

Observatory System for Monitoring Road Accidents in Nigeria

A thesis presented to the Department of Computer Science,

African University of Science and Technology

In partial fulfilment of the requirements for the degree of

MASTER of Computer Science.

By

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Abuja, Nigeria

November, 2017.

## **CERTIFICATION**

This is to certify that the thesis titled

*“Observatory System for Monitoring Road Accidents in Nigeria”*

submitted to the School of Postgraduate Studies,

African University of Science and Technology (AUST), Abuja, Nigeria

for the award of the Master's degree is a record of original research carried out by

Musa Muawiyya Modibbo in the *Department of Computer Science*.

Observatory System for Monitoring Road Accidents in Nigeria

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## **ABSTRACT**

Road Accidents are on the rise due to the high amount of migration from the rural area to the urban areas, Urbanization people are now finding it easier to own cars and use it for their day to day activities. Due to that reason the amount of Road Accident has also risen to all-time highs with estimate of 2000 deaths in four months around the country. Although we record such amounts of Accidents we are not able to learn from them and try to make changes with the same Roads claiming lives all the time. Thus, the need of an Observatory System, the system was developed to help in the data gathering process, storage, and visualization of the data to help in decision making and also knowing how to curb the menace of Road Accident.

## **DEDICATION**

I dedicate this piece of work to God Almighty for all His countless blessings upon my life and my family.

## **ACKNOWLEDGEMENT**

I would never have been able to finish my dissertation without the guidance of my supervisor Professor David Amos, help from friends, and support from my family.

I would like to express my deepest gratitude to my advisor, Mr. Roland Eteri, for his excellent guidance, caring, patience, and providing me with an excellent advice.

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## **LIST OF ABBREVIATIONS**

|       |                                       |
|-------|---------------------------------------|
| WHO   | World Health Organization             |
| CMS   | Content Management System             |
| RTA   | Road Transport Accident               |
| DBMS  | Database Management System            |
| DMZ   | Demilitarized Zone                    |
| HSM   | Hardware Security Module              |
| RDBMS | Relational Database Management System |
| FRSC  | Federal Road Safety Corps             |

## **Chapter One**

### **Introduction**

#### **1.1 Problem Statement**

Observatory System for Monitoring Road Accidents in Nigeria.

#### **1.2 Introduction**

What is a Road Traffic Accident? A lot of people would say that RTAs (Road Traffic Accidents) is when a vehicle or motorcycle collide with either a second vehicle or hits an individual, but Accident is far more than that, A road accident refers to any accident involving at least one road vehicle, occurring on a road open to public circulation, and in which at least one person is injured or killed. Intentional acts (murder, suicide) and natural disasters are excluded (National Institute of Statistics and Economic Studies, 2016). Road Traffic Accidents claim more than 1.2 million lives each year and have a huge impact on health and development they are among the major causes of deaths in young adults and children between the age of 15 – 29 years (World Health Organization, 2015).

A total amount of 35,092 people died in motor vehicle crashes in 2015, the United States Department of Transportation's most recent evaluation of the yearly financial fee of crashes was a \$242 billion dollars (Highway Loss Data Institute, 2015). According to a report by WHO, India is the foremost country in number of deaths in RTAs in the world ranking. According to data for 2007, 114,590 people died in India as an outcome of RTAs. The second place goes to china with 89,455 deaths RTA wounds are becoming rampant, their adverse consequences by far surpass results of both transmissible and non-communicable diseases (Aubakirova, Kossumov, & Igissinov, 2013). To date traffic accidents have developed into one of the major sources of injury, disability and mortality worldwide.

The Developing Countries tend to have more than developed 1<sup>st</sup> and 2<sup>nd</sup> world countries because they are far underdeveloped and control measures are not well in place, even if they are there the rate of corruption and lack of care has overshadowed the control measures. And it also affects the countries the worse as it reduces the major driving force of the economic population where men are the general breadwinners. and have the highest frequency in mortality rates in RTAs, A studies have shown that males tend to have more accidents than women, due to the bad habits they associate themselves with while driving such as Speeding, Eating or Drinking, risky overtakes, not wearing on seat belts and so on (Highway Loss Data Institute, 2015).

The cost of accidents between the developed countries and underdeveloped and developing countries on the GDP is also different a Conservative estimate pegs the cost of accident on GDP of the Developed Countries at 1% on the other hand the developing countries are estimated at almost 5%. One mechanism for dropping demise from RTAs is the so termed “golden hour” and “diamond half an hour”, when vital medical care is provided to wounded in the first hour after an accident transpires and injury is sustained.

By now we must have noticed that RTAs are not limited to a single part of the world and the lives claimed by RTAs is not limited to a single range of population. RTAs also lead to injuries that are sometimes permanent leaving an individual forever disabled. Nigeria being one of the most populous country on the earth surface, in Quarter two of 2017 recorded 2,503 road crashes with speed violations as the major cause (Source, Bureau, Road, & Corps, 2017)

### **1.3 Research Objectives**

The Objective of this research is to build and implement an observatory system to monitor road accidents across Nigeria and be able to visualize the accidents, by their severity, locations, driver, vehicle type, casualty, and in some cases fatalities. Also, it would be used to monitor the cause of the accidents and how it would be addressed, the system can be used to take certain decisions when trying to improve the safety of the

roads and when building new roads and bridges. It would be a very good source of data gathering, as Nigeria lacks a system where road accidents and users are being managed if properly managed, the system can be used to know and keep the number of vehicles and drivers in the country whether they have been involved in an accident or not.

#### **1.4 Motivations**

The motivation of this topic is the lack of a much needed and comprehensive source of data and information about road accidents in Nigeria. Without this information, some critical decision cannot be implemented properly and be addressed. This research will be able to show the locations with highest frequency of accident in the country. Which would lead to more research on how to make the roads safer and with the latest technological advancement the system can be used as a data warehouse where predictive analysis can be done and mitigate that may occur even before they happen.

#### **1.5 Research Methodology**

For this research Drupal content management system will be used to implement the web interface and source of information. Drupal is used because of its rich content, it is secured and open sourced, it has also been used for numerous website and information system and it is reliable, it is also free making it cost efficient, Drupal has a lot of modules which are also free and easy to use, it is managed by a large user base, and has security patches updated regularly making it very resilient to attacks. For the Database, a RDBMS (Relational Database Model) will be adopted and used with MySQL as the Database engine. I will also use jmerise as my tool to draw out the Diagrams and classes for the Database tables and Database as well.

#### **1.6 Expected Result**

The online collection and processing of road traffic data and accidents record will be among the expected result also a robust source of information would be gotten that will be used, by the agencies concerned and parastatals that might need correct and up to date information about road accidents. The system can be expanded with sensors to

be able to immediately report to all the emergency agencies like NEMA (National Emergency Management Agency), FRSC (Federal Road Safety Commission), and Nearby hospitals with standby ambulance when an accident occurs. The information system will also generate infographics for visualization purposes.

## **Chapter 2**

### **Literature Review**

#### **2.1 Introduction**

In this section a critical study and review was performed on Observatory System, Information systems, Drupal Content Management System, MySql Database and other related research work from journals, articles, related project and other sources that have made contributions to the study of the subject in question. This study was done with the aim of providing an in-depth understanding of the topic, its importance, characteristics, problems and composite features of the system from the subject study.

The study of scholarly work related to project management and planning was done to facilitate and aid in gaining understanding of the subject matter from the basic to the thorough level which will eventually help in streamlining the development of the affected system. This study will help in outlining the project needs and where to focus on.

#### **2.2 Data Collection**

Data Collection is the process of gathering and measuring information on targeted variables in An established systematic fashion, which then enables one to answer relevant questions and evaluate outcomes.(Sapsford & Jupp, n.d.)

Data collection has been around for as long as people found the need of storing information about some certain things or finding solutions to a certain problem, people have used questionnaires to collect data and store the given data also asking a trusted person's opinion is a form of data collection or the use of quantitative methods, all the above mentioned have been implored by people of various fields to source for data and make decisions based on the data they have gathered. Previously the major method in collecting data was the use of Questionnaires which is still used in so many places but

the problem with Questionnaires is, how easy they can be tampered with and also lost. In some other occasions people find it hard to fill a Questionnaire because of the amount of time spent filling it or the data required is not connected to the situation that needs to be addressed, also redundant data might be collected or invalid data thus making the whole process void. In a data collection process the major problem is finding the right problem to be addressed, where in the case of this project the problem that its addressing is the automation, collection and visualization of all aspects of an accident in the country.

The method of Data Collection in this regard will be the use of Online forms found on the information system to be created and will be saved directly to the database for future use and references. Charts will be drawn so that the decision-making process will be simplified and any decision taken will be justified with data as proof. There are so many examples of existing digitized data collection some as surveys we might feel online for visiting a site. Or as simple as registering on a website the owner of the website can check what content the Users used most and what page they visit, thus making changes to generate more traffic on the website. After seeing what Data Collection is we would move ahead to see the need of a Decision Support System and how it can be applied here.

### 2.3 Decision Support System

Just like how Data collection has been shown to be a very key player for a long time in our lives, Decision Support Systems(DSS) have been in existence since the advent of computers and have aided us in making critical and correct decisions. DSS are created to help people make decisions by providing them information and analysis tools, DSS is a to model data and make quality decisions based upon it (Faculty, Science, & Management, n.d.).

DSS is naturally constructed to back the solution of a certain problem or to assess an opportunity, it uses an interactive, flexible, adaptable computer based information system especially developed for supporting the solution, It uses data provides an easy

to use interface and sometimes incorporate the decision maker's insight. It supports all the phases of Decision making it can be used by a single user or on the web where it can be accessed by so many users at different locations.

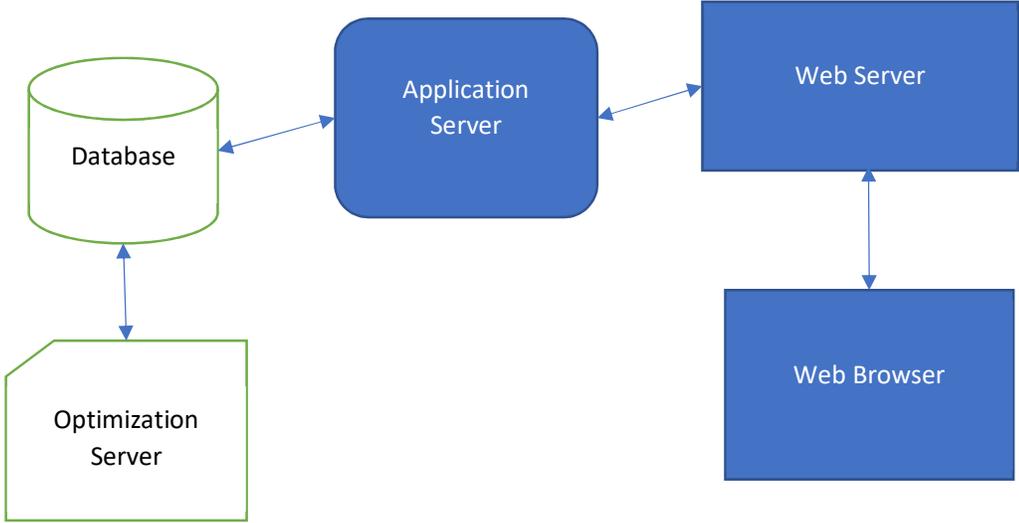


Figure 1 Structure of Web Based Decision Support System

From the above figure we can deduce that for a DSS to be implemented and work a Database server needs to be put in place to store and collect the data an application server to communicate between the web server and the Database server and a Web Browser to view the data by different users in separate locations.

While many people think of decision support as a specialized part of business, most comp-anies have actually integrated the system into their day to day activities. Many companies constantly download and analyze sales data, budget sheets and forecasts and the update their strategy once they analyze the current results (Faculty et al., n.d.).DSS can be categorized into different sections and each has a different method of implementation, here are the categories of the decision support system and their definitions.

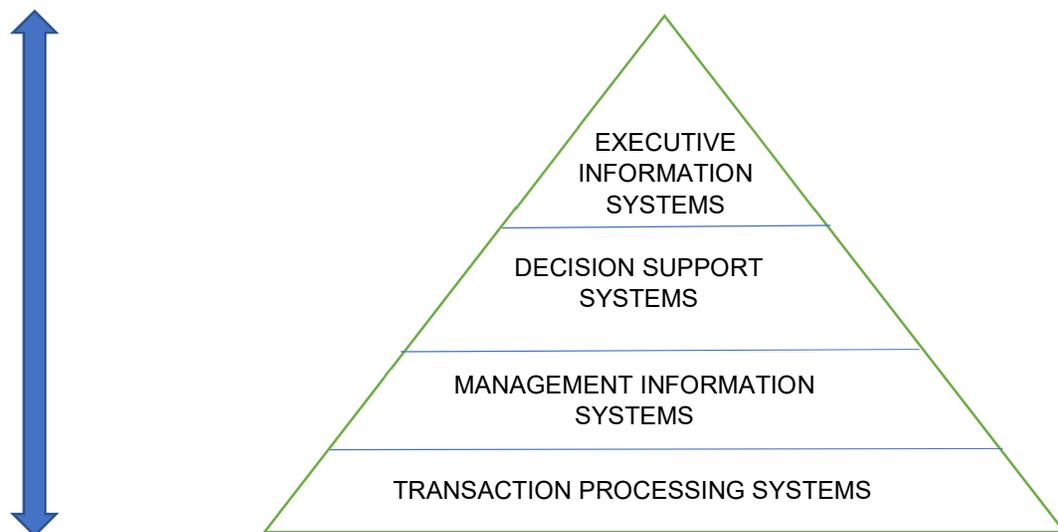
| <b>DSS TYPE</b>             | <b>Explanation</b>   |
|-----------------------------|--|
| <b>Communication Driven</b> | Includes how computer, collaboration and communication technologies supports groups in tasks.      |
| <b>Data driven DSS</b>      | Information collected in the database is manipulated to fit the maker's needs.                     |
| <b>Document driven DSS</b>  | Data are gathered from different sources on the web pages and find specific keywords and searches. |
| <b>Knowledge driven DSS</b> | Data mining and management Elastic Search applications are used all artificial intelligence based. |
| <b>Model driven DSS</b>     | They are complex systems that help analyze decisions or choose between different options.          |

*Table 1 Decision Support Systems Classification*

Decision Support Systems are very valuable in situations in which the amount of available information is prohibitive for the intuition of an unaided human decision maker and in which precision and optimality are of great importance. As we have seen the use of DSS will continue to grow in so many areas as emerging technologies continue moving forward to find perfection. In a world where everything is automated and user feedback is useful it will be of great help if DSS are incorporated into our technologies. A DSS always works together with an Information System which will be the next point of discussion.

## 2.4 INFORMATION SYSTEM

What is an Information System? When asked a question like this an average answer will be a system that stores and keeps information, but as we are going to see Information Systems are far more than that. Information System is the study of systems with a specific reference to information and the complementary networks of hardware and software that people and organizations use to collect, filter, process create and also distribute data, an emphasis is placed on an information system having a definite boundary, users, processors, storage, inputs, outputs and aforementioned communication networks (Marc S. Silver, 1995). Information systems found in the 1980's textbooks was a pyramid of systems that reflected the hierarchy of the organization, although the pyramid model remains useful since it was formulated a lot of technologies have been developed and new categories of information systems have emerged.



*Figure 2 Classic Classification of Information System*

Example of the new developed Information systems are:

- Expert Systems
- Enterprise Resource Planning
- Geographic Information Systems (GIS)

- Enterprise Systems
- Global Information System

This Information Systems mentioned above are used in various aspects of our lives and help ease the work done. A computer based information systems uses computers when carrying out some of its tasks, the major components of an Information System are.

| <b>COMPONENTS</b> | <b>USE</b>   |
|-------------------|--|
| <b>Hardware</b>   | These are the devices like the monitor, mouse, keyboard which help in collecting and processing Data |
| <b>Software</b>   | Helps the Hardware in processing the received information.   |
| <b>Databases</b>  | Is where all the data collected are stored either in structured or unstructured format for use       |
| <b>Network</b>    | Connects the Computers with other computers to allow diverse distribution of data.                   |
| <b>Procedures</b> | Commands for the above-mentioned components to produce preferred results.                            |

*Table 2 Components of Information System*

Information System Development and application of Information Technology in organizations has a series of processes to develop and use an IS, depending on the choice of the developer the use of software engineering techniques is employed, techniques such as the Waterfall model, V- Shaped Model, Iterative Model, Spiral Model,

Big Bang Model and Agile Model. Each of these techniques has its own strengths and weaknesses and depends on the type of Information System developed the model of choice can play a big role.

## 2.5 CONTENT MANAGEMENT SYSTEM

In this section I will introduce you to the concept of Content Management System and how important it is, the uses of CMS the strength and also the weaknesses of this systems.

Content Management System or CMS in short is a computer application that provisions construction and alteration of digital content, CMS include web-based publishing presentation management, history editing and version control, indexing, exploration and recovery. A web CMS is intended to support the management of the content web pages. Most popular CMS include text and embedded graphics, photos, videos, audios, maps, and program code for Applications that displays content and interact with the user.

A CMS has two main components:

- A CMA (Content Management Application) it is the aspect of the system that allows a user even with little expertise on web building and administration to be able to publish, add, remove and modify the content of the page.
- A CDA (Content Delivery Application) it compiles all that the user have done and uses it to modify the website accordingly.

Another type of CMS is the Digital asset management systems they help in managing things such as documents, movies, pictures and so many other things.

The Advantages of Using a CMS are:

- Reduce need to code from beginning
- The ability to add your own personal look and feel to a website

- Permission management
- Version control
- Faster Development
- The ability to leverage excellent third-party plugins.

Disadvantages of Using CMS:

- Increased need for special expertise and training for content authors
- A user cannot create a functionality that is not envisioned in the CMS
- If incorrectly used by the client it can break the site

## **2.6 DRUPAL CONTENT MANAGEMENT SYSTEM**

There are numerous existing CMS but the most popular ones are WordPress, Drupal and Joomla. For this project I used Drupal as the CMS of choice because of so many factors that will be mentioned in the coming lines.

Drupal is an open source free content management framework which was developed using the PHP scripting language and distributed under the GNU General Public License. Drupal is among the leading platforms for web content Management among Global Enterprises, Businesses, schools and even Government Organization making it cross so many branches of the various types of Website from Blogs to High End websites used for E-Commerce (W3Techs, 2011). Although Drupal offers a sophisticated API (Application Programming Interface) for developers, basic Web-site installation and administration of the framework require no prior programming skills.

Interest in Drupal increased in 2003 when it helped build "DeanSpace" a website for Howard Dean a candidate of the Democratic party in the United States presidential primary campaign for the 2004 elections. DeanSpace used open source sharing of Drupal to support a decentralized network of approximately 50 disparate, unofficial pro-Dean websites that allowed users to communicate with one another. As of the year 2014

Drupal was being developed by a community and its popularity growing rapidly from July 2007 to June 2008 the drupal.org site provided more than 1.4 million download of Drupal software an increase of approximately 125% from the previous year (*Buytaert.net*, n.d.). As of January 2017, the amounts of sites using Drupal was approximately 1,180,000, this includes hundreds of well-known organizations, including corporations, media and publishing companies, Governments, non-profits, schools and individuals Drupal has won several open source awards and won the Webware three times in a row (“OSS CMS Award Previous Winners,” n.d.).

Drupal is robust as it runs on any computing platform that supports web servers that can run PHP and a database to store content and configuration. Drupal has a lot of modules which are used to augment and extend the the functionality of a website, Drupal has also been able to incorporate 100 different languages and English as default, it also has right to left language support such as Arabic, Hebrew, and Persian.

The security of Drupal sites is very high as there are users working on developing patches as soon as a problem arises, thus making it very secured. As soon as there is a patch available Drupal sends a notification to all its users to update their systems for the patch to take action.

With all the above mentioned uses and efficiency of Drupal it still has some problems, such as the Usability for new administrators it was hard to understand and work around the site, The learning curve for Drupal is also very high, It is also difficult for unit testing Drupal 7 doesn't follow MVC (Model View Controller) framework and store all of its configurations to Database and as a result touching the code without going to the database is not possible.

Some Benefits and features of Drupal are:

| Feature/Benefit                        | Summary   |
|--|---|
| <b>Highly Scalable</b>                 | Drupal's scalability means it can manage the largest, most high-traffic sites in the world.   |
| <b>Mobile First</b>                    | Drupal also create web applications that deliver optimal visitor experiences, no matter what device they're on.   |
| <b>Integrated Digital Applications</b> | Drupal integrates easily with a wide ecosystem of digital marketing technology and other business applications, so you can use the best set of tools today, and flex with new tools tomorrow. |
| <b>Security</b>                        | Drupal's community provide countless eyes and ears to help keep Drupal sites secure.  |
| <b>Easy Content Authoring</b>          | Essential tools for content creation and publishing, like a customizable WYSIWYG editor for content and marketing pros.   |
|  |   |

*Table 3 Benefits and Features of Drupal*

| Benefits/Features                    | Summary   |
|--------------------------------------|---|
| <b>Multilingual</b>                  | Drupal makes it easy to create and manage sites for different regions and geographies, and support one to many languages. |
| <b>Flexible Content Architecture</b> | Create the right content architecture using the Admin Interface or do it programmatically.                                |

*Table 4 Continuation of benefits*

## 2.7 WHAT IS MYSQL DATABASE?

For us to talk about MySQL database it is right I first introduce what a Database is then a Database Management System and then RDBMS (Relational Database Management System) Each of the above mentioned all need to be in existence for the MySQL.

### 2.7.1 What is a Database?

A database is defined as a usually large collection of data organized especially for rapid search and retrieval (Merriam-Webster Dictionary, 1828). A database refers to a set of related data and the way it is organized access to a database is done by the use of a Database Management System(DBMS). Databases are used to support internal operations of organizations and to underpin online interactions with customer and suppliers. They are also used to hold administrative information and more specialized data, such as engineering data or economic models Examples of database applications include computerized library systems, flight reservation systems, computerized parts inventory systems, and many content management systems that store websites as collections of webpages in a database.

## 2.7.2 What is Database Management System?

A database management system or DBMS is essentially a computerized data-keeping (IBM, 1990). Users of the system are given facilities to perform several kinds of operations on such a system for either manipulating data in the database or the management of the database structure itself. A Database Management System(DBMS) is a single or set of computer programs that are responsible for creating, editing, deleting and generally maintaining a database or collection of records (S. R. Obbayi, 2017). There are four main types of DBMS and a database model determines the way data is stored in them. They are namely: 1) Relational Database Management System 2) Flat File Based Database Management Systems 3) Hierarchical Database Management System 4) Network Database Management System 5) Object-Oriented Database Management System.

- 1) Hierarchical Databases: - In a hierarchical database records contain information about the groups of parent/child relationships just like a tree structure.

### Advantages

Hierarchical database can be accessed and updated rapidly because in this model structure it is like a tree and the relationships between records are defined in advance.

### Disadvantage

This type of database structure is that each child in the tree may have only one parent and relationships or linkages between children are not permitted.

- 2) Network Database: - The network databases are mainly used on large digital computers. The connections can be made between different types of data.
- 3) Object-oriented Model: - In this Model we have to discuss the functionality of the object-oriented Programming. It takes more than storage of programming language objects. Object DBMS's increase the semantics of the C++ and Java. It provides full-featured database programming capability, while containing native

language compatibility. It adds the database functionality to object programming languages.

#### Disadvantages

- Object-oriented Databases are more expensive to develop.
- Most organizations are unwilling to abandon and convert from there databases.

### **2.8 Relational Database Management System(RDBMS)**

RDBMS are the most widely used database management systems today. They are relatively easy to use, Relational database management systems are named so because of the characteristics of normalizing the data which is usually stored in tables. The relationship between data files is relational, hierarchical and network database management systems require the user to pass a hierarchy in order to access needed data, but in relational databases connect data in different files by using common values known as keys, Data stored in relational database are have a unique Identifier for a set of records which is known as primary key, A primary key cannot be generated twice it must be unique to that record. When a record is needed in another table the primary key is used but in the new table it would be called a foreign key. In relational databases data can be changed without affecting the whole table.

#### Properties of a Relational Database

- Its values are atomic
- Each row is unique
- All column values share the same datatype
- Each column has a name
- Each record has an Identifier

Relational database management systems include Oracle, MsSQL Server, IBM DB2, MySQL, SQLite and PostgreSQL among others.

Now back to the question What is MySQL, MySQL is an open source relational database management system based on Structured Query Language. MySQL works on many system platforms, including AIX, BSDi, FreeBSD, HP-UX, eComStation, i5/OS, IRIX, Linux, macOS, Microsoft Windows, NetBSD, Novell NetWare, OpenBSD, OpenSolaris, OS/2 Warp, QNX, Oracle Solaris, Symbian, SunOS, SCO OpenServer, SCO UnixWare, Sanos and Tru64. A port of MySQL to OpenVMS also exists. MySQL can be built and installed manually from source code but it is more commonly installed from a binary package unless special customizations are needed. MySQL has a lot of User interfaces that can be used when working with it example such as, MySQL Workbench, Adminer, Database Workbench, PHPMysqlAdmin and a lot more.

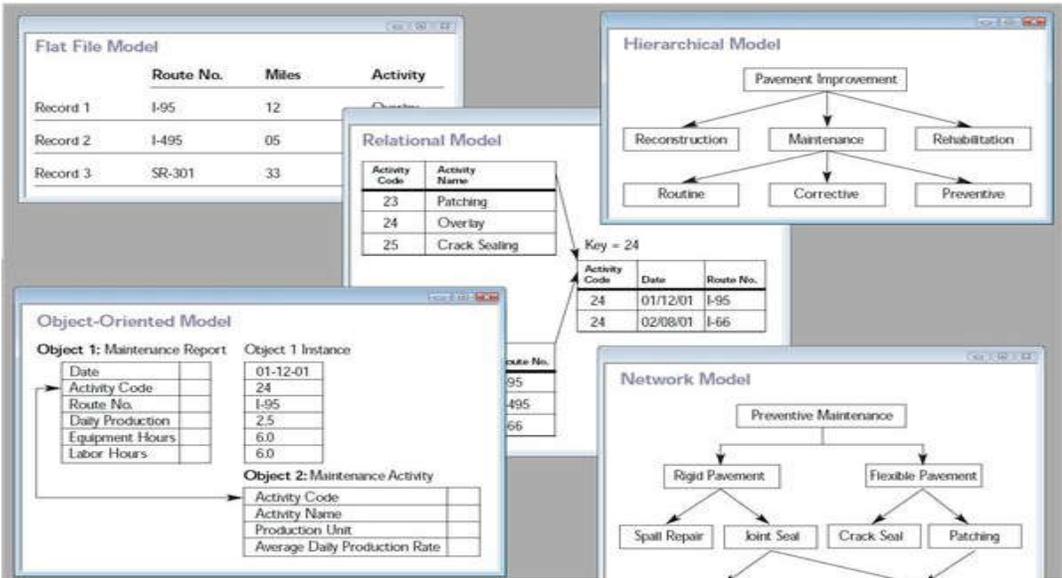


Figure 3 . A pictorial view of all the types of Database Management System

**2.9 Related Work**

There currently is no working software for managing, registering and visualization of road accidents in Nigeria, but there have been Research works related to this topic. Such as Road Accident View (RAV) from Malaysia.

### 2.9.1 Road Accident Views(S, 2000)

Is a proposed solution to Road accidents using a Geographical Information System and Microcomputer Accident Analysis Package in Malaysia.

After going through the work it is noteworthy to notice that the system doesn't store all the data needed on Accident as the owner of the paper was more concerned to zoning and having a GIS view of the Accident site.

### 2.9.2 Dutch Injury Surveillance System (Horan & Mallonee, 2003)

The Dutch Injury Surveillance System provides a basis for priority-setting in injury control in the Netherlands, for obtaining information on the direct medical costs of injury, and for identifying research priorities

### 2.9.3 **Fatal Injury Surveillance System (WHO & Monash University, 2012)**

Surveillance involves keeping records on individual cases, assembling information from those records, and analyzing and interpreting this information. The output from a surveillance system is intended to help users respond to the problem under surveillance by developing new – or improving existing – policies and strategies for prevention or intervention.

### 2.9.2 **Conclusion**

The advancement in Computer Science and Information Technology has helped across all aspect of human activities including the road accident management sections which is basically utilized to simplify performing activities that results in enjoying all the benefits that comes along. This led to the automation of several functions, from the Data gathering to the point of visualization and Decision Support on how to reduce the mortality on our roads.

## **Chapter 3**

### **METHODOLOGY**

#### **3.1 System Analysis**

This involved assessing the need for the system and possibilities of its implementation; I have also undertaken detailed analysis of the current system to understand more about the processes, information flows and work organization (Functional hierarchy).

It is a technique that once I applied, was able to decompose the proposed system into component pieces for the purpose of the studying how well those component parts work and interact with one another and so I can accomplish the main purpose. Systems analysis at the end is synthesis "and the goal of the proposed system is to create systems that can fix the problem of the current system and achieve the ultimate goal which is the registration, storing, visualization and monitoring road accidents in an efficient way".

Hence, Analysis and synthesis, as scientific methods, always go hand in hand; they complement one another. Every synthesis is built upon the results of a preceding analysis, and every analysis requires a subsequent synthesis in order to verify and correct its results. In system analysis, the requirements was determined and considered based upon the study which includes both functional and non-functional requirements.

##### **3.1.1 System Design**

This was achieved using modeling tools and techniques to model both the process and the data that make up the system. The System design phase is generally into two sub phases, top-level and detailed design.

Top-level: focused on identification of the major System component and their functions. In the top-level, numbers of alternative System design concept are synthesized and evaluated in terms of variety of selection criteria, which include cost

(implementation operation and maintenance), performance, satisfaction of requirements, development risk, flexibility for expansion/upgrading and political acceptability.

Detail design: was basically, specifying all of the System components and function in detail in the detailed design phase, decision was made concerning what were the element collected, how they were collected, how frequently they were collected, and at what level of detail they were aggregated.

### **3.1.2 Data Modeling**

Data modeling was used to model Entity Relationship Diagram (ERD) which always provided the graphical representation of all the data has been stored in the system, the data flow between the entities and their relationships. It served as the means of visualizing how the information the system produced were inter-related. The ERD however showed the data requirements and model, which yielded the structure of relations in the relational schema (database).

### **3.2 System Implementation**

In this phase, reporting the results, putting the result to use, recording the findings and documenting the model and the interaction between model components; It showed the physical realization of the system's back-end (database to store the data) and the front-end (in the form of web pages) which was the composition of logic to process the data in the database. The phase was involved in the implementation or creation of both the database and pages. The system implementation was accomplished by the use of data definition language (DDL), Data Manipulation language (DML) and data retrieval language (DRL), of the selected database management system (DBMS). I designed the interfaces of web-pages from Drupal, and coding of the pages to perform the required functionality.

### 3.3 Implementation Tools

The implementation cannot be fully achieved without the use of tools. The tools we used to accomplish these tasks are;

**MySQL:** is an open source Relational Database Management System (RDBMS) that uses Structured Query Language (SQL), the most popular language for adding, accessing, and processing data in a database. MySQL was used as a database management system to implement the backend of the system.

**PHP:** Hypertext Preprocessor is an open source server-side programming language that was extensively used in creating web scripts. It is a popular server-side scripting language designed specifically for integration with HTML/XHTML, and is used (often in conjunction with MySQL for database access) in Content Management Systems and other web applications.

**HTML/XHTML:** referring to Hypertext Markup Language or Extended Hypertext Markup Language is the predominant markup language for web pages. It provided the means to describe the structure of text-based information in a document by denoting certain text as links, headings, paragraphs, lists, among others and to supplement that text with interactive forms, embedded images, and other objects of the system.

**CSS:** stands for Cascading Style Sheets which is a style sheet language used for describing the look and formatting of a document written in a markup language. While most often used to style web pages and user interfaces written in HTML and XHTML. The language can be applied to any kind of XML document.

**DATANAMIC DATA GENERATION TOOL:** The acquiring of data was not fruitful as the parastatals involved didn't want to share sensitive information to students, and people without a security clearance from the Government, so the need for a tool to generate test data was needed. Datanamic was a very efficient Data Generation tool as it was able to

generate data that was used in the project but some aspects of the data was still generated manually because of the limitations of Datanamic.

### **3.4 System Study**

Based on the information gathered during the background reading and activities of the current system; the current system has some problems which I have taken into consideration to change and improve in the new system in process of development. Hence, I consulted some of the key stakeholders in order to understand the problems faced in the current system and the amendment made in the proposed system; stakeholders include:

- 1) FRSC Officers
- 2) Police
- 3) Drivers

### **3.5 Data analysis**

Responses collected from the interview verified that people affected by the system were dissatisfied and expressed lack confidence, hoping that the proposed system as anticipated can cover all problems and ramification of the current system.

#### **3.5.1 User Requirements**

These include the functionalities under the different constraints that the proposed system should provide, according to the demands of all users.

From the system study, stakeholders were identified.

##### **a) FRSC Administrator**

- i) Able to register new officers
- ii) Able to register Accident
- iii) Register volunteer workers

- iv) View registered Accidents
- v) View visualization of the records

**b) FRSC Road Officer**

- I. Register new Accidents.
- II. View Accident History.
- III. View visualization of the records.

**3.5.2 Functional Requirements**

These include the services that the proposed system has to provide to the entire system users. The system will perform the following functionalities:

- I. To register Accidents.
- II. Register Officers.
- III. Store Officers Details.
- IV. View Accidents.
- V. Add More functionality to the Database.
- VI. Provide views on all stored records.

**3.5.3 Non-Functional Requirements**

These are constraints that should be imposed on the services provided by the proposed system. The system was designed to fulfill the following non-functional requirements.

- i. System should be complete and consistent that is, able to deal with all the possible outcomes during its operation.
- ii. System should be robust that is, able to run on the specified platforms with no predictable failure.

- iii. System should be able to sustain the heavy load offered to it due to network requests (provide high performance in all situations).
- iv. System should operate efficiently under the TCP/IP protocol suite. By deploying TCP/IP to handle data communication between ends, the TCP manages the flow of datagram from the higher layers, as well as incoming datagram from the IP layer. It ensures that priorities and security are respected. While the Internet Protocol IP, as the primary protocol in the Internet layer of the Internet protocol suite, took task of delivering packets from the source host to the destination host solely based on the IP addresses in the packet headers.
- v. All its operations should be correct, that is, should produce expected results when supplied with the right inputs.
- vi. System should be reliable, up and running every time, its operations are needed.
- vii. System should verify/validate all user input and users must be notified in case of errors.
- viii. The system should only allow system administrators to delete records.
- ix. The system should be extensible.

### **3.6 System Design**

This section described the system design that includes process modeling i.e.; logical database design

#### **3.6.1 Data Modeling**

This was done by identifying data requirements for the new system database, identification of entities and their attributes making up the system and relationships between these entities. An Entity Relationship Diagram (ERD) was derived from the system analysis.

### 3.6.2 Data Requirements

The data requirements below were used to derive the entities for the Observatory and monitoring system database.

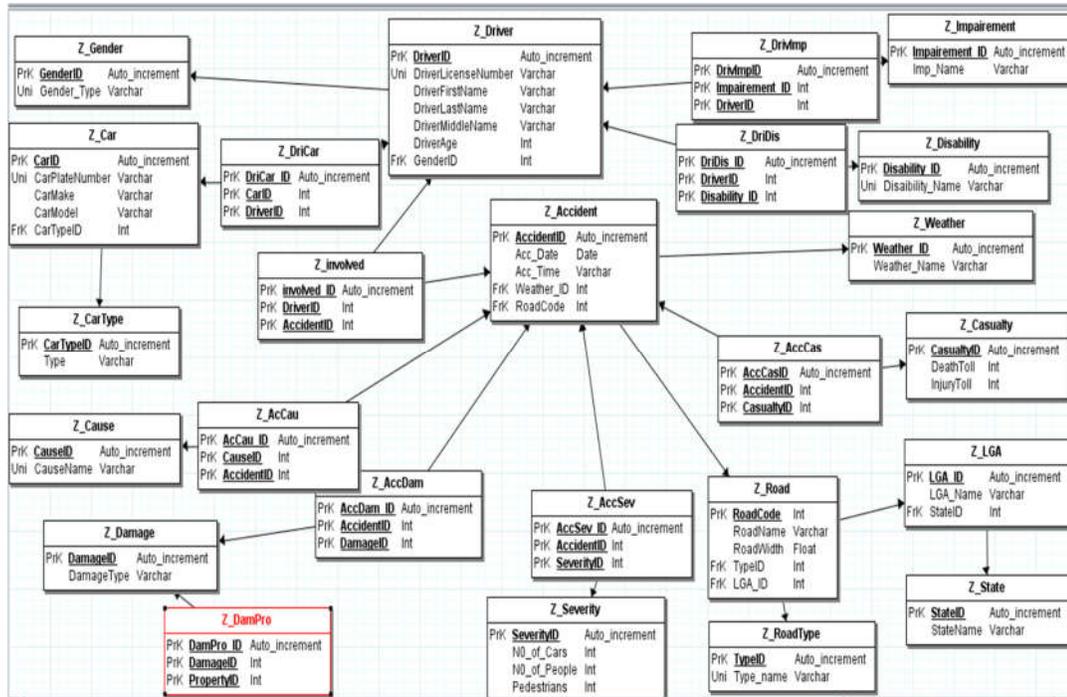


Figure 4 . Entity Diagrams with their Relationships

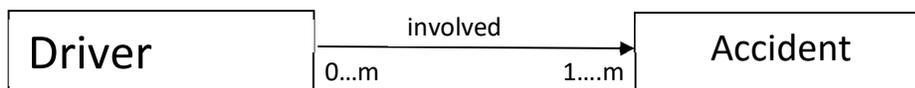
1. **Driver:** This entity represents the Driver of a vehicle, it is a very fundamental entity which is needed in every accident scene. The attribute details are Driver Id, Driver\_License\_Number, First name, Last name, Middle name, Age, GenderID as a foreign key of Gender table.
2. **Accident:** This entity represents the Accident description. The attributes are Accident ID, Accident date, Accident Time, Weather from the Weather Table and Roadcode from Road Table.

3. **Severity:** It depicts how severe the accident was by checking the number of people involved and also the pedestrians involved. the attributes **severity id**, No of cars, No of People, Pedestrians.
4. **Property:** Because we want to capture the whole scene of an accident we need this entity to know what was damaged by the accident. The attribute of the entity Property are **PropertyID**, property Name.
5. **Road Entity:** This entity keeps the data on the road on which the accident occurred this will help when data is needed or a decision is needed on why there is so many accidents on a particular road. The attribute of the entity field workers are **RoadCode**, Road Name, Road Width, LGA\_ID as a foreign key from LGA entity and TypeID as a foreign key from Road Type Table.
6. **Road Type:** This helps keep all the types of road we have and maybe add more if need be such as Dual ways, and Highways. The attributes of this entity are **TypeID** and Type Name which is a unique key.
7. **State:** This entity keeps all the states in Nigeria data so we know which state Accident occurred or occur the must. The attribute of this entity are **StateID**, stateName.
8. **LGA:** This is the entity for the local governments Area in Nigeria which also help in storing data on locations of accidents. The attributes foun in this table are **LGA\_ID**, LGA\_Name.
9. **Casualty:** This entity stores the type of casualties in an accident. The attributes are **CasualtyID**, Death toll and Injury toll.
10. **Weather:** This entity registers the type of weather that the accident occurred in and with this we can deduce what weather cause accident the most.
11. **Disability:** Nowadays people who have some disabilities can still drive maybe having a bad foot or may be leg, So if a Driver has a disability it will also be noteworthy. The attributes of this entity are **Disability\_ID and** Disability Name.

- 12. Impairment:** Some Drivers have some impairments that might lead them to have Accident this entity registers new impairments that can affect a driver. Attributes **ImpairmentID** and **Impairment Name**
- 13. Gender:** The Gender of a driver is stored and kept for data keeping. Attributes are **GenderID** and Gender Type.
- 14. Car:** The Car entity stores the data of all the cars involved in an accident and number of times a car was involved in an accident can be checked. Attributes are **CarID**, CarPlateNumber, CarMake, CarModel, CarTypeID as a foreign key from Car type table.
- 15. CarType:** The Car type entity registers the type of car we have in the country e.g truck, tankers and SUVs. Attribute are **CarTypeID** and Type.
- 16. Cause:** This entity checks the cause of an accident. Attributes **causeID** and CauseName.
- 17. Damage:** This entity is used to know the level of damage to a property that was as a result of an accident. Attributes are **DamageID** and DamageType.

### 3.6.3 Modeling relationship between entities

i) *Figure 5 Driver - Accident Relationship*



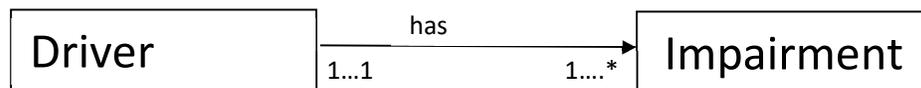
A Driver might be involved in one or more Accident and an Accident might have more than one Drivers involved.

ii) *Figure 6 Driver - Gender Relationship.*



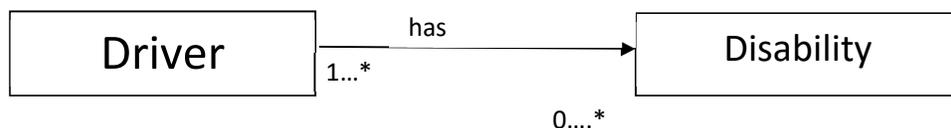
A Driver is of one and only one gender. But each Gender can be assigned to one or many supervisor.

iii) *Figure 7 Driver- Impairment Relationship.*



A Driver has one or many Impairments. And an Impairment belongs to one or many Drivers.

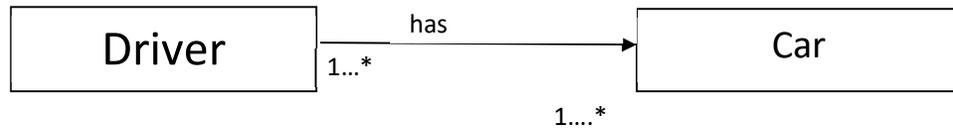
iv) *Figure 8 Driver - Disability Relationship*



A Driver has one or many Disabilities. And a Disability is can belong to 0 or many drivers.

Figure 9 Driver - Car Relationship

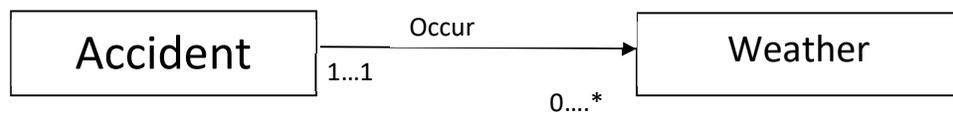
v)



A Driver has one or many Cars. And a Car can belong to 1 or many drivers.

Figure 10 Accident - Weather Relationship

vi)



An Accident can occur in One and Only one weather . And a weather can be associated to 0 or many Accidents.

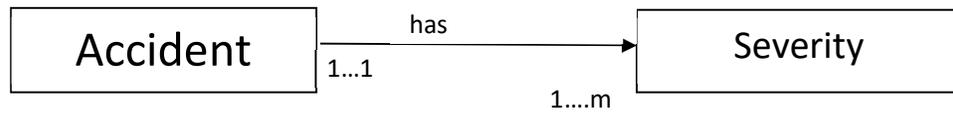
Figure 11 Accident - Weather Relationship

vii)



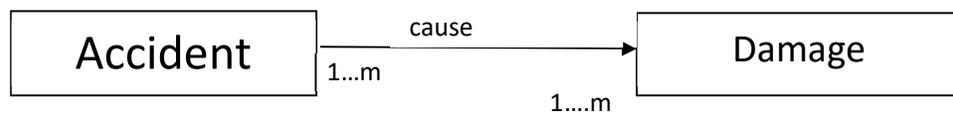
An Accident can have One or many Casualty . And casualties can be associated to 0 or many Accidents.

viii) *Figure 12 Accident -Severity*



An Accident can have One or many Severity level . And Severity can be associated to 1 or many Accidents.

ix) *Figure 13 Accident - Damage Relationship*



An Accident can cause One or many Damage to Property . And Damage can be associated to 1 or many Accidents.

This are some of the relationships found in the Entities. From this Section we can move forward to the Implementation Aspect. After all this were implemented we generated some results which will be shown in the next Chapter.

## Chapter Four

### Experimentation and Results

#### 4.1 Introduction

This chapter describes the implementation of the system as well as system testing. The implementation stage describes how the design of the Observatory system would be converted to a workable solution and installed in live working environment, while the system testing described the testing strategy that would ensure that the system is working effectively, and also to meet the user requirements.

The System was created and deployed on a live host system with a working server, the system was used to insert data and create users, also it gives anonymous users the opportunity to register. All registered users must be approved and assigned roles by the Administrator, without an Administrator to verify a user the user cannot access some parts of the pages. In this system the Major Administrator are the ICT staff from FRSC who will register and allocate roles to the users of the system, The Roles created are listed as follows;

- Road Officer
- Paramedics
- Senior Officers
- ICT (Administrator)
- Heads of Department concerned with the Management of Road Accidents and Users.
- Normal Users

**Anonymous User:** When anonymous users visit the website, they will be able to view the Dashboard of Accidents, that is the only view accessible to the anonymous users.

**Road Officer:** This are the people at the first point of contact on an accident scene, they can use their logged in pages to register New Accidents, Cars involved in an Accident, the Severity of the Accident, and also enter the Driver Details. These officers must be well trained on how to use the system and also be able to insert the required fields in capturing an accident scene.

**Paramedics:** This Users register the various ailments that might have caused the Driver to have an Accident, this phase would be registered after those involved in the accidents have been taken to the hospitals and have had tests performed on them, they are the second point of contact. Also, they will give valid reasons as to why the Driver can continue Driving or have his license seized so as to stop future occurrences and also reduce the risks of injuring other road users.

**Senior Officers:** The Senior Officers are the ones who make necessary decisions after analyzing the data they go through each record and see how it affects the users and make decisions based on those analysis.

**ICT(Administrator):** This are the technicians who work behind the screens to make sure that the system is always functional and accessible to all users of the system, they will handle the necessary updates and creation and approval of users, they also have the right to remove or block officers who have retired, resigned or have been sacked out of the system so as to protect the system from the vulnerability of disgruntled employees.

**Heads of Departments:** This are the most senior officers and users of the system the Senior Officers report to them and they take the decisions they have found useful to the senate for approval and to be passed into bill. They also have access to view the Pages and decide based on the analysis made.

## 4.2 Security of the System

This System contains private data of Drivers so allowing unknown users to bypass and gain access to the system is a very serious issue for that the system has to be fortified with a firewall, DMZ's (demilitarized zone) or Hardware Security Modules(HSM), with this in place. The network will be harder to breach making it hard for hackers to temper with the Data of the users and the Information stored in the system.

## 4.3 Maintenance of the system

Maintenance of the system can be taking care of by the ICT technicians but the update of software and deployment of more features of the system has to be done by a skilled technician with a good understanding of Computer Programming, Database Design and Web Development.

## 4.4 Sample code used in creating some of the functionalities of the system

Php Code for Creating a CarForm

```
<?php  
  
echo '  
  
<form method="post" action="" class="form-horizontal">  
  
<label for="Car" class="control-label col-sm-4"> <h3><u>Car  
Data</u></h3></label><br>  
  
<div class="form-group">  
  
<br>  
  
<label>Plate Number:</label>  
  
<input class="input" type="text" name="platenumber" value="" />  
  
<br >  
  
<label>Car Make:</label>
```

```

<input class="input" type="text" name="carmake" value="" /><br>

<label>Car Model:</label>

<input class="input" type="text" name="model" value="" /><br>

<label>CarTypeID:</label><br>

<select name="CarType" id="carid" ">;

    $result = db_query("SELECT * FROM {Z_CarType}");

    foreach($result as $record){

        echo'<option value="'.$record->CarTypeID.'">'.$record->Type.'</option>';

        };

    echo '

</select>

<br>

<div class="col-sm-offset-2 col-sm-10">

<br>

<input class="submit" type="submit" name="submit" value="Insert" />

</div>

</div>

</form>

';

if(isset($_POST['submit'])){

```

```

//Fetching variables of the form which travels in URL

if (isset($_POST['platenumber '])) {$platenumber = $_POST['CarPlateNumber'];}

if (isset($_POST['carmake '])) {$carmake = $_POST['CarMake'];}

if (isset($_POST['model '])) {$model = $_POST['CarModel'];}

if (isset($_POST['CarType '])) {$CarType = $_POST['CarTypeID'];}

    if($model != ""||$carmake != ""){

        //Insert Query of SQL

        $query = mysql_query("insert into Z_Car(CarPlateNumber, CarMake, CarModel,
CarTypeID) values ('$platenumber', '$carmake', '$model', '$CarType')");

        echo "<br/><br/><span>Data Inserted successfully...!!</span>";

    }

    else{

        echo "<p>Insertion Failed <br/> Some Fields are Blank....!!</p>";

    }

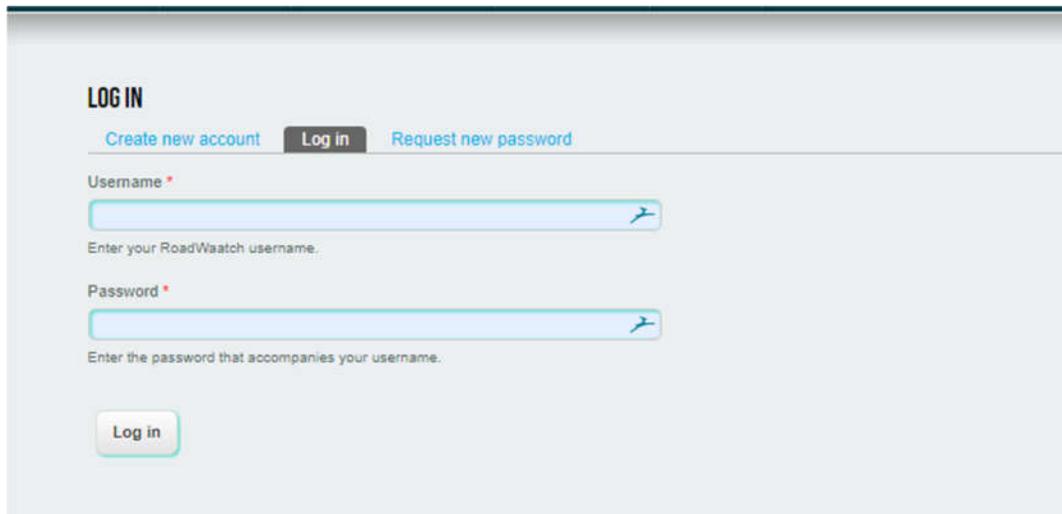
} //Closing Connection with Server

mysqli_close($conn);

?>

```

## 4.5 Sample Screen shots from the System

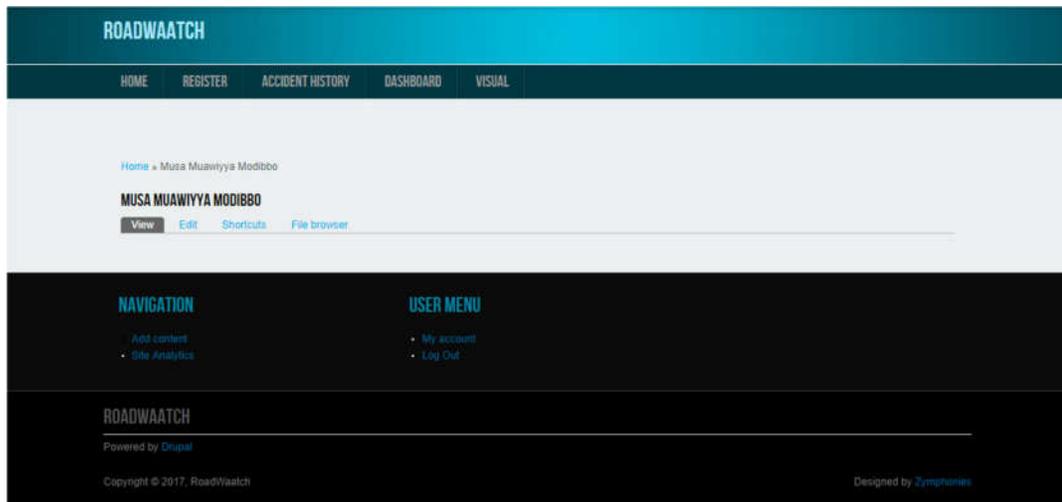


The screenshot shows a login interface with the following elements:

- LOG IN** header
- Links: [Create new account](#), [Log in](#) (highlighted), [Request new password](#)
- Username \*** field with a text input and a search icon.
- Text: "Enter your RoadWaatch username."
- Password \*** field with a text input and a search icon.
- Text: "Enter the password that accompanies your username."
- Log in** button

Figure 14 This is a sample Login form

This is the page where all registered users Login with their details and are giving access into the system.



The screenshot shows the admin view of the RoadWaatch system with the following elements:

- ROADWAATCH** header
- Navigation menu: [HOME](#), [REGISTER](#), [ACCIDENT HISTORY](#), [DASHBOARD](#), [VISUAL](#)
- Breadcrumbs: [Home](#) » [Musa Muawiyya Modibbo](#)
- User profile: **MUSA MUAWIYYA MODIBBO**
- User actions: [View](#), [Edit](#), [Shortcuts](#), [File browser](#)
- NAVIGATION** section:
  - [Add content](#)
  - [Site Analytics](#)
- USER MENU** section:
  - [My account](#)
  - [Log Out](#)
- Footer: **ROADWAATCH**, Powered by [Drupal](#), Copyright © 2017, RoadWaatch, Designed by [Zymphonias](#)

Figure 15 Admin View

**ADD DRIVER**

[View](#) [Edit](#)

---

**DRIVER DATA**

Driver Lisence

Firstname

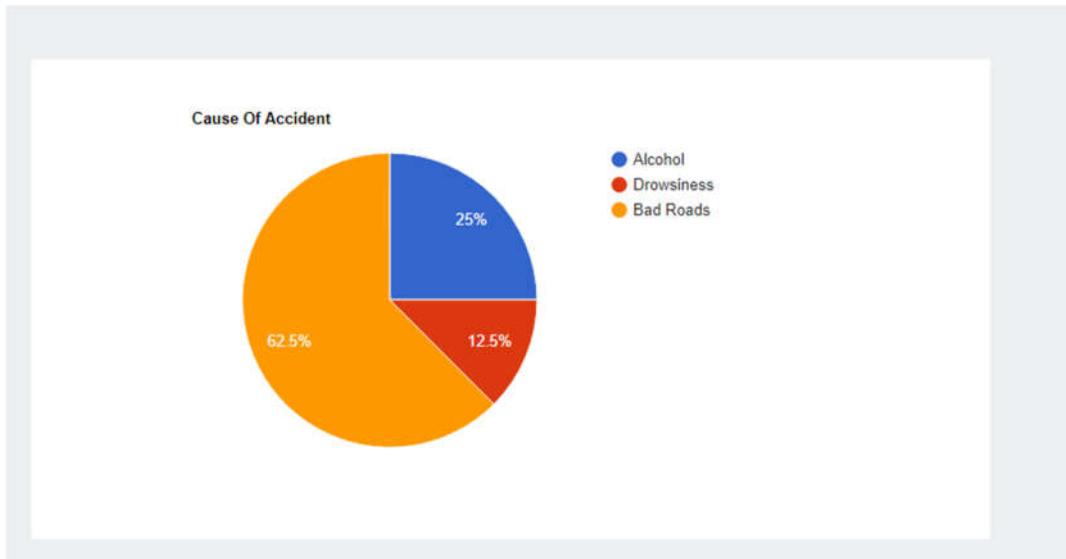
Lastname

Middlename

Age

Gender  
1 ▾

*Figure 16 Sample Driver Registration Form*



*Figure 17 Visualization of Data from The Database*

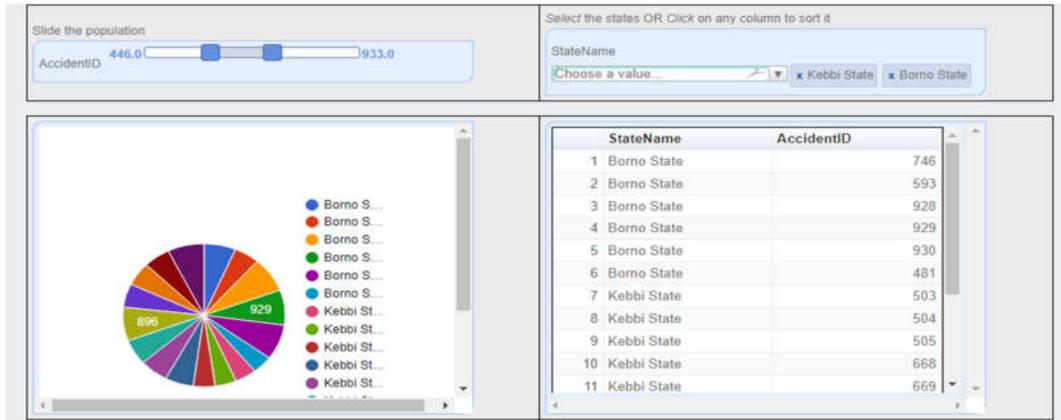


Figure 18 Dashboard Showing Accident and The Location

#### 4.6 Conclusion

The test results were obtained from the different testing phases that were conducted during system implementation. The system was tested in the unit level and integration level. During unit test, unit modules were tested to ascertain that they functioned as individual units. During integration test, the unit modules were joined together and tested to ascertain that they worked together as a system.

The system is developed with administrative username and password to allow for testing and provision of overall administrative changes when necessary. Privileges are created to authenticate other users and provide restricted access to the part of the system required for them to perform their functions effectively without tempering with system functions considered out of their domain of access. The Officer is given privilege that provide the highest access to the system functionalities after the Administrator. All administrative options were tested thoroughly and as a result the system was declared satisfactory to the user needs.

A test of the system was conducted to see whether it was capturing valid data. This was done by putting wrong data and then the system responded with alert

messages displaying the type of error caused by the wrong entry. Nonetheless, the system was tested successfully.

## **Chapter Five**

### **Summary, Recommendation and Conclusion**

#### **5.1 Summary**

The goal of this research is to build and implement an observatory system to monitor road accidents across Nigeria and be able to visualize the accidents, by their severity, locations, driver, vehicle type, casualty, and in some cases fatalities. There was need to improved quality of service, reduced operational cost, alleviate redundancy and inconsistency of data, reduced time consumption, increased information centralization and security, increased sense of direction towards what should be collected from an accident scene and participation in monitoring, gathering and dispersing information from the automated records and among the management, and also prevent the system being exposed to vulnerability by allowing authentication and for valid register input and better management output.

#### **5.2 Recommendation**

This system although it is able to gather information and visualize the stored data as charts to users still has more room for improvement, A system like this will be far more useful if it was able to leverage on modern technological advancement to project or predict where an accident might occur, with the use of machine learning tools and Application Programming Interfaces. If this is achieved then our roads will be very safe and also the rate of mortality from road accidents will be highly reduced. Which will have an indirect impact to the economy and growth of the country. This system can also be extended to collect data automatically without the use of user inputs, by the use of sensors.

#### **5.3 Conclusion**

The strength of this project is to facilitate easy Observation, Collecting and monitoring Road Accidents in Nigeria. Hence, it is cleared that all corresponding aims and objectives was effectively achieved through this medium. Furthermore, the

application of the above recommendations will also guarantee the program strength. This project had really enhanced my understanding of the non-obvious activities and processes. I learned to bring the knowledge I acquired in class to solve a real problem existing in the real world. I am finally also glad that the goals I set to achieve at the beginning have virtually been met as the completed part is fully functional as proposed.

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