Proceedings of the 2nd International Conference on Civil Engineering for Sustainable Development (ICCESD-2014), 14~16 February 2014, KUET, Khulna, Bangladesh, ISBN: 978-984-33-6373-2 (CD-ROM)

EVALUATING THE PERFORMANCE OF A ROAD: A CASE STUDY OF MURADPUR TO DEWANHAT ROAD, CHITTAGONG

Md. Rezuanul Islam*[1], Shoukat Ahmed[2], Debasish Roy Raja[3]

[1] *Undergraduate student, Department of Urban and Regional Planning, Chittagong University of Engineering and Technology, Chittagong-4349, Bangladesh.*
E-mail:fahiemislam@gmail.com
[2] *Undergraduate student, Department of Urban and Regional Planning, Chittagong University of Engineering and Technology, Chittagong-4349, Bangladesh.*
E-mail: eshan0905027@gmail.com
[3] *Assistant Professor, Department of Urban and Regional Planning, Chittagong University of Engineering and Technology, Chittagong-4349, Bangladesh.*
Email: rdebasishroy@gmail.com

ABSTRACT

Efficiency of transportation network has greatly influenced by traffic volume and capacity, speed, geometrical design, road side land use etc. Besides, all these factors have a great impact on the overall performance of the road. The aim of this research is to find out the performance of the feeder road connecting from Muradpur and Dewanhat junction in Chittagong City, second largest city of Bangladesh. The study road is very important road of the city because it is connected with Bahaddarhat, GEC Circle, WASA circle, Tigerpass, Dewanhat and many other important places of the city boundary and these areas have a great economic impact in the entire city. To evaluate the performance of this road, its geometrical characteristics and Level of Services (LOS) have been analyzed depending on the data collected through different field surveys. The present condition of the study road was tried to be focused by making a comparison between the measured data from survey and national and international standard. This research also explains how road way and traffic factors relating to LOS greatly influence the performance of the road. It was found from various surveys that the performance of this road was completely failed to meet the traffic demand during peak hour and traffic congestion is reached in an intolerable position. The research helps us to understand the magnitude of different factors to maintain a good performance of a road.

Keywords: *LOS, Speed, Volume, Road factors, Performance*

1. INTRODUCTION

1.1 Background information

Bangladesh is one of the most densely populated countries in the world bearing a population of 965 per square km (BBS, 2011). Rapid urbanization has also become a visible feature, especially in the three major cities of Bangladesh: Dhaka, Chittagong & Khulna, after the liberation of Bangladesh in 1971. While the total population of the country has been increasing at 1.37% per annum (BBS, 2011), the urban population is growing at about 3.27% per annum (Aqua Consultant et al, 2012). This rapid urbanization has created a strain on the resources of local bodies like cities, towns and municipalities, which are often finding it difficult to cope with the increasing demands of the city dwellers for urban services and civic amenities like transport, housing, utility services. Like all developing countries transportation is a very important ingredient to their economic activities (Mahmud et al, n.d.).To cope with the rapid urbanization and diversification of economic activities as a developing country the transportation system of Bangladesh is facing numerous problems such as extreme degree of traffic congestion (Hodgkin son and Ellery, n.d.). Like other countries, the traffic problems are increasing day by day and have become a burning issue for Bangladesh (Shamsher and Abdullah, 2013). In Bangladesh the overall annual growth rate has been nearly 8.2 percent for fright transport and 8.4 percent for passenger transport (Mahmud et al, n.d.). Annually country wise economic wastage caused by traffic jam was USD 79 million for the year 1997. The traffic congestion cost is USD 03 billion a year and the city losses over 08 million work hours daily (Shamsher and Abdullah,2013).Chittagong is the second largest city in Bangladesh having a population of about five million including people living in the urban fringes. The functional operation of Chittagong city is largely depends on the existing road pattern into city area. The concept, 'functional operation' has been brought out from the concept of 'Transport Efficiency' (Debnath and Islam, 2009). Because of increasing population in this city, the efficiency of transportation system is becoming more and more complicated as like Dhaka city. This

poor traffic system is being stimulated by heavy concentration of traffics, absence of adequate public transport, inadequate road infrastructure, faulty signaling equipment and poor enforcement of traffic rules (Shamsher and Abdullah, 2013). In order to keep the wheels of development, moving a sound and well performing transport system is must.

1.2 Statement of the problem

Chittagong city is experiencing rapid growth of population because of rural urban migration (1997; BBS 1981, 1991 and 2001). This rapid growth of population increasing the traffic pressure on road and making city dwellers life standstill due to traffic congestion (Shamsher and Abdullah, 2013).Chittagong city is functionally connected with surrounding area by mainly one road named Kalurghat to Patenga. Intolerable traffic jams as well as low performance at this important road especially in the Muradpur to Dewanhat segment have made lives of citizen miserable. The traffic system of this segment has already collapsed as the vehicles can't run on the main road of the city due to excessive congestion. According to experts opinion traffic congestion occurred in Muradpur to Dewanhat road mainly due to huge traffic flows and mixture of motorized and non-motorized vehicles ply at the same time in the main road intersections. As per BRTA (Bangladesh Road Transport Authority, 2010) source at present the total number of approved vehicle in Chittagong city is 84391. Among these, Bus -2816, Auto rickshaw (Taxi)-20847, Tempo-4666, Motorcycle-13470, Jeep-1951, Car-15961, Pickup-3656, Tank lorry-386, Tractor trailer-503, Truck-14065 and Micro-5998 where city roads are not enough to capable of carrying all this type of traffic especially in the peak hours. Day by day all these vehicles are gradually increasing. The road between Muradpur to Dewanhat segment is not well wide spread and getting narrower because of illegal possession on the road. According to DAP, 2008 road width of this road has recommended as 100 to 120 feet. But most part of this road have approximately 80-90 feet black top only. Illegal on street parking, high volume of traffic, poor lane management, improper planning of this road is decreasing its performance day by day.

1.3 Aims and objectives

Analyzing the performance of Muradpur to Dewanhat road in Chittagong city is the aim of this study. The road was sub divided into three segment named Muradpur to 2 no gate link, 2 no gate to GEC link, GEC to Tigerpass link and for fulfilling the aim traffic volume, speed, capacity and level of service for each link were calculated. Considering the factors that were affecting the performance of study area is also one of the key objectives of this research.

2. STUDY AREA

For analyzing performance and issues relating to the performance of a road, we have taken Muradpur to Dewanhat road of Chittagong city as our study area. This road contains major three intersections: 2 no gate, GEC and Tigerpass. Two very important roads named Chawkbazar and Hathazari road is connected with 2 gate junction whereas Dhaka-Chittagong highway is connected with GEC and New market, Pahartali and Agrabad road is connected with Tigerpass intersection point. This road is the major feeder road of Chittagong City Corporation and it provides numerous commercial, utilities and service centers of its both sides. Therefore most of the time it remains very working occupying different mode of vehicles by users.

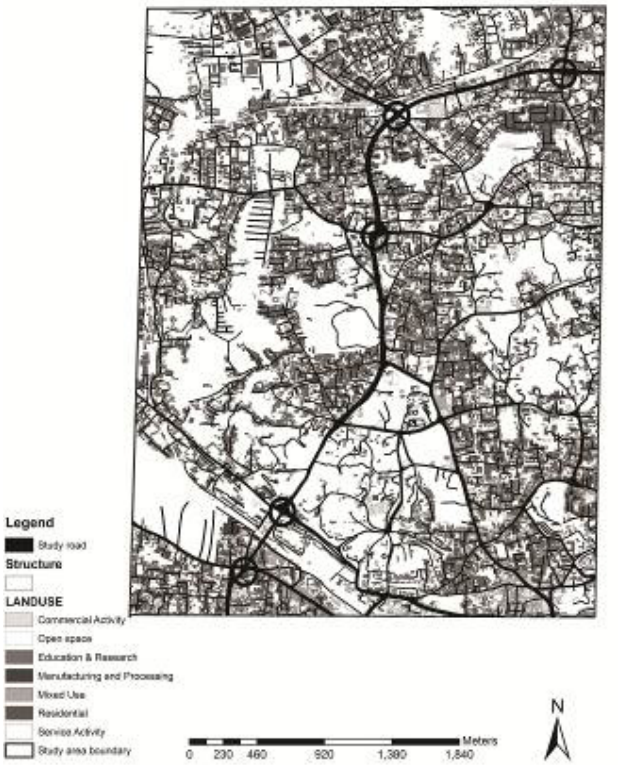

Figure 1: Study area

3. METHODOLOGY

The research consists of both primary and secondary data. Primary data were collected from reconnaissance survey and field survey. Secondary data were collected from literature review, newspaper reports, websites etc. The geometric data of the study road were collected through field survey and for collecting finding Level of Services (LOS) of the road some data relating to volume, speed etc. were collected through field survey and some data were extracting through different formulas. In this research for finding the LOS of the study road, volume and capacity ratio is used. The study road was selected from Muradpur to Dewanhat junction. To find the volume data we have counted traffics from three major intersection points (2 No. Gate intersection, GEC intersection and Tiger pass intersection) in different direction using manual method both in holiday and working day. In this method we personally counted and classified traffic flowing. Then the counted value of the traffic was multiplied by the relating PCU value of the traffic. By the way the volume data was found .We divided our counting time into peak and off peak hour. The time durations were 8:30-9:30 am, 11:00-12:00 am, 03:00-04:00 pm and 05:30-06:30 pm. The vehicular types and their relating PCU are given in the chart:

Table 1: Vehicle type with PCU

Vehicle type	PCU
Bus	2.5
Minibus/Truck	2
Car/Microbus/Zeep	1
CNG	0.5
Rickshaw	0.8
Tempo/Human hauler	0.6
Motorcycle	0.3
Bicycle	0.2
Push Chart	4

Source: Roads and Highway department of Bangladesh

For calculating the capacity the following theoretical formula was used:

Here flow rate (q) is obtained by moving observer method which was conducted at the same time of volume count. In this method flow was measured into selected directions. The using formula was use to find the flow rate:

$$q_{a-b} = \frac{X_{b-a}+V_{a-b}}{t_{a-b}+t_{b-a}} \quad \text{..... (1)}$$

q_{a-b}= flow rate to b direction, X_{b-a}= opposing traffic count of vehicles met when the test vehicle was travelling froma to b, t_{a-b}= journey time of a to b, t_{b-a}= journey time of b to a, V_{a-b}= number of vehicles overtaking the test vehicle – the number of overtaken by the test car, when the test car was travelling b direction.

For calculating average journey time the following formula was used:

$$\bar{t} = t - \frac{y}{q} \quad \text{..... (2)}$$

t= total journey time, q= flow rate, y= no. of overtaking vehicles- no. of overtaken vehicles when test vehicles was moving

For calculating average journey speed (v) we used following formula:

$$V = \frac{d}{\bar{t}} \quad \text{..... (3)}$$

d= total distance, $\bar{t}$= average journey time

Again for calculating average spacing (S) we used following formula:

$$S = L + .278vt \quad \text{..... (4)}$$

V= average journey speed, L= length of the test vehicle in meter, t= perception-reaction time in second. In our research L= 2.63 meter and t= .75 second

$$C = \frac{1000V}{S} \quad \text{..... (5)}$$

C= Capacity in vehicles per hour, V= average journey speed in K.P.H, S= Average spacing in meters of moving vehicles.

After calculating the LOS, it was justified through geometrical characteristics of study road, road way factors and traffic factors.

4. RESULTS

4.1 LOS analysis

Firstly the volume data was collected using the method mentioned earlier from three major intersections of the study road for definite direction. Then from speed survey average journey time was measured in the way which was mentioned in methodology part. Once volume and speed survey was completed, average journey speed was calculated from dividing total length of the study road by average journey time. Average spacing for study road was calculated from considering the perception time braking distance and length of the vehicle by using the formula stated in methodology.

Table 2: Link to link information for working day (Volume survey and speed survey)

Link Name	Average journey time (minute)	Average journey speed (Kmh^{-1})	Average spacing (meter)	Capacity (PCU/hr.)	Volume in working day (PCU/hr.)
Muradpur to 2 No Gate	8	8.25	4.35	1896.55	1401.85
2 No Gate to Muradpur	23.48	2.81	3.21	1875.38	1855.25
2 No. Gate to GEC	6.11	7.85	4.26	1842.72	1685.07
GEC to 2 No. Gate	13.71	3.5	1.91	1832.46	2051.3
GEC to Dewanhat	8.56	16.12	6	2686.66	2295
Dewanhat to GEC	8.78	15.72	5.91	2659.89	2587

Source: Field survey, 2012

Table 3: Link to link information for holiday (Volume survey and speed survey)

Link Name	Average journey time (minute)	Average journey speed (Kmh^{-1})	Average spacing (meter)	Capacity (PCU/hr.)	Volume in holiday (PCU/hr.)
Muradpur to 2 No Gate	7.67	8.6	4.42	1945.70	1194.55
2No Gate to Muradpur	8.27	7.98	4.29	1890.14	1417.45
2 No. Gate to GEC	6.41	7.48	4.15	1785.20	1447.45
GEC to 2 No. Gate	6.89	6.96	4.08	1705.88	1723.7
GEC to Dewanhat	9.29	14.84	5.72	2594.41	1801.9
Dewanhat to GEC	9.87	13.98	5.54	2523.46	1846

Source: Field survey, 2012

Table 4: LOS according to V/C Ratio for different links

Link Name	Working Day		Holiday		Standard	
	V/C Ratio	LOS	V/C Ratio	LOS	V/C Ratio	LOS
Muradpur to 2 No Gate	0.74	C	0.61	C	0	A
2 No Gate to Muradpur	0.99	E	0.75	C	0.0 - .12	B
2 No. Gate to GEC	0.91	D	0.81	D	0.12- .75	C
GEC to 2 No. Gate	1.12	F	1.01	F	0.75- .95	D
GEC to Dewanhat	0.85	D	0.69	C	.95- 1.0	E
Dewanhat to GEC	0.97	E	0.73	C	>1	F

Source: Analysis by authors, 2012 and High way capacity manual (TRB), 2000

From the above table it is shown that at working day among the six directional movements of vehicles one segment's (GEC to 2 No. Gate) LOS is F. Only in Muradpur to 2 No Gate it is C and rests of them it varies from D to E. In case of holiday there is no change in LOS for GEC to 2 No. Gate and in other segment it is C. So it can be concluded that during both holiday and working day GEC to 2 No. Gate intersection point is completely unable to meet traffic demand whereas other intersection points are at vulnerable condition. As a result congestion in our study area is very much common scenario.

4.2 Geometric Design Analysis

Cross sectional elements embrace aspect such as right of way width, road way width, pavement width, median, shoulder, and clearances. Muradpur to Dewanhat road is a feeder road considering its carriage way consists of 2 lanes. How calculated LOS was justified through geometrical characteristics of our study road is shown through the comparison between geometric design standard according to the Roads and Highway Department of Bangladesh and existing characteristics of cross sectional elements in study area:

Table 5: Comparison between geometric design standard and existing characteristics of cross sectional elements

Name of cross section	Right of way (feet)	Standard(feet)	Road way width(feet)	Standard(feet)	Carriage way width(feet)	Standard(feet)	Central reservation(feet)	Standard(feet)	Shoulder (feet)	Standard(feet)	Curbs (feet)	Standard(feet)	Clearance (feet)	Standard(feet)
2 no gate to Muradpur	98.8	---	42.9 & 34.3	71	42.9 & 34.3	48	10	--	----	6	3	1.44	--	3.28
2 no gate to GEC	128	---	57.3 & 43.3	71	57.3 & 43.3	48	10	**--**	----	6	2.3	1.44	**--**	3.28
GEC to 2 no gate	118.9	---	45.1& 48.8	71	45.1 & 48.8	48	4	**--**	**----**	6	1.5 & 1	1.44	**--**	3.28
GEC to Dewan hat	112.9	---	44.1 & 47.7	71	32.10 & 34	48	4.4	--	12 & 13.7	6	1	1.44	--	3.28
Dewan hat to GEC	76.6	---	32.1 & 29.1	71	22.1 & 21.7	48	1.9	--	10 & 7.4	6	1.1	1.44	--	3.28

Source: Field survey, 2012 and Geometric design standard for Roads and Highway department of Bangladesh, 2000

The above table states that existing road way width and carriage way width both are same and below standard value, meaning part of shoulder and clearance are absent in study road. As a result on street illegal parking is happened spontaneously on carriage way part and creates heavy traffic congestion. Besides during peak hour the study road is unable to occupied large volume of traffic due to inadequate carriage way space. In case of 2 No. gate to GEC segment, carriage width is almost equal more than standard value but width of road way is below standard, meaning that due to absence of shoulder this segment is completely unable to occupy the pressure of vehicles during both working day and holiday as this. Thus its LOS was F. Same cause is responsible for bad LOS at GEC to 2 No gate intersection in working day but during holiday it seemed better than working day. On the other hand GEC to Dewan hat and Dewan hat to GEC both segment has proper shoulder but due to too narrow carriage way width made the road inefficient during working day. In case of 2 No gate to Muradpur segments' LOS was bad both in holiday and working day due to insufficient width of road way and carriage way.

4.3 Factors affecting level of service

The factors which affect the level of service of study road can be considered under the following categories:

Lane width: A lane width of 3.65m is considered as the defined ideal lane (Kadiyali, 2003). In Muradpur to Dewanhat road, average lane width is 3.67m. But there are differences in lane width in different sections of the Muradpur to Dewanhat road. So difference in lane width and number of lane affects the level of service.

Shoulders: Shoulders of adequate width are necessary for maintaining traffic continuously. The highway capacity manual reckons that for lanes less than 3.65m wide, paved shoulders of 1-2 m or more width increase the effective width of the adjacent traffic length by 0.3m. There is no shoulder in Tiger pass and 2 No gate intersection but GEC intersection has shoulder.

Surface condition: A deteriorated and poorly maintained pavement adversely affects level of service. The surface condition of on Muradpur to Dewanhat road is different in different places. At 2 no gate the surface condition is not at satisfactory level due to construction work and GEC and Tiger pass intersection road condition are well enough.so surface condition affects the level of service.

Channelization: Traffic channelization is very important to control the flow of traffic. With thehelp of proper channelization the flow of traffic increase at high rate and traffic accident reduces. All the intersection Tiger pass, GEC and 2 No gate have medians, road dividers, Roundabout, traffic islands etc. proper Channelization greatly affects level of service.

Land use: As maximum land beside our study area is used as residential and commercial purposes. As a result people of this area are always working with their own work and thus congestion of people in this study area is very high and creates numerous obstacles to vehicles especially for drivers. So the general performance of this road is obstructed greatly. Following figure shows the general land use pattern in study area:

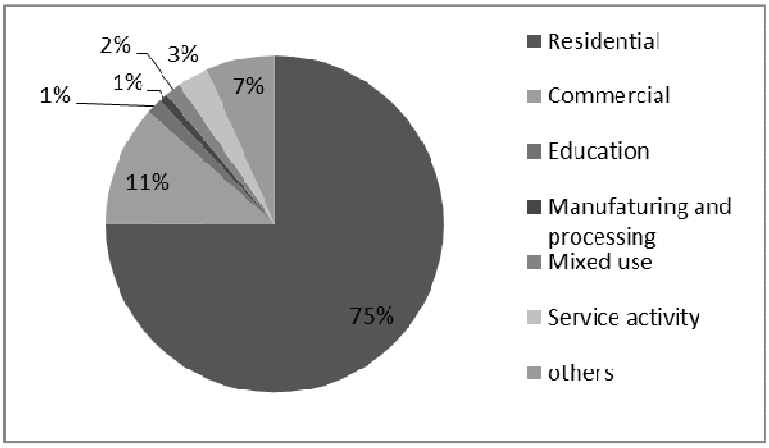

Figure 2: General land use pattern in study area
Source: CDA, 2007

Parking facility: It is one of the major problem in our study area because of illegal on street parking system creates lots of traffic congestion as well as cause of low speed of vehicles. Due to low parking facility, people park their vehicles at the road side which affect the level of service.

Existing traffic signal effect: Traffic signal system in our study area is very much poor because of improper traffic management. During survey it was found that there is no provision of digital traffic signal system as a result manual traffic system creates lots of problem like congestion, accident which effects largely on performance of this road.

On street parking: The road side shopping malls have no parking space though some malls have but it is not enough. For this reason it was found so much on street parking. Besides other factors are influencing on street parking like behavior of the drivers to park the vehicles on the street.

Small Motorized Vehicles: From Muradpur to Dewanhat road there have been found a huge number of small motorized vehicles having small Passenger Car Unit (PCU). This large volume of small vehicles are occupied most of the space of our study road and creates intolerable congestion.

Concentration of stoppage: The total length of study area is 4.5455 km. between these small lengths there are five stoppages which are in Muradpur, GEC, WASA, Lalkhan bazaar and Tigerpass. As a result during peak hour congestion becomes very high. So the increase number of stoppage affects the level of service. But in USA the minimum distance one stoppage to another stoppage is 5 km. while in UK it is 3 km.

Frictional effect: Frictional effect in our study road is not so severe though there are some places were found during survey where road condition seems to be affected by maintenance work done by utility department and also due to heavy load. As a result speed is being hampered.

Bus Bays and Stopping Places: It is completely absent in our study road as a result bus stops haphazardly and creates lots of trouble to other vehicles and road users

Drainage: Due to bad drainage system in our study road, during rainy season water stands on road and affect largely on level of service.

Footpath: It is one of the main causes of affecting the level of service of Muradpur to Dewanhat road. During survey poor maintenance of footpath was found in different parts of the road. Surface condition is not at satisfactory level and the path way is not wide enough. Most of the space of footpath is occupied by hawker and street dustbin. As a result pedestrians are forced to walk on main road.

5 CONCLUSIONS

There are many ways to measure transportation system performance, each reflecting particular perspectives concerning who, what, where, how, when and why. Different methods favor different types of transport users and modes, different land use patterns, and different solutions to transport problems. The Levels of Service is one of the most important factors in highway design. Highway design engineers and planners have to follow the levels of service criteria to determine the number of lanes and other geometry to suit with predicted traffic volume for ensuring better performance of road. The purpose of this study is to find out the level of service (LOS) and the factors affecting the LOS of a feeder road within the limit of Muradpur to Dewanhat junction. The Level of Service (LOS) is a composite of several operating characteristics that are supposed to measure the quality of service as perceived by the road users at different flow levels. Different types of practical observation methods and secondary sources were used to collect the required data. This study is helpful to identify the existing problem of Muradpur to Dewanhat road as well as its functional characteristics.

REFERENCES

Mahmud, S.M.S., Rahman, M.W. and Rabbi, S.H.E. (n.d). "Transport System in Bangladesh: Issues and Options for Sustainable Development", http://www.buet.ac.bd/ari/

Hodgkinson, D. and Ellery, S.W., (n.d). "Strengthening Bangladesh: Transport, Sustainability and Better lives", http://www.hodgkinsongroup.com/documents/transportation_sustainability.pdf.

Shamsher, R. And Abdullah, M.N., (2013), "Traffic Congestion in Bangladesh- Causes and Solutions: A study of Chittagong Metropolitan City",http://abrjournal.weebly.com/uploads/1/1/3/2/11327577/3.2_abr_template.pdf.

Debnath, R and Islam, M.S., (2009). "Managing efficiency of an urban road toward better transport system", http://academicjournals.org/journal/JGRP/article-full-text-pdf/16399851077

Kadiyali, L.R., (2003). Traffic Engineering & Transportation Planning, New Delhi, India. Mathew.V.T, Fundamental Parameters of Traffic Flow, Traffic Engineering and Management, Institute of Information and Technology, Bombay.

Bangladsh Road Transport Authority, 2010. http://www.brta.gov.bd/

Roads and Highway department of Bangladesh, (n.d). http://www.rhd.gov.bd/.

Transport Research Board, (2000). Highway Capacity Manual for Bangladesh.

Bangladesh Bureau of Statistics. Population Census 1981, Community Series, Zilla: Chittagong.

Bangladesh Bureau of Statistics. Population Census 1991, Community Series, Zilla: Chittagong.

Bangladesh Bureau of Statistics. Population Census 2001, Community Series, Zilla: Chittagong.(Dhaka:BBS-2007).

Aqua Consultant et al (2012). Study on Municipal Solid Waste Management. Professional Report. Bangladesh Municipal Development Fund.

Chittagong Development Authority, (2008). Detailed Area Plan (DAP) for Chittagong. (Chittagong:CDA-2008)

Roads and Railway Division, (2000). "Geometric Design standards for roads and Highway department, Draft version-4" Government of the People's Republic of Bangladesh, Ministry of Communications