

# Geographical Information System (GIS)-Based Analysis of Road Traffic Accident Blackspots in Federal Capital Territory (F.C.T)

Samaila Saleh

Department Of Civil Engineering, College of Engineering, Hassan Usman Katsina Polytechnic, Katsina, Nigeria  
Email: samailasaleh2003@yahoo.com

**Abstract**—The accident rates per vehicle in Nigeria are alarmingly high. The traffic condition in the city of Abuja is no different. The aim of this work is to develop road traffic accident information system, by centralizing the road traffic accident data and other related data on a GIS platform. This will be very useful for agencies (such as the Federal Road Safety Commission, the Nigeria Police and the Road Traffic Services) and other stakeholders (like Federal and State Governments including the Federal Capital Territory Administration etc) that are interested in developing means and works for eliminating or minimizing accidents on the roadways. The data used in this study were obtained from Federal Road Safety Commission, Nigeria Police and Road Traffic Services. In addition, primary data were obtained at location blackspots using GPS (Global Positioning System) device. The data obtained was entered and use to develop accident information system. Analysis and capability of the developed system was illustrated with numerical examples. Data retrieval and spatial analysis from attributes where shown. A total of 247 accidents occurred in the year 2010 of which 52 were fatal, 59 were serious and 98 were minor; claiming about 38 lives. Hence there is an urgent need to analyze the causes of accidents so as to minimize them. ArcGIS 9.3 Software was used for this work.

**Index Terms**—geographical information system (Gis), road traffic accident blackspots and federal capital territory

## I. INTRODUCTION

Accident data, collected for many years, serve as the ground base for programs designed to reduce the number of traffic accidents [1]. The traffic condition in the city of Abuja is no different. Since past few years, there is a steady and continuous growth of vehicles and in turn traffic. A total of 247 accidents occurred in the year 2010 of which 52 were fatal, 59 were serious and 98 were minor; claiming about 38 lives [2]. Hence there is an urgent need to analyze the causes of accidents so as to minimize them. These accident databases are usually in the form of record file system, which enabled an extensive amount of research to be undertaken using statistical methods. Geographic Information System (GIS)

has been identified as an excellent system for storing and managing these types of data and also as a potential tool for improving accident analysis process [3]. One of the reasons is that it provides an efficient system of linking a large number of databases and also provides a spatial referencing system for reporting output at different levels of aggregation.

The fundamental objective is to determine the factors that contribute to accidents at those spots and to take actions that will reduce crash frequency or severity. Determining such factors like roadway features and road user characteristics is usually done through a macroscopic study involving a large accident database [4]. However making inferences from a single site, solely based on historical data does not always yield consistent results, because accidents do not usually occur at the same specific location. They may be distributed over an area although they may be caused by factors in a specific location. Hence it is more appropriate to identify accident-prone areas, with a subset of locations having high number of accidents instead of accident spots. Death resulting from road traffic accidents in Nigeria is said to be about twenty five time that of great Britain and about twenty seven that of U.S.A [2]. Road Traffic Accident (RTAs) have far reaching social economic and environmental implication it has been revealed that Nigeria is losing huge revenue manpower resources and unfulfilled life through accident occurrences on our roads. Does this reason, research into causes and control of road traffic accident would be a matter of continuous interest until the 'menace' could be kept under control.

### A. GIS Technology

A Geographic Information System (GIS) is a computer system for capturing, storing, querying, analyzing and displaying geographic data [5]. GIS represents a new paradigm for the organization of the information and the design of information system, the essential aspect of which is the use of concept of location as the basis of structuring of information systems. Traffic accident analysis means to investigate the causes of accidents, to determine hazardous locations (Accident Prone Locations) and to determine to enhance road features, to evaluate traffic safety and enhancement.

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Benefits of using GIS in Traffic Accident Analysis GIS can easily represent accident and road accident based results using various tools like linear referencing, dynamic segmentation, and spatial analyst [6]. Moreover query can be easily performed, enhanced by graphical representation. Road characteristics, demographic and socio-economic data to enhance highway safety analysis can also be integrated into the analysis [7].

## II. AIM AND OBJECTIVES

The aim of this study is to identify accident-prone areas using GIS tools. Specifically this involves plotting individual accident spots, identifying accident-prone areas using GIS's spatial analysis tools, GIS tool capabilities will store, capture, query, analysis and display data.

The above aim was achieved with the following objectives:

- Digitization of the road map of the study area.
- Creating of database structure for the analysis.
- Generating data analysis map for given study area.
- Using ArcGis 9.3 of Environmental Systems Research Institute (ESRI).

## III. MATERIALS AND METHODS

### A. Data

The data used involve two sources i.e. primary and secondary data sources. The primary data source involves direct collection of information on the field, using GPS (Global Positioning System) and observations. The data collected from primary sources, therefore include: the geographic coordinates of some of the accident blackspots.

The secondary data source involves sourcing information from existing records. Such data includes traffic accident records for different road junctions in the city which were collected from Federal Road Safety Commission, Nigeria Police and Road Traffic Department of the Federal Capital City, Land Use Images, Topographical and Street Guide Maps of Abuja, which were collected, using Google Maps and Google Earth software.

The database was then structured in a format for implementation in a software environment, using the application of Arc GIS 9.3 for digitizing the topographical map and the images.

Similarly, Microsoft Words was used for writing reports in textual format and Arc GIS 9.3 with the network analysis extension was used for the building the database, processing of the maps and performing the analysis.

### B. Methodology

The following flow chart shows the methodology of the work.

## IV. DATA ANALYSIS AND DISCUSSION OF RESULTS

### A. Data Description

The data set used in this analysis include all the crashes on Abuja roads for the two year period of 2010 to 2011

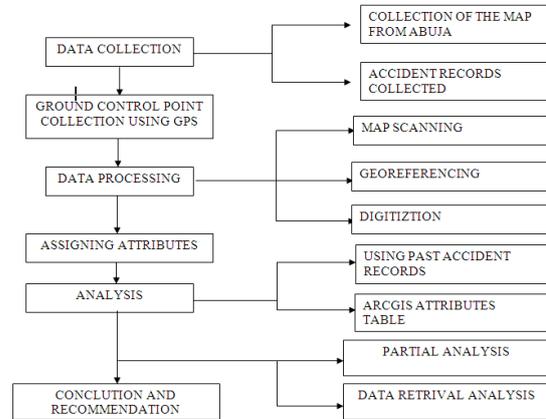


Figure 1. Flow chart for the methodology of the work

### B. Analysis of the Data Collected

Bar chart shows the number of traffic accident report per month for 2010.

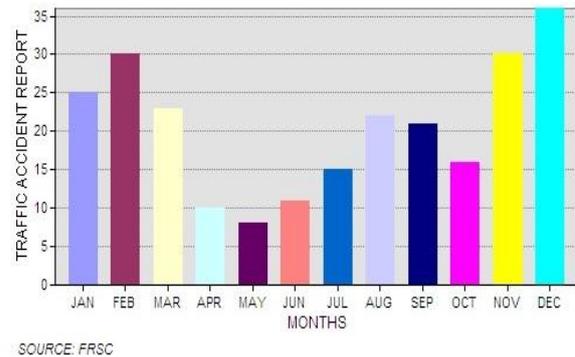


Figure 2. Traffic accident record (TAR) by Month

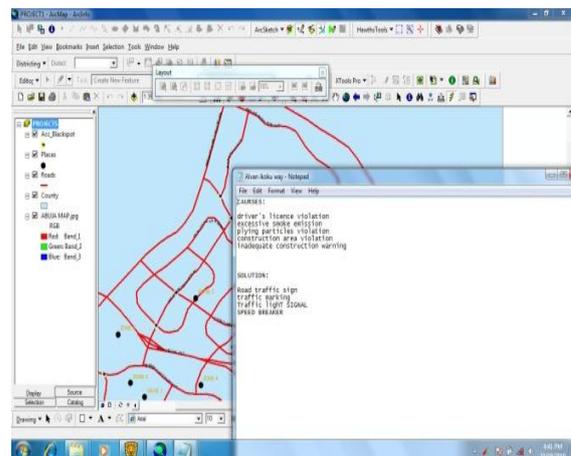


Figure 3. Screenshot of map of abuja show hyperlink

### C. GIS Maps Hyperlink Tool

This help to visualize the causes and the likely solution in very blackspots. The note pad that shows the causes

and likely solution are hyperlinked for each accident location. The “Hotlink” field in the accident location feature class stores the name of the image. All the features in the accident location layer with a valid hot link field value will be displayed in blue. When hyperlink tool for an accident location is clicked the linked note pad will displayed.

C. Querying Data in Arcmap (Identifying, Selecting, and Finding Features)

There are many ways to retrieve information about features in ArcMap™. The user can *identify* features by clicking on them in order to display their attributes. The user can *select* features by clicking on the features to highlight them and look at their records in the layer attribute table. The user can *find* features by using known information about the feature in order to search the map for that particular feature.

1) Identifying features

Perhaps the fastest way to get information about a single feature is to identify it, using the *Identify Tool*.

To use the *Identify* tool, the user must select it from the *Tools* Toolbar. Within the map, the user must click on the feature of interest in order to view the attribute information for that particular feature.

2) Selecting features

If the user wants to compare information about several features, the best way is to select the features on the map and look at their records in the layer attribute table. The easiest way to select multiple features is by using the *Select Features Tool* on the *Tools* Toolbar.

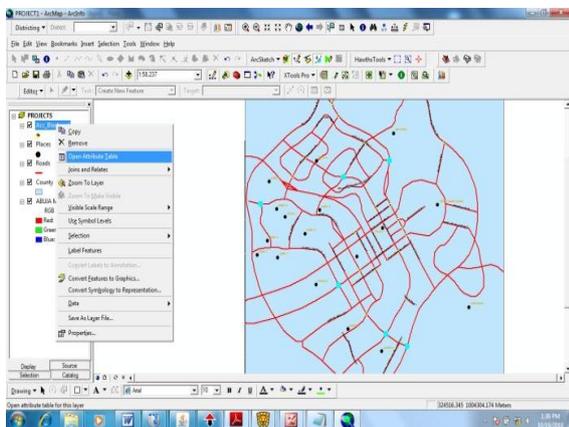


Figure 4. Screenshot of map of abuja show select features.

To use the *Select Features Tool*, the user must select it from the *Tools* Toolbar. On the map, all features of interest may be selected by holding down the *shift* key and clicking on the various features of interest. The selected features will be outlined in blue. If a feature is selected by mistake it can be de-selected by holding down the *shift* key and clicking the feature again. All features that have been selected can be cleared by clicking the *Selection* menu from the *Standard Toolbar* and selecting the *Clear Selected Features* option.

To view the selected features' attribute table, the user must right-click on the data layer where features have

been selected. The *Open Attribute Table* option should then be clicked.

After the *Open Attribute Table* option has been selected, the attribute table will appear with all of the selected features highlighted in blue.

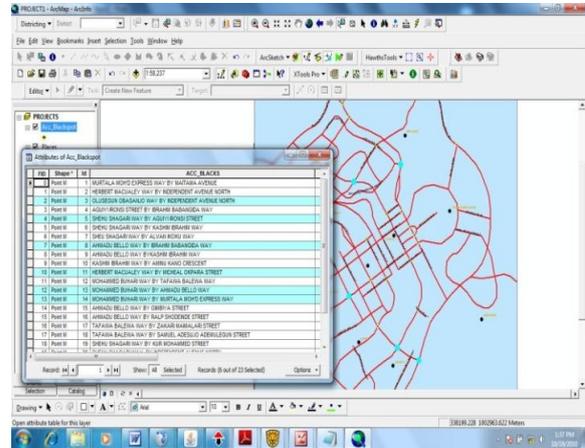


Figure 5. Screenshot of map of abuja show selected features

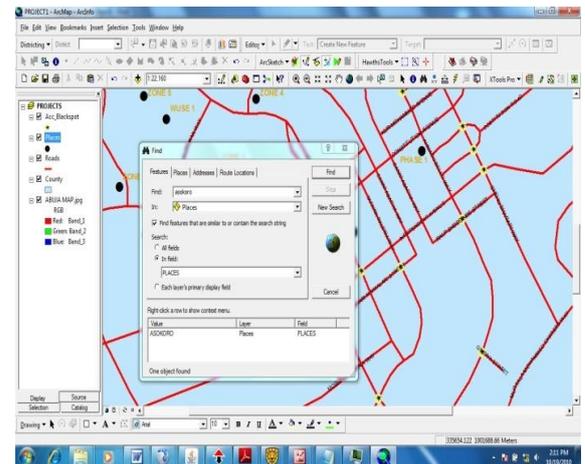


Figure 6. Screenshot of map of abuja show finding features

The user can group all of the selected attributes, by clicking on the *selected* button at the bottom of the attribute table. Only those features that were highlighted will appear.

Now the user can easily compare various attribute values, such as blackspot for each road junction. If the user wishes to see the selected features descending or ascending, the user can right click on the appropriate field name, and the *Sort ascending* option may be selected from the context menu.

3) Finding features

When the user has a piece of information about a feature, but is not sure where that feature is on the map, the user can search the map for that feature using the known piece of information.

The user can find a feature, by selecting the *Find* tool on the *Tools* toolbar. When the *Find* dialog Box appears, the *Features* tab should be selected. The known attribute information should be typed in the *Find* box. In the *In Layers* drop down box, the layer that the user wishes to

find features in should be selected. In the *Search* options, the user should choose to either search all fields in the attribute table or a specific field. Once all parameters are set, the *Find* button should be clicked.

In the following example, the place of asokoro was found in the Abuja, Place Data Layer by typing in the known attribute information (i.e. place = asokoro).

Once the *Find* button is clicked and the feature is found, the user can locate it on the map and get its attributes. This can be done when the user right clicks on the feature row found in the *Find* dialog box and clicks *Identify Feature(s)*. The feature will briefly flash within the map display and the *Identify Results* dialog box will open.

#### D. Selecting Features by Attributes

In addition to identifying, selecting, and finding features, the user can select features by attributes by writing a query that automatically selects features that meet specified criteria. The simplest type of query consists of an attribute (such as PLACE), a value (such as 'Asokoro'), and a relationship between the two (such as 'equal to'). A more complex query combines these simple queries using operators like 'and' / 'or'. These queries are constructed using *Structured Query Language (SQL)*. ArcMap creates the query automatically in this format.

To create an attribute query, the user must click the *Selection* menu on the *Standard* Toolbar. The *Select by Attributes* option should be clicked. In the *Select by Attributes* dialog box, the *Layer* drop down arrow should be clicked and the data layer of interest should be selected.

The fields in the attribute table appear in the *Fields* box on the left of the dialog box. When a particular field is highlighted, sample values display in the *unique* values list on the right. If the user wishes to see all of the attribute values, the *Complete List* button may be selected. The buttons in the middle are used to choose operators and to connect queries.

To perform a query, the user must double-click an attribute field of interest, in order for it to display in the bottom portion of the *Select by Attributes* dialog box. Then the user must click on the appropriate operator button. A unique value of interest may be double clicked on within the *Unique Values* box, or a value may be directly typed into the query string.

In the following example, all TAR were initially selected that had  $\geq 44$ .

Then, all TAR were selected that had  $\geq 44$  AND DAM  $\leq 33$ .

#### E. Selecting Features by Location

Instead of selecting features by their attribute values, the user may also select them by their location (their spatial relationship to other features, whether in another layer or in the same layer). To select features by location, the user specifies a selection method, a selection layer, a spatial relationship, a reference layer, and sometimes a distance buffer.

To begin selecting features by location, the user must click the *Selection* menu and click the *Select by Location* option. The *Select by Location* dialog box open

## V. CONCLUSION AND RECOMMENDATIONS

### A. Conclusion

This research gives an insight of the most accident prone area in the city. It can also facilitate spatial data sharing within transportation agencies and between transportation department and other government agencies. This study equally showed that GIS Technology is able to handle traffic accident analysis. Case study was carried out on Federal Capital Territory (F.C.T) Road. As the result is given graphical and map format, it is easy to interpret result. Many different data files can be interconnected to each other as shown in the study such as map, text file and graphic. The Geographic Information System is an effective tool to display different type of spatial accident distribution on digital road network. The use of GIS enables relevant accident data to be quickly processed and displayed on a map. GIS has also been used as a tool to identify hazardous locations on the junction depending on the historical road accident data. These in turn will help to improve the safety of road by advanced planning and maintenance of the so-called accident-prone areas.

### B. Recommendations

Since the main problem of traffic accident is the data collection, so it is very important to improving the method of collecting accident data and the ways of processing these data. The processed data could be linked to advanced systems of data analysis to produce regular reports to improve traffic safety.

It is recommended that the accident reports and accident database systems should be updated yearly.

The usefulness of an accurate and comprehensive system of collection and recording accident data cannot be over-emphasized. Such data serve to identify the basic causes of accidents and to suggest mean for overcoming the deficiencies that lead to such accidents.

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**Sama'ila Saleh** was born at Yargoje Katsina State Nigeria on 3rd May, 1979. I Studied B. Eng Civil Engineering at Bayero University Kano – Nigeria (2004), M. Sc. Civil Engineering at Ahmadu Bello University Zaria – Nigeria (2013). And M. Tech Geotechnical

Engineering at SRM University Chennai-India (Expected April 2015). He worked under Afdin Construction Company as CIVIL ENGINEER and under Job+Days Nig. Limited as a PROJECT ENGINEER. Presently under Hassan Usman Katsina Polytechnic – Nigeria as a LECTURER

Engr. Sama'ila Saleh is a corporate member of the Nigerian Society of Engineers, NSE, Nigerian Institute of Civil Engineers, NICE and a registered engineer by the Council for the Regulation of Engineering in Nigeria COREN. He is also a member of International Association of Computer Science and Information Technology (IACSIT).