# AVRA BANGLADESH
# Collection, Analysis & Visualization of Road Accident Data in Bangladesh

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***Abstract*—Road accident is a global issue of concern and like many other countries in the world Bangladesh also suffers greatly due to road accidents every year. Our goal was to provide a complete & accurate accident information source available to general mass. In our software, we have tried to incorporate a complete picture of accident rate & accident trend. We have included a way to explore every possible source for collecting accident data in our software. Anyone can provide information regarding an accident which includes hospitals attending accident victims, print or electronic media even simple spectators. Our software introduces an Internet-based, GIS-compatible software process for automated road accident analysis & visualization. This site is capable of performing accident information query, trend analysis, statistical analysis, color-coded mapping, and other accident information display within the web-based environment. The Internet-accessible user interface allows users to inquire about detailed information on vehicle crashes associated with road segments and intersections for any geographical regions in Bangladesh via query forms or zoom-enabled interactive maps. In our program we have generated automated visualizations of accident rate & factors of accidents in formats of charts, table & maps. Visualization of traffic accidents by collision type & road class based on real data is included to demonstrate the effectiveness of our software.**

## I. Introduction

An accident is an unexpected occurrence of physical damage to animate inanimate structure. Road accident in particular needs immediate attention to prevent it or to mitigate the loss. For that correct accident data is needed which is unavailable in our country. Two important characteristics related to road safety data is that their sources vary and they all suffer from under-reporting problems as described in [1]. The problems related to the accident reporting system in Bangladesh and the data derived from it, as reported by [2], have not been resolved and official statistics are prone to under reporting. There is no single centralized calculation of number of deaths in road accidents. According to government, in the last 10 years about 35000 people died. CIPRB(Center for injury prevention & research, Bangladesh) made a survey on 0.7 million people in 2011 & found out that about 12800 people die in road accidents every year in our country. Our website AVRA BANGLADESH [3] aims at providing that central source of information which is available to general mass at any time.

In Bangladesh police are the main source of accident data as they formally collects and records all the accidents within the country. According to police information from January 2011 till November 2011, 2241 accidents took place in the whole country & 2140 people have died in these accidents mentioned in a report in a famous local newspaper *"Daily Prothom Alo"*. Information of locally settled or rural accidents is rarely kept by police. Police takes into account only those accidents that have been reported. This situation is referred to under-reporting [4]. Hospitals & witness to an accident also has accident information. Our software attempts to find a link between all these sources. In our site spectators can also provide information about the vehicle which is responsible for any accident so the nearby traffic police can be informed as soon as the accident happens. *Hospital administrators* can directly add victim information in our site as soon as any accident victim is admitted in their hospital. So people can directly search for accident victims through our site.

Statics of severity and fatality in road accidents is a complex combination and interaction of different road user, vehicular, environmental, road, junction and roadside factors. So to comprehend an accident scenario, influence and contribution of all the related factors are needed to be considered and on the basis of these proper and rational rates of accidents for taking any measures corresponding trends are required to be drawn. In *AVRA BANGLADESH* we have implemented a system that automatically generates different types of visualization of accident data & corresponding factors in terms of various related variables. To understand the location of accident properly one also needs the visualization of geographic location. In our software we mark the location of accident in a way that anyone can realize where & what type of accident has happened. Besides, there is a system where map has been implemented to show accident rates by accident severity & divisions which gives a better understanding of which is the most affected area.

## II. Related Works

A National Road Safety Strategic Action Plan 2002-2004 has been organized into nine sectors by Road Safety Cell, BRTA(Bangladesh Road Transport Authority). The Plan is very comprehensive in scope but the progress report produced at the end of the plan period (December 2004) shows that very little have been achieved in many of the nine sectors [5].

Accident data system which was one of the nine sectors being

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implemented involves reporting of accidents in a prescribed format, data entry and processing using the Microcomputer Accident Analysis Package (MAAP5) software at the Accident Data Units (ADU), and transmission of the data to Police Headquarters on a monthly basis, from where it is delivered to the Road Safety Cell. The implementation of the data system, however, has been far from satisfactory and several areas that require improvement, including further training of personnel, upgrading of software and stricter monitoring, have been identified [6]. In Bangladesh, accident data could not get accurate due to under-recording to MAAP software and under-reporting as described in [7]. This leads to wrong analysis of accidents. Our site eliminates these middle processes & highlights in getting accurate & complete information about an accident.

The Accident Research Centre (ARC) was established in Bangladesh University of Engineering and Technology in 2002 with the aim to conduct studies and research on accidents and their remedies. ARC also provides training to professionals. But soon after 2008 their functionalities declined & they have been unable to produce the desired outcome.

Police reported trend of road accidents & fatalities(1970-2007) in Bangladesh was shown in [8]. They also included rate & trend analysis based on number of motor vehicles on road. But they have done this analysis manually & only police reported accidents were included.

A prototype GIS and Road Accident View System [9] was developed by University Putra Malaysia where they combine the information collection capabilities with visualization to reduce the number of accidents. Carsim [10] is a visualization system that visualize written road accident reports by creating animated 3D scenes of car accidents from reports written in Swedish. A data analysis tool was created for the Maryland State Highway Administration and local traffic engineers which is a secure, web accessible data visualization and analysis application which was described in [11].

The high rate of fatal accidents in Bangladesh is alarming and unacceptable. Not many tangible results have been achieved so far & the existing methods have been proved useless. It is imperative to review the measures adopted to identify the problems of implementation and improve or modify them so that they can be more effective.

## III. System Design & Architecture

To support the variety of functionalities, the web-based software system consists of three major components:

1) Web user interfaces
2) Web server (Web application server)
3) Databases

The relationships and information flows among these components are depicted in Figure 1.

The Web user interfaces allow users to create queries and view results. Upon receiving user inputs through the interfaces, the system dynamically retrieves information from the server databases, and sends processed outputs back to the interfaces for display. The Web application server supports the core functionality of the system. It generates SQL (structured query language) queries according to the user's inputs and sends the queries to databases. Then, the application server generates json, xml or string data formats for Google API to use based on retrieved data from the databases. They are sent to google visualization API & google sends the drawn charts, tables or maps to web user interfaces.

TABLE I: System Development Environment and Technologies

| Category | Technology |
|---|---|
| Web Application Layer | PHP Version 5.3.5 |
| Database | MySQL Server 5.1 |
| Server API | Apache 2.0 Handler |
| Presentation Layer | Web Client |
| Charting | Google Chart API |
| Maps | Google Maps API |

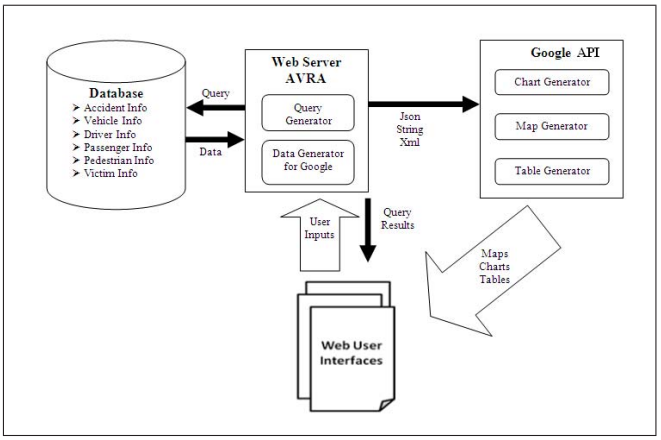



Fig. 1: System Architecture

The four basic components of Internet GIS : client, web & application server, map server & data server according to [12] is included in our implementation. The technologies used for the implementation of the system are shown in Table I.

## IV. Collection of Accident Data

### A. Digitalized Accident Form

We have taken the idea of the police accident reporting form (ARF) which is a mandatory part of investigation report. Completed ARFs are compiled at the ADUs with MAAP5. From these regional ADUs, the accident data is transferred by floppy disk to the National ADU at Police Headquarters, Dhaka. BRTA collects these data from the Police Headquarters and enters it into its own master database [13]. The shortcoming of the database is that it is a very lengthy process. Also it is prepared on the basis of reported accidents only which makes the database virtually incomplete.We have converted the ARF to a digital form. Police can now input accident data from any thana if they only had some form of internet access. The form is divided into several categories which are organized in different tabs. Entering the site user have to click the *Input*

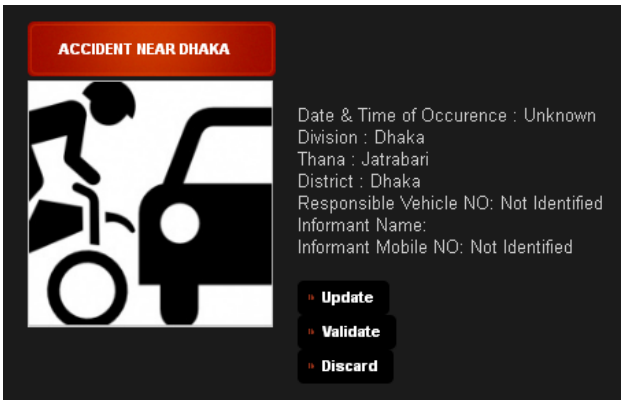



Fig. 2: Links to User Submitted Data

*Accident Data* in the left subpanel of home page to see the form.

We made the form as user friendly as it can be. User don't have to input any kind of data that can be predefined such as division, district or thana and collision type, junction type or contributory factors etc. These options are identical to options described in ARF. Any number of drivers, passengers or pedestrians can be added in the form just by one click in the **Add Another** button.

### B. Accident Information from Every Source Possible

Anyone or any source starting from the hospitals attending accident victims to a mere spectator can provide accident info in our site. As soon as a data has been entered the police of the corresponding thana see the information & will be able to take necessary measures to validate it or to complete it if only partial data is given. Normal users can edit those data just like Wikipedia only by clicking the "**Update**" button shown in Figure 2. The Validate or Discard button is not seen by general users. Police can both update & validate data. If the police checks the accident site & validates provided data, only then these data is inserted in main accident database. If the given data is false then the police can also discard this data.

### C. Accident Victim Information

The *hospital admin* can enter the accident victim data as soon as any victim is admitted in their hospital. They just have to click the "**Input Victim Data**" button. This way if anyone searches for accident victims they can find them easily.

## V. Visualization

In our website we have visualized number of accidents by various kinds of accident factors. The user only has to choose the type of accident & the visualization variables from a given set of choices. The variables by which number of accidents are calculated are *Collision type, Junction type, Road class, Road environment, Accident severity, Division, District, Month of occurrence, Year of occurrence, Date of occurrence, Time of occurrence & Vehicle type*. The user can visualize number of accidents by one choice or two choices. They can even choose the time range of accident occurrence if they want to.

TABLE II: Recorded Casualty Accidents (Fatal) by Type of Collision & Road Class

| Collision Type | Number of Accidents | | | | |
|---|---|---|---|---|---|
| | Road Class | | | | |
| | national | regional | feeder | rural road | city |
| Head on | 253 | 50 | 35 | 33 | 20 |
| Rear end | 167 | 38 | 36 | 20 | 52 |
| Right angle | 8 | 3 | 0 | 0 | 3 |
| Side swipe | 76 | 20 | 26 | 18 | 12 |
| Overturned vehicle | 93 | 31 | 41 | 32 | 5 |
| Hit object in road | 9 | 4 | 1 | 2 | 7 |
| Hit object off road | 23 | 9 | 7 | 8 | 0 |
| Hit parked vehicle | 42 | 8 | 7 | 2 | 2 |
| Hit pedestrian | 687 | 170 | 148 | 155 | 246 |
| Hit animal | 1 | 0 | 0 | 0 | 0 |
| Other | 38 | 14 | 18 | 16 | 14 |
| Unknown | 2 | 3 | 3 | 2 | 3 |

Here we show visualization based on actual data taken from **BRTA Annual Report 2008**. We have shown number of recorded casualty accidents which are fatal by *type of collision & road class*. Table II represents the data table from the RTA report [14].

Visualizations by collision type & road class from our site based on the data in Table II are illustrated in figures from Figure 3 to Figure 6. The left column of table II shows the collision types & the upper third row shows the road classifications by which the charts are made.

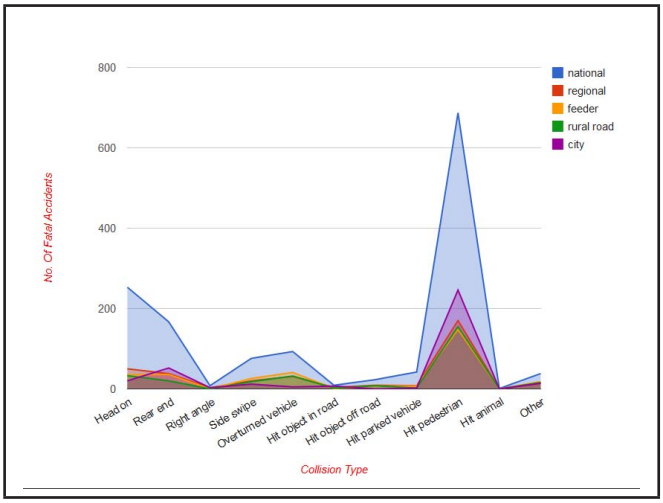



Fig. 3: Area Chart

### A. Implementation

Being taken the choices from the user they are used to form the actual query. Then the result of the query is formulated as a string in json format. We send this json string to **Google Visualization API** of corresponding chart. This API in return according to the choice draws the desired visualization. We have loaded **Google Javascript API** to draw the visualization. Then the **'corechart'** package is loaded from google to draw line chart, column chart, area chart & bar chart. Code for loading this package is shown in Code Segment V-A.1.

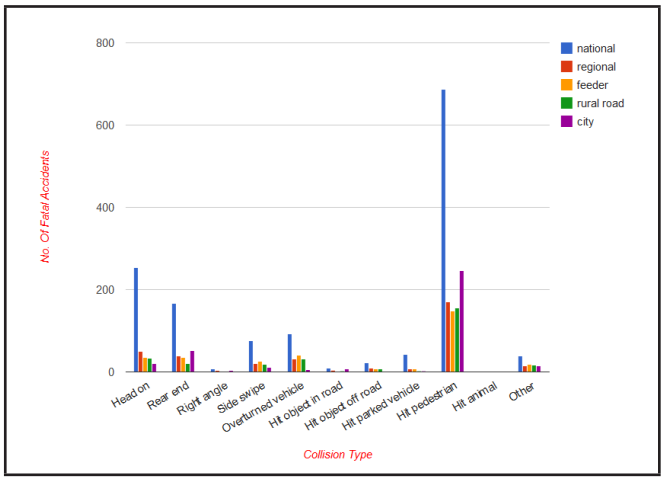



Fig. 4: Column Chart

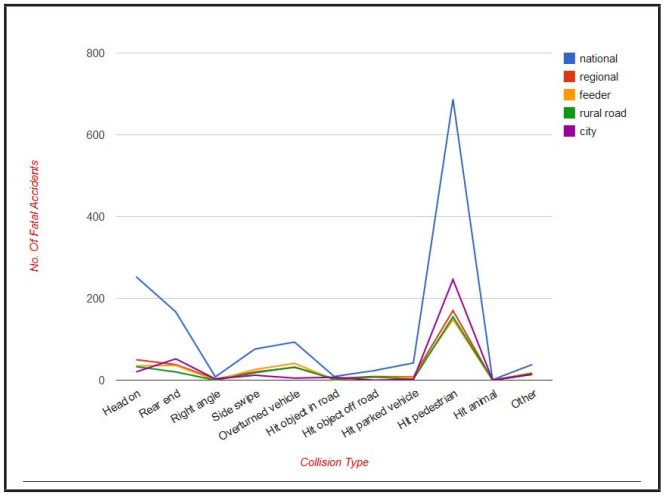



Fig. 5: Line Chart

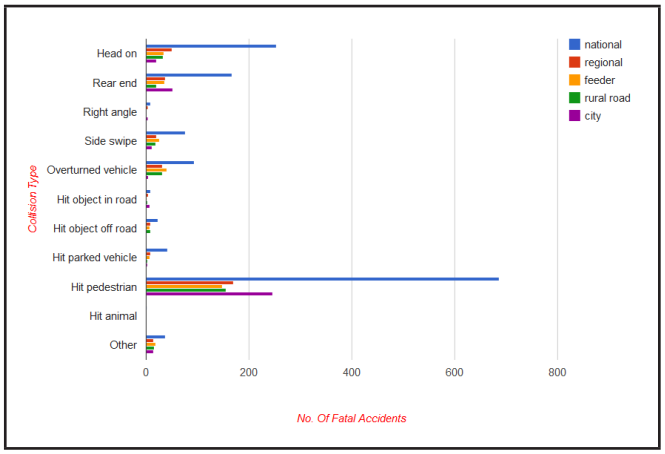



Fig. 6: Bar Chart

**Code V-A.1.** *Code for Loading Corechart Package:*

```
google.load('visualization', '1',
{'packages':['corechart']});
```

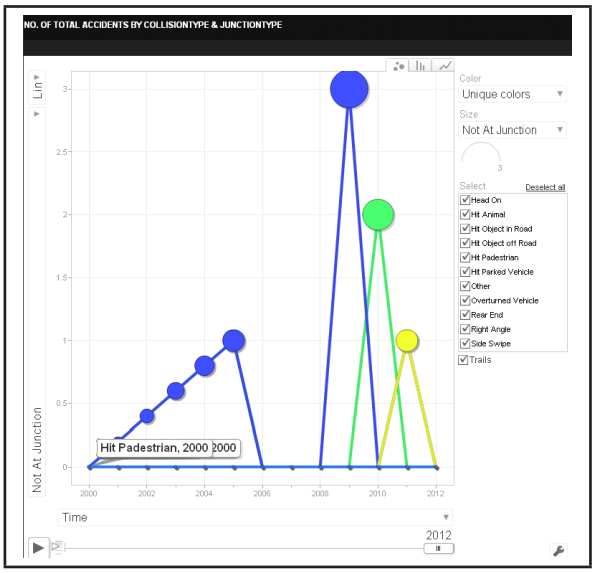



Fig. 7: Number of Accidents by Collion Type & Junction Type from 2000 to 2012 : Scatter & Line

For table chart the **'table'** package is loaded from Google to draw tables. Code for loading this package is shown in Code Segment V-A.2.

**Code V-A.2.** *Code for Loading Table Package:*

```
google.load('visualization', '1', {'packages':['table']});
```

When the "**draw**()" function is called Google API returns the drawn chart or table which is shown in our site.

## VI. Analysis or Motion Visualization

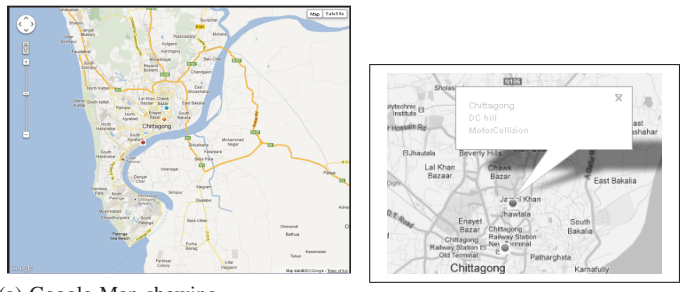
Analysis of number of accidents in terms of time has been included in our site. Increase or decrease in no. of accidents in terms of year & other variables can be found here. The variables by which user can see those analysis are *Collision type, Junction type, Road class, Road environment, Accident severity, Division, District, Month, Date & Vehicle type*.
A snapshot of *number of total accidents by collision type & junction type through the years 2000 to 2012* is shown in figure 7. A **video demonstration** of the motion visualization feature is uploaded in Youtube [15]. We have implemented it based on the test data we have built replicating the real data from BRTA reports.

### A. Implementation

The gradual change over the years in no. of accidents can be seen in this section. Taking the choices separately we combine them together as a SQL query. Then the result of the query is processed as a string in json format. The script that is loaded for this is same as the script for visualization charts. Then we load the "**motionchart**" package. Code for loading this package is shown in Code Segment VI-A.1.

**Code VI-A.1.** *Code for Loading Motion Chart Package:*

```
google.load('visualization','1',
{'packages':['motionchart']});
```




(a) Google Map showing Different Accident Locations

(b) Accident Locations with Division, Area & Severity

Fig. 8: Different Accident Locations on Google Map

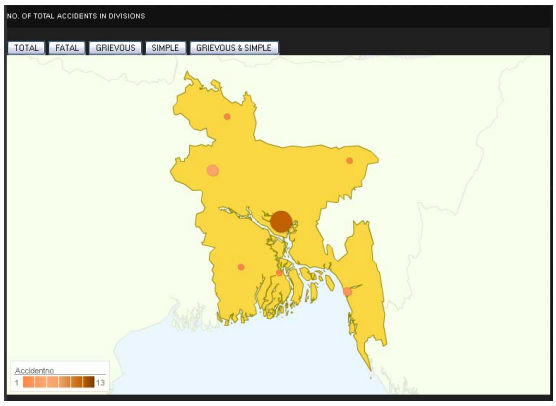



Fig. 9: No of Accidents by Division in Geo Map

## VII. Map Visualization

### A. Different Accident Locations on Google Map

An essential part of the accident data system was the accident location system. So we have pinpointed the accident locations in the Google map based on the latitude & longitude illustrated in Figure 8a. For now the police will be provided with a GPS tracker to track the coordinate. Clicking on circles of different colors will provide information on I) Division, II) Area & III) Severity of the accident. This is shown in Figure 8b. We have loaded the **Google Map API Script** to draw the map.

### B. Geomap Indication for Number of Accidents

Besides Google map we also have provided a division based accident location map defining the number of accidents per division. User can choose the type of accident they wish to see. For now we have shown the geomap implemented with our test data in Figure 9.

*1) Implementation for Geo Map:* The **'geomap'** package is loaded from Google to draw the geomap. Code for loading this package is shown in Code Segment VII-B.1. When the "draw" function is called Google API returns the drawn geomap which is shown in our site.

**Code VII-B.1.** *Code for Loading Geo Map Package:*

```
google.load('visualization', '1',
{'packages': ['geomap']});
```

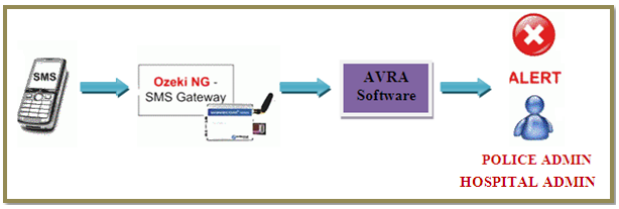



Fig. 10: Message Information System (MIS)

## VIII. Providing Information via Mobile Phone

Mobile phone is the most vastly used device in Bangladesh. So we intend to use it for our data collection purpose. Almost every people in Bangladesh have mobile phone. So if anyone witness an accident & wants to report it he can do it right away. He just has to follow a certain convention. As soon as they send the message the police admin of the corresponding thana will get the notification & a form with the given info will be filled out automatically. We have used **ozeki sms gateway** to implement the message information system. A schematic is drawn in Figure 10.

## IX. Other Features

### A. Easy & Reliable Source of Accident Data

Based on a report of [16], earlier studies have estimated that approximately 50% of road injuries are reported worldwide. To improve reporting, there is thus a need for methods to obtain fully reliable accident data. Our site provides that reliable & coordinated information of accident data. Users can enter the site & they are shown the links to the accident details that are already validated or inserted by police with a short description. User can see the accident details partially shown in Figure 11 by clicking on $i$) the **Details** button, $ii$) the **Underlined** link or $iii$) the **Picture**.

Police of a particular thana will see only those user submitted data that belong to corresponding thana. If the user wants to see details of a user submitted data they just have click the "***update***" button in Figure 2 & they see the whole accident form with already inserted data.

### B. Accident & Fatalities Search

A user can search for accident by *Division, Thana, District, Type of accident, Date of occurrence, Month of occurrence, Year of occurrence, Area of accident, Road name, Landmark name, Collision type, Junction type, Weather, Light condition, Contributory factors* etc. A user can search for drivers involved in accident by *District where license was registered, License no, Sex, Injury, Age, Alcohol taken or not, Seatbelt & helmet worn or not*. A user can search for passengers & pedestrians involved in an accident by *Name, Address, Sex, Injury, Age, Location or Position while accident, Action while accident*.

### C. Search for Accident Victim

Anyone can search for accident victims in our website just by clicking **"Hospital Admits"** button. Search returns the hospital name victim is admitted to & description of the


Fig. 11: Accident Details

victim. A user can search for victims by their **full name, thana, district, injury type or hospital name.**

### *D. Getting Culprit Vehicle Information*

Police can easily find out about the offender who is responsible for the accident from the user submitted data if they add any information about it. To ensure that the exact person who committed the crime is accused & no innocent is harassed, we keep track of the source. Mobile companies keep track of their users' information. So if we have the mobile number of the source we have all the information necessary to trace them back.

## X. Conclusion

In further future, we would like to incorporate the site with smart phones so that user can get updates of danger levels of a particular road. Identification of problematic locations will greatly help to reduce accident probabilities. In addition, we can predict the possible dangerous sites from the accident data we will gather from this site to take effective actions to avoid accidents.

AVRA Bangladesh is developed for the purpose of maintaining a reliable & complete collection of accident data. The information system described and evaluated in this paper wraps together a set of procedures for extracting information of interest for road safety evaluation starting from data concerning accidents. Such platform processes spatial data to provide end-users with a reliable tool to evaluate what roads have the highest accident density, the highest danger rate and any other statistical indicator which can be extracted from attributes. We can see the visualization & analysis of road accident data successfully from our site. It has been tested with real life data from cumulative reports of BRTA & it works fine. As far as we know this is the first software in Bangladesh where all these methods & facilities are collaborated together. So this could lead us to a complete or partial solution for road accident in Bangladesh.

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