

# A Mobile Solution for Road Accident Data Collection

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**Abstract** - Road accidents are a major cause of injuries and death in developing countries. It is crucial to build a road accident database and data retrieval system as a fundamental resource in improving road safety. Since the accident database needs to hold reliable data, accurate methods for accident data collection must be used. This study focuses on improving accident data collection by using a Smartphone-based application. The application's aim is to improve data collection, while supporting mobility, ubiquity and accuracy.

The name of the application is *CrashData*; it has been developed and tested in Kenya. Using the application, data are sent to a central database for storage and can be retrieved by the same application. The type of information collected is determined by the Model Minimum Uniform Crash Criteria (MMUCC), National Institute of Statistics (NIS) and other accident data sets. Location information recording is supported and depends entirely on Smartphone inbuilt GPS module and Google places API. The application provides a web interface for office based managers, who can use Google maps to identify accident hotspots by mining location information from the database.

**Keywords:** *Accident Database, Accident Data Collection, Accident data presentation, Android Smartphone Application, Google APIs*

## I. INTRODUCTION

The increase in motor vehicles, especially in developing countries, has resulted in an increase in the number of accidents. In Kenya, for example, by 2007, registrations showed that there were 2.7 vehicles per 100 people [6]. Accidents affect the economy as 75% of the road accident casualties are economically productive adults [12]. The most affected are passengers and pedestrians, who account for 80% of the casualties. In Kenya, an average of 3000 people die annually as a result of all types of road accidents. This accounts for 3.6% of total deaths. This figure is expected to rise to 4.9% by the year 2030 [6]. Ten times this number remain seriously injured [7]. There are many measures that have been put in place to curb road accidents as well as minimize occurrences of injuries in case of an accident. However, many of these attempts have failed to keep pace. For example, the requirement to install seat belts in all vehicles in Kenya, including Public Service Vehicles (PSV) failed due to poor administration and corrupt police.

On European roads, 30,000 deaths resulted from road accidents, and over 25,000 people remained seriously injured

[3]. In the United States, 30,000 deaths were caused by accidents, and 2.5 million people remained injured. Deaths caused by road accidents are expected to overtake other causes [10].

In Kenya, the traffic police department is responsible for collecting accident data on-site. The police fill P41 forms, which are presented to police headquarters, and finally to the Ministry of Roads and Public Works for analysis and planning [12]. A P41 form is a single paper form, which is used by the police to record accident details. It is the basis of police crash data system in Kenya because there is no electronic accident database. The data held in the P41 forms is occasionally summarized and presented in excel charts. In Kenya, more often, the statistics given above are inaccurate because follow-up examination on accident scenes and hospital updates on accident casualties are not added to the already held accident data.

In this paper, we propose a mobile solution based android platform that can be used to quickly and accurately collect accident data. This paper is organized as follows;

In section II, we present literature review, which covers various technologies that will support the solution and other related research in the area of accident databases. In section III, we describe the design, implementation and testing of the proposed solution. Section IV presents conclusions and suggests areas of further research.

## II. LITERATURE REVIEW

### A. Related Technologies

The solution presented in this paper depends on a number of technologies that are already in place. Examples include Global Positioning System (GPS), open Google Application Programming Interfaces (APIs), Smart phone cameras and Android's speech to text API.

1) *Global Positioning System (GPS)*: The use of GPS is the fastest and most accurate method of recording an accident's location [15]. A GPS receiver is an electronic device that receives signals from GPS satellites. Over time, the size of GPS receivers has reduced and they are now integrated in smart phones. Because of this, localization is very common and personal navigation and location-based services are widening the scope of mobile usage [9]. With GPS receiver modules, mobile devices offer sufficient location accuracy and can be used to collect accident data [15]. The receiver receives a signal from at least three satellites and extracts the current device coordinates.

2) *Google APIs and Map Markers*: Using the Google places API, the coordinates can be presented using names of

Pan African International Conference on Information Science, Computing and Telecommunications (2014) places and close range landmarks [5]. The most common Google Places API requests include place searches, place details and place actions. The latter allows users to supplement Google data by submitting data into Google Places Database. With the use of Google maps, locations of interest can be embedded on maps using colour markers. The details of such locations are shown when the markers are clicked [17]. Figure 1 shows map markers with info window.

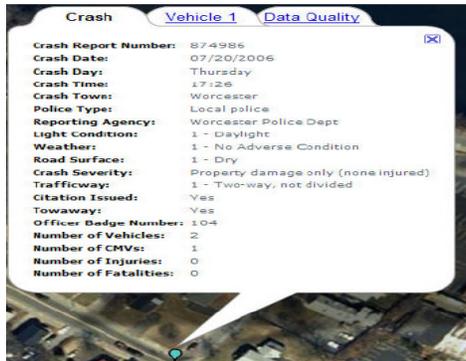


Figure 1: Map Markers with info window

3) *Smart Phone Cameras*: Modern Smart phones are equipped with high resolution cameras. These cameras can take detailed photos, which can be used for various uses. The photos can be stored in phone memory or be sent to some other location for storage. Road accident photographs shows evidence of an accident, and the extent of damage because they communicate more information than just text.

4) *Android's Speech to Text API*: The use of inbuilt mouthpieces in android enabled mobile phones to understand commands and automate some tasks. This feature can significantly expedite data input. However, it is largely dependent on clarity of voice input [11].

### B. Road safety databases

Presently, there are many available international road safety databases whose aim is to elaborate road accidents data in compatible and homogenous formats using standard accident datasets and to ease the work of researchers in collecting accident statistics [ [HYPERLINK \l "Jay09" 1](#) ]. These databases show that tremendous work has been done in collecting and storing accident data.

1) *International Road Traffic and Accident Database (IRTAD)*: This is the largest safety database in the world, which collects accident data from Organization for Economic Co-operation and Development (OECD) member countries. This database contains over 500 data items [16].

2) *GLOBESAFE*: This database shares road accidents from only nine Association of Southeast Asian Nations (ASEAN) member countries.

3) *Road Accident sampling system-India (RASSI)*: the accident database contains detailed crash data collected in accident scenes and follow-up examination. The RASSI database has over 500 data items. The advantage of RASSI is that, on-site data collection and follow-up examination by experts are linked.

### C. Related Work

Leelakajonjit proposes an accident database and insists that the location of an accident by use of GPS is very crucial [4]. The location data is used to identify accident hotspot. Lobont, Filichi, & Popescu explain how Illinois State uses a system fitted into a vehicle that goes around to record accident locations [3]. The system uses an inbuilt GPS module for marking accident locations. Jayan &

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Ganeshkumar proposes a Geo-database, which can be used to identify accident hotspots [14]. The main data item stored is location. International Road Federation (IRF) presents a system called RADaR (Road Accident Data Recorder), which is an android application on tablets [2]. It uses GPS or GPRS to record crash locations and then send data to a central database. The application is also able to take photographs and record video of the accident scene.

### D. Adopting a Common Accident Dataset

1) *Model Minimum Uniform Crash Criteria (MMUCC)*: it is a standard that defines how data must be collected and what data pieces are to be collected so that it is easier to share data. It categorises the data collected into crash data elements, vehicle data elements, person data elements such as all vehicle occupants, all drivers, non-occupants [8].

2) *National Institute of Statistics (NIS)*: According to NIS, traffic accident data contains a rich source of information on the different circumstances in which the accidents occurred: cause of the accident, traffic, environmental and road conditions and many more. Every NIS variable has a number of items associated with it and a total of 572 different data attributes [18].

## III. SOLUTION APPROACH AND DESIGN

In this section, we make assumptions and then describe how we designed, implemented and tested our application. Our solution is designed under the following assumptions;

- That the driver and vehicle database is in place
- For this study, dummy data will be used to represent these systems
- That data is easily shared within these sub-systems

### A. System Architecture Overview

The accident database interacts and shares data with driving license, driver penalty point, vehicle registration and other related subsystems. Figure 2 shows this relationship. The traffic accident subsystem, which is the interest of this study, is isolated and shown in Figure 3. It shows the components involved in accidents data collection and presentation.

Centralized client-server architecture has been chosen for this system. However, the use of web services makes it hybrid. The system has few users hence there was no need to have it distributed. Only the traffic police department has access to it plus a simple web interface that allows hospitals to give updates on the hospitalized accident casualties. Nevertheless, this architecture is determined by portability, data sharing and distributed processing.

Accident data is collected from an accident scene and sent to a central server over a 3G network. The 3G wireless network is the mobile broadband internet connection of choice. Data collection is done on a native mobile application. GPS satellites offers location services by the help of the GPS sensor on a mobile device such as a tablet or mobile phone. On the other hand, the web service offers geo-location for physical location name.

The central server offers storage and processing functions. Certain processing needs are offered by external web servers. For example, Google maps API offers accident data mapping.

The server also offers an interface for sharing data with other related systems. Data received from the mobile application is processed by PHP scripts and stored on MySQL database. An apache HTTP web server application provides an interface for smart phones to connect to the central server.

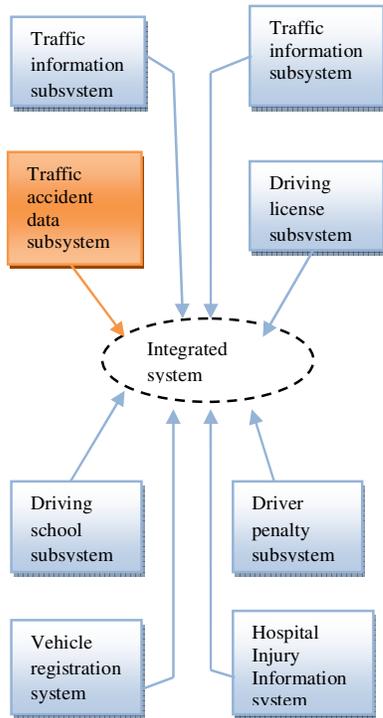


Figure 2: Proposed system architecture overview in relation to other sub-systems

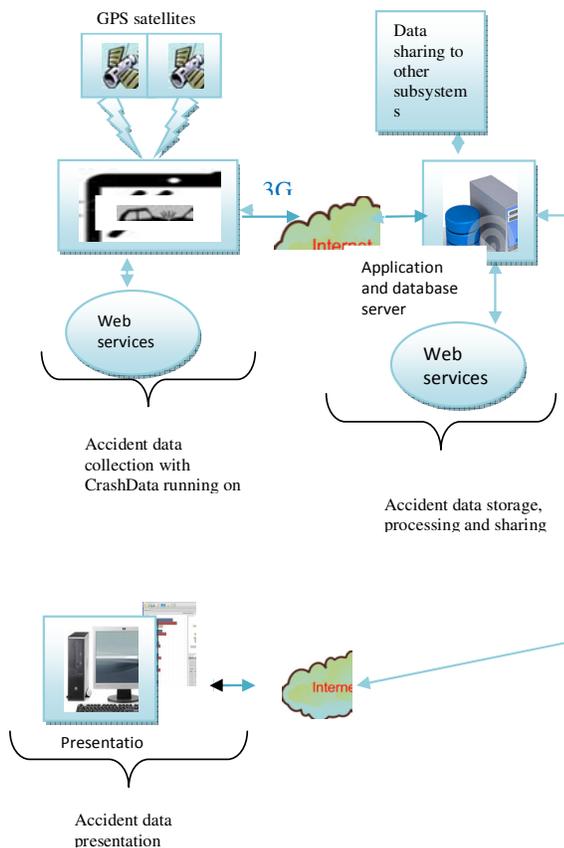


Figure 3: Proposed system architecture

**B. Context Diagram**

A context diagram represents a level zero data flow diagram. In this case, it presents CrashData as a single high-level process and then shows the relationship that the system has with other external entities. It, therefore, shows the relationship between external entities, and the systems as a single process. Data flowing into and out of the system is shown with the entities that produce and receive the data. Figure 4 shows the CrashData context diagram and Table 1 shows the key to the context diagram.

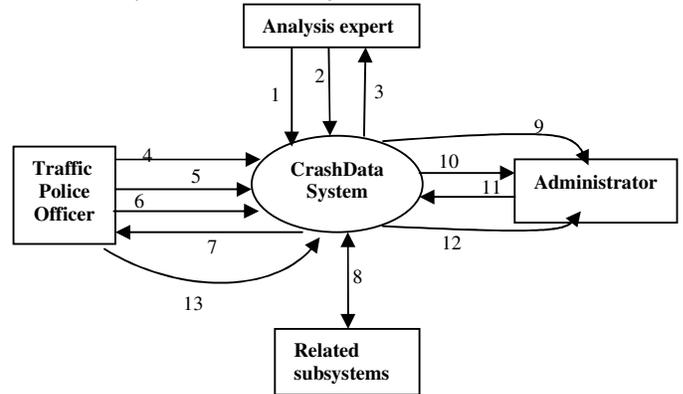


Figure 4: CrashData Context Diagram

Table 1: Context Diagram key

No.	Description	No.	Description
1	Analysis results	8	Shared data
2	Recommended safety measures	9	Accident analysis results
3	Accident details	10	User account details
4	Recommended safety measures	11	Reports
5	Accident details	12	Recommended safety measures
6	Follow-up examination	13	Accident casualty details
7	Accident analysis results		

The external entities of the system include:

*Traffic police officer:* the traffic police officer collects and uploads accident data to the central server. The traffic police officers can also add expert recommendations to the accident data and view the accident data afterwards.

*Analysis experts:* the analysis expert adds analysis recommendations and follow-up examination.

*Administrator:* the main role of the administrator is user accounts management and report generation, but can also add accident analysis recommendations, view user logs and add emergency responder contacts.

*Web Service:* this is an internet service, specifically Google APIs, which will offer geo-location for physical location name, map and map markers.

**C. Implementation**

1) *Implementation Environment:* The mobile application is implemented on the android platform. Thus, the source code is written in java utilizing android classes. After development, the application is compiled and tested using Software Development Kit (SDK) emulator on windows and a Samsung tablet. The software is optimized for android OS 4.3 (API 18) but, has a backward compatibility with android 2.2 (API 8). Android was chosen for the client application due to the flexible SDK, Android Development Tools (ADT) and availability of support from a number of developer communities online. The web interface is written in Hypertext Preprocessor (PHP) together with HTML and JavaScript. The

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 web system is hosted on a live Apache HTTP server. The main reason for choosing PHP as the server-side language is portability, easy debugging is powerful and error resilience. Support from a large online developer community is readily available. The web system receives interfaces with the mobile client to receive requests from end users, and it also provides front-end for presenting accident data to administrators. Accident data was stored in MySQL database. Storage of accident information in a database is preferred because it facilitates easy retrieval of information. MySQL database was chosen because it is open source and has full compatibility with PHP. It should be noted that the database also carries dummy data that was used to simulate other subsystems e.g. vehicle registry that are required by the accident data collection system.

2) Implementation Details

**Functionality:** The application is made up of a mobile and web components. The android mobile application runs on a tablet and its main purpose is to enable users, i.e., traffic police officers, to collect accident data and then send it to the server. The application also provides emergency numbers that can be dialed in an emergency. Data collected include text and multimedia (voice, picture and video). The Smartphone running the application requires an internet connection and an onboard GPS module for registering accident location. The application also has a feature that allows accident casualty details to be added to the accident details. The casualty details are then connected to the particular accident. In a nutshell, the mobile application is aimed at collecting accident data, recording accident casualty details and contacting emergency responders. The web application retrieves and presents accident information that is sent by the mobile client to the database. It resides on the HTTP web server and is linked to the database. In addition, user accounts are managed using the web interface. Using the web interface, accident casualties can be linked to a specific accident and reports can be generated.

**2.1 Mobile Application Component;** The mobile application starts with a splash screen, then to a login screen and finally an options screen, where the user chooses the action. This is shown in Figure 5.

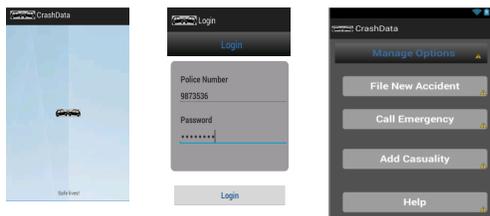


Figure 5: Splash, login and option dashboard screens  
 The 'File New accident' option allows the user to start collecting accident details. Table 2 below summarises the type of data that is collected by the application. Figure 7 shows sample application screens interfaces that were used to collect vehicle details. The 'Call Emergency' option leads the user to the interface shown in Figure 6.

Table 2: Data variable and items collected by CrashData

Variable	Items
Location	Coordinates, nearest town/city, nearest landmark, region (initially known as province)
Time	Time of accident, date of accident, date of accident recording.
Movement	Pre-crash events, crash configurations
Alcohol	Driver alcohol test results

Vehicle factors	Registration number, owner, vehicle type, loading, defects (lights, tires, mirrors, road worthiness), insurance policy, model
Casualty details	Consequences (deaths and injuries), gender, age group, names, nationality, eventual consequence of hospitalised casualty.
Multimedia data	Accident scene photos, witness videos,
Road factors	Nearby road signs, road surface characteristics
Other accident conditions general conditions	Hit and run, number of vehicles involved, accident severity, light conditions/illuminations, possible cause of the accident.
Whether conditions	E.g. normal weather, fog, rainy etc.
Driver	Name, licence number, consequences, alcohol test results , gender
Other damages	Property name, property description, property category (private or public)

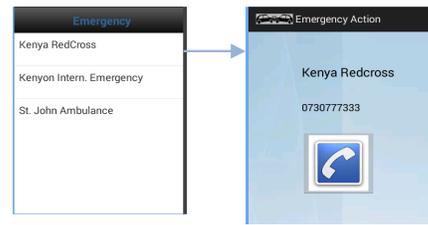


Figure 6: Calling Emergence Responders

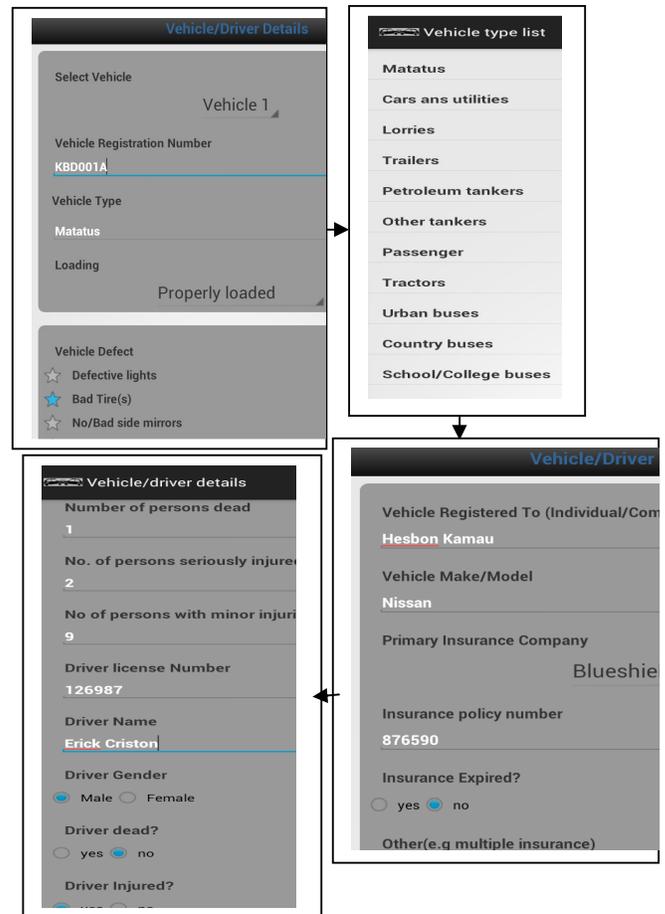


Figure 7: Vehicle/driver details screenshots

2.2) **Web application component:** The main role of the web component is to allow access to the collected accident data. With it, the following can be done;

- 1) Search accident by date and accident ID, to show the details on map and map markers with info window as shown in Figure. 8.
  - 2) Add follow up examination and recommendation to a selected accident
  - 3) Add casualty details to a selected accident
  - 4) Add emergence responder contact numbers
  - 5) Generate tabular and graphical reports from the stored data
  - 6) Give updates on the progress and condition of the hospitalised casualties as shown in Figure 11
- The kinds of reports that are generated by CrashData application include the following;
- 1) Graphical Accident Distribution per Region
  - 2) Graphical Distribution of Injury Severity by Age Group as shown in Figure 9
  - 3) Graphical Distribution of Accident by Vehicle Type
  - 4) Tabular Distribution of Accidents by Cause
  - 5) Yearly summary as shown in Figure 10



Figure 8: Accident Search and Map Locations

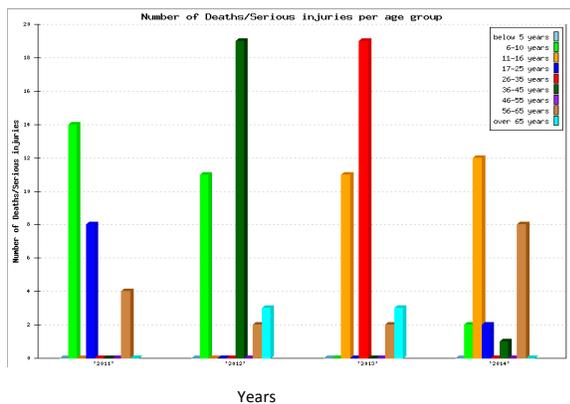


Figure 9: Graphical Distribution of Injury Severity by Age Group

Hospital updates are very important because it updates prevailing statistics, and reports from such updates can be used to show the recovery rates of accident victims.

Yearly summary				
Year	Number of Accidents	Number of Deaths	Serious injuries	Slight injuries
2012	56	102	200	150
2013	50	98	160	134
2014	121	3	50	21

Figure 10: Yearly summary

#### D. Testing

The process of evaluation entails comparing the completed system with the design goals. Use case requirements were used to check whether the goals were

reached. First, we set the measures, and then determined what results were considered successful.



Figure 11: CrashData hospital updates

Before the experiments and results, we discuss how we measured the functional and non-functional requirements and how successful results were measured. We used 5 subjects for 4 sessions (assumed as 20 subjects).

A use case was used to present functional requirements of the system. We checked whether the complete system had the features that were promised in the use case. The test cases were simulations on real-life scenario. The outputs from the tests were then compared with what was expected.

There were two non-functional requirements that were tested i.e. user interface and usability. A questionnaire was used to measure usability satisfaction from the users. The test questionnaire was presented to the users after they had used the application.

Acceptance tests were done on the final system to find out whether the system met functional requirements. One real life case was used to determine whether the mobile application and the web system delivered its promised functionality. In this case, users were located in Traffic Headquarters, Ruaraka, Thika Road (lat, -1.256962; lng, 36.857001). 5 user accounts were created in the web system and were used by 5 users to submit accident data. Functional requirements were tested as shown by a sample test case shown in Table 3. The last row shows the value *pass* if the result is what was expected, or *fail* if the result was not as expected.

Table 3: Creating user accounts and login test case

Identifier	1
Test case	Creating user accounts and logging in
Description	The administrator creates user accounts in the web system and users login from the mobile application into the system
Utilized use case	Manage user accounts upload accident data.
Results	Accounts were created and users were able to login using the mobile application into the system
Pass/fail	Pass

#### IV. CONCLUSIONS

In this paper, we have successfully designed and developed a mobile application that offers great benefits in

Pan African International Conference on Information Science, Computing and Telecommunications (2014) accident data collection. These advantages include; 1) increased mobility, 2) accuracy of data collection increased access to accident, 3) better storage of accident data and 4) increased speed of filling of data into the system. With improved access to data and location mining, accident hot spots can be shown on maps. However, the solution presented in this paper can only be successful if it is backed up by the government. With regard to this, a number policy recommendations to key stakeholders and the government are suggested below.

- 1) There is need for a standard accident data set for inclusion in accident reports and periodical audits to evaluate police performance
- 2) The government should build a national accident database based on the standard dataset identified above
- 3) The government should extend its efforts to ensure that the accident database collected is easily accessible to key stakeholders
- 4) Mapping of accident data per location to identify 'black spots'
- 5) Analytics should be performed on the accident data to derive sensible statistical trends
- 6) Connecting accident database with other related subsystems such as driver and vehicle databases and driver penalty database
- 7) Designing more report formats to be drawn from accident database, which can reflect the state of road
- 8) Training the police traffic department on the applications of current technologies in road safety
- 9) Because some accidents are not reported, the government can extend similar projects to enable the public contribute in accident reporting

From the forgoing, we realize that accurate accident data is an important resource in addressing road safety challenges. This research is not final and the following areas need more research.

- 1) There is need to do research on alternative positioning technologies such as GSM
- 2) Research needs to be done on the use of GIS analysis for mapping to complement use of external services such as Google maps
- 3) There is need for new ways of accident data coding for easier analysis
- 4) There is need for more research on data analytics, which will assist to extract sensible trends from the accident database when there is enough data available

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