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# Crime Mapping Software: A tool for Effective Crime Detection and Control in Nigeria

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**ABSTRACT**
The escalating rate of crime incidents in developing countries is due to change of technology and acquisitive way of life and also due to poor socio political, economic and environmental conditions. The distribution of crime incidents across the scenery is not geographically random since incidents are human phenomena. For incidents to occur, offenders and their targets - the victims and/or property - be required to exist at the same location for a period of time. Several factors, including the lure of potential targets and simple geographic convenience for an offender, influence where people choose to break the law. The Law Enforcement Agents have found it difficult to manage and control these crimes largely due to the obsolete methods and resources they employ in doing so. The purpose of this study is to see how the Law Enforcement Agents can adopt the use of crime mapping software in its operations and reap the benefits. Interviews were conducted with various units of the Nigeria Police Force. The findings of the interviews were combined with knowledge gained from an extensive literature review to produce a prototype of the crime mapping software that allows user interaction with the data. This study shows that crime mapping software will give the Law Enforcement Agents better insights into crime mapping and analysis which will be a tool to help them effectively detect and control crime. It was unraveled that crime mapping software can give a better synoptic perspective to crime study, analysis, mapping, proactive decision making and prevention of crime. It was however suggested that migrating from traditional method of crime management to crime mapping software demands capacity building in the area of personnel, laboratory and facilities backed up with policy statement.
**Keywords:** Crime, Crime mapping, Geo -database, Geographical Information System (GIS), Hotspots, Thematic layers

## 1.0 INTRODUCTION

Crime is a phenomenon which is collective in its anecdotal forms in all cultures and societies, at all stages of organization. It is an act against a person (for example, theft and property damage) and regulation (for example, traffic violations) [1]. In accordance with the opinion of [2], Crime can be considered as an act, default or conduct, prejudicial to the community, the commission which, by law, renders the person responsible to punishment by a fine, imprisonment or other penalty. The escalating rate of criminal activities in Nigeria, as reported daily in the media disregards class distinction in the society, as both high (haves) and low ( have nots), experienced similar and equal visitation of the hoodlums from time to time. The consequential tragedy, suffering, colossal loss and distress, occasioned by those inimical visits, have been pervasive and had left a negative impression on our national image and societal tranquility [3]. According to [4], there is no place or society that is completely devoid of crime. The existence of crime is as old as the creation of man itself and man has always searched for means to combat it and reduce it as much as possible. In [5], they stressed that there is a great deal of debate on the causes of crime and affirmed that in the 1980s the rate of crime occurrence grew sharply to nearly epidemic proportions. Worse still is the fact that the law enforcement agents are yet to fully embrace the possibilities of Information and Communication Technologies for effective record keeping, analysis of cases, easy reference, retrieval and storage of information to help strategize and adequately plan the combating and eradication of crimes in general. As an entity, crime has spatial attributes, i.e., location, time and process. In reality, availability and quick access to timely and up – to – date spatial information about crime – prone areas to the law enforcement agencies will in no small way contribute to effective crime detection and control in Nigeria. In today's modern age where ICT have become a way of life, it is important for Law Enforcement Agents in Nigeria to upgrade from the existing system in order to reap the associated benefits like crime mapping, crime hotspots identification and GIS analysis of crime. Case files go missing in manual systems yet this can be eliminated by computerizing the data storage. Warehousing Crime information in a database would lead to more efficient data sharing within the agencies. This would mean that the investigating Officers have access to up- to- date information from any location where there is an interactive platform. This can only be achieved through the use of Crime mapping information systems and Geographic information systems (GIS). Using qualitative and quantitative data from the Law Enforcement Agents, the objectives of this study include:

- To identify factors and develop a tool for mapping and analyzing the occurrence of crime in Nigeria.

- To define suitable system architecture including necessary interfaces for data collection and dissemination.
- To define an effective and efficient database model for data storage.

## 2.0 THEORETICAL FRAMEWORK

### 2.1 Theories of Crime Hot Spots

Crime theories are critical for useful crime mapping because they aid in the interpretation of crime data [6] and provide guidance as to what actions are most appropriate. Therefore, understanding how crime theories account for hot spots is critical. Several theories of crime and disorder concentration (hot spots) exist. Some theories disagree, but often the theories do not contradict each other. Rather, they explain different types of crime phenomena that occur at different geographic levels. Each level has basic units of analysis-the things being examined. Some theories help explain point concentrations of crime. Other theories help explain linear concentrations of crime or hot spot crime polygons. However, theories of crime are useful for helping to guide crime and disorder mapping only if one selects a theory appropriate for the level of analysis and action [6].

#### 2.1.1 Place theories

Place theories explain why crime events occur at specific locations. They deal with crimes that occur at the lowest level of analysis-specific places. They involve looking at specific incidents and asking such questions as, at what places are burglaries occurring and at what places are they not occurring? Crime phenomena at this level occur as points, so the appropriate units of analysis are addresses, street corners, and other very small places, which are typically represented on maps as dots. Police action, such as warrants, which specify exact addresses (not blocks or neighbourhoods), is very precise at this level. Similarly, nuisance abatement focuses on specific locations.

#### 2.1.2 Street Theories

Street theories deal with crimes that occur at a slightly higher level than specific places; that is, over small, stretched areas such as streets or blocks. A thieves running is an example. At this level of analysis analysts ask such questions as, - On which streets are thieves found and on which streets are they not found? The appropriate units of analysis can be street segments, paths, and sections of highways, which would be represented on maps as straight, bent, or curved lines. Police action is still relatively precise, although not as precise as at the place level. Concentrated patrolling occurs at this level, for example, as well as efforts to change traffic and street patterns.

#### 2.1.3 Neighbourhood Theories

Neigbourhood theories deal with large areas. Here, analysts are interested in such questions as, 'What areas are claimed by gangs and what areas are not?' The appropriate units of analysis are quite varied and can include square blocks, communities and census tracts, to name a few. Two – dimensional shapes such as ellipses, rectangles, and other polygons are used on maps to represent crime phenomena at this level. At this level Police action is far less precise because the areas are typically too large for effective concentrated patrolling [6]. Nevertheless, depending on neigbourhood characteristics, relevant action might include efforts to engage residents in collective action against crime and disorder. For the purpose of this paper the Neighbourhood theories of crime hot spots was adopted because the hot spots analysis was done at a larger space than spot, place or street level.

### 2.2 Literature Review

This section present and discuss the core aspects of Crime mapping and the technologies needed to realize it.

#### 2.2.1 Concept of Crime

According to [7] the word 'crime' is of origin that is 'Crimean' which means 'charge' or 'offence'. Crime is a multifaceted concept that can be defined in legal and non-legal sense. From a legal point of view, it refers to breaches of the criminal laws that govern particular geographic areas (jurisdictions) and are aimed at protecting the lives, property and rights of citizens within those jurisdictions. Non-legal point of view would define crime as acts that violate socially accepted rules of human ethical or moral behaviour. As the moral principles that underpin the notion of crime are subject to gradual change over time, the types of behaviour defined by the legal system as criminal may also change. Examples of behaviours that have been de-criminalized in some jurisdictions include prostitution, abortion, attempted suicide and homosexual intercourse. Other behaviours, such as tax evasion or credit card fraud, have been criminalized over time [7].

#### 2.2.2 Crime Hot Spots

The term hot spots have become part of the crime analysis glossary and have received a lot of attention. A hot spot is a condition indicating some form of clustering in a spatial distribution. However, not all clusters are hot spots because the environments that help generate crime (the places where people are) also tend to be clusters. So, any definition of hot spots has to be qualified. In the words of [8], hot spots is defined as small places in which the occurrence of crime is so frequent that it is highly predictable, at least over a one year period. He opined that crime is approximately six times more concentrated among places than it is among individuals.

### 2.2.3 e Policing

This is the use of Information and Communication Technologies in the full spectrum of policing. e Policing expands the channels of communication since members of the public can report incidents via the internet and the Police would then react to these reports as soon as resources become available. The police would also use their websites to communicate crime information to the public. The Nigerian Police Force (NPF) describes ePolicing as ways of bringing policing to the internet. They encourage members of the public to sign up to receive email newsletters, crime trends and other important information. They also encourage members of the public to also provide information about crime via email [9].

### 2.2.4 Crime mapping

Crime mapping involves mapping incidents to identify hot spots and analyze spatial relationship [6]. It is the process of using a geographic information system to conduct spatial analysis of crime and disorder problems as well as other police – related issues. Crime mapping is an important feature for the location of crime and that it does not occur accidentally but instead criminal offences may occur in a conspicuous structures that are harmed by the landscape in which they occur and psychological factors that govern the motion of offender [10]. Mapping provides the capability of displaying any subset of events on a map. Not only can the user specify the time period they want to examine, they can also display events of a certain type or that meet specific criteria. By enabling the visualization of subsets of information, mapping provide an invaluable tool for revealing clusters and patterns of crime that are not readily apparent from a list of crime events in a report.

This is accomplished by trying the size of the symbol at a location to the number of events occurring there: the more events, the larger the symbol. This method for identifying report events at a single address supports problem – oriented policing efforts by making locations with several calls easily identifiable [11]. Crime mapping capabilities are useful for police officers patrolling neighborhoods and investigators trying to solve cases. They can view the recent crime pattern of a neighborhood and query a GIS to search for particular types of crime patterns, such as the location of all recent burglaries within a mile radius of a given intersection. Crime mapping implementation is relatively low in Nigeria. However, numerous examples exist in the developed world e.g. MAPS (Map-based Analytical Policing System) developed by Rick McKee of the new Zealand police department in the year 2000 to assist his police colleagues in tackling crime. MAPS was predominantly built for and used by Police intelligence analysts to assist in identifying crime patterns and trends, it allowed basic mapping queries to be compiled with a wizard-based formula that could be conducted by all operational police staff. MAPS allow users to build a query, select, display and explore crimes for any location in New Zealand.

### 2.2.5 Geographical Information Systems (GIS)

With the rapid advancement of technology recently, a computer – based technique for examining, visualizing, and analyzing the occurrences of criminal activity is essential. Geographic Information System (GIS) is one of the most influential tools for facilitating and exploration of the spatial distribution of crime [12]. A GIS is a system of hardware and software used for the storage, retrieval, mapping and analysis of geographical data. It is a tool for revealing what is otherwise invisible in geographical information [13]. GIS assisted Crime mapping is often employed to understand the geographical distribution of crime, identify crime concentrated area, or hot spots, and facilitates deployment decisions regarding the duration and dosage of intervention programs [14]. The migration of GIS from mainframe to desktop computers provides the law enforcing agencies with a cost effective option for crime control since hardware and software prices have reduced drastically. Methods of data collection available to law enforcement agents include street investigations, informers and undercover operations. GIS would enhance the analysis of the collected data due to its ability to handle spatial data [15]. GIS according to [16], is an integrated system of computer hardware and software coupled with procedures and a human analyst which together supports the capture, management, manipulations, analysis, modeling and display of spatially referenced data. The fundamental strength of GIS over traditional crime analytical tools and methods is the ability to visualize, analyze and explain the criminal activity in a spatial context. Establishing a direct relationship between information and their geographical location is a unique characteristic of GIS, a versatile tool that also enables information to be displayed as maps. Every crime problem is related to some location, whether it is an address, street, zip code, or district. GIS can help you leverage the location aspect of your data to analyze, understand, and build solutions to the problems you face [17]. GIS supports the needs in tactical crime mapping by providing a platform for analyzing crime data to identify crime patterns and series, linking modus operandi and suspect information to specific crime locations through spatial tools and techniques, supporting operations plans and clarifying ideal deployment locations, clearing cases by linking suspects to specific crimes after arrest, continuous active monitoring of high risk and convicted offenders etc [17].

### 2.2.6 Geo- Spatial Data Storage

For storage and management of geographic and attribute data, GIS software packages rely on an underlying Database Management System (DBMS). Storage can also be directly controlling by the application.

### 2.2.7 Data Dissemination and Visualization

Police agents in developed countries have undergone organizational and technical changes in an attempt to improve the lines of communication and to smooth the flow of intelligence within the service. Data dissemination method area is necessary to ensure that different local area command centres receive up- to – date information round the clock.

### 2.3 Empirical Studies of Crime Mapping Software

Anton Borg et al., proposed a Decision Support System for comparing and analyzing residential burglaries. The prospective usage of the cut clustering algorithm for grouping crimes towards reducing the amount of residential burglary crimes for analysis based on characteristics was investigated [18].

Similarly, Krunal Patel et al., designed a GIS Based Decision Support System (DSS) which integrate and access massive amount of location based information. The system allows police personnel to plan effectively for emergency response, determine mitigation priorities, analyze historical events, and predict future events [10].

Ahmed Mohammed et al, anticipated the use of Geographic Information Systems (GIS) in determining crime hotspots in Dala L.G.A of Kano State and also analyzed the challenges for the police departments in implementing computerized crime mapping systems [13].

Also, Zhou, G. et al., designed and implemented a Web Based Mapping and Decision Support System. Four hotspots mapping techniques, i.e., chloropleth mapping, grid mapping, spatial ellipse mapping and kernel density mapping, were implemented in the system [19].

Nelson Devia et al., proposed an agent-based simulation model to test diverse policing strategies in a virtual environment that generates artificial street crime data. The model can thus evaluate the strategies effectiveness and collateral effects in supporting police personnel for decision-making process [20].

Giles C Oatley et al., developed a software system that enables the trending of historical data for crime reduction based upon victim, offender, location and details of victimizations. The software utilizes visualization tools and is capable of mapping a range of sophisticated predictions [21].

Shyam Varan Nath formulated crime pattern detection as a machine learning task and thereby use data mining to support police detectives in solving crimes. The author identified the significant attributes using expert based semi-supervised learning method and developed the scheme and discussed about k-means clustering with some enhancements to aid in the process of identification of crime patterns. Thus these data mining methods have promising future [22].

## 3.0 Methodology

This section will give an overview of the developed system. The utilised software development practices will be discussed and key implementations decisions taken will be identified and detailed as well. Firstly, a design phase of the project was conducted and its aims were to translate the user requirements into:

- A Geo-Database design consisting of database development, data manipulation and data storage and retrieval
- An Interface Design for the prototype, including the scope of the functions of the application.

### 3.1 Hybrid Model

The aim of the hybrid model was to be able to deliver basic functionality quickly then follow up with more functionality at regular intervals. The method used had to facilitate the incorporation of feedback from the users, that the system being developed is on the right track to fulfilling their requirements. Mostly the users were the police officers. The stages included User requirement and System Specification, Design and Build iteration and Implementation.

### 3.2 System Requirements

Clearly defined system requirements help the developer to come up with a set of required goals against which they can measure the extent to which the developed system satisfies its objectives. A list of system requirements was drawn up under three categories. These are storage, visualisation and interaction. The requirements are:

- The system should be able to store spatial data in order to store the crime location information.
- The system should be able to display several layers of spatial data at a time in order to integrate other GIS data and crime data in the maps.
- The system should allow users to turn layers on and off as well as display only data that meets a given criteria in order to allow the querying of the data by the users.

**Storage**

Storage requirements can be met by the development of a geo-database containing the crime data and other relevant spatial information that can be used in crime analysis.

**Visualisation**

To meet the visualisation requirements for displaying the data stored, an interface has to be developed that allows the overlaying of various layers of geospatial data.

**Interaction**
In order for users to be able to add and remove layers to the display while also being able to select specific crime data, layer switching components and simple querying tools should be added to the interface.

### 3.3 Database Design

A properly designed database will provide access to up-to-date and accurate crime and other spatial information. It will enable the law enforcement agents to achieve their goals by meeting organisational needs while accommodating change. Designing a database involves three major steps, namely, conceptual design, logical schema design and physical database design. Conceptual design begins with the collection of requirements and results needed from the database while in logical schema design, a description of the structure of the database (Relational, Network, etc.) is produced. In physical schema design, a description of the implementation (programs, tables, dictionaries, catalogs is produced [23]. In this design, a special type of database was required in order to accommodate spatial data; therefore, the three steps described above were incorporated into the major steps for creating a geo-database. Arctur, et al. [24], proposed a ten step approach to the design of a geo- database. The first three steps lead to the identification and characterisation of each of the required thematic layers. Steps 4 to 7 look at the development of the representation specifications, relationships and geo- database elements together with their properties. The last three steps then lead to the definition of data capture procedures, assignment of data collection responsibilities, testing and refinement of the design together with documentation. For this research these steps were appropriated to the crime database and the GIS information as follows:

**Step 1: Identify the information products that will be produced with GIS**
The sample final map products to be produced by the prototype were listed including the analytical models, the required reports, Web access, data flows and operational requirements. These were used in determining the data needs of the design.

**Step 2: Identify the key thematic layers based on information requirements**
A list of feature classes, tables, relationships, raster datasets and domains that would be needed was compiled. These would be used to produce the required map products leading to the effective analysis of the relationship between location and crime as well as to satisfy any other application and information requirements. For each theme, the visual representation (point, line, polygon and raster), the expected uses in GIS, the likely data sources, and the resolution were noted. Once these were noted, the specifications for their representation in the database were then developed [25]. Use of a Computer Aided Software Engineering (CASE) design tool, Microsoft Visio was made for the documentation of the design.

**Step 3: Specify the scale ranges and spatial representations for each thematic layer**
Since feature representation changes between points, lines and polygons at larger scales, the scale at which the each layer was compiled is recorded as well as the limits to which the data can be zoomed in order to satisfy the modeling, query and or map product applications.

**Step 4: Group representations into datasets**
A feature dataset is a group of feature classes clustered together based on their sharing of the same spatial reference, relationship classes, geometric networks and geo database topologies. The relationships identified among the feature classes in a dataset help in generating information needed by problem stakeholders [24]. Dataset are used to group feature classes that are edited simultaneously and are also used to group feature classes according to themes, for example, the theme Police Areas would have the location of police stations (points), the area covered by each police district (polygons) and the road network for that area (lines).

**Step 5: Define the tabular database structure and behaviour for descriptive attributes**
For each feature class, attribute fields are identified. The valid values and their ranges are also specified. Relationships between the different feature classes are created for referential integrity persistence, improving query and edit performance and also to optimise joins used in labelling and symbolisation. Subtypes are applied to relevant feature classes to add selected behaviour to subsets of features in a feature classes. The crime feature class can have offences against the public peace and order, offences against the public health and morals, offences against the person and offences against property. Subtypes help to reduce the number of feature classes and improve performance. The use of subtypes results in a coarse-grained model, good for database performance, with finely discriminated object behaviour.

**Step 6: Define the spatial properties of your datasets**
For those connected features like roads, networks are composed. These help enforce referential integrity. Spatial relationships are ensured through the use of topology rules. The topology rules can be used to enforce spatial relationships such as how police districts nest into cities. Topology rules help to maintain the topological integrity of the data.

**Step 7: Propose a geo-database design**
The set of geo-database elements needed in the design are defined. These include how the features will be rendered and symbolised on maps, a specification of attributes that will be used to describe each feature and a specification on maintaining spatial relationships. This is done for each data theme.

**Step 8: Implement prototypes, review and refine your design**
The prototype design was tested. This included building a sample geo-database from the proposed design. Maps were then built, visualised, and editing operations performed to test the design's utility. The design was then revised based on the prototype test results to refine the design.

**Step 9: Design workflows for building and maintaining each layer**
Editing procedures and integrity rules (for example, all streets are split where they intersect other streets and street segments connect at endpoints) were defined. Display properties for maps were defined.

**Step 10: Document your design using appropriate method**
Microsoft Visio was then used to create a graphic representation of the geo-database schema [25].

### 3.4 User Interface Design
In the words of [26], a user interface is that part of the computer system with which a user interacts in order to undertake his or her tasks and achieve his or her goals. They advocated for interfaces that provide an easy, natural and engaging interaction between a user and a system. Such interfaces can be achieved through good user interface design. Depending on the design of the interface, a system will either be usable, i.e. easy to learn and easy to use, or problematic for users. User-centred design is one common approach to user interface design and development. It involves user participation throughout the design and development process. In this method it is important to understand the users of the system under development. Furthermore, an understanding of the tasks those users will perform with the system and the environment in which they will operate is very crucial.

### 3.5 Creation of the System Prototype
In this phase, the system prototype was developed, the design of the database and user interface were implemented. The database was created using POSTGRESQL and POSTGIS. This was done on a Windows platform due to the researcher's familiarity with the Windows operating system.

### 3.6 Implementation
This section discusses the system architecture consisting of the geo-database, the connection between POSTGRESQL and POSTGIS and visualisation using Geoserver and OpenLayers as shown in Fig. 1.0 below. The system implementation stage involved phases where the system was installed, programmed, tested and modified to ensure that it satisfies the user requirements.

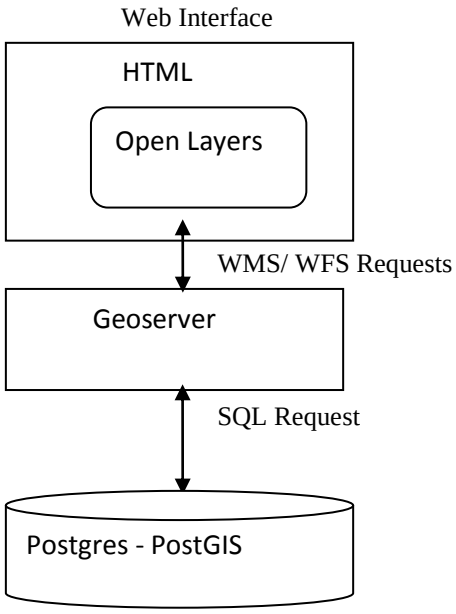


**Fig. 1.0: Proposed System Architecture**

**(Adapted from Mukumbira S., 2012)**

### 3.7 The Geodatabase

Following the findings of the literature review pertaining to data storage, in order to store spatial data, PostgreSQL was implemented together with PostGIS.


**Fig.1.2: PostGIS and PostgreSQL (pgday.postgresql.org.tr, 2012)**

OpenGeo [27] lists some of the features that a PostGIS database offers as:

- Support for big GIS objects – this would enable the storage of large datasets.
- Authentication services – in order to be able to update the database, the user must supply a username and password.

### 3.8 Geoserver

Geoserver, enables the publishing of the geospatial data contained in the geodatabase.

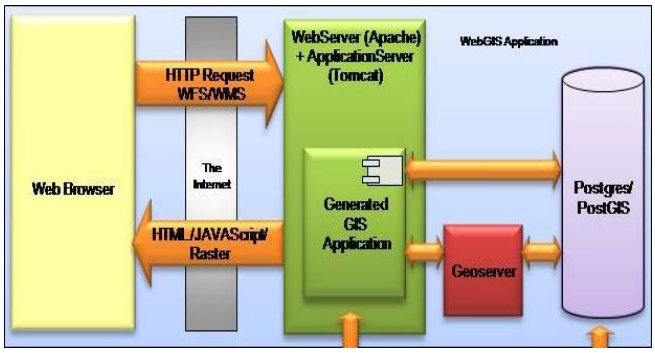


**Fig.1.3 WebGIS System Architecture**
**(Adapted from Di Martino, 2007)**

### 3.9 Evaluation

The resultant prototype was evaluated in order to investigate the research questions i.e. whether it proves the concept that crime mapping would improve the operations of Nigeria Police Force.
It was evaluated in terms of usefulness, efficiency, effectiveness, learnability and user satisfaction.

#### 3.9.1 Data acquisition

The evaluation involved collecting both qualitative and quantitative data. The questionnaire employed the use of the Likert scale to collect quantitative data while qualitative data was collected via a structured interview.
The focus of the evaluation was on the following criteria:

**Proof of Concept:**

- Can the prototype display crime data on maps?
- Can the crime data be integrated with other spatial data?

**Technical Feasibility:**

- Is the prototype development feasible within the limits of current technology?
- What required technology exists to build the prototype?
- Is the required technology available within given resource constraints for Nigeria Police Force?

**Usability**

- Usefulness
- Efficiency
- Effectiveness
- Learnability
- Satisfaction

## 4.0 Results

This section presents the data gathered during the study, interpretation of the results from the conducted demonstration and the prototype analysis.

### 4.1 Demographic Profile of the Respondents

| Age | Gender (Male) | Gender (Female) | Male (%) | Female (%) | Age (%) |
|---|---|---|---|---|---|
| **21 - 30** | | | | | |
| **31 - 40** | | | | | |
| **41 - 50** | 15 | 10 | 60 | 40 | 100 |
| **51 - 60** | | | | | |
| **Above 60** | | | | | |

**Table 4.1: Age and Gender of Respondents**

Table 4.1 shows that all the respondents were in the 41 to 50 age category. This is due to the tradition of rank within the police force. Only people above a certain rank are preferred to interact with members of the public. Having officers in this age bracket could influence results since these mature officers joined the force before computers were introduced. A group of younger respondents could have different opinions.

### 4.2 Respondents' Length of Service

| Years | No of Respondents | Percentage |
|---|---|---|
| **<5** | | |
| **5 to 10** | | |
| **> 10** | 25 | 100 |

**Table 4.2: Distribution of respondents according to years of service**

Again, 100% of the respondents have more than 10 years of service in the force. Since promotion within the force is dependent on a number of factors including years of service, the data shows that the respondents are highly experienced since their ranks are high as well. Of the 25 respondents, only 8 were sergeants, 5 were corporals, 7 were inspectors while 5 were superintendents. Having a group of respondents rich in experience is advantageous to the research since the respondents are well versed with the operations of various police units.

### 4.3 Respondents' Perception of the Prototype

| | Strongly Disagree (1) | Disagree (2) | Neither Disagree nor Agree (3) | Agree (4) | Strongly Agree (5) |
|---|---|---|---|---|---|
| Crime maps will add value to our operations. | | | | 7 | 1 |
| The crime mapping software can be directly | | | | 4 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| applied to our work. | | | | | |
| It is easy to understand and use the software | | | 1 | 5 | 2 |
| It is easy to learn the functionality of the software. | | | | 8 | |
| The software was very fast and responsive. | | | 2 | 6 | |
| The information portrayed by the maps is clear, concise, and informative to the intended audience. | | | | 5 | 3 |
| The information provided by each map encourages comparisons among locations or crimes. | | | | 5 | 3 |
| The software can be a useful resource in creating reports. | | | | 5 | 3 |
| The software provides information that can be useful in understanding reports. | | | | 5 | 3 |
| The language and terminology in the maps is clear and is in line with the language used in the police force. | | | 1 | 1 | 6 |
| The software can be used by officers at all levels in the force? | | | 1 | 6 | 1 |
| The software can be used to ct the occurrence of crime. | | | 1 | 4 | 3 |

**Table 4.3: Respondents' perception of the prototype**
The table shows the responses of the participants to the prototype and their rating for each statement, where the scale of 5 means strongly agree while the scale 1 refers to strongly disagree.

## 5.0 Discussion and Conclusion

From the literature review, it was shown that crime mapping has been successfully implemented in developed countries, and it is hypothesised that Nigeria can also successfully implement it and reap the associated rewards. The purpose of this study was to develop a crime mapping software which would enable the visualisation of crime data, integration of crime data with other spatial data and hence hotspot identification. Through the prototype development, it was shown that crime data can be integrated with other spatial data specific to an area which would help in identifying certain patterns associated with the incidents. The chapter presented the criteria used in the evaluation of the system, which was done with the help of participants from four different units of the police. All the participants agreed that a crime mapping software would be useful in Nigeria Police operations. The evaluation proved that crime mapping software can add value to police operations. This provides the confidence that when the prototype is fully developed in the future, it will add great value to the operations of Law Enforcement Agents.

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