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Identifications and investigations of hazardous road locations on Dhaka-Aricha Highway

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ABSTRACT: The Dhaka-Aricha highway plays a vital role in interregional road transport in Bangladesh but unfortunately, this corridor is the most hazardous corridor in terms of accidents and fatalities per kilometer. According to police reported accident record, every year almost 180 accidents and 120 fatalities occurred on this 75 km segment of the national highway. Investigation reveals that significant numbers of accidents are highly concentrated at few locations. Such locations with abnormally high concentration of road accidents are identified as 'Hazardous Road Locations' (HRL). Analysis shows that, almost 25 percent accidents took place in the 10 locations on road comprising only 3 percent of the total roadway segment. An in-depth study has been conducted to identify the major hazardous locations of that highway corridor and to evaluate the causative factors of accidents on those locations through data analysis, using GIS technology, on site field observation and focus group discussion. This paper summarized the findings of that brief study. At the very outset of the paper, the scale and magnitude of the problems particularly on that corridor are discussed. Accidents characteristics of the identified hazardous locations are also highlighted in this paper.

1 BACKGROUND

Travel, and especially road travel, is one of the hazardous activities which people in developing country countries like Bangladesh undertake. Rural people are badly affected by road traffic accidents in Bangladesh particularly on the rural section of National Highway.

Nearly 4500 accidents as reported by the police occur in Bangladesh each year among them 75 percent occur in the rural areas and around 40 percent of these accidents take place on national highways including rural section of national highway. Investigation reveals that significant numbers of accidents are highly concentrated at few locations. Such locations with abnormally high concentration of road accidents are identified as 'Hazardous Road Locations' (HRL). About 43 percent of national highway accidents concentrated on 5 percent of the total length, demonstrating that accidents are highly clustered at few sections and they are amenable to targeted and site specific treatments (Hoque, 2006).

The Dhaka-Aricha highway plays a vital role in interregional road transport in Bangladesh but unfortunately, this corridor is the most hazardous corridor in terms of accidents and fatalities per kilometer. According to police reported accident record, every year almost 180 accidents and 120 fatalities occurred on this 75 km segment of the national highway.

Black spots are still being created in this segment. Analysis shows that, almost 25 percent accidents took place in the 10 locations of that corridor comprising only 3 percent of the total roadway segment. Many of the accidents and casualties of that locations as well as other hazardous locations could have been prevented by implementing simple road engineering and environmental measures based on proper safety checks or audits as well as road safety inspections encompassing systematic analysis of road infrastructure deficiencies. However, there is an urgent need to identify and investigate the hazardous road locations and find out the particular road and roadway environmental hazards and operational and behavioral deficiencies of those locations. Incognizance with this facts, a broader study has been carried out by Sarkcr et al, 2009 on a selected section of a major national highway i.e. Dhaka-Aricha highway as a pilot study. This paper forms part of

that boarder study in particular aiming to present the common problems of that major hazardous locations and finally to recommend some effective and pragmatic actions for improving road safety situation.

2 OBJECTIVES

The main objective of this study was to identify and investigate the hazardous road locations and to provide some potential low cost corrective measures and approaches for safety improvements in that locations as well in Dhaka-Aricha highway corridor. The specific objectives of the study are:

- To develop a road traffic accident database which occurred on the Dhaka-Aricha highway corridor for the period of 1998 to 2006
- To updates road inventories of this corridor.
- To conduct a comprehensive analysis of accidents data and to identify major hazardous locations of this corridor
- To conduct detailed in-depth onsite investigations and road users behavior study on the selected hazardous road locations
- To identify the road and roadway environmental hazards and operational and behavioral deficiencies of those locations
- To propose some effective and pragmatic actions for improving road safety situation.

3 METHODOLOGY

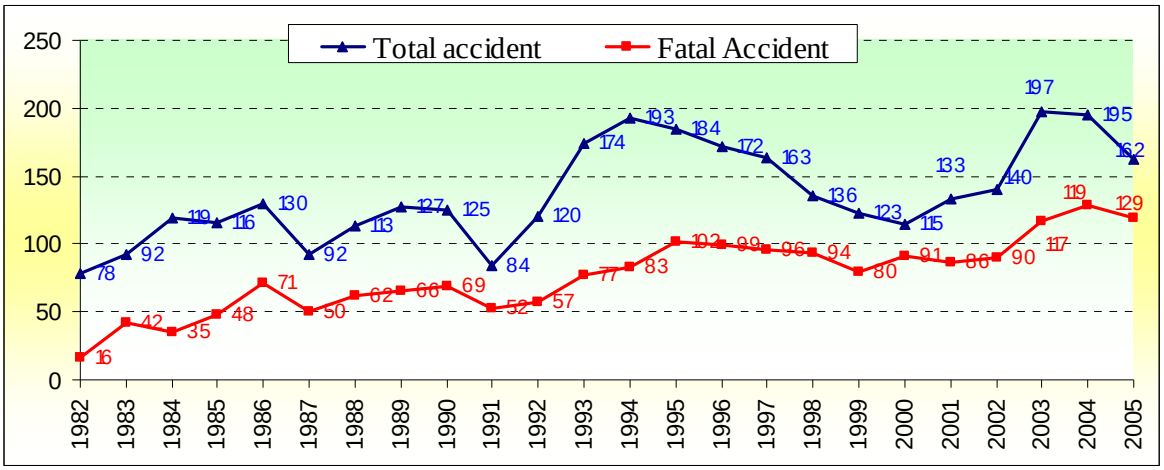
The study has been broadly divided into main two themes, firstly collection and analysis of the accidents data and secondly investigation of the hazardous road locations. The study location envisaged a total length of 75.4 km along Dhaka-Aricha highway, starting form 11.9 km reference at Aminbazar Bridge to 87.3 km at Aricha. This study predominantly concerned with extensive analysis of accident data and identification of Hazardous Road Locations. Long-term accident data is very important for any type of analysis. In this regard, details Geographic Information System (GIS) based database was created including various attributes particularly with the locational attributes to identified and visualized hazardous road locations using police reported accidents record collected from Accident Research Institute (ARI) in the period of 2004 to 2006 in that particular corridor and then analysis was done by using the GIS software ArcGIS 9.1. Besides, additional database has been developed using spreadsheet for accident characteristics analysis of the selected sites as well as the entire study area. For performing condition diagram of roadside and to show the accidents pattern in different locations, the highway corridor under study was divided into nine sections which are named as section 1, 2, 3....etc. After completing the in house data analysis, in-depth field investigation including observations of geometric and operational condition, road users behavior analysis and focus group discussion has been carried out to find out the particular road and roadway environmental hazards and operational and behavioral deficiencies of those locations.

4 STRIKING FEATURES OF ROAD ACCIDENT SITUATION IN THE STUDY AREA

A detailed analysis of reported accident data during the recent years revealed the following striking characteristics of accidents.

4.1 *Trends of Total and Fatal Accidents*

Figure 1 shows the number and trends of total and fatal accidents in Dhaka-Aricha highway corridor. Though it is seen that the number of accidents has been decreased in the year of 2005 than the previous year, it has significantly increased in the last two decades. In 1982 there were 78 accidents reported among them 16 were fatal accidents, whereas in 2005, the number of reported accidents and fatal accident were 162 and 129 respectively. The number of fatal accidents has been increasing from 16 in 1982 to 129 in 2005, around 7.5 times in 23 years period.



Source: Banik 1982-84, Hoque M. M.1985-1989, Moniruzzaman 1990-2002, ARC 2003-2005

Figure 1: Trends of Accidents in Dhaka Aricha Highway corridor

4.2 *Predominant Accident Types:*

Table 1 shows the types of accidents in two different distinct year and group of years. From the Table 1, it is found that hit-pedestrian is the most frequent type of accident and it has been increased from 34 percent in 1991 to 42 percent in 1998-2006. This accident type is followed by head on (18%), rear end (14%), and running off road (9%). Head on type accidents also has been increase almost 4 percent in the recent year compare to the year of 1991. These four accident type groups accounted for about 83 percent of all accidents.

Table 1: Types of accidents

Types of Accident	Percent (1991)	Types of Accident	Percent (1998-2006)
Hit Pedestrian	34%	Hit Pedestrian	42%
Read End	14%	Head On	18%
Head On	9%	Read End	14%
Running off Road	7%	Running off Road	9%
Overtaking	3.5%	Hit Object	5%

Source: Hoque M. M.1985-1989, ARC 1998-2006

4.3 *Vehicles Involved in Accident*

Table 2 represents the percent of average traffic composition in the last thirteen years and their involvement in accidents on the Dhaka-Aricha Highway corridor. Of the vehicles involved in all accidents, nearly three-fourth are buses and trucks. The composition of trucks and buses are almost equal, 24.9 and 24.7 percent respectively, but the involvement in accident of buses is much higher than the trucks, 45.6 and 31.6 percent respectively, which represents that buses are more serious in accidents particularly for this corridor than trucks. This also certify by the accident involvement per vehicle class, which is 1.8 for buses and 1.3 for trucks. These groups of vehicles are particularly over involved in pedestrian fatalities. Involvement of car and other light vehicles in accidents is 5 percent, followed by motorcycle and auto rickshaws, 4 percent and non-motorized vehicles 2.8 percent.

Table 2: Vehicle composition and there involvement in accidents

Vehicle Type	Average ADT*	Composition (%)	Accident Involvement (%)	Accident Involvement per Vehicle Class
Bus	2539	24.9	45.6	1.8
Truck	2524	24.7	31.6	1.3
Light Vehicle	1993	19.5	5.0	0.3
2/3-Wheeler	1465	14.3	4.0	0.2
NMV	1693	16.6	2.8	0.2

* Based on 13 years vehicular yearly flow data (1991- 2003)

4.4 *Accident Locations and Severity*

About 91 percent of the accidents occurred in rural segment of the highway corridor areas. Accidents are predominantly occurred on road links both in urban and rural areas, almost 90 percent. Rural accidents are more severe than the accidents in urban areas. The accidents were classified as fatal 67 percent, grievous injury 24 percent, simple injury 4 percent and collision type 4 percent. This clearly demonstrate the prevalence of significant under reporting of injury accidents.

5 IDENTIFICATION OF HAZARDOUS ROAD LOCATIONS

In this study, the criterion of specified weighted point of accidents with specified section length in the period of 3 years (2004-2006) has been considered for the identification of hazardous locations. Weighted point of accidents is clauclated by the following equation:

Weighted point of accidents = Fatal acccidents *5 + Non-fatal Accidents*3

Under this criterion, the minimum section length was 0.1 Km with greatest length of 0.5 Km where there were more that 30 weighted point of accidents in the period of three years, were considered as hazardous locations. In the absence of precise locational details of accidents and exposure data only the criteria of the number of accidents has been used to identify highway sections that are to be considered as hazardous locations on the entire study area.

Under this criteria, a total of 10 hazardous road locations have been identified in the study area. A total of 97 accidents (64 fatal and 31 non fatal accidents) occurred at these 10 locations. The total length of these hazardous locations is 2.4 km which represents only 3 percent length of the highway segment. This gives an accident rate of about 40 accidents (27 fatal and 13 non fatal accidents) per Km length of hazardous locations on highway segement in the space of 2004-2006. Table 3 represents the list of that hazardous locations with the number of accidents, weighted point and land marks. From this table is found that Tepra Bazar, kilometer post 82.3 to 82.7, is the most hazardous location (weighted point 61) followed by Goloda Bus stand (kilometer post 57.6 to 57.7, weighted point 50), Manikganj Bus Stand (PTI) (kilometer post 63.3 to 63.5, weighted point 44), Tara Toll Plaza (kilometer post 68.5 to 68.9, weighted point 44).

Table 3: Ten most hazardous road locations (HRL) in Dhaka-Aricha highway corridor

SL No.	Km Post		Segment Length	Fatal Accident	Non-fatal Accident	Total Accident	Weighted point of accidents	Landmark
	From	To						
1	25.6	26.1	0.5	7	1	10	38	Savar Bazar Bus Stand
2	41.8	41.9	0.1	7	1	8	38	Joypura Bus Stand
3	51.2	51.3	0.1	8	1	9	43	Bethuli Bus Stand
4	57.6	57.7	0.1	7	5	12	50	Goloda Bus Stand
5	63.3	63.5	0.2	7	3	10	44	Manikganj Bus Stand PTI)
6	65	65.3	0.3	5	2	7	31	Muljan Bus Stand
7	68.5	68.9	0.4	7	3	10	44	Tara toll Plaza
8	73.5	73.6	0.1	4	4	8	32	Pukhuria Bazar/Bus Stand
9	82.3	82.7	0.4	8	7	15	61	Tepra Bus Stand
10	84.5	84.7	0.2	4	4	8	32	Paturia Intersection (Tee)

5.1 *Some Striking Accident Characteristics of the Selected HRLs*

Some striking Accident characteristics which is revealed from the more detailed and individual analysis of the accidents occurred on the selected hazardous road locatioons are presented in the following sections.

- Like many other road network in all around of Bangladesh, in almost all of the selected locations, vulnerable road users, particularly pedestrians are by far the biggest user group in road accidents and their involvement varied between 25 and 100 percent of the total accidents in the selected areas except two locations i.e. Muljhan and Paturia intersection with an average of 54 percent of all accidents. It is found that among the total 64 fatal accident during the period of 2004-2006, hit pedestrian accident alone are 37 (58%). The most vulnerable movement of pedestrians is while crossing the highway which is followed by walking along the traffic and walking against the traffic. Trucks, buses and minibuses are major contributors to pedestrian fatalities.

Pedestrians being physically unprotected are thus considered to be the most vulnerable road user group and demand a priority consideration in road safety strategy.

- Studies revealed that heavy vehicles such as buses and trucks including minibuses are major contributors to road accidents. As indicated earlier, buses are disproportionately more involved than trucks in accident in this highway segment which are also comes in true in the case of HRL accidents characteristics. The involvement of buses and trucks in accidents in the selected HRLs are 34 and 30 percent respectively.
- The temporal analysis of the police reported accident data reveals that 72 percent of accidents occurred during day time (6 am to 6 pm) and 28 percent at night (6 pm to 6 am) that's accidents frequency in day is 2.6 times higher than the night. It is also found that accident and fatalities remained fairly evenly distributed in day times with the peak occurrence during 10 am to 12 noon.
- Around 89% accidents are occurred in rural areas where vehicle speed is too much high and around 11% accidents are occurred on urban area.

6 ON SITE FIELD INVESTIATIONS

As described earlier, the second part of this study was to investigate and observe locational and traffic characteristics of the selected hazardous road locations. The investigation was conducted comprising the following major tasks:

- Overall site observation including location identification of the site with local station, territory of the site etc.
- Observe road and road side land use pattern as well as roadside development pattern
- Observe abutting socio-economic and land use activities
- Road geometric survey like measurement of lane width, curvature, shoulder width, no of access, access width, road marking, sign, surface friction, slope of road side etc.
- Observe nature and operational behaviour of traffic particularly loading and unloading, overtaking, loading and parking characteristics.
- Observation of pedestrian behavior in particular crossing and walking characteristics
- Conduct road user opinion survey and discussion with the neighbourhood people to gather experiences and suggestion of the local people
- Counting speed of different vehicle from two approach points
- Capturing video and photograph for further in-house analysis and to present the facts

6.1 *Investigation Findings:*

From this study, it is evaluated that except few exception, most of the striking features, road and road environmental deficiencies, operational hazards are common in all locations. The most striking locational features and road environmental and traffic hazards are discussed.

6.1.1 Road and Roadside Environmental Deficiencies:

Almost of the hazardous locations, roads and roadsides deficiencies or hazards were particularly predominant.

- Adverse roadway elements contributing to highway accidents were substandard road way alignment or geometry, lack of shoulders and shoulder defects, absent or inappropriate pedestrian facilities, narrow and defective lanes and bridges/bridge approaches, uncontrolled as well as staggered access roads in many of the locations.
- In the entire study section, unmarked pavement condition is considered to be good in many of the locations. Smooth road surface and very few potholes or undulations were found. However there is no usable shoulders or edge and pavement centre and edge line markings many of the sections of the selected road.
- In general, road signs, markings and other regulatory devices were found to be very insignificant to regulate and control traffic.
- Poor sight distances and visibility, unmarked and inappropriate design of intersections like Paturia intersection, serious delineation deficiencies along the route are poses serious safety threat in many sections of the road.
- Most of the temporary shops and stalls are built just besides the road which obstructs the visibility when traffic from access roads merges into the main traffic stream.

- Overall situation is worsen by illegally use of the roadsides or encroachment of the road sides for trading, shopping, marketing, piling of wooden logs and other goods, parking and loading /unloading activities which force the pedestrians use the high-speed road carriage way.
- Very complex and high roadside frictions with varied local activates and functions due to high concentration of retail/trading centers particularly at the Bazaar day.
- There is very few dedicated side walk or cross walk facilities for pedestrians except savar and absence of regulatory/warning signs or signals which are highly required particularly for the bazaar and built-up areas. In absence of footways pedestrians are forced to use the high-speed carriage ways and there by face conflicts with motor vehicles.

Examples could be seen in Figures 2

Figure 2: Glimpses of Road and Road Environmental Deficiencies

6.1.1 *Traffic Operational and Behavioral Hazards*

- High speed, high occupancy through traffic mostly commercial vehicles very often have conflicts with local low speed operated minibuses, tempos and other non-standard vehicles, particularly NMVs from access roads. Traffic from unmarked access roads also creates hazards.
- The volume of motorcycle traffic is also high in many locations and most of the riders don't use safety helmet which makes them one of the prime vulnerable road user groups.
- Presence of large share of non motorized vehicles like rickshaws, handcarts, and bicycles and poorly maintained and worn out motorized vehicles create conflicts with the high standard inter district buses.
- Frequently access of vehicle from the side road also creates create conflicts and operational hazards of the site. Most of the driver does not follow the traffic rules, sign and markings and there is a lack of traffic police on the sites also.
- In the built up sections (having markets, schools adjacent to highway) of the highways speed differentials and the excessive speeds pose a serious safety hazard.
- Reckless overtaking, overloading and braking/stopping on road and road sides poses a great operational as well as safety hazards of all the section.
- Absence of edge line and centerline markings or other delineation devices lead drivers into unsafe operations and their path selection.

Figure 3:

Glimpses of Traffic Operational and Behavioral Hazards

6.2 *Underreporting of Accidents*

From the field observation as well as discussion with the local people and local traffic police it is revealed that there are huge under reporting of the accidents in the spot. According to the opinion of the local peoples and the local authority, the actual accidents could be 3 to 5 times higher than the reported number in many of the sites particularly in the Bathuli, Joypura and Goloda bus stand. Particularly, property damage and injury accidents are highly underreported. This might be for the long distance of the thana and most of the case people are not interested to inform police or tried to avoid police intervention and they often tried to negotiate this occurrence by local intervention.

7 SOME STRIKING RECOMMNADED MEASURES

Accident black spot treatments have demonstrated high economic benefits and therefore demand priority consideration in Bangladesh. Desirably, emphasis should be placed initially on introducing low cost improvement schemes which proved to be highly effective. Typical such safety measures are incorporation and treatments of shoulders, pedestrian facilities (segregated footways, crossings), Speed control devices, median barriers, access control, channelisation, traffic islands, skid resistance treatment, safety zones etc (Hoque 2006a). Some of the striking but vital and immediate measures to achieve greater road safety which would also offer cost-effective results include:

7.1 *Road and Road Environmental Improvement Measures:*

- Physical separation of pedestrians from motorized traffic particulary in the sites in uraban or bazaer areas where the concetration of pedestrian is very high.

- Treatments of road shoulders; wide and strong shoulders are seen as particularly important to cater for pedestrian, cyclist, rickshaw and animal drawn traffic
- Self-enforcing physical measures are necessary to encourage and or force drivers to slow down and controlling of over speeding. Some sort of speed calming devices (rumble strips or jiggle bars) may be placed to control over-speeding vehicles and driver aggressiveness.
- Adequate access control through proper geometric design modifications of access roads and placement of give way and stop signs and markings.
- Installation of proper traffic sign in proper place and ensuring of the maintenance of that sign.
- Raised reflective pavement and edge markers, guide posts, chevrons are of critical importance to the safe and efficient operation of the road system and are vital in enabling drivers to locate the vehicle on the roadway and to make path selection and control decisions
- Treatment and re-location of physical obstructions e.g. poles, trees, shops and other objects.
- Provision of rural bus bays to provide of road operation for bus to pickup/drop passengers.
- Relocation of road side bazaar and hut in a proper place to avoid road and road side conflict with the local activities.

7.2 *Operational and Behavioral Measures:*

- A local community based road safety program could be developed for raising safety awareness among the local people for their safety conscious behaviour and actions.
- Strict regulatory and law enforcement measures are seen important to reduce roadside frictions and hazards.
- Additional police enforcement is needed particularly at day of Bazaar in some locations.
- Training of police personnel is vitally important for proper enforcing of traffic laws and regulation and proper recording and reporting of accident.
- Basic road safety education should be introduced in the primary curriculum importantly in the roadside school.

8 CONCLUDING REMARKS

This paper forms part of that boarder study on identifications and investigations of hazardous road locations on dhaka-aricha highway and set out to highlight the some striking accident problem characteristics in a most important highway corridor in Bangladesh with particular emphasis on the hazardous road locations accidents. Detailed objectives, methodology of the study and investigation findings are also highlighted. Investigation revealed that road and roadside environmental deficiencies are the major problems of the selected hazardous locations and significant safety improvement is possible through wider application of low cost engineering measures including treatments and provision of roadway shoulders, self enforcing speed reducing measures, special facilities for pedestrians and other NMV traffic, treatment of roadside hazards, special off-road bus stops facilities, installation of delineation devices and others. Pedestrian and vehicle conflicts are the biggest problem in terms of vulnerability, it is very urgent to change behavior, attitude as well as physical separation by community based safety initiatives and by providing physically separated spaces in the form of segregated footways particularly in Bazaar areas where concentration of pedestrian is very high. This study was a preliminary on for identification and investigation of hazardous road location. Detailed investigation and inspection commensurate with road geometric survey by the group of safety expert are recommended for adapting and implementing the corrective measures.

REFERENCES

ARC. 1998-2006. Microcomputer Accident Analysis Package (MAAP) Database, *Police Reported Road Traffic Accident*, Complied and edited by Accident Research Institute (ARI), BUET, Dhaka.

Banik G.C. 1987. Aspects of Road Geometry's in Relation to traffic and Road Accidents: a Case study of Dhaka-Ariche road. *M.Sc Engineering thesis BUET*, Dhaka.

Hoque, M.M., Rahman, M. F., Ashrafuzzaman, M. and Sarkar, S. 2006a. Observational Studies of Hazardous Road Locations on National Highways in Bangladesh. *Proceedings of 22nd Australian Road Research Board (ARRB) Conference*.

Hoque, M.M., Rahman, M.F., Ashrafuzzaman, M. and Sarkar, S. 2006b. Hazardous Road Locations (HRL) on National Highways in Bangladesh. *Proceedings of International Conference on Road Safety in Developing Countries*, BUET, Dhaka, 22-24 August, 2006, pp 229-237.

Hoque M.M. 1985-1989. Accident Investigation for the Safety Improvement of Dhaka-Aricha Highway (A section of Asian Highway, *Bureau of Research Testing and Consultation, Bangladesh Univeristy of Engineeting and Technology (BUET),* Department of Civil Engineering , December, 1991, Dhaka.

Moniruzzaman (2004). Performance evaluation of Road Safety Measures in Dhaka-Aricha Highway. *M.Sc Engineering thesis* BUET, Dhaka.