3.5 million people is living in 4,000 slums in the Dhaka metropolitan area (Source: http://bdnews24.com/bangladesh/2013/02/24/3.5-mn-people-live-in-dhaka-slums). Most slum dwellers are extremely poor, uneducated and careless regarding the family size. As there is no family planning policy for these slum areas, the growth rate of population is very high. It should be controlled very strongly by introducing family planning policy in the city slum area.

11.1.9 Ensuring quality of health and education in district and rural area: People move to the mega city Dhaka mostly for businesses, quality health and education services and good jobs. Considering this, the central government has to take necessary measure for ensuring quality health and education facilities at the district, as well as lower urban and rural levels. It will reduce the flow of people to the mega city and simultaneously contribute to economic development.

11.2 Second Strategy: Take Measures to Reduce the Existing Traffic Congestion in Dhaka City

As huge number of people are already living and working, mostly as settlers in Dhaka city, it is not possible to push them out of the city and the government should develop a proper infrastructure and appropriate strategy to reduce the existing traffic congestion.

11.2.1 Establishment of U-loop system: Introduction of U-loop system at intersection points of roads will drastically reduce the traffic congestion. In this system, very small amount of cost will be involved. If the U-loop system is introduced, the cases of traffic rules violation will be reduced and traffic signals will not be required.

11.2.2 Promulgation of the law: Introduction of the legal system is required in the following area:

a. No political or any other public program can be held by blocking the roads.

b. The ground floor of every roadside building in the city has to be kept open for parking. Owners of such building may also think of creating basement parking spaces. Failure in complying to this may be rigorously penalized.

c. Illegal parking and setting up business temporary/permanent shops on the roadside or footpath should be strictly prohibited. All the moment, these are practised and sometimes the authorities allow them by corruption, especially by interest groups and the law catering authorities show execuses of not having enough personnel. The trafficking system is not properly implemented. We used to introduce a counter measure system that, in illegal parking and business on the road will be reported to the ministry of communication (with video documentary) and they report it to the ministry of home to take necessary action against the responsible traffic person. Also any citizen should have an option to report to the ministry of communication electronically (internet or any other way) to report against the illegal parking and business on the roadside. The employment of human resource of the counter measure system may be done by outsourcing for say, 15 days and after that a new outsourcing party is to be employed for the job to ensure free of corruption servcie, neutrality and finally efficient outcome. The report of the communication ministry implemented by the ministry of home should be discussed in the standing committee of the communication ministry.

11.2.3 Introduction of jobs-housing balance policy: Residential arrangement in the office area is known as the job-housing balancing policy. If government arranges 20 to 30 percent one-room residential arrangements in the office area, especially in the high-rise office building, it will reduce the movement of the employees and their residential problem and will reduce traffic congestion. If this one-room residential system become available, these employees will not shift their family in the Dhaka. There may be budget constraint for the central government for the high rise construction. Under the PPP program, for construction of the high rise office, government can provide land and construction company will construct the building and government will pay their costs and also cover profit by payments in long–run installments.

11.2.4 Construction of flyover on the railway level crossing: The number of level crossings within the Dhaka metropolitan area is 29 (Kabir, 2004). More than 80 trains through pass in these crossing between 06 and 11 pm. On average in every 13 minutes a train passes these crossings, which spoils more than 06 hours in the 24 hour day. There is no alternative to build flyover at the intersection point of railway crossing.

11.2.5 No new educational institution in Dhaka city: No new public or private education institution should be established in the Dhaka city. Qualitiful post graduate level online education system may be introduced, certainly not below the under-graduate level.

11.2.6 Introduction of adequate public transport system: Due to lack of a comfortable and adequate number of public transport, most of the mid and above the mid-level income group people are using private cars, which occupy 78% road capacity but carry only 5% trip. BRTA or under the PPP program, the government can introduce comfortable public transport system. In the morning, heavy traffic is created by the movement of personal vehicles of guardians to carry their children for more security and safety. If the school authorities introduce safe and secured transportation system, traffic congestion will be reduced as well as tension, time and financial cost of the guardians will also be reduced.

11.2.7 Imposing more cost on the private vehicle: Private vehicle operating cost may be increased by taxing policy like registration, fuel, insurance, and many other systems to reduce the numner of private vehicles in the Dhaka city.

11.2.8 Unauthorized bus stops and truck loadings: Within the city, vehicles are loading/unloading passengers, goods etc. in any place whereas they are supposed to do so only in the DNCC and DSCC specified stands.

11.2.9 Developing a bicycle network: Develop a region wide bicycle network, with specific focus on dense urban areas where bicycles can serve a large share of trips. It will reduce not only traffic but also carbon emission.

11.2.10 Car clubs or car sharing/pooling: Car clubs have begun to take off in the UK over the last few years, largely because of the added expense of running a car in the midst of a recession. Car clubs have been already popular in continental Europe before the recession and have proved to be popular for a range of reasons. For instance car clubs are environmentally more friendly than owning your own car and save a member a significant amount in comparison to the costs of running their own car.

11.2.11. Construction of infrastructure: Elevated expressway, metro rail, bypass road, underground footpath, foot overbridge, fly over and many other mega infrastructural facility certainly will reduce the traffic congestion. But, these involve a large amount of cost. There are a lot of mega projects that the government has already initiated to reduce the traffic congestion but the issue is not discussed here in details.

PPP projects of infrastructure (transport) sector in Dhaka city will certainly reduce the traffic congestion and following is a list of such projects.

The list of CCEA/LM approved projects under the Public Private Partnership Program:

SL	Sector	Project Name	Status
01.	Transport	Dhaka-Elevated Expressway.	Award Stage - Preparatory Activities
02.	Transport	Upgrading of Dhaka Bypass to 4 Lane (Madanpur-Debogram-Bhulta-Joydebpur).	Procurement Stage - ROI
03.	Transport	Flyover from Santinagar to Mawa Road via 4th (New) Bridge over Buriganga River.	Project Development Stage - Feasibility Study
04.	Transport	Hemayetpur-Singair-Manikganj PPP Road.	Project Development Stage - Feasibility Study
05.	Transport	Dhaka-Chittagong Access Controlled Highway.	Project Development Stage - Feasibility Study
06.	Transport	Dhaka-Ashulia Elevated Expressway.	Project Development Stage - Feasibility Study
07.	Transport	Jatrabari-Sultana Kamal Bridge-Tarabo PPP Road.	Project Development Stage - Advisor Appointment
08.	Transport	Construction of Laldia Bulk Terminal.	Project Development Stage - Feasibility Study
09.	Transport	Construction & Operation of Inland Container Terminal (ICT) at Khanpur.	Project Development Stage - Feasibility Study
10.	Transport	Construction of a New Inland Container Depot (ICD) near Dhirasram Railway Station.	Project Development Stage - Advisor Appointment

Source: http://www.pppo.gov.bd/projects.php; Retrieved at 31.08.15

Note[1]: Article 7B: Basic provisions of the Constitution are not amendable:Notwithstanding anything contained in article 142 of the Constitution, the preamble, all articles of Part I, all articles of Part II, subject to

the provisions of Part IXA all articles of Part III, and the provisions of articles relating to the basic structures of the Constitution including article 150 of Part XI shall not be amendable by way of insertion, modification, substitution, repeal or by any other means.

12. Conclusion

Dhaka is the heart of Bangladesh as the capital city and it plays the role of an internal and external economic and business hub of the economy. If the heart is attacked or blocked, whole body will be collapsed. Free flow of transportation can be compared to the blood circulation of the human body where the capital city (like heart) is the main player. Bangladesh would enjoy the benefits of a huge economic boost by alleviating traffic congestion in the capital city, the share of which alone in the country's GDP is more than 35 percent (MCCI & CILT, 2010). Constitutionally Bangladesh is a unitary state and the severity of its economic problems is more than that for other non-unitary states like India, Pakistan, USA. Michael Hobbes, a human rights consultant in Berlin mentions that Dhaka is the “Traffic Capital of the World” and this comment, indicates how seriously the economy is affected. The total GDP of Bangladesh (in current value) is 173.8189 Billion USD (WB Data-bank) and it is estimated that the total economic loss due to traffic congestion in Dhaka is 12.561 Billion USD, which is around 7% of the country's GDP. Certainly, this amount of congestion cost for the lower-middle of Bangladesh is very much higher compared to any other country of the world. If, the problem of traffic congestion in Dhaka city is solved per-capita GDP would increase and the country's GDP per capita will increase from today's US$1314 to US$1392. The cumulative loss of GDP because of traffic congestion during the period from our independence in 1971 till date is huge and if such losses continue, the aspirations of the country to become a middle inincome nation by 2021 will be jeopardized. Subsequently, to become a developed nation by 2041 will become simple impossible to attain.

References

Allsop R.E., (1990). Urban Safety Management. Highways and Transportation. http://www.dhakatribune.com/long-form/2014/feb/03/death-road, Retrived on 24-07-15

Al-Mamun A., (2012). "Cost of Traffic Congestion in Dhaka City and its Implication in Business" held at the Institute of Engineers, Bangladesh (IEB). A Unpublished Article. The Financial Express, Sunday September 9, 2012

Bickel, P., Schmid, S., Krewitt, W., & Friedrich, R., Eds. (1997). “External Costs of Transport in Extern E”, Final Report. IER, Stuttgart.

Boyce, C. (2009), ATA President Discusses Dangers of Congestion Pricing and Privatization of Roadways, American Trucking Association (www.trucking.org); at www.trucking.org/article.aspx?uid=6dd59be6-c9e8-4920-a8fc-f2736aa6bd4e.

Binnie Partners (1994). “Preparation of Structure plan, Master plan, and Detailed Area plan for Chittagong, Component 2C: present situation report, traffic and transportation in Chittagong”, Project BGD/88/052, UNDP/UNCHS (Habitat),Govt of Bangladesh.

Cambridge Systematics (2012). Assessing The Economic Benefit Of Transportation Infrastructure Investment In A Mature Surface Transportation System, National Cooperative Highway Research Program, Transportation Research Board (www.trb.org); at http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-24(80)_FR.pdf.

EDRG (2007).The Cost of Highway Limitations and Traffic Delay to Oregon’s Economy, Oregon Business Council and Portland Business Alliance (www.orbusinesscouncil.org); at www.portofportland.com/PDFPOP/Trade Trans Studies CostHwy Lmtns.pdf.

Disney S., Naim M., Towill D., (1997). “Dynamic Simulation Modelling for Lean Logistics”, International Journal of Physical Distribution and Logistics Management), 20 3-4 194 196

Fernie J., Pfab Regan F., A., (2000). “Retail Grocery Logistics in the UK”, International Journal of Logistics Management, 11 2 83 95.

Financial Express, August 4th, 2011.

Fioravante, E. F., & Fígoli, M. G. B. (2009). “Environmental impact due to automobile use.” XXVI IUSSP International Population Conference, Morocco.

Geunes J. Konur D., (2009). “A Competitive Facility Location Game with Traffic Congestion Costs, University of Florida”, Center for Multimodal Solutions for Congestion Mitigation, Gainesville, FL. Retrieved from http://cms.ce.ufl.edu/news_events/Dincer.pdf

Greater Dhaka Metropolitan Area Integrated Transport Study (D1TS) (1993). “Mid term report”, draft no. 1, Government of Bangladesh, Planning Commission, UNDP and Dept of Economics and Social Development, Dhaka 1993.

Government of the People’s Republic of Bangladesh, Ministry of Communication, BRTA, National road Safety strategic Action Plan, 2013.

GOB, Report on Traffic Accident Study n Dhaka City, 2007-2011), 2012.

Golob T., Regan A., (2003). “Traffic Congestion and Trucking Managers” Use of Automated Routing and Scheduling, Transportation Research Part E: Logistics and Transportation Review, 39 61 78.

Hoque.M.M. (1997). Road Safety Audit in Developing Countries. Research Report, Transport Research Group, Department of Civil and Environmental Engg, University of Southampton.

Iwasaki.M. (1992). “An analysis of capacity reduction on rural expressway”, Proc. of the 16^{lh} ARRB Conference, Part 5, Perth, Western Australia, 9-12 November 1992.

Karim M. M. (1997). Traffic Pollution in Bangladesh & Metropolitan Dhaka a Preliminary Investigation. 90thAnnual Meeting of A&WMA, Toronto, Canada.

Khan, T., & Rashedul, I. (2013). “Estimating Costs of Traffic Congestion in Dhaka City. International Journal of Engineering Sciences and Innovative Technology”, 2, 281-289

Lee H., PadmanabhaV. and, Whan S. g, (1997). "The Bullwhip Effect in Supply Chains", Sloan Management Review, Spring, 93 102

Litman, T., (2015). Smarter Congestion Relief In Asian Cities: Win-Win Solutions To Urban Transport Problems, Transport and Communications Bulletin for Asia and the Pacific, No. 82, December 2013 (www.unescap.org/publications/detail.asp?id=1581)

Litman, T., (2014). The Mobility-Productivity Paradox: Exploring The Negative Relationships Between Mobility and Economic Productivity, presented at the International Transportation Economic Development Conference (https://tti.tamu.edu/conferences/ited2014); at www.vtpi.org/ITED_paradox.pdf.

Mahmud K., Gope K., & Chowdhury S. M. R., (2012). "Possible Causes & Solutions of Traffic Jam and Their Impact on the Economy of Dhaka City" Journal of Management and Sustainability; Vol. 2, No. 2; 2012

Maitra, B., Sikdar, P. K., & Dhingra, S. L. (2004). Modeling of Congestion: A Tool for Urban Traffic Management in Developing Countries. European Transport, 27, 45-56.

Mayeres, I., Ochelen, S., & Proost, S. (1996). "The Marginal External Costs of Urban Transport. Transportation Research", Part D: Transport and Environment, 1, 111-130. http://dx.doi.org/10.1016/S1361-9209(96)00006-5

Mason-Jones R., Namim M., Towill D., (1997). "The Impact of Pipeline Control on Supply Chain Dynamics", International Journal of Logistics Management, 8 2 47 61

MCCI (Metropolitan Chamber of Commerce and Industry) and CMILT (Chartered Institute of Logistics and Transport), "Traffic Congestion in Dhaka City: Its Impact on Business and Some Remedial Measures", July 2010 http://www.bpc.gov.bd/contactus.php?id=39

Mohammad R. A., Bhuiyan A. R. and Sultana S. (2013). "An Overview of the Traffic Congestion in Dhaka City: Its Causes and Consequences" Proceedings of 9th Asian Business Research Conference 20-21 December, 2013, BIAM Foundation, Dhaka, Bangladesh ISBN: 978-1-922069-39-9

Moinzadeh K., Klastorin T., Emre B., (1997). "The Impact of Small Lot Ordering on Traffic Congestion in a Physical Distribution System", IIE Transactions, 29 671 679

O'Mahony, M., & Kirwan, K. J. (2001). "Speed-Flow Relationship and Feasibility of Road-Pricing Technology". In: B. De, Borger, & S. Proost (Eds.), Reforming Transport Pricing in the European Union: A Modelling Approach (pp. 191-207). Cheltenham: Edward Elgar.

Piyapong Jiwattanakulpaisarn, Robert B. Noland and Daniel J. Graham (2012). "Marginal Productivity Of Expanding Highway Capacity," Journal of Transport Economics and Policy, Vol. 46, No. 3, Sept., pp. 333-347; summary at http://tinyurl.com/odsv4t

Rao, A. M., & Rao, K. R. (2012). Measuring Urban Traffic Congestion—A Review. International Journal of Traffic and Transport Engineering, 2, 286-305. http://dx.doi.org/10.7708/ijtte.2012.2(4).01

Ross Silcock and TRL (1996)."Road safety international guidelines", ADB Regional Technical Assistance Project (RETA 5620) (Draft), Bangkok, August 1996.

Richmund M. M. D., Primitivo C. C., Ricardo G. S., (2005). "ESTIMATION OF SOCIO-CONOMIC COST OF ROAD ACCIDENTS" Journal of the Eastern Asia Society for Transportation Studies, ol. 6, pp. 3185-3189, 2005.

TTI (annual reports), Urban Mobility Report, Texas Transportation Institute (http://mobility. tamu.edu/ums).

Sankaran J., Wood L., (2007). "The Relative Impact of Consignee Behavior and Road Traffic Congestion on Distribution Companies", Transportation Research Part B: Methodological, 41 1033 1049

Sen, A. K., Tiwari, G., & Upadhyay, V. (2010). "Estimating Marginal External Costs of Transport in Delhi. Transport Policy", 17, 27-37. http://dx.doi.org/10.1016/j.tranpol.2009.09.003Sun, C., Arr, G., and Ramachandran, R. P. 2003. 'Vehicle Re-Identification as Method for Deriving Travel Time and Travel Time Distribution', Transportation Research Record, (1826), pp.25-31.

Singh, A., & Sarkar, P. K. (2009). Determination of Congestion Cost in Central Business District of New Delhi—A Case Study. Journal of Indian Roads Congress, July-September.

Turochy, R.E. and Smith, B. L. 2002. 'Measuring Variability in Traffic Conditions By Using Archived Traffic Data', Transportation Research Record, (1804), 168-172.

Tom, T., (2014).TomTom Traffic Index (www.tomtom.com); at www.tomtom.com/lib/doc/pdf/ 2014-05-14%20TomTomTrafficIndex2013annualAme-mi.pdf.

Varmora, K. K. C., & Gundaliya, P. J. (2013). Effect of Traffic Composition and Road Width on Urban Traffic Stream. IndianJournal of Research-PARIPEX, Vol. II, Issue IV.

Sen A. K., Tiwari G., Upadhary V., (2005) "Estimating marginal external costs of transport in Delhi" Online Article, Retrieved: http://www.sciencedirect.com/science/article/pii/ S0967070X09001000, date, 26.06.2015.

Sen, R., Sevani, S., Sharma, P., Koradia, Z., & Raman, B. (2009). Challenges in Communication Assisted Road Transportation.

Shuichi, M., & Hironao, K. (2003). A Study on the Traffic Impacts in City Traffic Consideration of the Value of Time about Streetcar. Journal of Nippon Kikai Gakkai Kotsu, Butsuryu Bumon Taikai Koen Ronbunshu (Japan), 12, 403-406.

Weisbrod G. and Fitzroy S (2011). "Traffic Congestion Effects on Supply Chains: Accounting for Behavioral Elements in Planning and Economic Impact Models, Supply Chain Management - New Perspectives", Prof. Sanda Renko (Ed.), ISBN: 978-953-307-633-1, InTech, DOI: 10.5772/23057. Available from: http://www.intechopen.com/books/supply-chain-management-new-perspectives/traffic-congestion-effects-on-supply-chains-accounting-for-behavioral-elements-in-planning-and-econo

Wilson M., (2008). "An Exploration of the Road Traffic Congestion and Supply Chain Performance", 2008 Oxford Business and Economics Conference, College of Business Administration, California State Univ., Sacramento.

http://blogs.worldbank.org/endpovertyinsouthasia/can-we-build-dhaka-out-traffic-congestion

http://opinion.bdnews24.com/dr-adnan-morshed/