Causes of Traffic Flow Interruptions in Chittagong City (Case Study: Tigerpass to Customs, A Major Road in Chittagong City)

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Abstract

Unanticipated increase in the traffic volume is hampering the socio-economic development of Bangladesh. As a result, the development of big cities of the country such as Chittagong is retarding. The main aim of this study is to identify the factors interrupting traffic flow of Chittagong city. Tigerpass to Customs major road is selected as the study road. After collecting data through different field surveys, the Level of Service (LOS) and trip rate of this road is evaluated. From analysis it is clear that the Level of Service (LOS) of this road is poor, which represents unstable flow of traffic. Trip rate analysis shows that massive commercialization around this road is attracting huge volume of traffic to this road. Microsoft excel and Geographic information system (GIS) techniques were used for analysis. The entire research helps us to understand the magnitude of different factors to maintain a good performance of a road.

Keywords: *Level of service, Commercialization, Trip rate, Capacity, Flow.*

1 Introduction

1.1 Research Background

Chittagong is the second largest city in Bangladesh having a population of about five million including people living in the urban fringes (Ashraf, 2015). The preliminary results of the population and housing census 2011 shows that, the city has a population of 25, 92,459 distributed within the 41 wards of the city (BBS, 2011). Chittagong city has a number of pull factors which acts as a force of attraction for manpower throughout the division and beyond. The city has been experiencing rapid growth of population because of rural urban migration (1997; BBS 1981, 1991 and 2001). The city is also undergoing rapid commercialization due to this uncontrolled and intense migration of manpower from surrounding areas. As a result the rate of urbanization of the city is accelerating. 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 (Islam, 2014). The impact of rapid urbanization on the transportation system of the city is devastating. The increase in population and commercial activities of the city has created an extra demand for vehicles to run within the city. The Tigerpass to customs road being an important major road of the city has to carry the load of a huge number of vehicles every day. This rapid growth of population is increasing the traffic pressure on road and making city dwellers life standstill due to traffic congestion (Shamsher and Abdullah, 2012).

1.2 Statement of Problem

Chittagong city is functionally connected with surrounding area by mainly one road named Kalurghat to Patenga (Islam et al, 2014). Intolerable traffic congestion and low traffic performance of the road, especially in the Tigerpass to Customs portion have made life of city dwellers miserable. The traffic system of the city has already collapsed as the vehicles can't run on the main roads of the city due to congestion (The Independent, 2011). Although, Traffic research still cannot fully predict under which conditions a "traffic jam" (as opposed to heavy, but smoothly flowing traffic) may suddenly occur (TTI, 2009). But the performance of the road can be justified

by determining its level of service. Level of service is defined as a qualitative measure describing the operational conditions within a traffic stream, and their perception by motorists and/or passengers (Kadiyali, 2003).

1.2 Research Aims and Objectives

The aim of this research is to determine the causes of traffic flow interruptions on Tigerpass to Customs major road. The aim requires four objectives to be completed. The objectives are, evaluation of level of service of the study road, analysis of geometric design of the road, determination of the density of roadside commercial spaces and trip rate analysis of the roadside commercial spaces.

2 Study Area

The Tigerpass to Customs major road of Chittagong city has been selected as a typical study road to determine the causes of traffic flow interruptions in Chittagong city. The total length of the studied road is about 4.5 Km. and has 7 intersections or conflict points at intervals of 0.5-1 Km (approximately). The intersections are respectively Tigerpass, Dewanhat, Choumohoni, Badamtoli, Barik building, Fakirhat and Customs. This road is the most important road of Chittagong city because it connects the important commercial centers of the city. Therefore it has to face the pressure of different mode of vehicles by city dwellers.

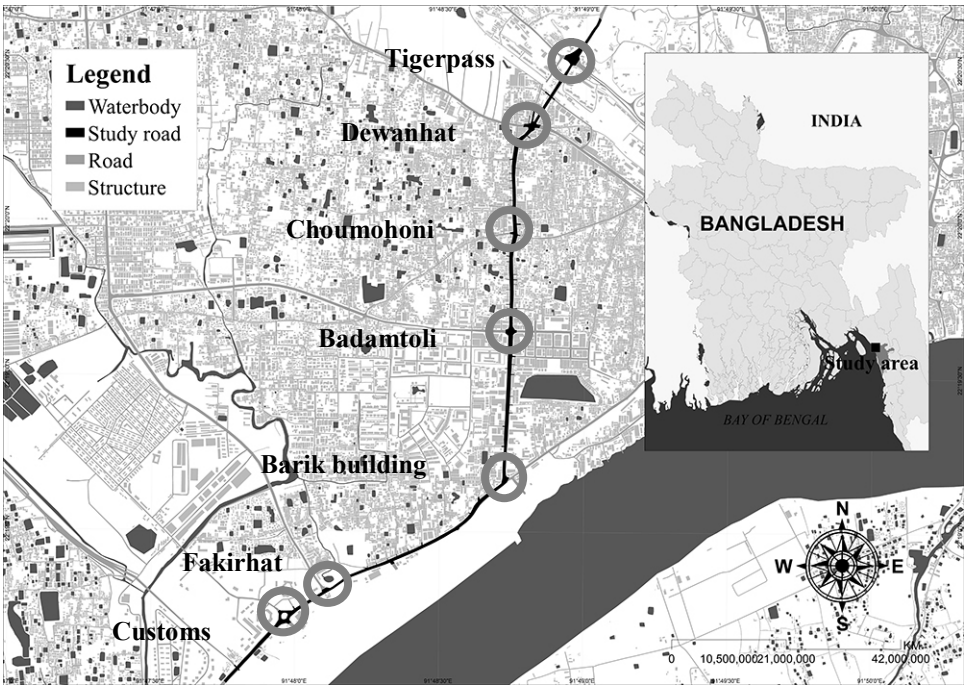

Figure 1. Location map of study area

3 Methodology

3.1 Methodology of Research

To evaluate the impacts of roadside commercialization on traffic performance of Tigerpass to Customs road, at first the existing traffic condition and the factors affecting the existing traffic condition of the road were studied. The entire study was conducted with the help of primary and secondary level data. The primary level data was collected using different transportation survey techniques. The conducted surveys are Geometric design survey, moving observer survey and trip rate survey. The secondary data were acquired through Geographic information system (GIS), literature review of related articles and newspaper reports. The results were obtained using various statistical and mathematical terms and formulas related to the acquired data analysis. Microsoft excel and Geographic information system (GIS) techniques were used for analyzing the data. At first the traffic performance of the road was evaluated by calculating Level of Service (LOS) of the road on both off days and on days, by analyzing the moving observer survey data. Then the geometric design of the road was analyzed by comparing the cross sectional elements of the road with standard values. From these analysis the impact of geometric design on Level of service was observed. After that the density of commercial establishment on either

sides of the road was determined using the Geographic information system (GIS) data from DAP 2008. Then the impact of commercialization on transportation system of road was derived through trip rate analysis. Finally a conclusion was made depending on the results obtained from the above mentioned analysis.

3.2 Mathematical Terms and Formulas

The Level of service was evaluated using various mathematical formulas.The mathematical terms and formulas used in the analysis were collected from the book "Traffic engineering and transport planning" by Kadiyali. The formula are as follows:

i. $$Q_{a-b} = \left[\frac{X_{b-a} + Y_{a-b}}{T_{a-b} + T_{b-a}}\right] \quad (3.1)$$

Where, Q_{a-b} = Rate of flow; X_{b-a} = Opposing traffic count of vehicles met when the test vehicle was travelling from a to b; Y_{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; T_{a-b} = Journey time of a to b; T_{b-a} = journey time of b to a

ii. $$\bar{T} = T - \left[\frac{Y}{Q}\right] \quad (3.2)$$

Where, $\bar{T}$ = Average journey time; T = Total journey time; Y = Number of vehicles overtaking the test vehicle – the number of overtaken by the test car; Q = Rate of flow

iii. $$V = \left[\frac{D}{\bar{T}}\right] \quad (3.3)$$

Where, V = Average journey speed; D = Total distance; $\bar{T}$ = Average journey time

iv. $$S = L + 0.278VT \quad (3.4)$$

Where, S = Average spacing; L = Length of test vehicle (In this research L= 2.6); V = Average journey speed; T = Time (In this research T= 0.75)

v. $$C = \left[\frac{1000V}{S}\right] \quad (3.5)$$

Where, C = Capacity; V = Average journey speed; S = Average spacing

4 Research Results

4.1 Speed, Capacity and Volume

Moving observer survey technique was use for collecting data to calculate flow, speed and capacity of the road. The surveys was conducted separately during both working days and holidays. During the survey, data was collected for all six the intersections separately. Equations 3.1-3.5 were used for calculating results.

Table 1. Link wise data on Speed, capacity and volume

Link name	Journey time (sec)		Journey speed (ms^{-1})		Average spacing (m)		Capacity (PCU/sec)		Volume (PCU/sec)	
	Working days	Holidays	Working days	Holidays	Working days	Holidays	Working days	Holidays	Working days	Holidays
Tigerpass - Dewanhat	282	270	1.96	2.04	3.01	3.03	650.72	675.57	468.52	432.36
Dewanhat – Choumohoni	360	348	1.50	1.55	2.91	2.92	515.83	531.64	495.20	398.73
Choumohoni – Badamtoli	378	336	1.56	1.76	2.93	2.97	533.54	592.00	485.52	515.04
Badamtoli – Barik building	432	642	2.10	1.41	3.04	2.89	691.80	488.56	588.03	322.45
Barik building - Fakirhat	1530	1098	0.84	1.17	2.78	2.84	303.08	412.09	309.15	461.54
Fakirhat - Customs	414	456	0.70	0.64	2.75	2.73	255.09	232.73	252.54	204.80

Source: Field Survey, 2016

4.2 Level of Service Evaluation

The Highway capacity manual (HCM) has introduced the term "Level of service (LOS)". It is defined as, a qualitative measure describing the operational conditions within a traffic stream, and their perception by motorist and/or passengers (Kadiyali, 2003). There are six levels of service which determines the performance of a road. The levels of service according to the Highway capacity manual are as follows.

Table 2. Levels of service according to Highway capacity manual

Level of service	Highway characteristics
A	Free flow condition
B	Stable flow condition
C	Lower speed range of stable flow
D	Lowest speed range of stable flow
E	Unstable flow condition
F	Forced flow condition

(Source: Highway capacity manual)

In Tigerpass to Customs major road, the level of service varies from 'C' to 'F' at different links. When compared between all the links, the Tigerpass-Dewanhat link has the highest level of service and Barik building-Fakirhat link has the worst level of service. The level of service at all the links in between Tigerpass to Customs road is shown in the following table.

Table 3. Level of service of all links of the Tigerpass to Customs major road

Link name	Working day			Holiday		
	Speed	V/C ratio	Level of service	Speed	V/C ratio	Level of service
Tigerpass - Dewanhat	1.96	0.72	C	2.04	0.64	C
Dewanhat – Choumohoni	1.50	0.96	E	1.55	0.75	C
Choumohoni – Badamtoli	1.56	0.91	D	1.76	0.87	D
Badamtoli – Barik building	2.10	0.85	D	1.41	0.66	C
Barik building - Fakirhat	0.84	1.02	F	1.17	1.12	F
Fakirhat - Customs	0.70	0.99	E	0.64	0.88	D

Source: Field Survey and calculation, 2016

4.3 Geometric Features

Geometric features of a road has a significant influence over its level of service. Level of service rises and falls depending on the quality of geometric design. Thus by comparing the road's geometrical elements with standards fixed by Roads and Highway department of Bangladesh, the effect of geometric design on level of service can be justified.

Table 4. Comparison of existing cross-sectional elements with standard values

Name of cross section	Right of way		Carriageway width		Central reservation		Shoulder		Clearance	
	Existing	Standard	Existing	Standard	Existing	Existing	Existing	Standard	Existing	Standard
Dewanhat - Tigerpass	30.4		12.2	14.6			3	1.8		0.4
Dewanhat – Choumohoni	32.6		13.5	14.6			2.8	1.8		0.4
Badamtoli - Choumohoni	26.6		10.3	14.6				1.8		0.4
Badamtoli – Barik building	32.6		13.3	14.6				1.8		0.4
Fakirhat - Barik building	30.2		12.6	14.6			2.5	1.8		0.4
Fakirhat - Customs	32		13.5	14.6			2.5	1.8		0.4

(Source: Field survey, 2016 and Geometric design standard for Roads and Highway department of Bangladesh)

Table 4 states that the carriage way length of the road falls below the standard values. As a result, in some parts of the road the shoulder and clearance are unsatisfactory or absent. This reduction in the carriage way of the road hampers the fluent flow of vehicles on this road. Moreover it also reduces the driving efficiency of the drivers on this road. From here it can be justified that the geometric features of the road have resulted to poor level of service of the road.

4.4 Roadside land use and trip rates

There are mainly four types of land use around Tigerpass to Customs major road. They are commercial, Residential, Industrial and mixed land use. The total floor area of major land uses are determined using GIS data (DAP, 2008). Then through trip rate survey, the trip rate of the major land uses were individually determined. Table 5 shows the roadside land use and their trip rates.

Table 5 Floor area of major landuses and their trip rates

Land use	Car	Truck	Microbus	Taxi	CNG	Bus	Motorcycle	Rickshaw	volume (PCU)	Floor area of sample size for survey	Total floor area (sq ft)
Commercial	13	0	6	8	34	66	12	28	229.4	5936	1150928
Residential	4	0	0	7	17	13	8	30	72.4	4074	514900.3
Industrial	8	7	3	0	12	35	2	7	123.3	10569	93087.92
Mixed use	10	0	4	3	18	34	11	19	125.7	4646	435001.5

(Source: Field survey and GIS data (DAP 2008)

5 Research findings

5.1 Impact of geometric features on Level of service

From table 4 it is seen that the level of service of Tigerpass to Customs major road is hampered due to poor geometric conditions. The following table shows the variation of level of service according to variation of geometric condition from standard values.

Table 6. Comparison of existing cross-sectional elements with standards for justification of Level of service

Name of link	Carriageway width		Shoulder		Clearance		Level of service (On day)
	Existing	Standard	Existing	Standard	Existing	Standard	
Dewanhat - Tigerpass	12.2	14.6	3	1.8		0.4	C
Dewanhat – Choumohoni	13.5	14.6	2.8	1.8		0.4	E
Badamtoli - Choumohoni	10.3	14.6		1.8		0.4	D
Badamtoli – Barik building	13.3	14.6		1.8		0.4	D
Fakirhat - Barik building	12.6	14.6	2.5	1.8		0.4	F
Fakirhat - Customs	13.5	14.6	2.5	1.8		0.4	E

Table 5 shows that Dewanhat - Tigerpass and Dewanhat - Choumohoni links the geometric features are almost similar but their level of service between the two links varies from C to E. Large variation is also observed between Badamtoli – Barik building and Fakirhat - Barik building links although geometric features are almost similar. This indicates that, after geometric features, the huge flow of traffic has further reduced the level of service of the road at some parts of the road.

5.2 Impacts of roadside land use on level of service

Commercial land use holds a major portion where residential land use holds only a small portion of the roadside land use of Tigerpass to Customs major road. From the trip rate survey, it is seen that, the commercial land use is responsible for the generation of huge traffic flow on this road on working days. As a result of this, the generated flow exceeds the capacity of the road. Thus the level of service of the road falls on working days. On holidays the level of service of Dewanhat – Choumohoni and Badamtoli – Barik building links are found to be increased in table 3. Thus it can be concluded that, the level of service of the study road is greatly hampered due to flow generated for commercial land uses. A huge portion of the city's manpower has to travel on this road for various commercial purposes. Every day the road is overflowing with vehicles which are beyond its carrying capacity. This huge flow generated by commercial land use also acts as triggering factor for other transportation hazards such as traffic congestion, traffic mismanagement etc. on Tigerpass to Customs major road.

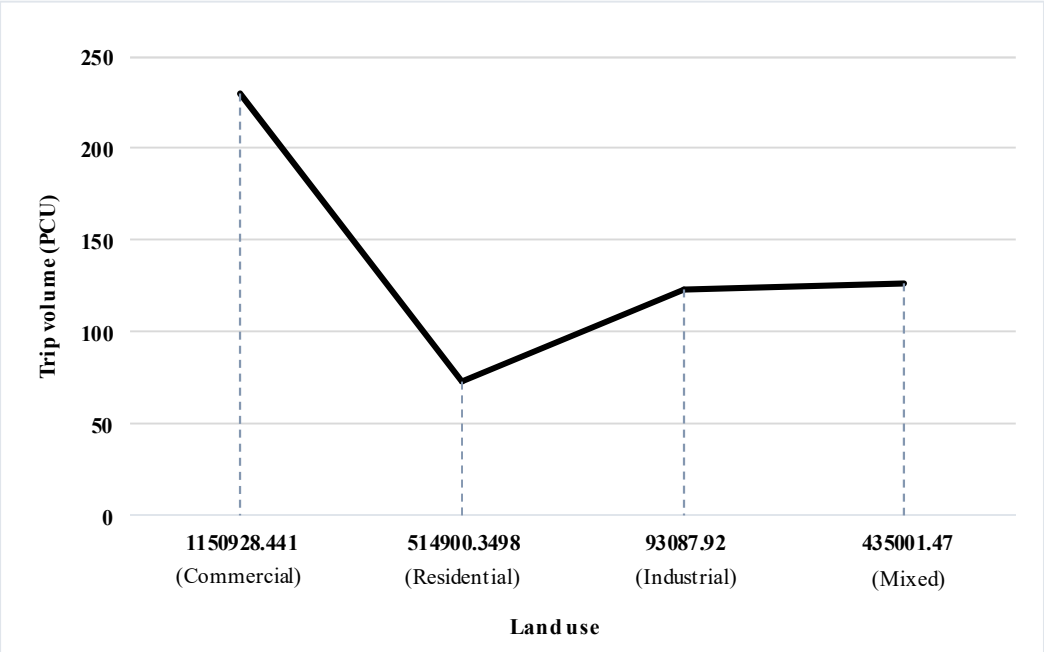

Figure 2. Trip rate generated from commercial land use

(Source: Field survey, 2016 and GIS data (DAP, 2008)

6 Conclusion

Level of service (LOS) is a vital factor for measuring the performance of a major road. This research tried to determine the different causes that influences the level of service of Tigerpass to Customs major road negatively. It has identified the poor geometric condition and overflow of vehicles generated due to commercial land uses along the road as the primary cause of unsatisfactory traffic performance of this feeder road. The research required different types of practical observation methods and secondary data, to identify the problems of the study road and their causes. The entire study is helpful in identifying the causes behind the interruption of traffic flow on Tigerpass to Customs major road.

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