Identifying Hazardous Road Locations of National Highway: A Case Study on Joydebpur-Jamuna Bridge Section

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Abstract:

Traffic accident is a serious problem around the world, especially for a developing country like Bangladesh. A large number of accidents occurred in the recent past in the national highways of Bangladesh. The purpose of this study is to find out accident-prone locations of the corridor and to suggest possible instruments for future accident reduction. This study takes Joydebpur-Jamuna Bridge highway section, where 313 accidents occurred between July 2009 and June 2014. Geographic Information System (GIS) is a smart tool to analyze accidents data and represent accident locations graphically. Relevant Accident Report Forms (ARF) were collected from Gazipur and Tangail Superintendent of Police (SP) office. The Accident Frequency Analysis technique was applied to identify accident-prone locations and 18 hazardous locations were found on Joydebpur-Jamuna bridge highway corridor. About 51.44% of the accidents occurred in 15.51% length of the corridor whilst 48.21% length is free from accident. Traffic accidents could be significantly reduced by taking proper safety improvements and counterstrike measures for accident prone locations.

Key words: Hazardous road location, GIS, highway, accident.

1. Introduction

Traffic accident is a major safety hazard of the world. About 80% of global road traffic deaths occurred in developing countries, which represent the highest annual road traffic fatality rate approximately 20.1 per 100000 population (WHO, 2013). Traffic accident takes the 9th place as a leading cause of human deaths and it is anticipated that in the upcoming days the situation will be worse (Arvind, 2005). Nearly 1064 fatalities are occurred per 100,000 motor vehicles that means roads are virtual death traps in Bangladesh (Rahman, 2006). About 4500 accidents are occurring every year in Bangladesh and nearly 40% of these crashes occurred on national highways. Traffic accidents are unusually concentrated on some specific locations which are known as Hazardous Road Location (HRL) (Hoque, 2011).

Geographic Information System (GIS) is a very crucial tool for accident analysis and to identify the black spots where accident concentration is abnormally high (Supomchai, 1999). Joydebpur-Jamuna Bridge approach corridor was considered as the study area for this research. This corridor plays an important role to connect the capital with the northwest and southwest parts of Bangladesh. According to the Bangladesh Police, a total 1339 casualties occurred in 313 traffic crashes on Joydebpur-Jamuna Bridge approach highway section between July 2009 and June 2014. The objective of this study is to find out the accident-prone locations of the study area and to suggest possible instruments for future accident reduction on national highway.

2. Methodology

ARF contains information about road accident and GIS present hazardous road locations through using accident records and spatial data.

2.1 Data Collection

As already mentioned earlier, the study location is from Joydebpur Jagroto Chowrasta to Jamuna Bridge weight station, about 83.8 km along Dhaka-Tangail highway corridor. Police reported Accident Report Forms (ARF) for the period of July 2009 to June 2014 were collected from Gazipur and Tangail Superintendent of Police (SP) office. Ground Control Points (GCP) of road crash locations on the highway corridor were collected through Global Positioning System (GPS) and Google Earth software.

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Land use images, topographical and street guide maps of the highway section were collected using Google Map. The distance of road crash point from nearer well known locations or features has been calculated through GPS, Distance Calculator and Measure Distance on satellite map. Field verification were required to get the true conditions of road features and to evaluate exact road crashes locations as well as for peoples' opinions about accident prone locations.

2.2 GIS Application

GIS is a smart technique to incorporate spatial and non-spatial data to find out the hazardous road location through analyzing those accident related information. In order to scan the map of Joydebpur to Jamuna Bridge approach highway network and to input this image into Arc Map for digitizing (convert Raster map to Vector map), digitized map was required for spatial analysis. Bangladesh Transverse Mercator (BTM) coordinate system was used for the map projection. Map digitizing was required to create spatial data of Joydebpur to Jamuna Bridge approach highway from existing topographic maps and documents of the corridor by using ArcGIS 10.2 software.

2.3 Hazardous Road Location Analysis

This analysis process divided the highway corridor into 200m segments, emphasizing on most accident-prone locations of the highway, which is, termed as Hazardous Road Location (HRL). If three or more accidents are concentrated on a 200m segment over a period of 5 years, then that particular segment is considered as Hazardous Road Location.

3. Analysis and Findings

Analyzing ARF and GCP of road crashes through GIS to present hazardous road locations of the highway corridor.

3.1 Accident Severity

During the last 5 years, 1339 casualties (1061 passengers, 139 pedestrians and 139 drivers) occurred due to traffic accidents on Joydebpur-Jamuna Bridge approach highway corridor. Of the total casualties, passengers' fatal casualties are comparatively less than from grievous and simple casualties. Passenger fatality is 257, grievous injury is 400 and simple injury is 391.
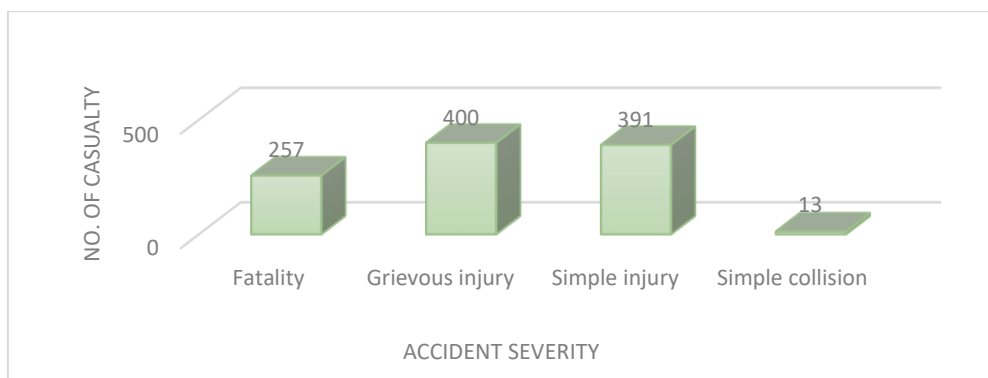

Figure 1: Passenger Accident Severity by Types
Source: Gazipur and Tangail Superintendent of Police (SP), 2014.

Usually passengers are protected inside the vehicle in case of minor accidents. However, vehicles carrying excess passengers of their capacity are prone to fatalities. Minor collision injury is reported very rarely by police and it is about 13 as seen in Figure 1. Pedestrians are the most vulnerable highway user; their fatality is very high (128) compared with other users. The grievous and simple injury casualties of pedestrian are 9 and 2 respectively (Figure 2). Due to absence of safety barriers in highway, most of the pedestrians die after getting accident.

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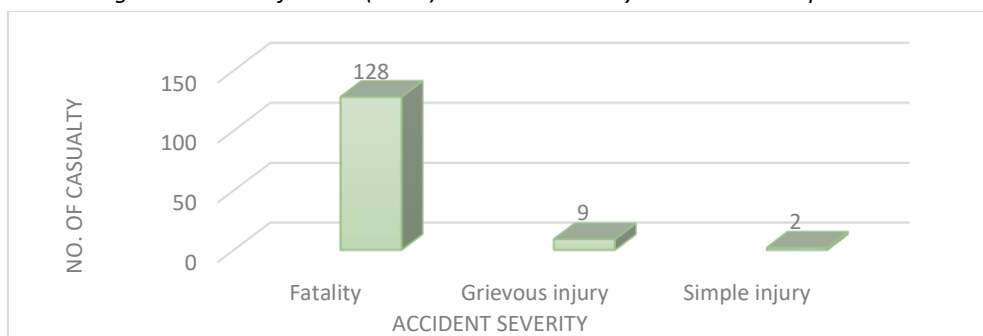Jahangirnagar University, Dhaka 1342, Bangladesh

Figure 2: Pedestrian Accidents Severity by Types
Source: Gazipur and Tangail Superintendent of Police (SP), 2014.

Of the drivers' accidents, 50 with fatality, 49 with grievous, and 39 with simple injury (Figure 3). Majority of the drivers in Bangladesh do not use seat belt while driving for their safety and they are often responsible for most of the accidents. Moreover, drivers in Bangladesh rarely comply with the rules and often try to violet traffic rules and regulations if there is no traffic police present. Furthermore, it is very difficult to catch the bus driver or staff and bring him under justice after accident.
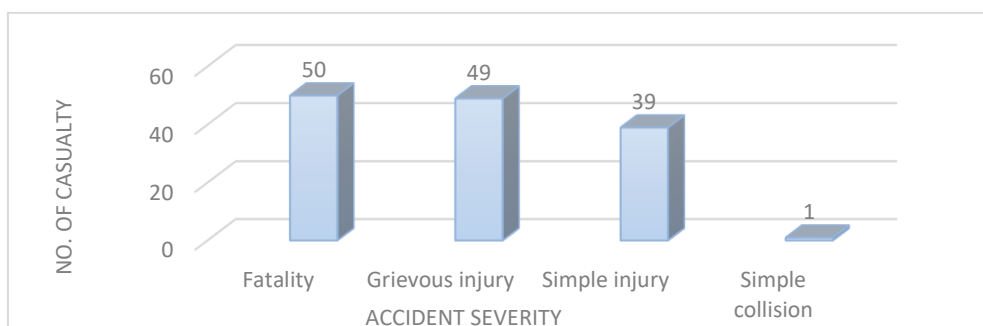

Figure 3: Driver Accident Severity by Types
Source: Gazipur and Tangail Superintendent of Police (SP), 2014.

3.2 Hazardous Road Locations

According to the criteria, as defined by the authors mentioned earlier, if the location of three or more accidents are concentrated within 200m of highway segment in the 5 years then that particular segment is considered as hazardous road location. The resultant major Hazardous Road Locations Based on those criteria, major hazardous road locations of the study area are shown in table 1.

Table 1: Major Hazardous Road Locations

Segment Length(km)	Location Name	Accident Frequency	Type of Accident		
			Fatal	Injurious	Property Damage only(PDO)
16.6-16.8	Chandra	4	3	1	0
21.2-21.4	Saheb Bazar	4	4	0	0
24.2-24.4	Boardghar Bazar	4	2	2	0
27.0-27.2	Gorai	5	5	0	0
40.4-40.6	Dholla Bus Stop	4	3	1	0
46.8-47.0	Natiapara Bazar	5	5	0	0
69.8-70.0	Elenga Bus Stop	4	4	0	0

Segment Length(km)	Location Name	Accident Frequency	Type of Accident		
			Fatal	Injurious	Property Damage only(PDO)
70.4-70.6	Mymensingh Link Road	4	3	1	0
72.6-72.8	Chorbabla BBA-E 4 No. Bridge	5	5	0	0
82.8-83.0	Ibrahimabad Rail Station	4	2	2	0

Source: Gazipur and Tangail Superintendent of Police (SP), 2014.

The result shows that around 21.40% accidents are occurred in only 4.30% length of the highway and 51.44% accidents are occurred in 15.51% length. Total 313 accidents are occurred in 51.80% length of the corridor whilst the remaining 48.2% length of the highway is free from accident. Of the accident, the majority (about 84.66%) are fatal, whilst 12.14% are personal injury accidents and 3.2% are property damage only accidents.
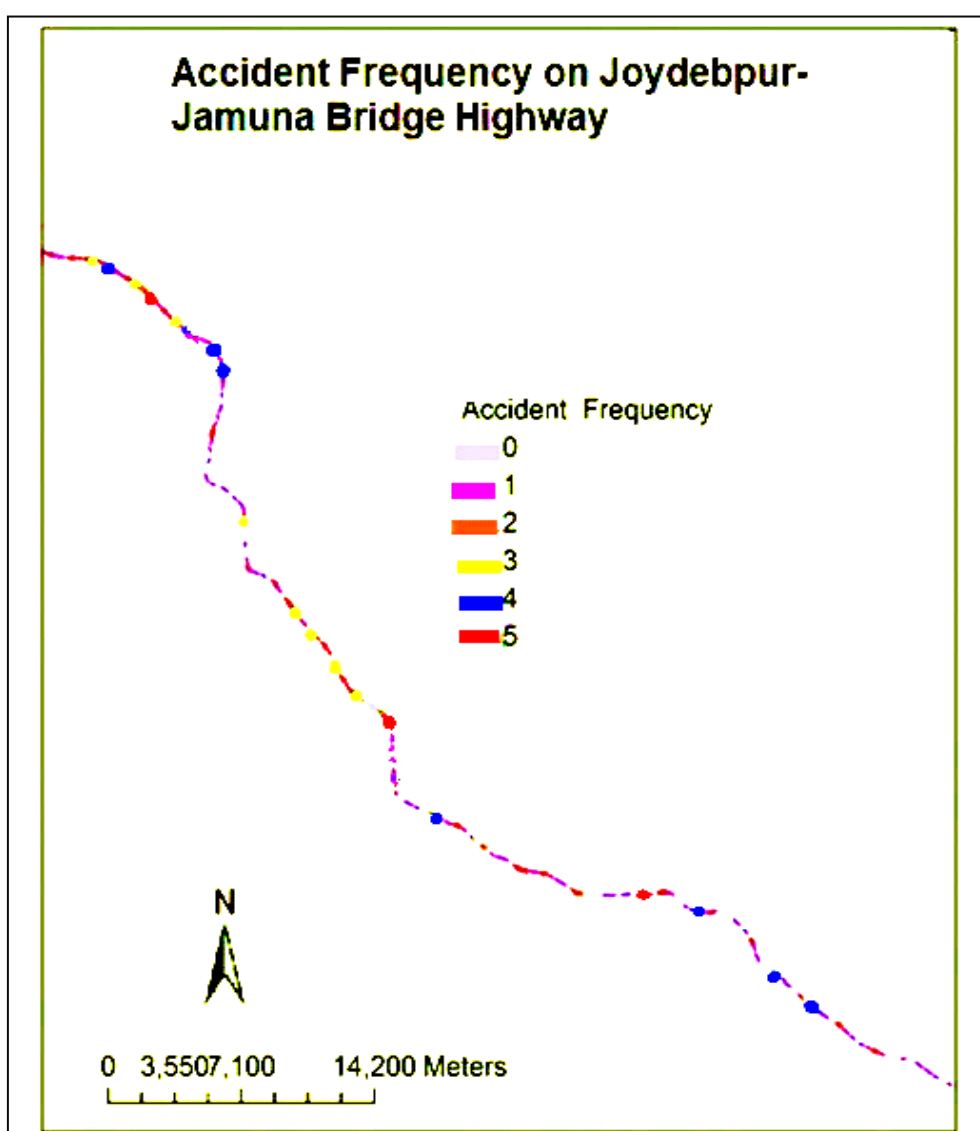
Map 1: Accident Locations on Joydebpur-Jamuna Bridge Approach Corridor

Source: Roads and Highways Department, 2014.

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4. Recommendations

Based on findings and environmental, behavioral and operational deficiencies of the highway, some recommendations are provided to improve traffic safety of highway.

4.1 Safety Programs for Major Hazardous Road Locations

Accident data just depicts the patterns and characteristics of road crashes. Survey with victims and site visit is very crucial to find out the actual causes of accidents on the highway to improve traffic safety by taking counterstrikes against the aberrant nature of accidents. To prevent the abnormality of accidents on some highly accident prone locations, the following recommendations are given in table 2.

Table 2: Necessary Steps for Major Hazardous Locations

Segment Length(km)	Location Name	Necessary Steps
16.6-16.8	Chandra	☐Need to improve shoulder quality and footpath. ☐Required to provide sufficient pedestrian crossing. ☐Need to separate the bus stopping lane from the active carriageway.
21.2-21.4	Saheb Bazar	☐Need to remove obstacles from road and road side. ☐Foot over bridge is required. ☐Need to ban non-motorized vehicles.
24.2-24.4	Boardghar Bazar	☐Need to remove/relocate market from road. ☐Widening the width of curve of the highway. ☐Separate bus stopping lane is advised. ☐Need to control vehicle speed; imposing speed limit. ☐Need to provide speed breaker although it is not a valid option for highway for improving safety
27.0-27.2	Gorai	☐Need to increase visibility. ☐Need to prohibit on street parking.
40.4-40.6	Dholla Bus Stop	☐Need to improve sight distance. ☐Need to prohibit non-traffic activities on road. ☐Isolated bus stop should be installed.
46.8-47.0	Natiapara Bazar	☐Required to provide sufficient pedestrian crossing. ☐Need to remove/relocate market from road. ☐Widening the curve width of the highway. ☐Isolated bus stop with shelter should be installed. ☐Requirement for controlling vehicular speed/provide speed breaker for improving safety. ☐Need to prohibit non-motorized vehicles on highway.
69.8-70.0	Elenga Bus Stop	☐Pedestrian crossing. ☐Need to remove on road marketing. ☐Requirement for bus stop with grade separate system for moving vehicles. ☐Need to control vehicle speed at this section.
70.4-70.6	Mymensingh Link Road	☐Need to improving road features. ☐Required grade separation between slow and fast moving vehicles. ☐Need to install traffic barriers.
72.6-72.8	Chorbabla BBA-E 4 No. Bridge	☐Requirement for eliminating non-motorized vehicles. ☐Requirement for controlling vehicular speed. ☐Need to install traffic barriers.
82.8-83.2	Ibrahimabad Rail Station	☐Requirement for removing on road and road side non-vehicular activities. ☐Need to eliminate non-motorized vehicles from the highway. ☐Requirement for controlling vehicular speed. ☐Requirement for providing pedestrian crossing.

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4.2 Accident Report Form and Recording Accident Parameters

In accident analysis, ARF provides detail information about different accidents to take necessary steps to improve traffic safety.

- Missing/Wrong data of ARF, sometime leads to misinterpretation of actual condition. Therefore, care should be given towards recording of each parameter of ARF.
- Traffic accidents are not only loss of lives or disabilities but also a major burden to the economy. To have a better insight about accident the ARF should have additional information regarding the property damages.
- Graphical location of accidents need to be added in the ARF for finding the actual point of accidents.

4.3 Safety of Road Users

To obey traffic rules and regulations by highway users would increase traffic safety dramatically.

- Pedestrian involvement with accident is very high. Most of the accidents involved with pedestrian are occurred either in roadsides or pedestrian crossings. Therefore, there is a need to enough shoulders and pedestrian crossovers at regular interval, especially in the areas where there are settlements or built up areas.
- Most of the hazardous locations are at specific sections of the highway with moderate traffic volume. Majority of the accidents occurred due to careless driving and over speeding. Therefore, displaying of speed limit at regular intervals need to be installed. It is very important to specify vehicle types for highway, non-motorized and slow moving vehicles are one of the major cause of fatal accident, because long range vehicles need to overtake them in regular basis to reach their destination at time.
- As a large number of accidents are concentrated at curve sections, so widening curve width of those areas.
- Daily driving hours for drivers should be introduced and enforced to reduce accidents due to drivers' fatigue.
- Defected vehicles must be prohibited by all users.

4.4 Need of Regular Surveys and Safety Programs

Traffic safety campaign would create awareness about to reduce road crashes. Past traffic data would help to predict future traffic condition.

- Survey and study related to traffic safety, should be conducted regularly.
- Road users must be well aware of their responsibilities and traffic laws as drivers, passengers and pedestrians.
- Need to traffic safety oriented programs from school level.

5. Conclusion

This paper revealed that, a total of 313 accidents occurred on Joydebpur-Jamuna Bridge highway section. The concentration of accidents aberrantly high in some locations named as hazardous road location, hence 21.40% road crashes occurred on only 4.30% lengths of the highway corridor. Hazardous road locations were mainly located in buildup areas, near side of bus stop, junction type locations and few of them in free segments of the highway. Besides, one and two accidents occurred on 151 and 48 segments of the corridor. However, 202 highway sections were free from any kind of accident occurrence. Most of the accidents of the corridor were fatal and it was about 84.66%, whereas 12.14% were personal injury and 3.2% were property damage only accidents. Traffic accident could be significantly downsized by taking safety improvement and counterstrike measures for accident-prone locations. Strictly implementation of traffic rules and regulations, traffic related regular survey and study, campaign about how to use highway properly from root level would improve traffic safety tremendously.

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6. References

WHO, ed. (2013). Global Status Report on Road Safety 2013: supporting a decade of action. Available at: http://www.un.org/en/roadsafety/pdf/roadsafety2013_eng.pdf.

Arvind Kumar Mavoori (2005), "An activity plan for Indian Road Safety". MSc Thesis. Department of Science and Technology, Linköping University, Sweden.

Rahman, M. F., Hoque, M.M., Ashrafuzzaman, M, Sarkar,S. (2006). Observational Studies of Hazardous Road Locations on National Highways in Bangladesh. Published on: 22nd ARRB Conference, Australia, 2nd November 2006.

Hoque M.M., Mahmud S.M.S, Sarker A. (2011). Identifications and Investigations of Hazardous Road Locations on Dhaka-Aricha Highway. 4TH Annual Paper Meet and 1ST Civil Engineering Congress, December 22-24, 2011, Dhaka, Bangladesh.

Supomchai Utainarumol, Robert E (1999). Stammer, "GIS Application for Better Identification of Hazardous Highway Locations". Journal of the Eastern Asia Society for Transportation Studies, Vol. 4 (1), pp. 271-286.

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