

Contextual Mitigation Measures of Air Pollution and Travel Demand: The Case of Dhaka City.

¹Jasmin Ara Begum, ²Rumana Rashid and ³Md. Mahfil Ali

Air pollution particularly by transport mode has been identified as the major source of air pollution in Dhaka, the capital city of Bangladesh. Pollution standard in Dhaka has been exceeded comparing to the pollution standard decided for Dhaka by the USEPA (United States Environmental Protection Agency) and WHO (World Health Organization) (Paul M K et al, 2002). Dhaka traffic composed of motorized and non motorized traffic. Three hundred thousand vehicles are registered in Dhaka and most of them emit harmful pollutants. A number of short term measures have been undertaken that have improved air quality at certain level. Till now, the increase of pollution rate is higher in compare to the achievement of the short-term mitigation measures undertaken to reduce pollution. Therefore, long-term mitigation measures like 'Reduction of Travel Demand' can be one of the fruitful strategies for Dhaka. Impetus of this paper is to review the existing pollution problem, impact of pollution, present public and private initiatives, and lessons from the developed world. Main focus of the paper is to evaluate the possibility for the long-term pollution mitigation measures by reducing travel demand in context of Dhaka City.

Key words: Travel Demand, Air Pollution, transport and traffic, disease, information technology, land use, long term integrated planning.

1. INTRODUCTION

Most significant output of the Industrial Revolution is perhaps increased mobility of people. It has provided people new forms of housing, new forms of transport, and new forms of job. In parallel with the advancement of technology, industrial revolution has imported new problems too. Air pollution is one of such problems that have been severely affecting the global urban and rural area environmental quality. The rapid growth of population along with unplanned land use development and inefficient traffic management system caused tremendous pressure on existing road network in Dhaka city. Air pollution caused by transportation is a serious environmental problem in Dhaka city. The impact of air pollution is many folds. In local context it has acute impact on physical and mental health of people. The intention of this paper is to review the existing pollution problem, impact of pollution, present public and private initiatives, lessons learned from other countries. Main focus of the paper is to recommend the long-term pollution mitigation measures by Reducing Travel Demand in the context of Dhaka city. The study is based on desk-top research of published papers, direct observation of Dhaka's traffic related problems and issues, changes in land use pattern of Dhaka city over

¹Professor, Department of Architecture, Ahsanullah University of Science and Technology, (AUST), Dhaka, Bangladesh, E-mail: Jasmin.arch@aust.edu

²Phd in Architecture (candidate), Department of Architecture, Faculty of Built Environment University Technology Malaysia (UTM), Malaysia, E-mail: rashid_rumana@yahoo.com

³Associate Professor, Department of Architecture, Ahsanullah University of Science and Technology (AUST), Dhaka, Bangladesh, Mahfil@yahoo.com, mmali@graduate.hku.hk

Begum, Rashid & Ali

last forty years, experience in different developing and developed countries and design exercises carried out in undergraduate architectural design studios.

2. EXISTING SITUATION

It is felt an urgent need to review the existing situation concerning travel demand in Dhaka city, air pollution and pollution caused by transport as well as the impact of pollution on urban dwellers. The underlying reasons for transport related air pollution in Dhaka would give a clear understanding for future development proposals.

3. TRAVEL DEMAND IN THE CONTEXT OF DHAKA CITY

Dhaka, the capital city of Bangladesh, has emerged as a mega-city due to its rapid population growth. The estimated population of Dhaka is 12.8 million as of 2008 (Bangladesh Bureau of Statistics, 2005) with a projection of 25 million by the year 2025, making it the seventh largest populous city in the world (Rahman et al, 2001). Rural-urban migration in search for better job opportunities and urban amenities is the pressure working behind the rapid growth pattern. Along with the population growth, demand on different urban infrastructure has increased in an alarming rate; transportation and travel demand is one of the major areas of concern in this regard. According to Dhaka Urban Transport Project 1998, vehicle population on road is growing at an average rate of 10% annually (Alam Md .J. B. et al, 2003). Though total vehicle number is not that significant in terms of developed countries, but their impact over the city is markedly evident as the overall city is unplanned. Inefficient integration between land use and transport is one of the significant issues in this context. Air pollution associated with transportation is one of the major areas of concern for the growing mega city Dhaka.

Dhaka traffic composed of both motorized and non-motorized traffic. Out of a little over 200,000 motor vehicles that ply on roads, about 35,000 were three wheel taxis (Rahman et al, 2001). Table: 1 shows the number of registered vehicles in Dhaka city in 1995, 2000 and 2005 Bangladesh Bureau of Statistics (BBS 2005). According to available government statistics, growth of car and jeep, s. wagon and microbus, buses, and motor cycle in 2005 compared with 1995 were 90%, 125%, 62%, and 212% respectively.

Table 1 : Number of motor vehicles registered in Dhaka metropolitan area by type

Year	Car	Taxi/ Maxi	Auto tempo	Bus	Truck	Auto rickshaw	Jeep	s. wagon microbus	Motor cycle	Tractor
1995	3482	-	1278	521	1974	6217	307	769	4132	41
2000	5337	-	68	835	993	218	353	2246	7127	49
2005	5633	514	139	846	1104	-	1571	1732	12879	-

Source: 2005 Statistical Year Book of Bangladesh, Bangladesh Bureau of Statistic

Begum, Rashid & Ali

The majority of the commuters in Dhaka city depend on road transport, rather than on rail or water transport. The overall road network in Dhaka has severe disadvantages. There are three major routes connecting Dhaka with other parts of the country and the important places within the city. Most of the major roads are north south oriented with only a few major east-west connecting roads. Thus the pressure on the major roads is tremendous. Moreover travel demand on all the roads is not equal. The following table: 2 show the number of people using different mode of travel and the length of travel using each mode. Pedestrian traffic constitutes around 62% and rickshaw around 35% of total trip per day, two major modes of travel.

Table 2: Mode of travel used by people and travel distance covered

Mode of travel	Number of personal trips		Average length of travel	Passenger kilometre	
	000/ day	(%)		000/day	(%)
Car	576	10.5	10.4	5990	11.9
Bus	1482	27.0	13.5	20007	39.8
Auto rickshaw	845	15.2	12.8	108116	21.6
Rickshaw	1927	35.0	4.3	8286	16.5
Other	675	12.3	7.5	5066	10.1
Total	5505	100	9.1	50165	100
Pedestrian	9000	62.0	1.0	9000	15
Total	14505	100	4.1	59165	100

Source: Habib M. A., Mitra S., Shapatta and Nirman, No: 10 p.53

But unfortunately these two types of traffic are not integrated in the present traffic management system. Sharing of same roads by slow moving vehicles like rickshaws with fast moving vehicles and road crossing by pedestrians in a haphazard manner is causing traffic hazard and congestion. The average speed of traffic slows down due to mixed traffic flow in Dhaka city. Lack of hierarchy between roads, too many intersections, inefficient traffic management system, mixed traffic use – all are the reasons for continuous traffic congestion and the increased level of air pollution on these roads.

Figure 1: Mixed Traffic in Dhaka city



4. AIR POLLUTION AND TRANSPORT

Air pollution can be defined as the addition of harmful substances to the atmosphere resulting in damage to the environment, human health, and quality of life. It can develop inside and outside the physical premises, in the city and even globally. Some air-pollution return to earth in the form of acid rain that is harmful for buildings, damage crops and make exposed water bodies harmful for lives depending on them. In Bangladesh air pollution is concentrated mainly in major towns and cities, particularly the capital city Dhaka due to the existence of industries, excessive traffic congestion and movement. The quality of air and air pollution in urban areas depends on movement of air, traffic volume and congestion, uncontrolled emission from motor vehicles, dust particles and other activities related to high population density.

The exhaust from all types of motorized vehicles emits harmful pollutants, including small particulate matters, carbon monoxide, hydrocarbons, and oxides of nitrogen and oxides of sulphur. The principal pollutants from gasoline-powered internal combustion engines are carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide, particulate of lead compound, and unburnt carbon particles (soot). Emissions from diesel engines are odor, smoke, carbon monoxide, unburnt carbon, nitrogen oxides and sulphur dioxide (Rahman et al, 2001). Dhaka city's SPM levels are about two times higher than the accepted standard of 200 microgram/m³ in residential areas and ten times higher than the WHO guidelines of 120 microgram/m³ (24 hours) in commercial areas. The International Atomic Energy Agency (IAEA) also studied that pollution levels of lead in Bangladesh are among the world's highest during dry seasons (IAEA news brief, 1996).

The Department of Environment (DOE) has made an assessment that 80% of the automobiles in Dhaka city is faulty and emits black smoke in excess of the prescribed limit. They also identified that, two-stroke engines used in auto-rickshaws, tempos, mini-trucks and motorcycles and leaded petrol being the main reasons for air pollution (Rahman et al,2001). Along with the growing number of the vehicles, narrow roads, congestion, quality of fuel and poor traffic management are further aggravating the air pollution situation. DOE and other agencies identified that two-stroke engine used in auto rickshaws, tempos, mini trucks and motorcycles and the leaded petrol and use of age-old vehicles as the main reasons for air pollution. Though the baby taxi is now replaced by Compressed Natural Gas (CNG) fuelled taxis.

5. IMPACTS OF AIR POLLUTION

Air pollution threatens human health and economic growth. The city dwellers are being slow poisoned by air pollution particularly by lead particles dispersed in petrol, which is used as fuel. Air, which the city dwellers and the road users breathe, contains lead in concentrations almost ten times above the government safety standard set by DOE. Reports from scientific studies revealed that the density of lead in the air of Dhaka city in the dry season reaches 463 nanograms per cubic meter, the highest in the world in

Begum, Rashid & Ali

comparison to 383 and 360 nanograms in Mexico City and Mumbai respectively. Lead concentration in the blood of automobile drivers and office goers was found to be as high as 120 parts per million, (Rahman et al, 2001).

Air pollution badly affects the respiratory tract, causes irritation, headache, fatigue, asthma, high blood pressure, heart diseases and even cancer. Excessive lead in the blood of children could damage their brain and kidney and children are three times more at risk than adults. In a World Bank report it is stated that public exposure to air pollution in Dhaka city is estimated to cause 15,000 premature deaths and several million cases of sickness every year. Brandon (1997) and Ostro (1994) estimated that 3,580 premature deaths, 10 million restricted activity days, and 87 million respiratory system days annually could be avoided if the SPM concentration could be reduced to the level of Bangladesh air quality standard (Xie et al, 1998). The resultant economic cost due to such illness and premature death could reach US \$800 million per year (The Daily Star 2003).

Present public and private initiatives

The Department of Environment (DOE) has taken a number of measures to reduce the causes of air pollution in Dhaka city. In majority of the cases it was found that the continuous evaluation and monitoring of those measures were not feasible due to multifarious reasons. The daily monitoring of automobiles at certain points in Dhaka city to check the extent and quality of automobile exhaust did not work out due to non-availability and co-operation of law enforcing agencies. Raising public awareness through media and mass campaigns were also inadequate and could not reach the desired goal. On the other hand punishing the faulty automobile owners using mobile courts did not function well due to lack of co-ordination among the concerned agencies (Bangladesh Road and Transport Authority, Dhaka Metropolitan Police and Dhaka Metropolitan Magistracy).

A consultative meeting organized by the World Bank in association with Department of Environment (DOE) and the Bangladesh Government came out with a few important recommendations (Rahman et al, 2001).

1. Phasing out of the use of leaded petrol as soon as possible.
2. Stopping of issuance of new licenses and route permits of three wheelers with two stroke engines and phasing out the existing 2-stroke engine-powered three wheelers.
3. The sale of loose lubricants should be stopped to prevent adulteration.
4. The use of Compressed Natural Gas (CNG) in vehicles should be promoted.
5. The big gap in the prices of gasoline, diesel and kerosene should be removed to prevent adulteration.

A number of short-term measures have been initiated, which have brought substantial changes in the air pollution situation of Dhaka city. Use of lead in gasoline has been banned and three wheeler gasoline used baby taxis have been replaced by CNG fuelled taxis. In order to prevent adulteration, the

Begum, Rashid & Ali

government also took measure to colour Kerosene to prevent its mixing with petrol or octane. Islands and traffic dividers are rearranged, fly-over, pedestrian over-passes are constructed and new traffic signals are installed in several road intersections to control and manage traffic. Government has already taken decision to offer financial incentives (reduction of registration and renewal fees) for converting four stroke automobiles using petrol and diesel to CNG. The DOE under its Bangladesh Environment Management Project (BEMP) has converted a few auto-rickshaws into CNGs.

As a part of Government policy, to reduce pollution and traffic congestion several commercial transport services Bangladesh Road Transport Corporation (BRTC), Premium Bus (special bus), Big commercial Buses, Mini buses and Taxi services have already been introduced in public and private sectors in the last few years. The DOE has procured sophisticated equipment to detect air polluters in the city particularly automobiles. The DOE has also set up modern laboratories to determine the nature and quantum of air pollution. Question can be raised about the monitoring of these initiatives. Signals do not work properly, public buses generate pollutants and roads are not aligned considering rickshaw (most sustainable mode) and pedestrians.

Figure 2: Pedestrian crossing busy road intersection (Left) Age old bus emitting pollutants (Right)



The International Development Association (IDA), the World Bank's concessionary lending arm, has announced the approval of a US\$ 177 million credit to help solve Dhaka's air pollution and traffic crisis under the Dhaka Urban Transport Project. The total project will exceed US\$ 234 million. Air quality management and control is a significant part of the project (Rahman et al, 2001). It is essential to make use of limited resources judiciously in order to meet our long-term goals of mitigating air pollution.

All the initiatives over the years with respect to growth of the city - first attempt in 1958, second by Dhaka Metropolitan Area Integrated Urban Development Plan (DMAIUP) in 1981, the statutory Metropolitan Development Plan (1995-2015) were never given emphasis to transportation system, accessibility to it and any other related issues. The Dhaka Metropolitan Development Plan 1995 introduced some policies for metropolitan Dhaka for the first time, among which construction of eastern by-pass and incremental network

Begum, Rashid & Ali

development are the two major policies. These strategies neither govern nor influence growth strategy for Dhaka and also failed to establish the essential linkage between land use and transportation system (Habib et al,2003).

Lessons learnt from developing and developed world

The governments of developed countries have fought for clean air by regulating all major and many minor sources of air pollution. The new vehicles in developed nations are now 90% cleaner than those manufactured in 1970's (Karim M.M, 1997). A command-and-control measure was taken in Mexico City, Sao Paulo, Beijing and other cities to reduce travel demand. The government of Mexico City bans car driving on specific days. This kind of measure can be inefficient and even counterproductive as "Eskeland and Feyzioglu (1995) found that in Mexico City the driving ban actually increased total driving after an initial adjustment period of about six months." (Xie et al, 1998). The development of master plan of Curitiba shows a success story where mobility and land use were planned together. The main transport arteries were modified over time to give public transport the highest priority. Two-way arteries were used exclusively for two-way buses creating a safe, reliable and efficient bus service operating without the hazards and delays inherent to mixed traffic bus service. The buses travel as fast as subway cars, but at one-eighth the construction cost (Ashraf K.K, 2004).

Figure 3: Curitiba Road system (Left) Rapid bus service (Right)



Mountainland's Regional Transportation Plan used TDM (Transportation Demand Management) system where the stress was given on reducing single- occupant vehicle travel. In a study by Xie, J. et al from the World Bank in April 1998, discussed the possibility of demand control via fuel taxes, as an economic incentive measure. The main intention of their suggestion was to "turn consumers away from fuel-intensive consumption activities by levying fuels or travel based on their impacts on the environment." (Xie et al, 1998). The fuel prices have raised over the years, the regular leaded gasoline was 13 taka per litre (about US\$ 0.30/ litre) until August 1997 to lead free Octane taka 35 per litre (about US\$ 0.60/ litre) and Petrol taka 32 per litre (about US\$ 0.60) in March 30, 2004. Lead free Octane and Compressed Natural Gas in 2010 are US\$ 1.1/litre and US\$ 0.24/cft respectively. The overall reduction in travel demand is not perceivable; rather it is increasing day by day. The annual fuel consumption in transport sector rather increased steadily from 777,000 tons in 1990 to 1.2 million tons in 1995 (BBS 1997). On the other hand the gradual increase in use of Compressed Natural Gas instead of petrol/ octane is markedly evident in Dhaka City. The reason for this change is

obviously the marked difference in prices of Gas and petrol/ octane. The impact of using gas in reducing air-pollution in Dhaka city is worth mentioning.

6. LONG TERM POLLUTION MITIGATION STRATIGY

Reducing travel demand in Dhaka city

The aim of reducing travel demand is to control vehicle emissions by minimizing vehicle-kilometres of travel and associated fuel consumption in long-term basis. The overall planning should be a comprehensive process integrating transport planning, land use and air quality management. A number of measures have already been taken in developing and developed countries to meet the above end that shows both successes and their limitations. The paper focuses on the possible measures that could be taken along with the successful ones to mitigate the problem of air pollution in Dhaka city.

Integration of transport and land use

In the present context of Dhaka city, reducing travel demand is not only dependent on fuel prices or command-and-control measures. It is also necessary to find out the possible destinations people travel to on a daily basis, the mode of travel they use, the location related aspect that cause increased travel time and many other related factors. The major areas the city dwellers travel to on a daily basis are to work places, shopping, living and recreational facilities. Travel to meet social demand, though important, usually does not put pressure on peak hours. An integrated planning of land use pattern and urban transportation can reduce travel distance. To save travel time and money and also to avoid traffic congestion related painful experiences, city dwellers prefer to live close to their work places, school/ colleges/ universities and in some cases close proximity to shopping areas. The mixed-use development of previously designed residential areas, for example Dhanmondi, Gulshan, and Mohammadpur areas indicate the similar trend. Now a day travel between Gulshan to Dhanmondi, during peak hours, takes around 45 minutes to an hour journey each way, which are only 8-10 kilometres apart.

Traffic congestion due to over crowded roadways, blocked intersection, slow paced movement for mixed traffic, railway crossing within busy roads – are the hazards people face daily in Dhaka city. It is not only the pollution content in air, also the time people remain exposed to air pollution, causes health hazards in Dhaka city. The possibility of organizing job centres/ offices, school/colleges/universities, residential areas and shopping centres should be explored through research, so that people would travel less to reach their destination. An idea of compact city planning is being in the process of development in many cities of the world. There can be a number of centres, self sustained with all the above facilities and interconnected with each other, could be good possible solution. Interconnection not only by roadways, river taxis, railways and other modern transport could alleviate present state of congestion. Smart Growth, a new concept that encourages land-use density,

Begum, Rashid & Ali

clustering and mix, more balanced transportation, and reduced urban expansion in the planning process can also have impact on future development.

Public mode of transport

Sharing of transport is another important aspect to reduce travel demand. Individually owned private vehicles in Dhaka city is growing at a faster pace along with the economic growth of city dwellers. Private mode of transport must be discouraged. Mass use of public transport can reduce trip numbers, fuel consumption and over all cost of travel. Providing buses for individual offices, educational institutes, park and ride system and so on could reduce number of trips and share of spaces on roads. Use of Mass Transit System (e.g. Rapid Bus Service, Sky train/ mono rail/ sub-way/ surface train) should be considered in the long term planning process. Examples from Singapore, Thailand, Malaysia and India show a success story that we can follow. Use of electricity, though expensive in terms of money and available resources for Bangladesh, battery-operated transport can be used as alternative to reduce air pollution in Dhaka city.

Pedestrian facilities

Proper urban design and space planning in residential and commercial areas could encourage people to walk. People in European countries (e.g. U.K., Belgium, and France) prefer to walk, as there are well-designed pedestrian walkways, safe traffic system with pedestrian crossing, less air pollution and better overall environment. In Dhaka people face problems to walk safely, as there are no such pedestrian walkways, efficient traffic system to cross roads, unauthorized use of walkways, and environmental pollution. Along with this social and political hazards make pedestrian pathways unsafe and hazardous. Designing pedestrian pathways could also reduce the number of trips using motorized vehicles. Therefore, future extension and redevelopment planning of Dhaka city need due consideration to pedestrian traffic, bi-cycle users and other mode of oil free transport, which in long run would reduce air pollution caused by urban transport.

Figure 4: Pedestrian foot path people are waiting for bus (Left) Occupied for other use (Right)



Time staggering

Time staggering is one of the strategies to reduce air pollution. Time staggering can reduce peak hour traffic congestion. It will also help reduce fuel consumption and pollution contents. It is evident from the present traffic demand pattern in Dhaka city that the traffic congestion and travel demand is higher at certain hours of the day:

- From 7:30-9:00 School/College/University and Office/work hour begins
- From 1:30-2:30 School/College/University closing hour
- From 5:00-6:30 Office closing hour

Not only the educational and office facilities, opening and closing hours and weekly holidays of shopping facilities also have impact on travel demand. For example the Mirpur road close to New-market, Gaosia and Chadni chok market shows different traffic load during Tuesday, the off day, compared to the rest of the their working days. Though the traffic volume spread over through out the shopping hour, there are significant variations over the year due to different religious and other social occasions. The shopping centres can also stagger their opening/ closing time as well as their weekly holidays. The staggering of opening and closing hours of all major facilities would reduce pressure on existing roads and consequently increase speed of travel.

Use of advanced technology

The advancement of technology has made the world smaller these days. Now a days the communication system is so advanced that it is possible to do lot more work being at home. Use of telecommunication system including mobile phone, fax, internet made the works lot easier and it is possible to send important information, letter, and data from one place to another in a short period of time. All these technologies, if utilized properly, can reduce the demand for travel. In developed countries, a patient can even get treatment over phone and need not to visit hospital. The impact of using advanced technology on location aspect and land use is tremendous.

An agreement has already been signed with twelve foreign countries to install submarine cables in Bangladesh. It will open up a new window in the area of communication at cheaper rate. It has an optimistic impact on land-use plan and also it will be possible to reduce substantial amount of travel demand. Impact of new communication system is varied. Different government and non-government offices can be shifted to the out skirt of the city as they could now rely on new communication systems. Use of inter net, e-mail, e-cash would reduce the need to travel to post-offices, banks or shopping centres. In near future people would be capable to complete their major portion of works at home and need not to work in the office for a long time. Office hour can be reduced or staggered to reduce travel demand. Thus in the long run traffic congestion and peak hour rush would be reduced.

ONE STOP SERVICE

Paying bills of different sorts cause lot of delays, travel time and trips in a busy urban area. Use of credit cards, bankcards, telephone billing, and shopping charge cards can save time and people can avoid travelling to Banks for money collection or paying their bills. Within last few year people in the country have come to know about the supermarket culture, particularly in Dhaka city. The culture of super market will reduce travelling, as shoppers will get all different type of goods in one place. It will also enhance the trend of weekly shopping. In some cities super markets provide home service if shoppers order a handsome amount of goods. In Hong Kong Park N Shop provides this service. In this way a single van serves a number of families and thus reduces travel demands. In Dhaka this culture is not yet developed, though a number of private initiatives were taken but couldn't get much success.

Institutional integration

Significant political will and technical support is essential for implementing all the existing and suggested measures. As the mass population is the victim of air pollution, it is urgent to create public awareness and attitude regarding impact of air pollution and possible measures. Public education through mass campaign and media can keep an impact in this regard.

Along with the above options traffic management can also reduce travel demand. Appropriate parking facilities, discouraging parking on busy roads, modern method of road crossing for pedestrian traffic should also be encouraged.

7. Conclusion

To mitigate the present state of air pollution in the context of Dhaka city, reducing travel demand is identified as one of the main long-term strategy in this paper. Short-term measures can only improve temporary situations. Moreover the present state of air pollution and its impact on urban dwellers is much higher than the improvement initiatives so far undertaken. Therefore long-term strategies have no alternatives at all. Reducing travel demand is a modern strategy to mitigate air pollution problem in Dhaka city. A systematic and integral planning approach is sought for considering all different existing approaches and future possibilities of reducing travel demand and associated air pollution.

REFERENCE

- Alam, J.B. and Habib K.M. 2003 "Effects of Alternative Transport Options on Congestion and Air Pollution in Dhaka City". *The Journal of Civil Engineering, IEB*, Vol. CE 31, No.2
- Ashraf K. K., 2004 *The miracles of Curitiba*, *The daily star*, Vol. XIV, No. 67, march 25, pp.5.

Begum, Rashid & Ali

- Bangladesh Bureau of Statistics "[Statistical Pocket Book, 2008](#)", Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh, January 2009. <http://www.bbs.gov.bd> Retrieved 31-12-2009
- Bangladesh Bureau of Statistics, Transport and Communication (Chapter 7), *2005 Statistical Year Book of Bangladesh*, ed. Jafar Ahmed Chowdhury, 25th edition, The Government of Bangladesh, pp.267-269, January 2007.
- Bangladesh Bureau of Statistics, Transport and Communication (Chapter 7), *1997 Statistical Year Book of Bangladesh*, ed. W. Islam, eighteenth edition, The Government of Bangladesh, pp.269-295, September 1998.
- Habib, A.H. and Nabi, A.S.M., *Impacts of land use and transportation system on urban form and structure of Dhaka city*, Proc. of the International Seminar on *Architecture Overcoming constraints*, eds. Z. N. Ahmed, K. M. Haq Gary, Han W J, Kim C and Vallack H. 2002 *Bench marking Urban Air Quality Management and Practice in Asian Cities*. 3.5 Dhaka: Situation Analysis and Urban Air Quality Trends pp 31-33. Dec.. www.cleanairnet.org/caaasia/1412/articles-36570-recurso-1.pdf
- IAEA News briefs *Bangladesh studies pollution levels*, Vol.11, No. 4(73), Nov.-Dec., 1996.
- Karim, M. M., *Traffic Pollution in Bangladesh and Metropolitan Dhaka, a Preliminary Investigation, Japan*, 1997. www.eng_consult.com/pub/dstar.htm
- Maniruzzaman and R. Hafiz, 2003 Department of Architecture, BUET, Dhaka, pp.167-175, June.
- Molina Mario J. and Molina Luisa T. *Improving Air Quality in Megacities: Mexico City Case Study*. Massachusetts Institute of Technology, USA. <http://peace-foundation.net.7host.com/file/Mexico>
- Paul M. K. and Quader A.K.M.A. 2002 A Study of the Air Pollution of Dhaka City. The paper presented at CHEMCON 2002 (at Hyderabad), December 19-22,. www.cleanairnet.org/caasia/1412/article-59766.
- Rahman, G., Majumder, M.K. & Rana, B. 2001, "Air pollution in Bangladesh (Chapter IX), Bangladesh State of Environment Report 2000," ed. Q. I. Chowdhury, *FEJB publication, Dhaka*, pp 101-113, June.
- The Daily Star Web Edition, Vol.4, Num. 55, p.1
www.thedailystar.net/2003/07/20/d30720250278.htm
www.worldbank.org/wbi/cleanair/global/topics-dhaka
- Xie, J., Brandon, C. J. & Shah, J. J., 1998 "Fighting Urban Transport Air Pollution for Local and Global Good: The Case of Two-Stroke Engine Three Wheelers in Dhaka", The World Bank, April,