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EVALUATING THE LEVEL OF TRAFFIC CONGESTION AT GOALANDO MORE INTERSECTION IN RAJBARI

Md. Anwar Hossain*[1], Muhammad Lukman Husain[2], Md. Sazzat Ahammad Himel[3] and Md. Ekhlas Uddin[4]

[1]Student, Department of Civil Engineering, Faridpur Engineering College, Bangladesh, e-mail: anwarce15@gmail.com
[2]Student, Department of Civil Engineering, Faridpur Engineering College, Bangladesh, e-mail: lukmanfec2k14@gmail.com
[3]Student, Department of Civil Engineering, Faridpur Engineering College, Bangladesh, e-mail: himelfec@gmail.com
[4]Lecturer, Department of Civil Engineering, Faridpur Engineering College, Bangladesh, e-mail: ekhlas09ce@gmail.com

***Corresponding Author**

ABSTRACT

Traffic congestion is an unfortunate reality that every major city has been affected. Long-standing traffic congestion specially in peak hour creates a tremendous situation. A growing urban area creates an undeniable problem in daily life with traffic as it has become a common scenario both in developing and developed countries. Bangladesh is one of them, suffering traffic congestion with unendurable proportions. The traffic congestion is rising faster because of socio-economic and population growth in Faridpur and Rajbari city. In order to evaluate the level of congestion at Goalanda More Intersection, this study was performed. This study was conducted by counting manual traffic volume. Geometric measurement was also accomplished to fulfill the study objectives. In this study, the level of traffic congestion in Goalanda More Intersection was evaluated by comparing the traffic volume of entry and exit legs and the level of service was measured by VISSIM software. The Level of Service was different for several legs of this intersection. Some of these were mostly congested. Moreover, there was also a different time of peak period for different approaches. The number of Auto Bike was also noticeable for its importance to travel a shorter distance. On-field observation, the heavy weighted and slow-moving vehicles are mainly responsible for congestion. A large number of slow-moving vehicles and scattered on-street parking which occupy the road, reducing roadway capacity and generating congestion. It is found that the traffic flow of the Ferryghat approach was higher than the others.

Keywords: *Transportation system; Traffic congestion; Level of service; Mobility; Unplanned deeds.*

1. INTRODUCTION

The role of transportation has become very important in a situation of rapid urbanization, which is increasing over time in the population of cities in relation to the region's rural population. Since the end of the Second World War, there have been rapid urbanization and economic growth activities in third world cities, resulting in high demand for mobility there. Urban transport in the third world countries is characterized by huge traffic growth along with a shortage of adequately maintained transport facilities, traffic system inefficiency and settlement structure thereby causing congestion. Urban transport technology mix and misuse in these countries are reflected in the coexistence of motorized and non-motorized modes often resulting in congestion and accidents. Similarly, ineffective traffic management and enforcement are reflected in the ignorance and disrespect for traffic rules and regulations *(*Aparajita, 2015).

One of the major problems in cities and municipalities in Bangladesh is traffic congestion. It makes life in cities uncomfortable for people. Every year governments spend huge budgets to solve this problem. The number of traffic is increasing day by day in Rajbari and Faridpur city. That's why traffic congestion occurs at major intersections in these cities and the congestion problem is rising faster. In order to assess the level of congestion at Goalanda More intersection, this study was carried out. Many urban centers in the southern part of Bangladesh from inadequate facilities that could ensure smooth urban movement.

According to the Joint Transport Research Centre of the Organization for Economic Cooperation and Development (OECD) and the European Conference of Ministers of Transport (ECMT), "Cities and traffic have developed hand-in-hand since the earliest large human settlements. The same forces that draw inhabitants to congregate in large urban areas also lead to intolerable levels of traffic congestion on urban streets and thoroughfares." (ECMT 2007:5). This captures the relationship between urban cities and traffic congestion as well as the world-wide dimension of the problem of traffic congestion in urban cities (Gabriel., 2013).
So far, the conventional approaches to traffic management have not been able to make the desired impact, judging from the traffic congestion patterns in Rajbari and Faridpur City.

1.1 Objectives of the Study

The congestion problem at major intersections and road sections in Rajbari and Faridpur City are growing faster. The specific objectives of the study are as follows:

- To identify the peak periods of traffic flow of the day in the study intersection.
- To measure the Level of Service (LOS) of the intersections by using VISSIM Software.
- To identify the most congested road and period of congestion at the study intersection by comparing the traffic volume of entry and exit legs.

1.2 Scope and Limitations

The scope of this study was limited to the Goalanda More intersection of Rajbari and other road sections and intersections of the city were not included in this study. Furthermore, the analysis was a segmented study rather than an area-wide or regional study. Hence, it focused mainly on the road segments at the entry of the intersection and the relative effect of the consecutive intersection was not discussed. Since the main objective of the study is to evaluate the Level of Service by VISSIM Software, the congestion management procedures and measures were not discussed as it needs a wider and comprehensive exploration.

The study was conducted by PTV VISSIM-11 (student version) where simulation time is limited to one hour.

2. LITERATURE REVIEW

Many researchers and professionals in the field of transportation agree that road traffic congestion is an ever-growing problem and the global phenomenon of major cities throughout the world. Further to this Lomax (1997) showed that traffic congestion is expanding toward the suburbs as commercial activities are being pulled out of the central business districts (Lomax et. al., 1997; Maitra et. al., 1999). In fact, it is almost certain that traffic congestion will also get worse during at least the coming decades mainly due to the increasing population number and the growing economy of nations. Traffic congestion is a negative output of a transportation system which has many detrimental effects on the performance of the road network, the traffic flow, the society, the national economy and the environment. Maitra et. al. (1999) summarizes some of the negative effects of traffic congestion as; considerable loss of travel time, higher fuel consumption, more vehicle emission and associated environmental and health impact, increased accident risk, stress and frustration on commuters and greater transportation cost.

Further to the above; many more researches have been conducted by different researchers and professionals to develop measuring parameters and models (Maitra et. al., 1999; Lomax et. al., 1997; Cottrell, 2001). So far, different congestion measures and models have been proposed and used to determine the extent, severity and duration of congestion and also transport professionals are still developing different models for congestion prediction and simulation (Moran et. al., 2010).

2.1 Peak Hour

Peak hour is a part of the day during which traffic congestion on roads and crowding on public transport is at its highest. Normally, this happens twice every weekday; once in the morning and once in the afternoon or evening, the times during which most people commute. The term is often used for a period of peak congestion that may last for more than one hour (Wikipedia, 2019).

The Peak Hour Factor (PHF) compares the traffic volume during the busiest 15-minutes of the peak hour with the total volume during the peak hour. It indicates how consistent traffic volume is during peak hour. The peak hour factor is used in HCM capacity and level of service analysis to account for the variation in traffic volumes during the peak hour (hcmguide, 2019)

The peak hour factor can then be computed as follows:

PHF = (Peak hour volume in an hour)/(4*Peak 15 min volume in the peak hour)

PHF $\leq$ 1

2.2 Definition of traffic congestion

Traffic congestion is a condition on transport networks that occurs as usage increases and is characterized by slower speeds. When traffic demand is great enough that the interaction between vehicles slows the speed of the traffic stream, this result is some congestion.

2.2.1 Types of Congestion

The three types of congestion are outlined by Brownfield et al (2003) as recurrent congestion, nonrecurrent congestion, and the pre-congestion state, as shown in Table1below. These types are based upon the frequency and predictability of the congestion – factors which will impact on driver behavior. The costs associated with each type of congestion are likely to be different. Non-recurrent congestion costs may be more difficult to quantify due to the inherent sparseness of adequate amounts of data needed – it may be argued that the costs could be higher as drivers have not been able to take the possibility of congestion into account in planning their journey or alternatively the costs may be less dramatic as drivers pre-developed strategies for coping with congestion will not have come into play. Some routes are increasingly subject to non-recurrent congestion however, for example with accident black spots. In these cases, drivers may 'learn' an expected cost in terms of likely delay and successful contingency routes. The Pre-congestion state will carry some costs similar to those of

congestion, including loss of control over drivers' environment, deterioration in the environment and other impacts.

Table 1: Type of Congestion

Congestion type	Definition
Recurrent congestion	This occurs at regular times at a site. It can be anticipated by road users that normally use the route during those times. Examples of recurrent congestion are morning or evening peak hour congestion or congestion due to a regular event such as a street market on a particular day each week.
Non-recurrent congestion	This occurs at non-regular times at a site. It is unexpected and unpredictable by the driver and is normally due to incidents such as accidents, vehicle breakdowns or other unforeseen loss of carriageway capacity.
Pre-congestion (Borderline congestion)	Occurs where free-flow conditions breakdown but full congestion has not yet occurred. This may occur either side of the time period when congestion occurs or upstream or downstream of congestion that is already occurring.

Source: (Brownfield, 2003).

2.2.2 Causes of Traffic Congestion

Different researches and reports identified many interrelated factors that cause traffic congestion in developed and developing countries where the road network and road users behavior are different" (Systematics, 2005) Accordingly, the results showed that in the United States of America the cause and their percentage share are; bottleneck (40%), traffic incidents (25%), work zone (10%), bad weather (15%), poor signal timing (5%) and special events contribute 5% of the traffic congestion.

Adedimila "(Aworemi, 2009) classifies the major causes of traffic congestion in Lagos metropolitan into five and the summary of his discussion is shown in Table 2.

Table 2: Major Causes of Traffic Congestion in Lagos Metropolitan

Item No.	Factors	Causes
1	Social & Economic factors	Rising population number together with the rural-urban migration. Unplanned land use which results in unidirectional traffic flow especially at pick hours Increased car ownership in line with the improved living standard.
2	Road factors	A smaller number of lane & Narrow road with Lack of sidewalk which results in occupation of traffic lanes by pedestrians Distressed pavement which results in reduced travel speed Uncontrolled traffic Intersections.
3	Vehicle factors	Size of vehicle Age of vehicles.
4	Human factors	Perception of drivers Perception of pedestrians.
5	Accident	The severity, number, and location of the accident.

Source: (Aworemi, 2009)

Traffic congestion occurs for limited road capacity, road parking, un-integrated urban planning, and lack of mass transit, accident, poor vehicle condition, and roadside illegal trade.

2.2.3 Congestion Indicators

It is essential to define or have indicators of the presence of congestion in the system. According to many other researchers, LOS is the best empirical indicator of congestion in the transport system.

2.2.4 Level of Service (LOS) as Congestion Indicator

The objective of the High way Capacity Manual is to provide a consistent system and techniques for the evaluation of the quality of service on highways and street facilities. HCM presents LOS as an easy-to-understand methodology of analysis and performance measure for single homogenous road segments.

HCM doesn't specify the boundary LOS for the congestion state but clearly states that the LOS F is defined as the worst state of flow and represents congested flow and A is defined as a congestion-free flow state. Though there are some reports using another level of service (D and E) as congested flow, LOS C is generally accepted as a state of traffic flow and hence LOS is the most appropriate congestion indicator.

The LOS criteria of HCM are summarized in Tables 3.

Table 3: Typical Highway Level of Service (LOS) Rating.

LOS	Description	Speed (km/hr)	Flow (Veh/hr/ln)	Density (Veh/km)
A	Traffic flows at or above the posted speed limit. Motorists have complete mobility between lanes.	Over 96	Under 700	Under 8
B	Slightly congested, with some impingement of maneuverability. Two motorists might be forced to drive side by side, limiting lane changes.	91-96	700-1100	8-13
C	The ability to pass or change lanes is not assured. This is the target LOS for most urban highways	86.5-91	1100-1550	13-19
D	Speeds are somewhat reduced; motorists are hemmed in by other vehicles. Typical urban peak-period highway conditions.	73.5-86.5	1550-1850	19-26
E	Flow becomes irregular, speed varies and rarely reaches the posted limit. This is considered a system failure.	48-73.5	1850-2000	26-42
F	Flow is forced; with frequent drops in speed to nearly zero km/hr. Travel time is unpredictable.	Under 48	Unstable	42- max

Source: HCM-2000.

3. METHODOLOGY

The intersection with three different approaches was selected where all vehicles are moved freely. The approaches are Faridpur leg, Rajbari leg and Ferryghat leg of the intersection.

3.1 Research Approach

The research approach in this thesis involves quantitative approaches. Quantitative data and analysis were used to determine the level of service of the intersection and to measure the congestion level. Observations and direct field measurements were the main sources of quantitative data. The level of congestion at the considered Intersection and road sections were evaluated by Observations, collected relevant data and subsequent analysis.

The congestion indicator parameters used in this research were the Level of Service (LOS). The LOS criterion was according to HCM-2000 and determined using the widely used **VISSIM** software.

3.2 Data Collection

Data collection is very important to find and understand the flow pattern, determine the peak periods. To attain the objectives of the paper, several data were collected in the type of quantitative such as traffic volume data, geometric data, and vehicle characteristics as it is extremely required to determine the Level of Service.

3.2.1 Traffic volume

The selected vehicles are Buses, Microbuses, Trucks, Car, Auto Bike, Motorcycle, and Bicycle. Directional traffic volume was calculated by counting the number of vehicles in both directions. And it is conducted with a manual traffic data collection system at the same time on each lane of each leg. Traffic volume count was conducted in vehicle per 15 min interval. Bicycles, Auto Bike was taken

as slow-moving vehicles. Traffic volume count was collected for a period of 10 hours (8.00 am to 6.00 pm) on the study day.
The traffic volume in the passenger car unit and the movement of traffic on each approach leg are also essential for the analysis. The passenger car equivalent factors are used to convert the number of vehicles in the passenger car unit. The PCU values given in the geometric design of Highways (MoC, 2010) are given in Table 4.

Table 4: PCU of Different Types of Vehicles in Bangladesh (MoC, 2010).

Categories	PCU
Passenger Car	1.00
Light Good Vehicle	1.00
Bus	3.00
Truck	3.00
Auto Rickshaw/ Motorcycle	0.75
Rickshaw/ Van	2.00
Bicycle	0.50

3.2.2 Geometric Data

Field measurement was done to collect data of geometric features of the road section. The geometric data of road sections were measured by using tape. These include a number of lanes, lane width, configurations of lanes, mattered and unsettled shoulders. These measures were done for the intersections whose level of service is going to be determined.

3.2.3 Speed calculation

From the selected site, average spot speed was measured by using Speed Radar Gun. Different speed was found for several vehicles tabulated bellow.

Table 5: Spot Speed of different vehicles

Vehicle	Spot Speed(km/hr)
Truck	17
Bus	21
Microbus	24
Car	23
Autobike	12
Bike	25

3.3 Description of study location

Road transport has been serving the major mode of transport for both national and international transport services. Goalanda more intersection has connected with two major cities and Daulatdia ferry ghat, connecting the southern part of Bangladesh with Dhaka. This channelized T-intersection accommodates mostly heavyweight vehicles, carrying goods and raw materials of various industries which have a tremendous impact on socio-economic conditions in the southern part of Bangladesh specially Faridpur and Rajbari.

Figure 1: Goalanda More intersection (Google, 2019).

Goalanda more intersection is located in south-western Bangladesh at 23°41'02.7" N 89°41'55.5"E.

4. RESULTS AND ILLUSTRATIONS

The peak hour volume was identified by the gathered quantitative data analysis with the trend of traffic flow within the day. The level of Service for the identified intersection was analysed by using **VISSIM** software.

4.1 Directional traffic volume analysis

Directional traffic volume data counted at 15min interval in all legs of this intersection for 10 hours (8.00 am to 6.00 pm). Traffic volume analysis is conducted for both directions for three legs. The road sections were considered:

- Faridpur approach
- Ferryghat approach
- Rajbari approach

Directional traffic volume analysis of each leg is discussed bellow.

Faridpur approach

In figure 2 it is seen that the most crossed vehicle is truck in both Faridpur to intersection and intersection to Faridpur. As the intersection connects the southern part of Bangladesh with Dhaka city, so it is the most used intersection to shipping heavy and light goods by tuck. It is also seen that the common vehicle is Auto Bike. People like to travel on Auto Bike from one place to another in a shorter distance. And it is getting popular day by day. It was seen that the car and microbus were very small in number. Motor Cycles are used in a mentionable number. Bus as Public transportation is also taking place to congest the road.

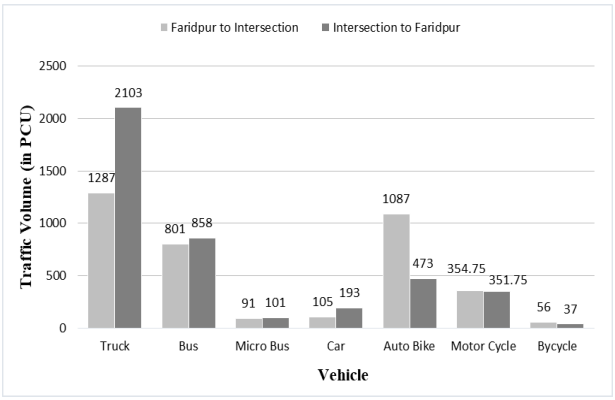

Figure 2: Traffic volume by vehicle type

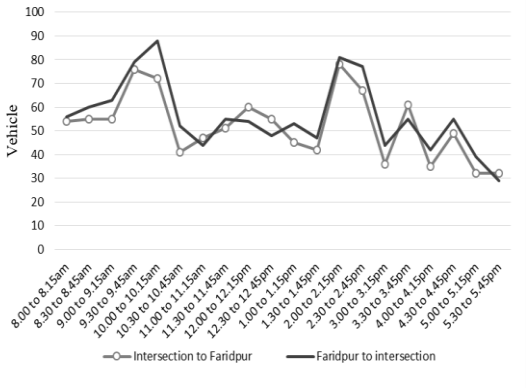

Figure 3: Traffic volume (veh/15min)

From figure 3 it is seen that both intersection to Faridpur and Faridpur to intersection approach, traffic volume is increasing after 9.00 am and it is maximum from 9.00 am to 10.00 am In the morning and 2.00 pm to 3.00 pm in the afternoon.

4.1.1 Ferryghat Approach

At the intersection of Ferryghat road shown in figure 4, it is seen that the number of the truck is also leading here in both Ferryghat to intersection and intersection to Ferryghat road. The number of busses is also dominating here. Auto Bike and motorcycle are also in considerable numbers.

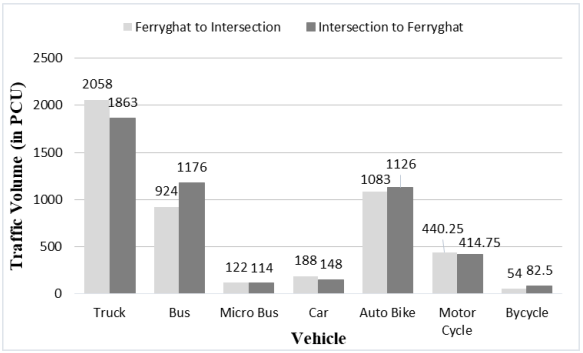

Figure 4: Traffic volume by vehicle type

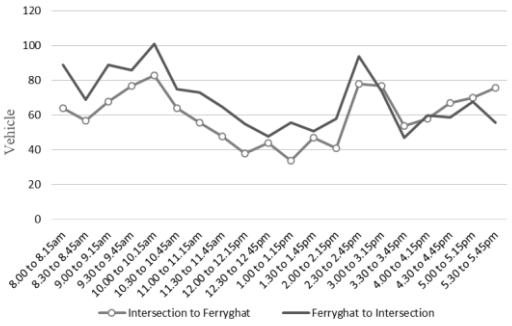

Figure 5: Traffic volume (veh/15min)

In figure 5 it is seen that intersection to Ferryghat and Ferryghat to intersection approach traffic volume are increasing after 9.00 am and maximum from 9.30 am to 10.30 am in the morning and 2.00 pm to 3.00 pm in the afternoon.

4.1.3 Rajbari Approach

From figure 6 it can be seen that Auto Bike is the most common vehicle in both Rajbari to the intersection and intersection approach to Rajbari. People like to travel by Auto Bike in one place to another quickly. Microbus and cars are very small in number. People like to travel in the Motor Cycle also.

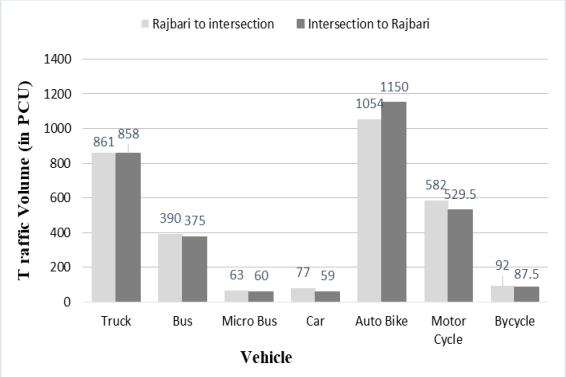

Figure 6: Traffic volume by vehicle type

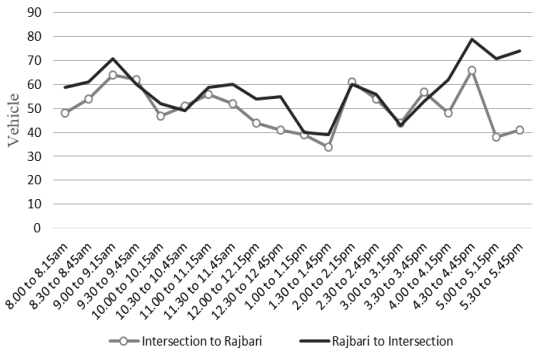

Figure 7: Traffic volume (veh/15min)

Figure 7 shows that traffic entry and exit on this intersection almost the same. Here the peak period is 8.30 am to 9.30 am in the morning and 4.00 pm to 5.00 pm in the evening. And it is noticeable that the overall traffic volume is less than the previous two approaches.

4.2 Estimation of Level of Service

In order to justify the level of traffic congestion, the analysis was made using VISSIM software. The analysis was performed with the left-hand driving rule and matric unit. As only the Level of Service will be determined for an indicative result leaving the other outputs of the program, calibration wasn't taken as an issue for the purpose. In order to conduct the analysis of the geometric and directional hourly traffic volume data were prepared as an input for the program as summarized below in Table 6. However, recommended and default values were taken for other input data.

Table 6: Level of Service for each route of Goalanda more intersection through **VISSIM**

Approach Route	Level of Service
Faridpur to Ferryghat	C
Faridpur to Rajbari	D
Ferryghat to Faridpur	A
Ferryghat to Rajbari	A
Rajbari to Faridpur	C
Rajbari to Ferryghat	E

Overall Level of Service of Goalanda more intersection was found C.

4.2 Comparison of total traffic volumes among the entry and exit legs

Figure 8 shows the comparison of the traffic volume counted for 10 hours in both directions on each leg. It shows that the highest traffic volume on the direction of the intersection to Ferryghat and the second-highest traffic volume is Ferryghat to intersection direction. From the figure, it is clear that Ferryghat's leg from the intersection carries the huge traffic volume from two other approaches. Rajbari leg shows the lowest volume of traffic throughout the day time in both lane Rajbari to intersection and intersection to Rajbari.

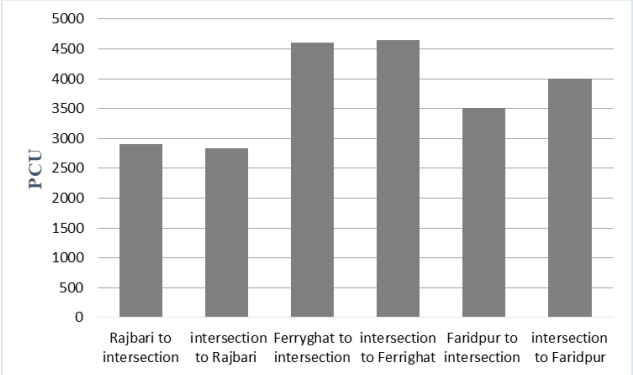

Figure 8: Total directional vehicle volume at the intersection.

Figure 9 shows the directional traffic volume pre 15 min for exit legs. And it shows that the maximum traffic volume in the intersection to ferryghat leg among the three legs. the highest traffic volume is nearly 85 vehicles per 15 min during the morning peak period it is greater than 75 vehicles during the afternoon period.

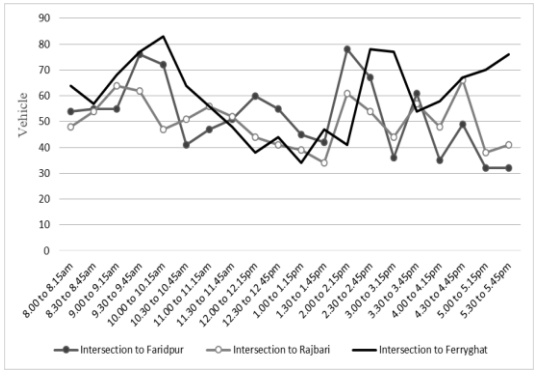

Figure 9: Comparison of traffic volume (veh/15min) of exit legs of three approaches

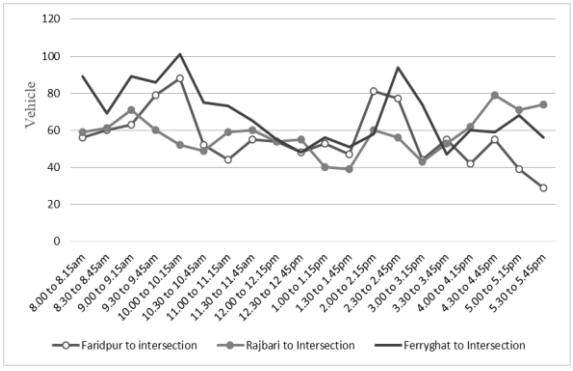

Figure 10: Comparison of traffic volume (veh/15min) of entry legs of three approaches

The chart shown in figure 10 represents the entry legs to the intersection. Here also seen that the Ferryghat to intersection leg is the most congested with traffic volume above 100 during the morning peak period. And greater than 95 vehicles per 15 min during the afternoon peak period.

5. CONCLUSIONS AND RECOMMENDATION

The findings of the research work concluded below in brief:

- The traffic flow of Ferryghat approach was higher than the others and the peak period was found from 9.30 am to 10.30 am.
- The overall Level of Service of the intersection was found as C. Which represents the stable flow, at or near free flow condition. Most experienced drivers are comfortable on this circumstance.
- By comparing the approaches, it was seen that the Ferryghat approach was more congested in both entry and exit legs. On the other hand, the Rajbari approach was less congested compared with others.

This study will facilitate further research and development to the respective authorities. The overall traffic condition would be alleviated by controlling on-street parking, scattered pedestrian flow and slow-moving vehicles.

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