Traffic Congestion at Road Intersection due to Absence of Efficient Traffic Management and Planning: A Case Study on Fulbarigate, Khulna

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ABSTRACT

Road intersection is a very critical part of road network system as vehicles from different roads merge and diverge frequently, and therefore, it has high significance to ensure safety and avoid traffic congestion. This study has been carried out to identify the reasons behind traffic congestion at road intersection in the context of Fulbarigate, Khulna. The normal design speed in this road intersection is 40-50 km/hour, which gets drastically reduced to 10-20 km/hour due to heavy pedestrian movement and improper traffic management, causing traffic congestion. A field survey was conducted through which various types of data were collected, such as types and number of vehicles, number of pedestrian crossing the road/hour, number of vehicle merging and diverging per hour, number of parked vehicles at a particular moment. The survey analysis shows that roadway environmental and operational conditions as well as traffic safety situation are getting worse mainly due to reduction of road width for on street parking, absence of zebra crossing and foot over bridge, stoppage delay of the three-wheelers (e.g. Atul, Battery-easy bikes etc.) until getting passengers, huge number of slow moving vehicles at intersection and absence of proper traffic management and transportation planning. Based on these results, this paper provides some improvement schemes along with guideline to effective traffic management system and appropriate design standards to improve the overall condition of Fulbarigate road intersection.

Keywords: *Road intersection, traffic congestion, inefficient traffic management, on street parking, unplanned activities*

1. INTRODUCTION

Traffic congestion at road intersection is very crucial as the performance of intersections affects the overall road network. Like other countries, the traffic congestion are increasing day by day and have become a burning issue for Bangladesh (Shamsher and Abdullah, 2013). Developing country like Bangladesh suffers much from this vital problem which results in a great hinder to sustainable development. Traffic congestion adversely affects country's economy, kills time, causes waste of fuel and pollution, and most prominently causes sufferings to all class people. It takes away people's 8.15 million working hours, 40 percent of which are business hours. Taka 20 billion is lost due to 3.2 million business hours wasted in congestion (Shahiduzzaman, 2014). The problem of traffic congestion in urban areas is worse at road intersections. As defined by (O'Flaberty, 1997), intersections (where two ormore roads meet), are points of vehicle conflict.

Population growth, high density vehicular movement, inefficiency of road capacity due to unauthorized parking, traffic mismanagement, as well as unplanned roadside development plays a vital role causing traffic congestion. In Khulna city traffic congestion is lesser than the Capital. Traffic flows on roads of Khulna city are heterogeneous. In many parts of Khulna, rickshaw and other non- motorized transport (NMT) account for 60 % or more of the overall traffic flow. The numberof vehicles operating in Khulna city is more than 20990, comprising about 13360 non-motorized and 7630 motorized vehicles. The average annual growth rate of the motorized vehicles is about 15%. For motorized vehicl es the average speed varies in the Central Business District (CBD) area between 24 km/h to 58 km/h depending on locations (Uddin and Sen, 2004). But nowadays traffic congestion at different road intersection (i.e. Shibbari Mor, Dakbangla, Fulbarigate, Gollamari-Shatkhira connecting road, Rupsha Ghat) has been observed. As the consequences of population growth and transportation demand, this fact should be kept in concern before it diverts to a giant problem as in Dhaka city.

This study has been carried out with the aim to identify the causes of traffic congestion at road intersection and provide some short time improvement scheme. To identify the problems and issues relating to traffic congestion at road intersection we have taken Fulbarigate road intersection, Khulna as our study area. This is a major highway connecting Dhaka, Jessore and Khulna. This T-shape intersection consist a major rail crossing, a market place/bazar, bus stoppage counters and an access to Jessore bypass road and Khulna University of Engineering & Technology. This intersection is always crowded due to local bazar, bus counters and unauthorized parking of the motorized and non-motorized vehicles waiting for passengers all the time. As a result traffic congestion is seen at regular intervals. A map has been provided below in figure 1 of the study area.

2. METHODOLOGY

This study contains both primary and secondary data. Secondary data were collected from various journal papers and websites. A layout plan was drawn using "Corel Draw X6" to have an overall outlook of the study area. Then collected data were tabulated and problems causing traffic congestion were identified. After the analysis phase some recommendations were provided to improve the overall condition and to reduce traffic congestion in this area. The methodology can be divided in some phases as described below:

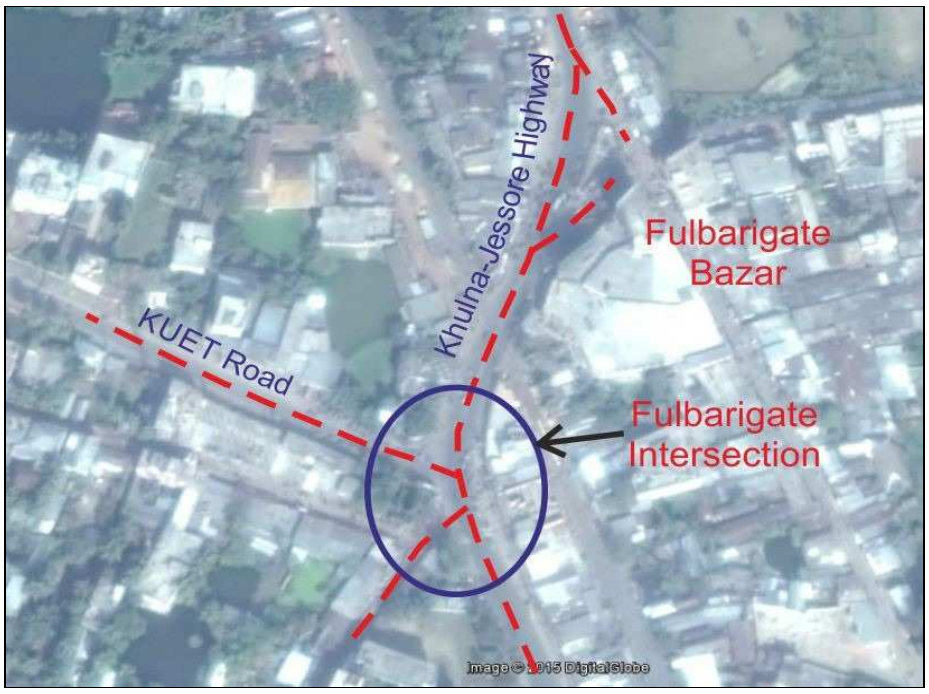

Figure 1: Map of Study Area-Fulbarigate Khulna (Source: Google Earth)

2.1 Collection of Data

This study consists of mainly two types of data. Primary data and secondary data.

2.1.1 Primary Data Collection:

Primary data like traffic volume, number of merge diverged vehicles, surrounding land use type, road geometric condition; pedestrian crossing and parking volume etc. were collected through field survey. For the measurement of road, measurement tape was used and for the vehicular volume, pedestrian crossing, parking volume study and to determine merged diverged vehicles different observation points were selected as shown in figure 4, 5, 6 and 7 respectively. To compare the collected data different time period were selected. (i.e. 9.00AM-10.00AM, 1.00PM-2.00PM, 6.00PM-7.00PM, 9.00PM-10.00PM). The data were collected using manual tally method. So there are possibilities for some error.

2.1.2 Secondary Data Collection:

Secondary data like study area map and geometric road standard were collected from different websites. Study area map was downloaded from google earth and taking measurement from the google earth the road

measurement taken earlier as primary data were compared to present the measurement as accurate as possible. All the layout plan in this case study were drawn by using "Corel Draw X6" for proper representation.

2.2 Situational Analysis

Collected data were tabulated in various data tables showing different vehicular characteristics. These tables reflected the existing situation with which we interpreted the result as the frequency of pedestrian crossing the road, parking volume and most used parking area, the amount of road width reduction due to unauthorized parking and other current conditions.

2.3 Results and Discussion

Based on the overall existing condition and situational analysis problems were identified. Some recommendation has also been provided to improve the overall condition and reduce the traffic congestion at this intersection.

3. SITUATIONAL ANALYSIS

3.1 Existing Road Geometric Condition

The geometric condition of road in this important intersection is not properly planned. The common features of a road intersection are present in limited edition. They are given below:

3.1.1 Carriage way

In general, metaled pucca strip of road meant for vehicular traffic movement is called carriage way. Normally IRC standard of carriage way for a single lane is 3.5 meter including 68 cm of clearance. As in this case, the study area road is double lane the standard carriage way width should be (3.5*4) or 14 meter for two way road. But in practical only 12.22 meter exists.

3.1.2 Median

Median is dedicated to separate the vehicular flow moving in opposite direction to each other. It is also used to direct the traffic flow at a particular space. The existing median is in very poor condition and it is about one feet in width.

3.1.3 Pavement Condition

The surface of the pavement is very rough which creates greater frictional resistance between the tyre and road surface. The road surface is not smooth and damaged in various points which is very dangerous for a road intersection. Water logging is seen during rainy season and due to roughness of the surface water cannot pass over the road surface.

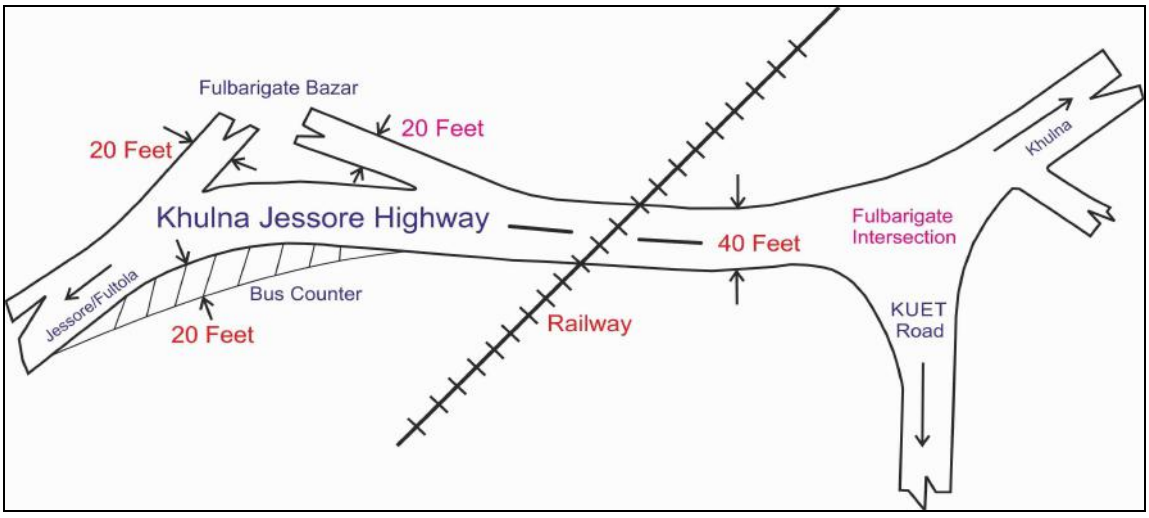

Figure 2: Layout plan of the study area

3.1.4 Camber and Drainage Facility

Camber was provided during the reconstruction of this road few years ago. But due to excess vehicular flow and heavy moving vehicle the crown is damaged at the midpoint of the road surface. Camber is provided for surface runoff. Due to absence of sloping surface runoff is interrupted and there are no proper drainage facility on both sides of the carriage way.

3.1.5 Footpath or Sidewalks

Sidewalks provided for this road is insufficient which cannot supply the demand requirement due to heavy pedestrian flow at this road intersection. The sidewalks are informal and are about two feet of width. Most of them are abused by the on street parking and on street shops as a result people tend to walk over the carriage way which is very risky.

3.2 Surrounding Land Use

This highway is a very busy road as it severs a mixed use zone. Mainly this is a commercial area. Few banks, a newly constructed market, daily Fulbarigate bazar, bus counters, hotels on street shops and departmental stores are located here. The overall surrounding land use pattern has been shown in the following figure below-

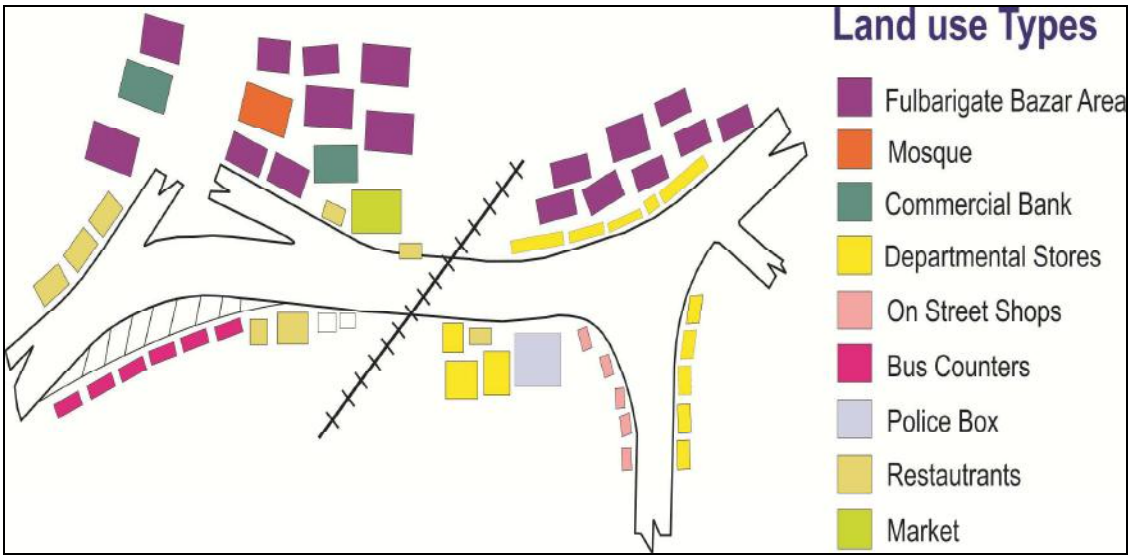

Figure 3: Surrounding landuse pattern

3.3 Type of Vehicles Observed

Various types of vehicles were seen at different time. The vehicles which were seen in this road intersection are categorized in two, mainly motorized and non-motorized. The categorized vehicles are given below in table 1:

Table 1: Vehicular Types

Motorized Vehicle	Non-motorized Vehicle
Bus	Rickshaw
Three-wheelers	Easy-bike
Motor-cycle	Van
Car	Bicycle
Truck	
Mini-truck	

(Source: Field Survey, October'15)

3.4 Vehicular Volume

Khulna-Jessore highway is a very busy road and movement of heavy weight vehicles are most common. A field survey was carried out to figure out the volume of motorized and non-motorized vehicles in this road. And the survey showed that vehicular volume increases in the evening and comparatively lesser at night due to less movement of low weight vehicles and three wheelers. In this study traffic volume has been determined by the number of vehicles passing a specific cross section of the road per hour. The observation point is given below in figure 4. Traffic volume at different time period is given below in table no. 2:

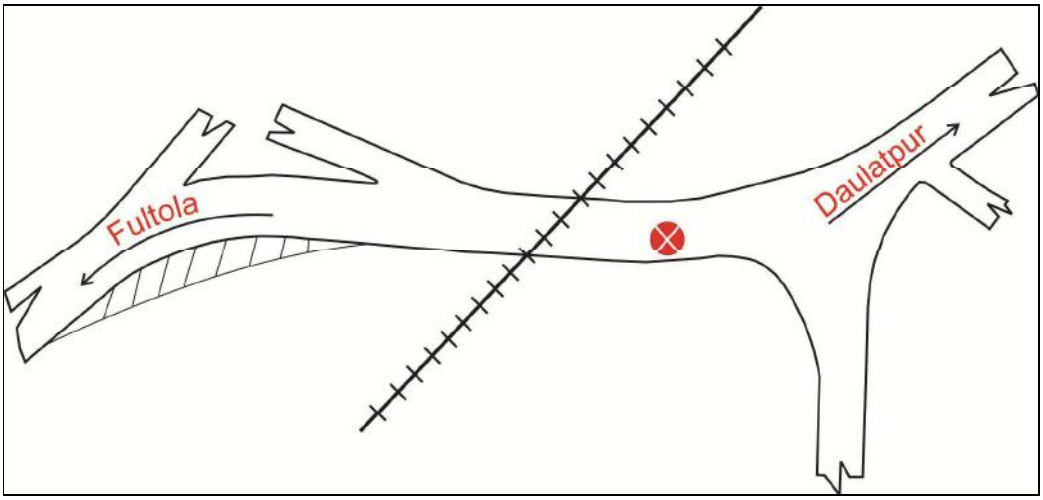

Figure 4: Observation point of vehicular movement

Table 2: Vehicular flow to at different times and direction

Vehicle Type		No. of Vehicles/Hour							
		9.00AM-10.00AM		1.00PM-2.00PM		6.00PM-7.00PM		9.00PM-10.00PM	
		To Daulatpur	To Fultola	To Daulatpur	To Fultola	To Daulatpur	To Fultola	To Daulatpur	To Fultola
Motorized	Bus	10	28	18	42	37	32	9	24
	Three-wheelers	98	124	150	196	156	158	124	100
	Motor-cycle	153	175	198	184	184	149	133	121
	Car	12	7	50	30	43	34	23	35
	Truck	12	23	36	54	14	16	24	33
	Mini-truck	10	8	14	12	21	20	22	7
Total		**295**	**365**	**466**	**518**	**455**	**409**	**335**	**320**
Non-Motorized	Rickshaw	7	5	6	12	8	12	19	22
	Easy-bike	53	35	64	102	116	80	34	76
	Van	75	98	84	124	164	160	67	103
	Bicycle	113	85	85	116	258	150	92	146
Total		**248**	**223**	**239**	**354**	**546**	**402**	**212**	**347**
Grand Total		**1131**		**1577**		**1812**		**1214**	

(Source: Field Survey, October'15)

3.5 Average Vehicular Speed

Design speed of this highway road is about 40-50km/hr. *(Field Survey)*. But due to traffic congestion and ineffective traffic management it reduces to 15-20 km/hr. in average. The average vehicular speed in this road intersection is given below in table no. 3:

Table 3: Average vehicular speed of motorized and non- motorized vehicle

Motorized Vehicle	Average Vehicular Speed, km/hr	Non-motorized Vehicle	Average Vehicular Speed, km/hr
Bus	15-20	Rickshaw	4-5
Three-wheelers	13-15	Easy-bike	10-12
Motor-cycle	10-15	Van	5-5
Car	15-20	Bicycle	5-7
Truck	10-15		
Mini-truck	10-15		

(Source: Field Survey, October 2015)

3.6 No. of Diverged & Merged Vehicle

A vehicle from minor road merges into the highway as well as vehicles from highway diverges into minor roads without any signals or traffic rules. Here in the table no. 4 (a, b & c) numbers of merged and diverged vehicles are given below at different points and the observation point is given in figure 5:

Table 4 (a): Number of merged and diverged vehicles at different points

Point A

Types of Vehicle	Diverged Vehicle				Merged Vehicle			
	9.00AM-10.00AM	1.00PM-2.00PM	6.00PM-7.00PM	9.00PM-10.00PM	9.00AM-10.00AM	1.00PM-2.00PM	6.00PM-7.00PM	9.00PM-10.00PM
Bicycle	87	40	72	47	67	51	40	55
Van	45	37	51	32	49	40	25	23
Motor-cycle	17	13	22	10	32	27	21	36
Mini-Truck	0	3	0	1	2	1	5	2
Easy-bike	3	6	5	8	9	4	4	3
Total	**152**	**99**	**150**	**98**	**159**	**123**	**95**	**119**

(Source: Field Survey, October 2015)

Table 4 (b): Number of merged and diverged vehicles at different points

Point B

Types of Vehicle	Diverged Vehicle				Merged Vehicle			
	9.00AM-10.00AM	1.00PM-2.00PM	6.00PM-7.00PM	9.00PM-10.00PM	9.00AM-10.00AM	1.00PM-2.00PM	6.00PM-7.00PM	9.00PM-10.00PM
Bicycle	32	40	66	51	57	51	40	38
Van	23	49	47	37	32	48	25	19
Motor-cycle	9	16	22	5	29	27	21	23
Mini-Truck	0	3	0	0	2	1	7	2
Easy-bike	3	8	7	2	3	4	4	6
Total	**67**	**116**	**142**	**95**	**123**	**131**	**97**	**88**

(Source: Field Survey, October 2015)

Table 4 (c): Number of merged and diverged vehicles at different points

Point C

Types of Vehicle	Diverged Vehicle				Merged Vehicle			
	9.00AM-10.00AM	1.00PM-2.00PM	6.00PM-7.00PM	9.00PM-10.00PM	9.00AM-10.00AM	1.00PM-2.00PM	6.00PM-7.00PM	9.00PM-10.00PM
Bicycle	57	29	38	19	25	19	35	15
Van	32	25	26	33	26	16	29	18
Motor-cycle	37	13	22	5	29	27	21	23
Mini-Truck	5	8	12	17	10	5	9	11
Easy-bike	26	6	5	2	3	4	4	6
Rickshaw	21	17	32	19	34	26	47	16
Total	**178**	**98**	**135**	**95**	**127**	**97**	**145**	**89**

(Source: Field Survey, October 2015)

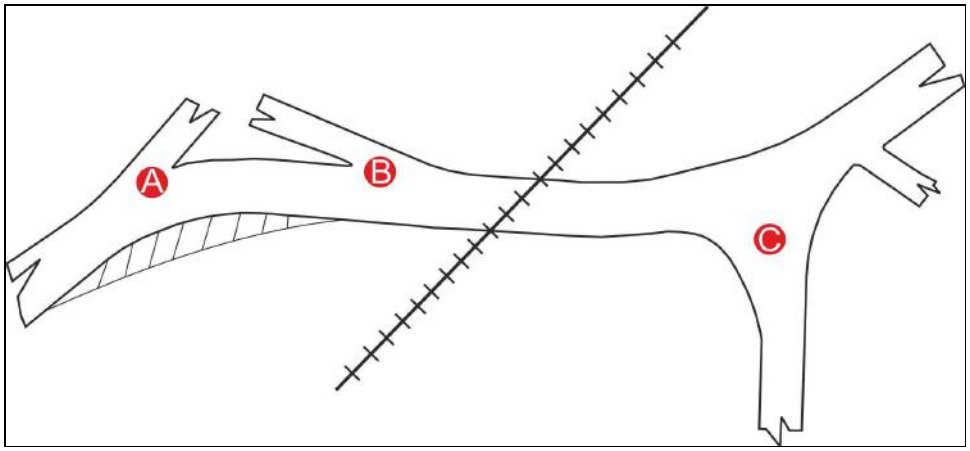

Figure 5: Observation points of merged and diverged vehicles

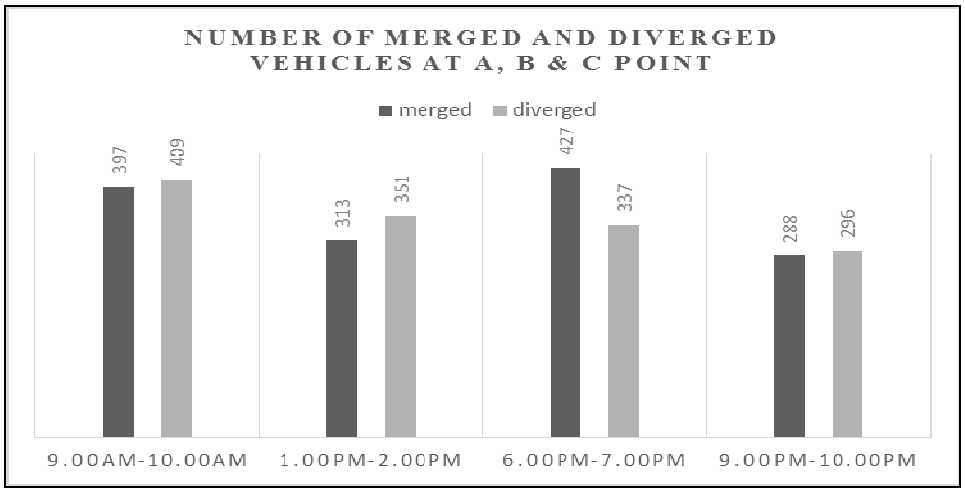

Figure 6: Number of Merged and Diverged Vehicles at different points

3.7 Pedestrian Movement

In this road intersection there is no specific space for the pedestrian to cross the road or any existing zebra crossing. A huge no. of pedestrian cross this highway which is too risky and often slows down the regular vehicular speed. From the field survey we see that point C is the most used crossing point and it is a must to

provide a zebra crossing in there. We can also see that during the evening hour the pedestrian movement is very high comparing to the other time of the day. The major crossing point A, B & C are shown below in figure 6:

Table 5: Pedestrian movement at different crossing points

Time Period		9.00AM-10.00AM	1.00PM-2.00PM	6.00PM-7.00PM	9.00PM-10.00PM	Total
No. of people crossed the road at point	A	147	74	172	62	455
	B	94	56	121	56	327
	C	162	67	185	79	493
Total		**403**	**197**	**478**	**197**	

(Source: Field Survey, October 2015)

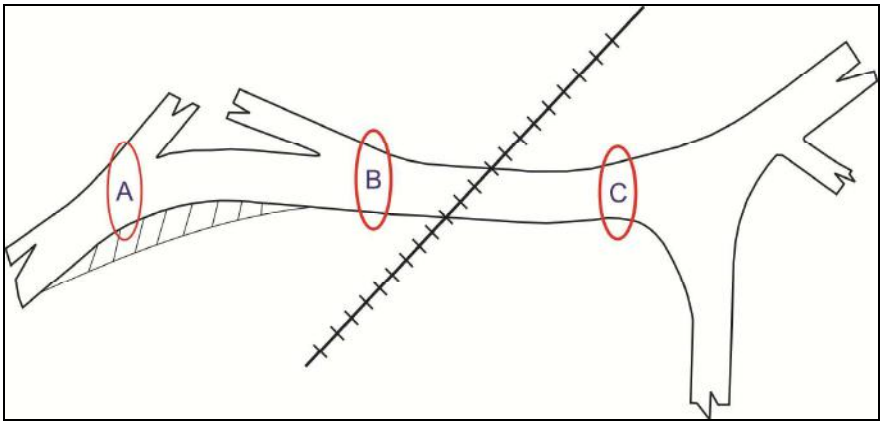

Figure 7: Observation points of pedestrain crossing

3.8 Parking Volume and Type

On street parking in this highway is a common phenomenon. But drivers follow no rules in maximum case. Parking at the points of road intersection, on street parking of vehicle in two bays, parking vehicle in a wrong manner is most common scenario. Parking volume in road intersection is given below in figure 7:

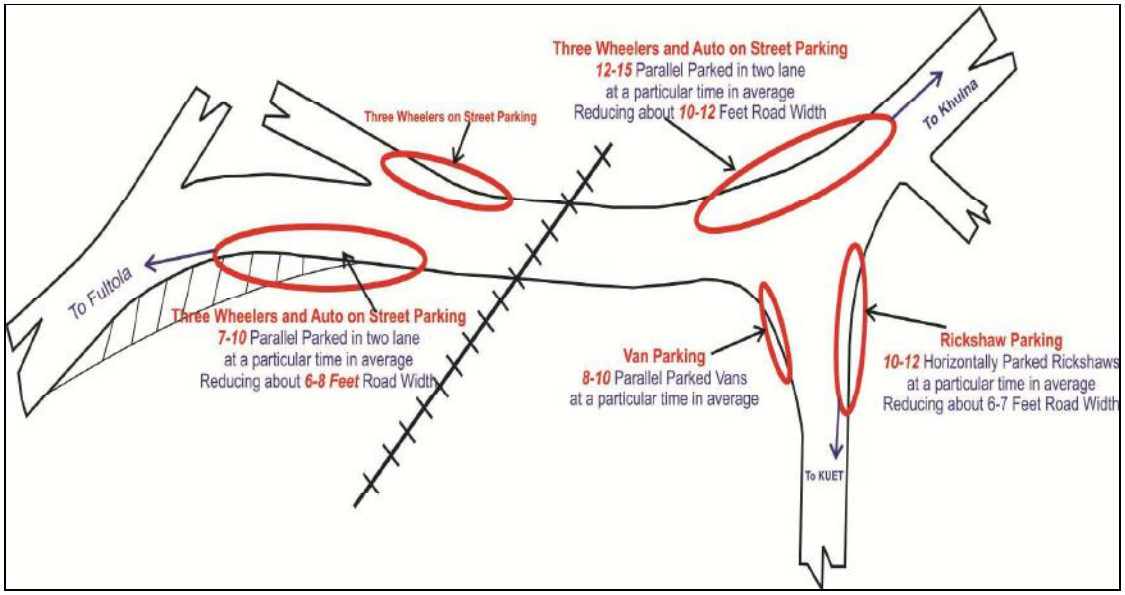

Figure 8: Onstreet parking locations with number of vehicels parked in average

4. RESULT AND DISCUSSION

This section provides the identified problems and relative recommendations based on the analysis of field survey and collected data mentioned above in earlier section.

4.1 Problem Identification

Based on the overall situational analysis problems are identified below. These problems reflect the overall traffic mismanagement and lack of planning by the traffic controlling authority. This also indicates the incapacity of the local authority to handle such kind of situation.

4.1.1 Insufficient Land for Future Extension

In this road intersection there is on street business covering 3 feet or more at point of intersection and along the road. Increasing number of vehicle and pedestrian movement causes congestion and there is a need for separating slow moving vehicle to maintain regular traffic flow. For this purpose and for future growth it is needed to extent the road width. But it is a matter of fact that there exists roadside buildings which are of mainly commercial use. The shoulder of the highway road is used by hawkers and this cause a great disturbance to pedestrian movement. Installation of separated lane is too tough due to lack of enough space as the shoulder and edge of the road is used for parallel parking. Extension of the road is difficult due to road side built infrastructures adjacent to the shoulder of the road.

4.1.2 Surrounding Land-use Pattern

Fulbarigate road intersection is highly dense due to surrounding land use which includes a daily bazar/market, bus stoppage counters and a rail crossing. This is a critical transit point which connects to several district roads.

Figure 9: Unauthorized Parking causing reduction in road width (Source: Field survey-9/11/2015)

As a result the frequency of travelers from this junction is very high. Buses stop at frequent interval having heavy passenger. The peak hour of buses which enters and leaves the bus stoppage is from 7 am to 9 am and 8 pm to 11 pm at night respectively. Other than this local buses also stops frequently all the time. This causes high density travelers movement along with daily bazar. The only bazar located in this ward for daily transaction as a result the locality is very much dependent on this bazar causing frequent crossing of roads. On the other hand about seventeen passenger trains daily crosses this junction which causes about 5 minutes of delay at the rail crossing. So the surrounding land use pattern causes heavy gathering at the road intersection.

4.1.3 Frequent Pedestrian Movement at Critical Point

Due to opposite location of residential zone and daily bazar people need to cross the road frequently to get their required goods. Lack of zebra crossing and foot over bridge along with proper systematic approach is the main cause of frequent pedestrian crossing resulting reduction of design speed of the vehicles. Three observation points were selected for the determination of the frequently crossing zone that needs proper safety measures and attention for a systematic pedestrian crossing. The peak hour of heavy pedestrian flow and crossing is at 6 to 7 pm in the evening.

4.1.4 Reduction of Road Width Due to Unsystematic Parking

There are various public transport services such as ATUL, CNG and autos which travel to town. For passenger loading frequent on street parking is seen. There are no specific parking zone and parking regulation regarding the passenger vehicles as a result these vehicles stops on the streets without any concern. This may be dangerous

in terms of vehicles moving just behind the stopping passenger vehicle often cause accidents at this point. Two occurrences has been observed in recent times regarding this fact (Field Survey). In this study four problematic areas were selected which reduces roadway width by on street parking. The total roadway width is 40 feet but due to unsystematic on street parking this becomes 25 to 30 feet at the road intersection which creates problems for heavy vehicles like buses and trucks to pass between them. In addition, parking of slow moving vehicles like rickshaw and vans on the curves of merge and diverge act as an obstacle to the merging and diverging vehicles. There are about ten to twelve rickshaws and eight to ten vans parked on average in the major intersection leading to Jassore bypass road reducing roadway width about five to seven feet. Due to lack of insufficient space for parking this causes congestion in this intersection.

4.1.5 Reduction of Design Speed Due to Slow Moving Vehicle

Major part of the area are middle and low income groups which heavily depend on bicycles and motor bikes for private transportation and rickshaw and vans are used frequently for public transportation in short range travel distance. So huge number of slow moving vehicles make a gathering at this intersection reducing design speed up to half on average than the normal speed. As a result small scale traffic jams occur randomly. The analysis in the previous section shows that bicycle and motorbikes are the most used transportation mode on the highway during all the times of a day. This indicates that lack of a slow moving traffic lane causing the reduction in design speed at this intersection.

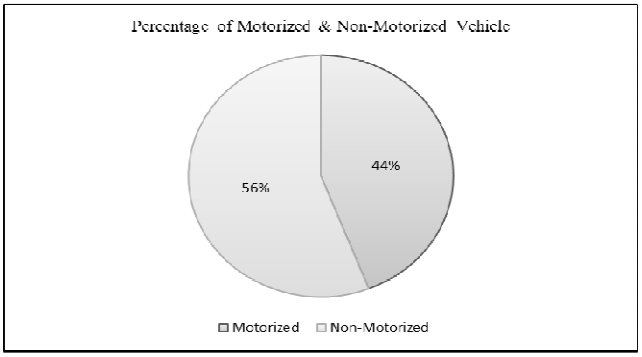

Figure 10: Percentage of Motorized and Non-motorized Vehicles

4.1.6 Abuse of Parking Lot Provided for Buses

On street shops in the bus stoppage over the shoulder generates gathering place for the people resulting reduction in parking capacity provided for the bus counter. This causes the buses to park partially over the main carriage way reducing sufficient amount of roadway width for the other moving vehicles. Moreover unplanned settlements of the bus counters which lacks sufficient passenger requirement services causes the passengers to move randomly along the sidewalks of the highway. Though a passenger sitting arrangement has been provided this is not enough to meet the present requirement according to this fact.

4.1.7 Absence of Efficient Traffic Management

Though a police box is located at the crucial intersection of the road it is inactive due to lack of an efficient traffic management system. In this road intersection there are absence of a rules and regulations about car parking, delaying of vehicle for passenger on road, specific space for bus stoppage, pedestrian crossing, traffic signals, on street business. Traffic congestion at this intersection is a result of these mismanagements. There is a huge number of three wheelers and rickshaw in this road without any licence which results in an uncontrolled increase in number of vehicular flow. Traffic police is seen at a specific point only though traffic congestion, on street business, uncontrolled traffic and most importantly risky pedestrian crossing occurs here and there. This inefficient traffic management and absence of traffic rules is a major problem in this road intersection.

4.2 Recommendation

Based on the problems mentioned above a small scale recommendation has been provided below. These are short term immediate recommendations which can be applied under short notice with little effort by the local authority. These improvement and regulation can minimize the existing hazardous situation in small extent. But for further permanent solution long term planning provision should be considered under government supervision.

4.2.1 Providing Zebra Crossing at Critical Points

From the figure above the important crossing areas were identified at A, B and C. These points needs efficient safety measurement as user friendly crossing services. In this regard zebra crossing should be provided for safe crossing of the pedestrians. It should be noted that crossings should appropriately sited with respect to the road geometry, i.e. avoid bends, departure sides of crests. Motorist parking too close or on a pedestrian crossing should be prevented. It is beneficial to both the users and the installing authority because of relatively low cost installation and less delays to motorists than signalized crossings. The width of painted lines on zebra crossings range between 3 m and 6 m; MRWA standard is 3.7 m. For crossings without kerb protrusions, parking must be restricted for a minimum of 20 m on the approach and 10 m on the departure side of the crossing to achieve minimum sight distances. *(Planning and designing for pedestrians: guidelines)*

4.2.2 Providing Specific Parking Space

To avoid collision at this point of intersection as well as to maintain regular traffic flow parking rules and monitoring should be imposed strictly. On street parking in several lines should be prohibited. Parking of three wheelers in the parking lot should be banned to ensure parking facility to buses. Parking lots for the vehicles should be specified. Horizontal parking of rickshaw and at the point of intersection which most common in this case study area should be banned and maintained strictly. On street business at the parking lot shown in the figure and the shoulders of the road should be strictly prohibited to ensure enough spaces for parking. Getting passengers on road and delaying for 5 to 10 minutes should also be prevented. A specific parking space should be provided for the three wheelers nearby. Parallel parking by rickshaws and vans should be followed. To reduce unnecessary parking tendency of drivers a small amount of money can be charged to park for per hour.

4.2.3 Providing Separate Lane for Slow Moving Vehicle

Movement of slow moving vehicle reduces the traffic flow in this intersection as well as it is too risky when a bi-cycle or van merges into this road. This might tend to a collision or accident when vans or easy bikes cross a road as this road is used by buses and trucks also. To avoid collision or accidents a separate lane for slow moving vehicles should be provided under Government construction if possible. A separated lane of 3m in both side of the carriage way should be installed. There will be linkage between this separated lane and main lane in case of crossing the road. Crossing the road or changing lane should be controlled by a traffic police or traffic signals. Providing separated lane will separate slow moving vehicle and fast moving vehicle which will not disturb the regular vehicular flow of this road intersection and traffic congestion can be reduced. As the installation of a proposed separated lane installation is time consuming, rules can be imposed on the movement of slow moving vehicle in this highway as an alternative. From the field survey it has been observed that from 1.00PM to 2.00PM and 6.00Pm to 7.00Pm is the peak hour when a heavy traffic flow exists. Movement of slow moving vehicles like rickshaw, van and bi-cycle can be banned to use this road in this peak hours.

4.2.4 Improving Existing Road Condition

Improvement of road condition is a must for this road intersection. Absence of a specific footpath results in street business at both side of the road and this causes congestion to pedestrian movement. Providing separated footpath, kerb to separate footpath from carriage way, a median to separate two lanes, improving road surface, providing an efficient speed breaker to control the vehicular speed at the point of crossing will improve the overall condition.

5. CONCLUSIONS

Though traffic congestion is a rare scenario in respect to Khulna city but with the continuous growth of population and transportation the number of unlicensed vehicles increases. A proper and efficient traffic management and planning has to be performed to control as well as to regulate the overall transportation system. In conclusion we can say that in this road intersection absence of efficient traffic management and planning is highly observed under the above circumstances. Data from field survey upholds the mismanagement and unplanned traffic condition which causes conflicts among pedestrian-vehicles, vehicle-vehicle and between fast and slow moving vehicles at road intersection. On street business, unauthorized on street parking, frequent pedestrian crossing without any signals or zebra crossing causes the average design speed to decrease. Reduction of road width due to on street parking, high frequency of pedestrian movement and crossing without any concern, on street business at the existing bus counter/stoppage, high density of slow moving vehicles at the intersection, delay time of the vehicles to get passenger at any point of road, lack of awareness among the drivers and also the public, lack of traffic rules and signalized traffic are the main cause behind the overall hazardous traffic condition at this major road intersection. Proper planning and an efficient traffic management can reduce the overall problematic condition to a great extent which were mentioned in a small scale. But the

overall situation cannot be changed until the public participation is ensured. So both drivers, traffic controlling authorities and general people have to be concerned about this fact otherwise all the efforts of improving the overall condition could result in failure.

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