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A Study on Traffic Congestion in Major Points of Dinajpur City under Mixed Traffic Flow

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Abstract

Due to the proportional growth of the population and the rapid development of modern society the increment of vehicles is a major concern in urban areas in developing countries like Bangladesh. So, it is important to monitoring traffic volume as well as the quality of transport referred to as the level of service (LOS). The current study investigates behavior of mixed traffic flow in Dinajpur City. The field traffic volume survey was conducted to determine the level of service in the 3 main intersections in Dinajpur. The LOS is determined by Peak Hour Factor and volume capacity ratio method. The LOS of the three intersections was calculated and compared with Highway Capacity Manual (HCM) 2010. From data analysis Lily Mor and Kalitola road intersections are designated as F grade level of service. F grade level of service represents the worst condition with heavily congested flow. On the other hand, Phulbari Busstand road intersections are designated as D grade level of service which represents traffic operations approaching unstable flow with high passing demand and passing capacity near zero. Concern authorities need to ensure an overall appropriate traffic management system to improve service levels, mainly at intersection areas.

Keywords: *Peak Hour; Traffic Composition; Traffic Congestion; Traffic Flow; HCM.*

1 Introduction

Traffic congestion is an extensive global phenomenon resulting from high population density, the growth of motor vehicles and their infrastructure, and proliferation of rideshare and delivery services (Ahmed Malik, 2016). Congestion has been explained by researchers in many contexts. The most common definition of congestion in the state of traffic flow is when the travel demand exceeds road capacity (Studies, T. V., 1995). Congestion is a frequent issue in metropolitan regions for a number of reasons. Congestion can be categorized as either recurrent or nonrecurring depending on these many factors. The former sort of congestion, which is more prevalent during the weekdays, is the kind that always takes place at the same location and time. The latter sort of congestion results from transient events like a vehicle breakdown, an accident, or minor road construction (Afsar&Yaman, 2014). The effects of congestion are manifolds; some directly affect the drivers' sense of wellbeing, be it times wasted sitting in a traffic queue and the changes in the behavior of drivers (Ghosh et al., 2013). Any nation's economic success depends heavily on its cities, but most of them have traffic congestion. Economic losses and environmental deterioration come from any traffic congestion caused by the gap between rising transport demand and available network capacity. The traffic study serves as a benchmark for the amount of transport engineering. Engineering is used to successfully fulfill operations and management (Nedevska et al., 2017). In order to assess the current situation and forecast future traffic volume circumstances, traffic volume surveys are crucial (Mahidadiya et al., 2016). Traffic in the majority of the cities of countries like Bangladesh is very heterogeneous in character and consists of various forms of motorized and non-motorized vehicles, including bicycles, rickshaws, cars, buses, etc(Shamsher & Abdullah, 2015). Level of service (LOS) of a traffic facility is a concept introduced to relate the quality of traffic service to a given flow rate. LOS a letter that is designated a range of operating conditions on a particular type of facility. Six LOS letters are defined by HCM, namely A, B, C, D, E, and F, where A denote the best quality of service and F denote the worst (Ali et al., 2014; Banik et al., 2009; Islam et al., 2019).

Congestion and traffic volume growth in Dinajpur city are two issues that are escalating rapidly. Traffic congestion at intersections is now frequently seen throughout the morning and evening rush hours. This may be

due to poor road planning and improper nature of road intersection that affects geometric features of these intersections (GANI et al., 2017). Intersections become very congested if traffic volumes are high, make inefficiency as a result peoples suffer delay and frustration (Mardani et al., 2015). Lack of street lights and road marking also contribute traffic congestion (al Kafy, 2018; Mehar et al., 2014). Due to traffic congestion, air pollution, fuel usage, and travel time (Marwah et al., 2000; Minocha, 2004). Therefore, it is a significant issue to investigate traffic congestion and to monitor the quality of transport supply in terms of level of service for major intersections of Dinajpur city. This study on traffic congestion will be helpful to know about the mixed traffic flow, calculate the passenger car unit (PCU) (Luttinen, 2001), evaluate the level of service (LOS), to compare the capacity of carriageway between the available capacity and the critical capacity, to find out other possible reasons that hamper traffic capacity of road. To compute traffic volume, the traffic flow characteristics, traffic variation factors, hourly traffic distribution, and traffic composition at selected intersections, manual method was adopted (Arasan&Arkatkar, 2010) and case studies were conducted over the course of 3 days at 3 intersections. The total number of different type of vehicles by moving in each direction of road was recorded. The counts were carried out for 8-hours each day during peak times (morning, noon and evening). On one side of the projected road, one enumerator started recording vehicles, while on the other side another enumerator started the same activity. A simplification known as the passenger car unit, or PCU (Luttinen, 2001), is developed to turn the various types of vehicles into an equivalent number of passenger cars in order to analyse mixed or heterogeneous traffic. Finally estimated PCU values are used to determine LOS on intersections. Level of service (LOS) was determined by volume capacity ratio and peak hour factor method (Anand et al., 1999).

2 Methodologies

Study Area:
The data was collected from Dinajpur district in the Rangpur Division which is northern part of Bangladesh. The place was selected on the visual identification of roads which sometimes become congested, and the capacity of the road becomes reduced. So, Kalitola, Lily mor and Phulbari bus stand mor intersection were selected for the study. To achieve the target objective traffic data was collected at the peak period. The data were measured in the field directly with the help of skilled persons.
Geometric data were collected for carriageway and lane width. Traffic volume was counted in the unit of Passenger Car Unit (PCU). For traffic counting, manual counting methods and video recording were implied. In the manual calculation method, a tile sheet was used to calculate the traffic flow. Data was collected at 15-minutes intervals for three days at all intersections. The concept was to collect vehicle movement data within the field of study which would give a good picture of the current traffic at the intersection of the Calvary Road network. The total number of types of vehicles moving in each direction was recorded. The counts were carried out for 8 hours each day. As one enumerator recorded a vehicle on one side of the project road, a team from another field also assembled for the purpose, and another enumerator began the same exercise on the opposite side. The count conducted at these stations forms the basis for computing the traffic flow characteristics, traffic variation factors, hourly traffic distribution, and traffic composition. The following classes of vehicles were used: Bicycles, Cars, Buses, Light Trucks or Pickups, tractors, Heavy Trucks, Motorcycles, Van or Rickshaw, CNG or Tempo.
The capacity flow or maximum possible flow on a roadway or a traffic lane is attended at a particular optimum speed. Capacity flow is reached when the vehicles flow as a stream at this optimum speed with no opportunity for overtaking. Traffic performance measurement of roads measured by HCM with respect to V/C ratio and PHF are listed in Table 1 and Table 2 respectively.

Table 1. Traffic performance measurement by V/C ratio (HCM 2010) (Source: Mathew & Bombay, 2017; Wikipedia, 2017)

LOS	V/C Ratio	Detailed Description
A	0.00-0.35	Represents the best operating conditions and is considered free flow. Individual users are virtually unaffected by the presence of others in the traffic stream
B	0.35-0.58	Represents reasonably free-flowing conditions but with some influence by others.
C	0.58-0.75	Represents a constrained constant flow below speed limits, with additional attention required by the drivers to maintain safe operations. Comfort and convenience levels of the driver decline noticeably.
D	0.75-0.90	Represents traffic operations approaching unstable flow with high passing demand and passing capacity near zero, characterized by drivers being severely restricted in maneuverability.
E	0.90-1.00	Represents unstable flow near capacity. LOS E often changes to LOS F very

F	>1.00	quickly because of disturbances (road conditions, accidents, etc.) in traffic flow. Represents the worst conditions with heavily congested flow and traffic demand exceeding capacity, characterized by stop-and-go waves, poor travel time, low comfort and convenience, and increased accident exposure.

Table 2. LOS with respect to PHF

Peak Hour Factor Value	LOS
0.7 or less	A
0.8 or less	B
0.85 or less	C
0.90 or less	D
0.95 or less	E
>1 or less	F

To estimate the LOS of the intersection roads volume capacity ratio (V/C) for each road were determined. Volume capacity ratio (V/C), in which V is the total number of vehicles passing a point in one hour and C for the maximum number of vehicles that can pass a certain point at a reasonable traffic condition, "Volume -Capacity Ratio (V/C) is a measure that reflects mobility and quality of travel of a facility or a section of a facility. It compares roadway demand (vehicle volumes) with roadway supply (carrying capacity). The V/C method is associated with LOS and determining how well a roadway is performing. Early studies on capacity were based on the theoretical formula,

$$C = \left[\frac{1000V}{S}\right] \quad (1)$$

$$S = 0.278Vt + L \quad (2)$$

Where, C = capacity (vehicles/hour/lane)
V = Speed (km/hour)
S = Average spacing of moving Vehicles or space headway (m)
t = Average Reaction time (second)
L = Average length of vehicles (m)

$$\text{Volume Capacity Ratio} = \left[\frac{\text{Total Hourly PCU}}{\text{Capacity}}\right] \quad (3)$$

The 2nd method to calculate the LOS is the Peak Hour factor (PHF) method. Traffic engineers focus on the peak-hour traffic volume in evaluating capacity and other parameters because it represents the most critical time. The analysis of level of service is based on peak rates of flow occurring within the peak hour because substantial short-term fluctuations typically occur during an hour. Common practice is to use a peak 15-minute rate of flow. Flow rates are usually expressed in vehicles per hour, not vehicles per 15 minutes. The relationship between the peak 15-minute flow rate and the full hourly volume is given by the peak-hour factor (PHF) as shown in the following equation (Authority, 2003). Peak-hour factors in urban areas generally range between 0.80 and 0.98. Peak-hour factors over 0.95 are often indicative of high traffic volumes. PHF was evaluated by the following formula

$$\text{PHF} = \left[\frac{\text{Hourly Volume} \times \text{Volume count at 15 minutes}}{4}\right] \quad (4)$$

2 Data Analysis & Results

To meet the objectives of the study, data were analyzed and completed in two stages. First, analysis on existing conditions the intersection has been managed. Second, there has been survey data conducted to search its recent traffic performance terms of these intersections.

2.1 Geometric Elements of Intersections

Geometric data for each intersection was collected and listed in Table 3. Traffic effect analysis is the appropriate way to adopt transportation planning and land use planning together.

Table 3. Geometric Element for each intersection

Name of the Routes	Carriageway width (m)
Mohila College Rd to Phulbari Busstand	7
Terminal to Phulbari Busstand	6.5
Nimnagor busstand to Phulbari busstand	8.1
Lily Mor to Paharpur road	7.5
Lily Mor to Jail road	7.5
Lily Mor to Munshipara road	11

2.2 Peak Hour Factors for Evaluation of LOS

Peak Hour Factor (PHF) is the amount of hours per day during the maximum-volume hour of the day divided by the peak 15-minute flow rate within peak hours; a measure of the fluctuations in traffic demand during peak hours. Level of service calculated from PCU and PHF is tabulated in Table 4.

Table 4. Level of service of different lanes by Peak Hour Factor.

Intersection	**Link name**	**PCU**	**PHF**	**LOS**
Phulbari Busstand	Mohila College Rd to Phulbari Bus stand	2117.85	0.79	B
	Terminal to Phulbari Bus stand	1224.8	0.80	B
Lily Mor	Nimnagor bus stand to Phulbari bus stand	2588.85	0.81	C
	Lily Mor to Paharpur road	2202.55	0.83	C
	Lily Mor to Jail road	2233.65	0.84	C
	Lily Mor to Munshipara road	1484.1	0.76	B
Kalitala	Kalitala to Charubabur mor	2202.6	0.78	B
	Kalitala to Suihari	2005.05	0.83	C

2.2 Traffic Volume to Capacity Ratio for Evaluation of LOS

Volume capacity ratio is the main parameter of traffic stream which is usually taken as the effective parameter for assessing the level of service (LOS). In evaluation the average PCU value of V / C ratio is considered. A good difference in V / C was found compared to the study Department. The effect of V / C ratio on PCU was studied to determining PCU standards for different types of vehicles in different ranges of V / C ratio. Level of service calculated from V/C is tabulated in Table 5.

Table 5. Level of service of different lanes by Volume Capacity Ratio

Roadway	Capacity, C (vehicles/hr/lane)	Volume, V (PCU/hr)	V/C	LOS
Lily mor to Paharpur Rd	1934.24	2202.55	1.14	F
Lily mor to Jail Rd	1934.24	2233.65	1.15	F
Lily mor to Munshipara Rd	1934.24	1484.1	0.77	D
College Rd to Phulbari Busstand	1934.24	2117.85	1.09	F
Terminal to Phulbari Busstand	2085.51	1224.8	0.59	C
Nimnagor to Phulbari Busstand	1934.24	2778.1	1.44	F
Kalitala to Charubabur mor	1934.24	2202.6	1.14	F
Kalitala to Suihari	1934.24	2005.05	1.04	F

3 Conclusions

Transportation system is an integral part of a city. Dinajpur is one of the fastest growing cities in Bangladesh where narrow road network is not enough to support the growing number of vehicles. So, traffic congestion has become a common problem for city dwellers. Traffic congestion is even worse in the intersection area compared to other parts of the road network.

Lily Mor, Kalitola&Phulbari Bus stand are the major intersections area of Dinajpur city, where three major road are Paharpur road , Munshipara road and Jail road connects at Lily Mor intersection; Charubbur mor, Suihari

connects at Kalitola intersection; Mohila college, Dinajpur Terminal, Nimngor bus stand connects at Phulbari Bus stand intersection. In this regardpeak hour factor with respect to level of service varies from B to C. “B” represents a high degree of driver comfort & little delay and “C” represents acceptable level driver comfort & traffic flow with some delay.

According to, volume capacity ratio of the level of service of different lane has been obtained. From analysis Lily Mor to Paharpur Road, Lily Mor to Jail Road, College road to Phulbari, Nimnagor to phulbari bus stand, Kalitala to Charubabur Mor, Kalitala to Suihari are designated as F grade level of service. F grade level of service represents the worst condition with heavily congested flow and traffic demand exceeding capacity, characterized by stop and go waves, poor travel time low comfort and convenience. Lily Mor to Munshipara road is designated as D grade level of service which represents traffic operations approaching unstable flow with high passing demand and passing capacity near zero, characterized by drivers being severally restricted in maneuver ability. Dinajpur Terminal to Phulbari bus stand is designated as c grade level of service which represents a constrained constant flow below speed limit, with additional attention required by drivers to maintain safe operation. The comfort and conveniences level of the driver declined noticeably.

4 Recommendations

Various reasons such as illegal parking, temporary shops on the street, narrow road width and lack of footpaths are the main reasons behind the change in the level of service covering major roads. Only successful implementation of proper traffic management plan in Dinajpur can reduce traffic congestion. Roads cannot be widened due to unavailability of land on both sides of the road. Heavy vehicles should not be allowed to cross the intersection during the day. Temporary street shops need to be evicted and sidewalks built to protect pedestrians. Illegal parking near three intersection’s routes should be strictly prohibited. The public carpooling facility can reduce traffic congestion at a high rate at maximum times. Concern authorities need to ensure an overall appropriate traffic management system to improve service levels, mainly at intersection areas.

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