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### **RESEARCH ARTICLE**

# **Public Crime Reporting and Monitoring System Model Using GSM and GIS Technologies: A Case of Zambia Police Service**

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**Abstract**— *The proliferation of mobile handheld devices has made them a viable medium for carrying out a wide range of business activities in areas such as education, agricultural, healthy and security. In the area of security, one major problem hindering crime detection and reporting is lack of efficient communication platform between the police and the general public. Mobile technologies using mobile devices is proving to be a more effective implementation for crime detection and monitoring. In this study, we are proposing a crime reporting and management model using GSM and GIS technologies in order to mitigate the challenges faced by most developing countries in reducing the crime rates. We began by a baseline study that was carried out to ascertain how citizens report crime to the police. This was followed by a study that looked at how the Police receive and manage crime information. Based on the baseline study, we then designed a Public Crime Reporting and management System that integrates GMS and GIS Technologies.*

*In our baseline study, the results showed that 68% of the citizens walk to the police station, 30% made phone calls and less than 1% used Short Message Service (SMS), Internet or social media platforms to report crime. In crime reports management, our results showed an absence of an electronic capturing/recording system by the police with 98% of the police stations using a physical log book to record crimes. Using the results from the baseline study, a mobile crime reporting and management system model was developed. Using this model, we developed the prototype which showed improved results in terms crime reporting by the public using mobile devices and improved management of reports due to automation of crime reporting and monitoring.*

**Keywords**— *Crime Reporting, Crime Monitoring, ICTs, Mobile Application, GPS*

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## **I. INTRODUCTION**

Crime is one of the major challenges that most governments around the world are strangling with [1] [2]. Every family and business has been directly or indirectly affected by robberies, burglaries, vandalism, sexual and other crimes [3] [4] [5] [6]. Recent research has identified mobile handheld devices as a possible tools for effective crime detection and reporting [7][8]. The high computational power of phones, smart phones, tablets and PDAs accounts for their high demand and usage by the general public. Smartphone shipments worldwide reached 485 million in 2011, increased to about 655 million in 2012, and expected to rise over one billion smart phones by 2016 [9],[10]. Another key factor making mobile phone technology a viable medium for fighting

crime is the advancement of cellular networks technologies. The introduction of 3G/4G cellular network technologies by most mobile network operators has improved the communication demands for mobile users [11]. With these two factors in place, development of dedicated mobile platforms for detecting and reporting criminal activities is a great possibility.

In this paper, we propose a model for reporting and management of crime reports through mobile technologies such as GSM and GIS. The rest of the paper is organised as follows; Section I gives the Introduction, Section II gives the literature review, Section III is the methodology while Section IV gives the implementation results. Section V gives the conclusion.

## II. LITERATURE REVIEW

The advancement of computer technologies has led to the advancement of computer technologies has led to more effective ways of detecting and fighting crime in society [39]. Today, engineers and researchers have proposed and developed a number of computer based systems, especially for crime detection and reporting. With the improvements in spatial information and databases, this is making the integration of GIS more effective in these implementations. The section below gives a summary review of the crime partner around the world and how these are being addressed by various governments.

### A. Crime Patten Around the World in Developing Countries: Asia

In this subsection, we look at the crime pattern in most developing countries around the world. We begin our analysis with Asia. In Malaysia, The ten year (2004-2013) archival analysis showed that a total number of 314,675 violent crime incidents were recorded. In general, violent crimes occurred in a fluctuating pattern [12]. The highest number of violent crime incidents were recorded in the year 2009 (42,365 cases) followed by the year 2008 (35,159 cases) [13]. In the Philippines, The total crime volume for the last four years has been fluctuating. It registered 80,108 in 2000, 76,991 in 2001, 85,776 in 2002 and 83,704 in 2003. For the period January to November 2004, the total crime volume registered is 8.5% lower compared with the same period last year. Out of the total crime volume, 55% are index crimes and the rest are non-index crimes. [14]. The most common crimes in the Philippines are street crimes, illegal drug trafficking, violent crimes against women and children, terrorism and smuggling and trafficking in human [15]. In Japan, during the period from 1960s to early 1990s, the crime rate in Japan remained stable and at a low level, with the number of recorded penal code crimes being in the proximity of 1.5 million cases per year [16]. In 1991 however, this situation changed, with the number of recorded penal code crimes rising above 1.7 million for the first time, and then climbing above 2 million in 1998 [16] [17]. The financial crisis was followed by another increase in crime, with penal code crimes peaking at approximately 2.85 million in 2002, which was the highest number ever recorded [16] [17]. Overall, the increase in the crime rate during the 5-year period between 1998 and 2002 was a startling 40.3 % [16] [17].

### B. Crime Patten Around the World in Developing Countries: South America and the Caribbean

Next we look at South America and the Caribbean Countries. In Caribbean, murder rates are at 30 per 100,000 population annually—are higher than for any other region of the world and have risen in recent years for many of the region's countries [21] [22]. Assault rates, at least based on assaults reported to police, are also significantly above the world average [25]. Victimization surveys are needed to even approximate true levels of assault, yet standardized victimization surveys have rarely been undertaken in the Caribbean. Violence against women affects a significant percentage of women and girls in the Caribbean [22]. One such regional victimization survey revealed that 48 percent of adolescent girls' sexual initiation was "forced" or "somewhat forced" in nine Caribbean countries [22]. The UNODC's Crime Trends Survey (CTS) [23] which is based on police statistics, three of the top ten recorded rape rates in the world occur in the Caribbean. All countries in the Caribbean for which comparable data are available (Bahamas, St. Vincent and the Grenadines, Jamaica, St. Kitts and Nevis, Dominica, Barbados, and Trinidad and Tobago) experienced a rate of rape above the unweighted average of the 102 countries in the CTS [22]. Despite their diversity, one thing all Caribbean countries have in common is that they have long been caught in the crossfire of international drug trafficking [23]. Despite these recent shifts, large quantities of drugs continue to transit the Caribbean. In 2005, it is estimated that about 10 tons of cocaine transited through Jamaica, and 20 tons through Haiti and the Dominican Republic. In addition to drug trafficking, kidnapping and corruption are other forms of organized crime which affect the region. Two countries—Haiti and Trinidad and Tobago—have seen recent and rapid increases in kidnappings. The kidnapping rate nearly doubled in Trinidad and Tobago between 1999 and 2005 (Central Statistics Office of Trinidad and Tobago, 2006) [24]. Corruption is a difficult crime to measure. While there are methodological concerns about Transparency International's Corruption Perceptions Index (CPI) [25], it remains the standard for international corruption comparisons and boasts one of the few datasets with near-global coverage. In the 2006 CPI, ten Caribbean countries were included in the world rankings [26]. Haiti was ranked as the most corrupt country in the world, while Barbados was ranked as the 24th least corrupt country, ahead of many

European countries [26]. Latin America has the highest violent crime rates in the world. Of the 520,000 homicides committed world-wide in 2000, 140,000 were in this region. The homicide rate, 27.5 per one hundred thousand inhabitants, is triple the world average of that year [27]. Even taking into account the importance of gender violence in these countries, the death rates are much higher among the male population, 51 homicides per one hundred thousand inhabitants. Moreover, the phenomenon is especially prevalent among the young. The homicide rate among the male population of between 15 and 29 years old is 89.7 per one hundred thousand inhabitants [28]. In view of these figures, it is not surprising that homicide is the fifth leading cause of death in the region. Furthermore, interpersonal violence is the third cause of loss of disability-adjusted life years (DALYs) [29].

### *C. Crime Patten Around the World in Developing Countries: Africa*

Moving to Africa, in Nigeria, political and business crime rate is on the increase almost on a daily basis [31]. The Nigerian crime problem is multidimensional and is capable of undermining its corporate existence as well as efforts towards sustainable development [31] [32]. Security and crime have been deeply rooted in the political history of this country, particularly in recent time, which has emerged as a key concept in Nigeria's struggle for good governance, sustainable democracy and development [31]. South Africa suffers high levels of crime and violence [33]. Although crime statistics for the financial year 2006/2007, reported some decreases, such as attempted murder (3%), rape (5.2%), some categories show ongoing increases [33]. During the period under review (2012/2013), a total of 2 126 537 crimes were recorded by the South African Police Service (SAPS) [33]. These include 1 833 775 (86.2%) crimes reported by the community and 292 762 (13.8%) crimes that were detected through police action [34]. Table 3 below shows the comparison of contact crime raw figures and population dynamics: Then (2004/5) and now (2012/13) 1st Year(2004/5) Vs 9th year (2012/13) of current administration. Contact crime is the biggest contributor to the total reported crimes [36]. These crimes are committed against the person and involve physical contact between the victim and perpetrator. The contact is usually of a violent nature and most of the contact crimes cause physical, psychological and material damage to their victims [34]. This category includes the following crimes: murder, attempted murder, sexual offences, assault with the intent to cause grievous bodily harm, common assault, common robbery and robbery with aggravating circumstances [35]. This broad group of crime categories contributes 33.7% to the total of the 17 crime categories reported to the police service by members of the public.

In this paper, the case study looks at Zambia and we give a brief overview of the crime pattern in Zambia as compared to other African countries around the world and in Africa. The ever increasing crime rate in Zambia is a serious problem that needed to be attended to urgently [36]. Today, every family and business has been directly or indirectly affected by robberies, burglaries, vandalism, sexual and other crimes [36] [37]. The significant increase in criminal activities impairs the overall development of a nation, undermines people's spiritual and material well-being, compromises human dignity, and creates a climate of fear and violence that erodes the quality of life [36][37]. Therefore, Sound Police – Community Relations are indispensable in the fight against crime in Zambia. Without adequate involvement by the local communities in fighting crime, for example, police officers are not likely to succeed in their endeavours [38]. Burglary, House Breaking and Other Breakings in High, Middle and Low Density Residential Areas of Lusaka Urban District are rampant. The most common crimes are Theft, robbery, rape/defilement, murder, burglary and assault.

## **III.RELATED WORKS**

The advancement of computer technologies has led to the advancement of computer technologies has led to more effective ways of detecting and fighting crime in society [39]. Today, engineers and researchers have proposed and developed a number of computer based systems, especially for crime detection and reporting. This section presents an overview of some of the most powerful computer based crime fighting systems developed within the past six years. The overview pays attention to functionalities and principles of operations of these systems.

The Crime Stoppers, New Orleans has launched a new free mobile crime-fighting app, for Android and iPhone platforms, called Tip Submit [40]. The app was created by Tip Soft and Crime Reports and is known to be the first anonymous tip submission mobile software. By design, Tip Submit allows citizens to submit crime tips to Crime stoppers securely and anonymously. The system identifies tipsters by their tip number only, which it assigns to the tip. The Mobile App allows tipsters to upload photos or video and is able to send the location of the video by a GPS locator. Other key feature of TipSubmit is that, it has no limits on the amount of text as with sending SMS text messages. Also, it maintains two way dialogue and real-time chat between the tipster and Crime stoppers.

Engineers in the University of Virginia have developed software which helps the police easily access crime data online [41]. The system, called Webcast allows establish trends on the data, showing the types of crimes

that commonly occur, and the places with which they are associated. By typing in specific dates, types of crimes, locations, and selecting names of weapons used, web-Cat produces graphs, reports, and maps of high crime areas.

Another powerful computer based crime fighting tool is Mobile Vic PD [42]. Mobile Vic PD is a recently released mobile application, released by the Victoria police in Canada for fighting crime. The mobile application can be used to report minor crimes, offer anonymous tips to police, stay updated on crimes in progress, receive missing child reports or check on stolen property. Mobile Vic can be used for the following activities

- Report Crime: Report crimes where the suspect is unknown to you and the total loss is less than \$5000 from the convenience of your iPhone,
- Is This Yours?: Reconnect with your lost or stolen property through this photo catalogue.
- Crime Maps: See reports of crime in your geographic location.
- Photos: View and search for the latest images of VicPD in action in our Flickr archives.
- Videos: Watch videos from the VicPD You Tube Channel Audio: Listen to VicPD News features, media releases and interview.
- Traffic Complaints: After a 24-hour cooling-down period, report traffic violations online, with actions ranging from general information for our traffic section, warnings, or issuing a ticket.

Accurint is produced by LexisNexis for the iPhone and iPad. This Mobile app connects government and law enforcement agencies to more than thirty billion public records and critical investigative tools needed to verify information in the field, and rapidly follow-up on new leads as they develop. Accurint is a powerful investigative public-records research tool used by thousands of government and law enforcement agencies to enforce laws and regulations, fight fraud, waste and abuse, and provide citizen-centric services. Accurint's next generation search technology enables researchers and investigators to instantly search through billions of public records and perform their jobs more efficiently and effectively. Some of the features of Accurint are; advanced Person Search, People at Work Search, Phones Search, Death Records Search, Business Search, Corporate Filings Search and Fictitious Business Name.

The most widely used tactical lead generation tool for law enforcement in the United States is Cop Link mobile plus app, created by i2 [43]. The app runs on iPhone, iPad and Android platforms. The app enables officers to achieve better situational awareness with automated geospatial searches of recent events, as it allows the searching of state and local criminal records from multiple jurisdictions' databases. Another great feature of the app is its ability to organize vast quantities of seemingly unrelated data to assist in making tactical, strategic and command-level decisions.

IPOL-mobile is an iPhone application used for crime fighting by police in Geneva, Switzerland [44]. Trends in local authorities [44]. It enables the police to have immediate access to various information such as the latest burglary or violence incident as well as the identities of culprits of such crimes. It enables the police to have immediate access to various information such as the latest burglary or violence incident as well as the identities of culprits of such crimes, IPOL-Mobile tracks the statuses and stages of the crime. Officers can track ownership information of vehicles by simply entering its number plate into the Smartphone application and officers can also get important real time information about their duties (patrol hours and location), police directories, lawyers and translators and their availability hours using the application.

Hatari.co.ke is a web based platform that enables citizens in Kenya to report to report various crimes by sending a text message containing the location and the type crime you are reporting to a number, the message will be displayed on the platform including a position on the map where it was reported from[45].

## IV.METHODOLOGY

### A. Baseline Study

The Zambia is one of the most highly urbanized countries in Sub-Sahara Africa with estimated population of 13.5 million. The rate of urbanization has resulted into unplanned, informal settlements commonly known as Peri- urban areas. The Peri-urban population is estimated to range from about 40% in smaller towns to 80% in big cities. Lusaka City has 29 Peri-Urban Areas. Although local authorities regard these settlements as "illegal" or "Squatter" compounds, they continue to grow without planning controls [46]. Lusaka is the capital city of Zambia and it is the focal point of Zambia's economic, political and international affairs. Currently the city is a fast growing town, with estimated Population of about 3 million .The Population density of Lusaka is 100.1 persons per square kilometer [47]. Lusaka is a sprawling city featuring considerable spatial, social and digital divides [47]. While in recent years the city of three million has experienced rapid economic growth, the dividends have not been evenly shared [48]. 5 Indeed, the gap between the wealthy elite and the poor majority is widening as the city's poor population continues to expand [49]. It is estimated that approximately half of Lusaka's population lives in informal settlements the city is also young. The majority of the population in the

informal settlements is under 22 years of age [47].Table 1 below the townships considered and population density categorizations.

For this study, 200 questionnaires were distributed to the general public and 80 were distributed to various police stations around Lusaka. Audio recording and oral interviews were also used as means to obtaining information. The study focussed on providing answers to the various crime and technology challenges faced in Zambia and Lusaka and also the integrations on ICTs in crime reporting .Below are the specific areas of focus.

TABLE I  
TOWNSHIP AND POPULATION DENSITY LEVEL

| Township No. | Township Name | Population Density | Township Number | Township Name | Population Density |
|--------------|---------------|--------------------|-----------------|---------------|--------------------|
| 1            | John Howard   | High Density       | 12              | Kabulonga     | Low Density        |
| 2            | John Leigh    | High Density       | 13              | Makeni        | Low Density        |
| 3            | Kabanana      | High Density       | 14              | New Kasama    | Low Density        |
| 4            | Kalingalinga  | High Density       | 15              | Rhodepark     | Low Density        |
| 5            | Kanyama       | High Density       | 16              | Chelstone     | Medium Density     |
| 6            | Matero        | High Density       | 17              | Kabwata       | Medium Density     |
| 7            | Chawama       | High Density       | 18              | Kamwala       | Medium Density     |
| 8            | Chibolya      | High Density       | 19              | Libala        | Medium Density     |
| 9            | Garden        | High Density       | 20              | Munali        | Medium Density     |
| 10           | Avondale      | Low Density        | 21              | Nyumba Yanga  | Medium Density     |
| 11           | Ibex          | Low Density        |                 |               |                    |

The Mobile device landscape has quite improved in Lusaka especially for the middle class and the lower income bracket of the population. Most of the population now possess handsets which use for communications. Zambia has also become a fertile dump site for counterfeit (fake) phones. These offer basic capabilities such as multimedia, internet access and ability to install various applications. The cost of these phones is quite low making them affordable to a lot of people. To fully understand the type and nature of the devices on the ground ,A questionnaire was distributed to residents of densely populated settlements such as John Howard, John Howard, Kabanana, John Leigh, Kalingalinga, Kanyama, Matero, Chawama, Chibolya, Garden Compound .Medium populated areas such as Chelstone ,Kabwata, Kamwala, Libala, Munali, Nyumba Yanga were also part of the study. The low density areas such as Avondale, Ibex, Kabulonga, Makeni, New Kasama and Rhodepark completed the last category of the study.

Crime is one of the biggest challenges facing the country and Lusaka is home to many criminal activities because of the various opportunities that the city offers to criminals. To gauge the state of crime and crime activity on the ground, a survey was carried out in various townships of Lusaka namely; John Howard, John Howard, Kabanana, John Leigh, Kalingalinga, Kanyama, Matero, Chawama, Chibolya, Garden Compound, Chelstone ,Kabwata, Kamwala, Libala, Munali, Nyumba Yanga, Avondale, Ibex, Kabulonga, Makeni, New Kasama and Rhodepark.

It is worth emphasizing that Lusaka is also a comparatively violent city. However, residents are exposed to different forms and levels of crimes. Residents of densely populated settlements such as John Howard, John Howard, Kabanana, John Leigh, Kalingalinga, Kanyama, Matero, Chawama, Chibolya, Garden Compound experience much higher rates of crime than medium populated areas such as Chelstone ,Kabwata, Kamwala, Libala, Munali, Nyumba Yanga. The low density areas such as Avondale, Ibex, Kabulonga, Makeni, New Kasama and Rhodepark experience the least crime incidents.

Crime capturing and recording is one of the most important stages in any crime documentation process. This offers and opportunity for law enforcement officers such as the policy to fully document and capture the

specifics of the crime. This study tries to uncover the various ways that citizens use to report crimes to the police and how the police actually capture those crimes.

The study also looked at utilization of ICTs in crime reporting by the citizens at the point of reporting the crime and by the police at the point of recording and capturing the crime reports.

This study also looks at integrating ICTs in crime reporting and monitoring. This can be achieved through the development of a mobile application that can allow the citizens report crimes and the police to monitor them in real time. With regards, to software development, the methodology that was used in developing the mobile application is the Microsoft Solutions Framework (MSF). This methodology was used because of its agility and focus on milestone achievement and the risk management component of the project. The framework is shown in the in Fig 1 below

#### B. Crime Reporting and Monitoring Application Model Design and Implementation

This section looks at the development of a mobile crime reporting and monitoring tool. This tool will be used by the general public to report crimes and allow the police to monitor them in real-time. The system consists for two main parts; the mobile application (front end) and the Graphical User Interface (GUI) a backend system that is used to monitor and act on the reported crime. The solution is based on client-server architecture. The front end has an Android application and web based Graphical User Interface (GUI) for the police to monitor whatever crimes are reported within a certain radius. The technology that was used to develop the mobile crime reporting application frontend is android, it runs on any android powered phone. The web based Graphical User Interface (GUI) was developed using PHP, The system database is implemented using MYSQL. For location mapping, the Google API was used and a web service was developed to listen for web requests from the mobile application.

##### IV.B.1 Basic Concept and Design

The architecture of the mobile crime reporting application is client-server. The client side is a mobile application running on the handheld device of the user (general public). The user can report a crime by pressing the 'Hot Button' and the nearest police station receives the crime incident notification as a pop up on the screen. A two way SMS messaging system also kicks in, The police officer receives the phone number of the crime reporter and the crime reporter receives the phone number of the police station. The running on the users' handheld device communicate directly with the server; retrieving in real time the crime incident reports that the user reported. Fig 10 below shows the basic architecture of the mobile application

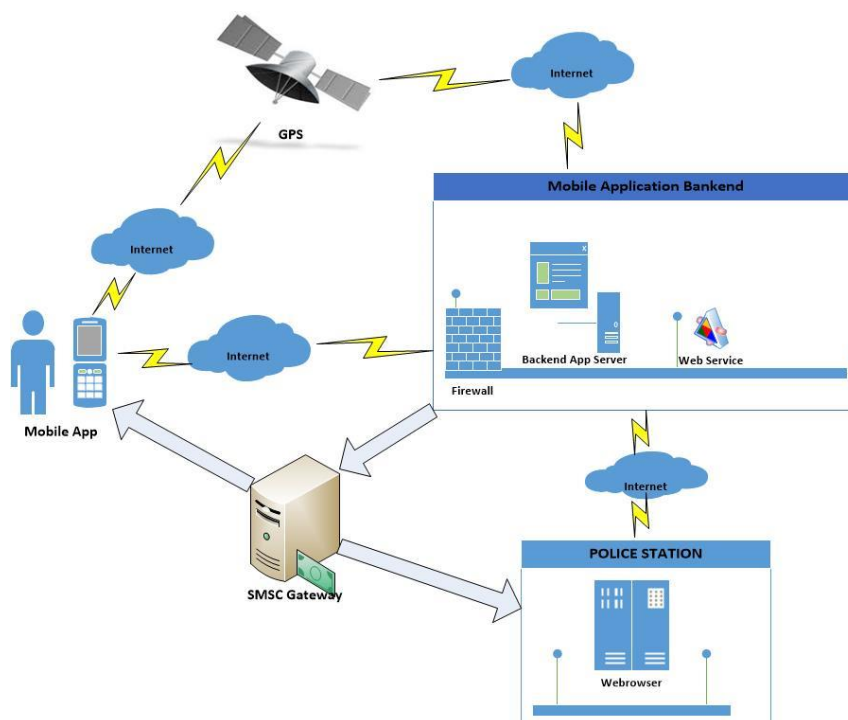


Fig. 10 Mobile Application Architecture

#### IV.B.2 Platform User Interaction

The mobile application will enable users to report crimes in two different ways namely;

- The Normal Way
- Panic Mode Way

*The Normal Way:* The user will be able to log in the Mobile App, Select the type of crime they want to report and add a description. The nearest police station will be able to pick it up.

*The Panic Mode:* The user will be able to press a 'Hot Button' on the app and the nearest police will be able to pick the incident report. The user will also be able to view the crimes they reported. Fig 11 shows the interaction between the citizens, the police and the mobile platform.

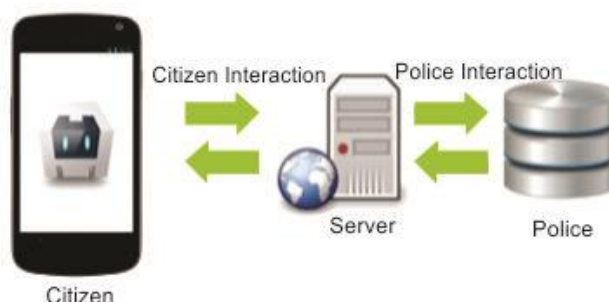


Fig. 11 Platform user interaction

The Police will be able to conduct the following activities on the system

- View reported crime incidents
- Assign reported crime incidents
- Analyse reported crime trends
- Call crime reporter

#### IV.B.3 Mobile Application Use Cases

The use cases depict the activities that a user will be able to do in the system. The citizen will be able to do the following activities in the mobile application

- Create an account in the mobile application
- Report a crime.
- View reported crime.

Fig 12 show the citizen's interaction with the platform

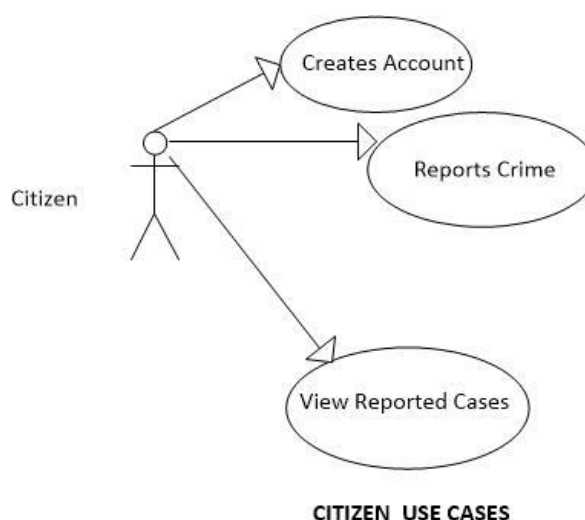


Fig. 12 Citizens Use Case



The police officer will be able to do the following activities in the mobile application

- View reports
- Assign Crime
- Call Crime Reporter

Fig 13 show the citizen's interaction with the platform

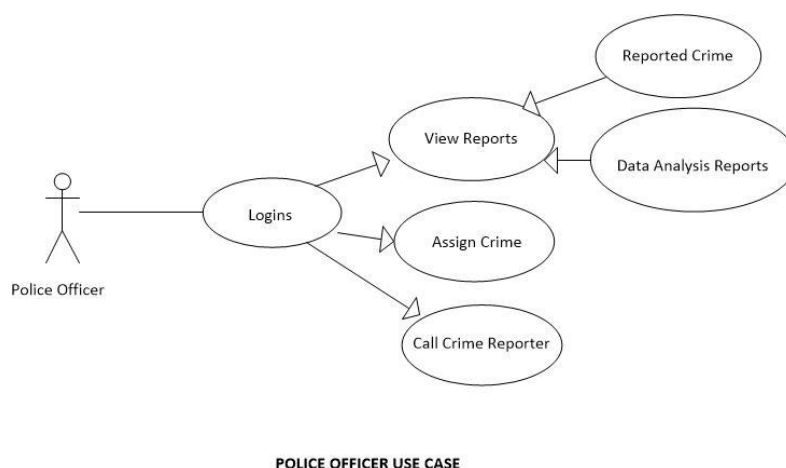


Fig 13 Police Use Case

#### IV.B.4 Mobile Application Sequence Diagram

The sequence diagram below depicts the chain of events in the system. There are two main actors, the citizen and the police officer and their roles and the order of the activities in the system have been defined. Fig 14 below shows the Use Case for the mobile application.

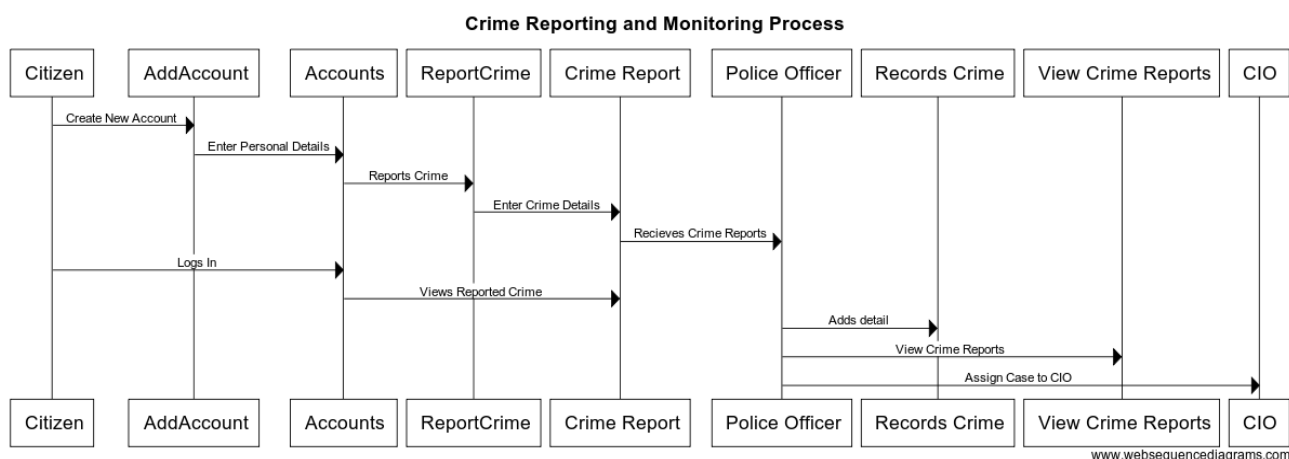


Fig 14 Police Use Case

#### IV.B.5 Entity Relationship Diagram

An Entity Relationship Diagram (ERD) is a graphical representation of an information system which shows the various entities and their attributes. Fig 15 below shows the Entity Relationship Diagram (ERD) of the Mobile Application.



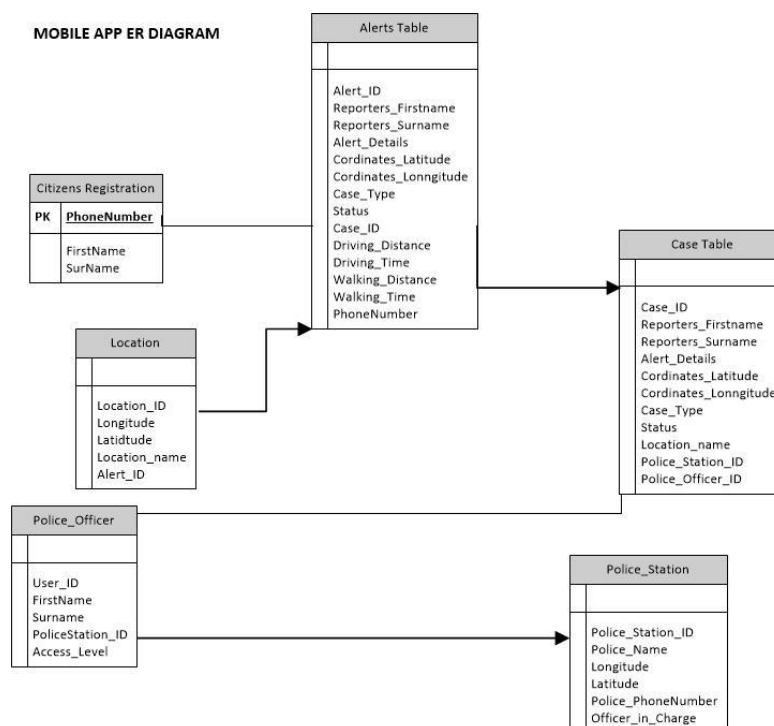


Fig 15 Entity Relationship Diagram

## V. RESULTS

This section looks at the results of the survey based on the questionnaires, oral interviews and audio recordings. The results are organised according to various specific areas that the study set out to answer.

### A. Baseline study

#### V.A.1 Mobile Device Landscape of Lusaka

To fully understand the type and nature of the devices on the ground, A questionnaire was distributed to residents of densely populated settlements of Lusaka such as John Howard, John Howard, Kabanana, John Leigh, Kalingalinga, Kanyama, Matero, Chawama, Chibolya, Garden Compound. Medium populated areas such as Chelstone, Kabwata, Kamwala, Libala, Munali, Nyumba Yanga were also part of the study. The low density areas such as Avondale, Ibex, Kabulonga, Makeni, New Kasama and Rhodpark completed the last category of the study.

In terms of the mobile phone technological space, Lusaka has a whole spectrum. Figure 2 below shows the percentages of internet capable phones from the study that was done. 74% of all the phones considered in the study were internet enabled while 26% were not.

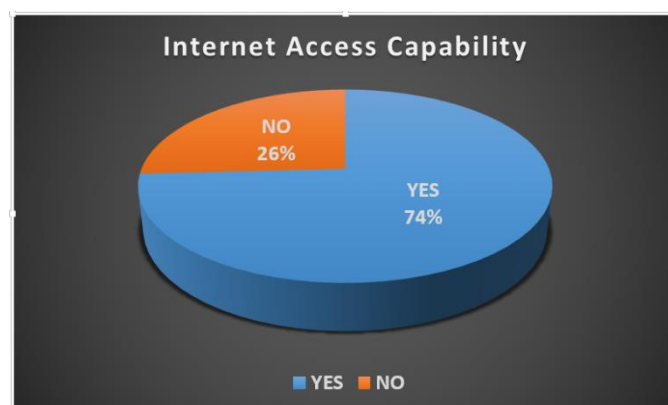


Fig. 1 Mobile Phone Internet Capability

The study also wished to uncover the various operating systems that the mobile devices considered in the survey were running. From the results as shown in Fig 3, 40% of the phones in the study run on android, 24% run of Blackberry IOS, 2% run on windows, 2% run and Apple iOS, 2% run in Symbian and rest which account for about 24% run an unknown operating system.

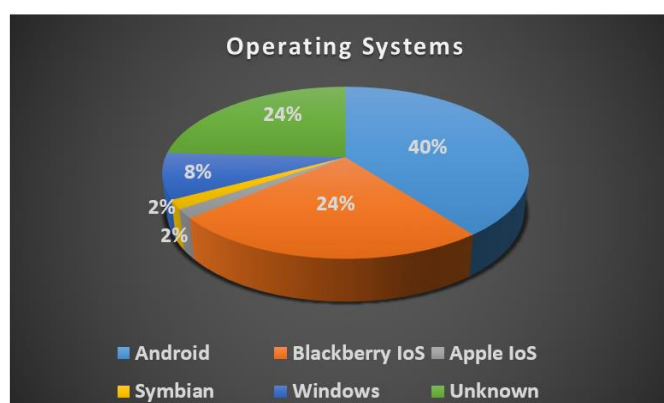


Fig. 3 Device Operating Systems

From the survey results with regards Lusaka's mobile devices landscape, it is evident that for any technology solution to be built that should capture a lot of people, that solution has to be web based or be built on Android

#### V.A.2 Lusaka Crime Landscape

Crime is one of the biggest challenges facing the country and Lusaka is home to many criminal activities because of the various opportunities that the city offers to criminals. Residents of densely populated settlements such as John Howard, John Howard, Kabanana, John Leigh, Kalingalinga, Kanyama, Matero, Chawama, Chibolya, Garden Compound experience much higher rates of crime than medium populated areas such as Chelstone, Kabwata, Kamwala, Libala, Munali, Nyumba Yanga. The low density areas such as Avondale, Ibex, Kabulonga, Makeni, New Kasama and Rhodopark experience the least crime. Fig 4 shows the Lusaka crime prevalence.

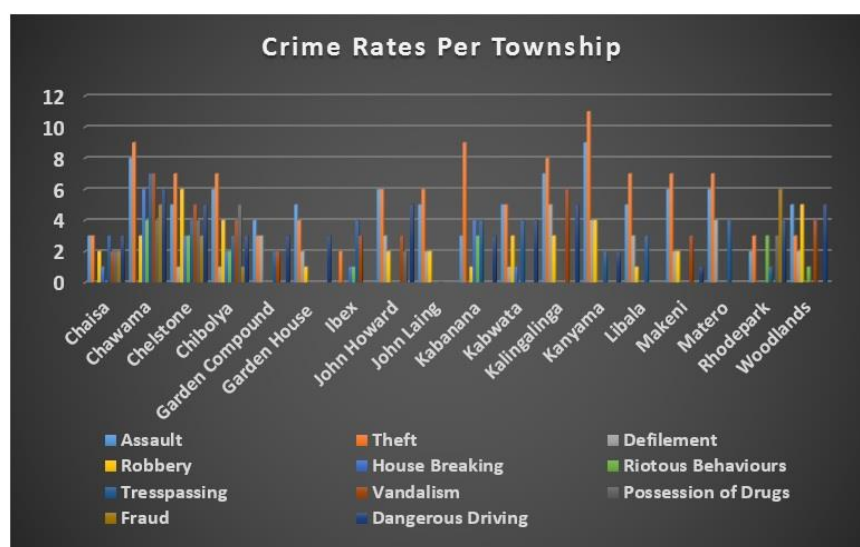


Fig. 4 Lusaka Crime Prevalence

From Fig 4, it is evident that the high density areas such as Chawama, Kalingalinga, Kanyama, Kabanana, Matero, Garden Compound, John Howard, Chaisa, John Laing and Chibolya have high crime frequency prevalence rates than middle density such as Libala, Chelstone, Garden House and Kabwata. The lowest crime prevalence rates were recorded in low density areas such as Woodlands, Ibex, Rhodopark and Makeni.

In terms of the frequency at which crime happens. Fig 5 below reviews that 37% of the citizens experienced crime within the last day, 28% experienced crime within the last week, 9% experienced crime in the last month, 8% experienced crime within the last four months, 13% experienced crime in the last and year and 5% never experienced any crimes. From results, we can deduce that Lusaka is actually a very violent city and its residents are exposed to high levels of crime.



Fig. 5 Lusaka Crime Frequency

### V.A.3 Ways Citizens Report Crime

The study also looked at ways the residents of Lusaka report crime the police, the objective of this study was to determine the mode of interactions that citizens have with the police. The results show that 68% of the citizens walk to the police station, 30% make phone calls and less than 1% use Short Message Service (SMS). In terms of ICT utilization in crime reporting, only 32% of the sampled citizens use ICTs. Fig 6 below shows the study results

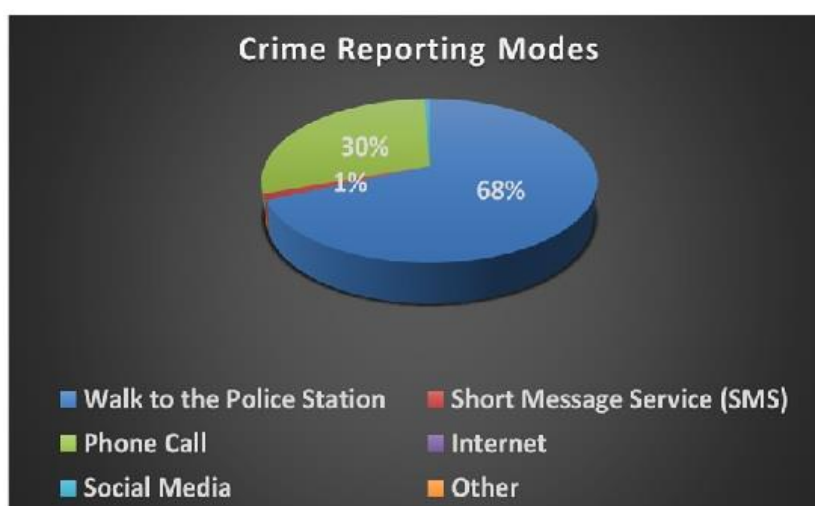


Fig. 6 Lusaka Crime Frequency

### V.A.4 Ways Police Capture and Record Crime

Crime capturing and recording is one of the most important stages in any crime documentation process. This offers and opportunity for law enforcement officers such as the police to fully document and capture the specifics of the crime. The study results show that 68% of the citizens walk to the police station, 30% make phone calls and less than 1% use Short Message Service (SMS). In terms of ICT utilization in crime reporting, only 32% of the sampled citizens use ICTs. Fig 7 below shows the pictorial depiction of the results.

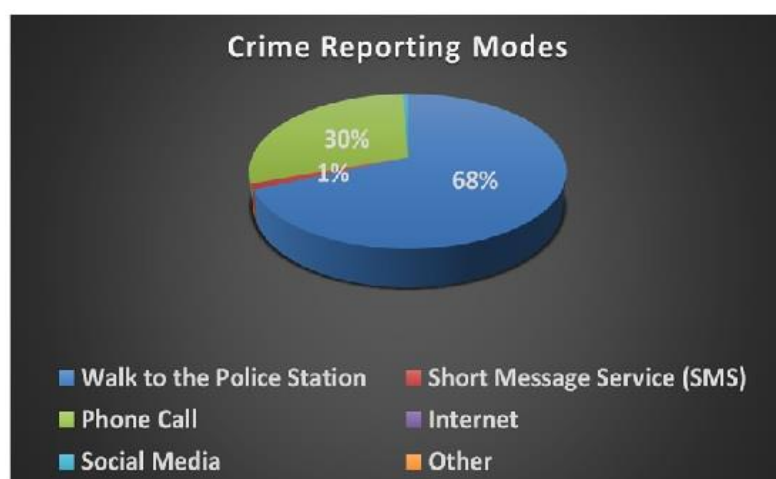


Fig. 7 Ways Police Receive Crime Reports

The study shows that over 98% of the police respondents use manual processes to record crimes. 67% of all the crime reports are received via citizens walking into the police station. Only 33% of the reports are received via electronic means such as phone calls, SMS, Internet and social media platforms. Fig 8 shows the utilization of ICTs in crime recording process. The results show that 98% of the police use manual processes in the crime recording process and only 2% use electronic means.

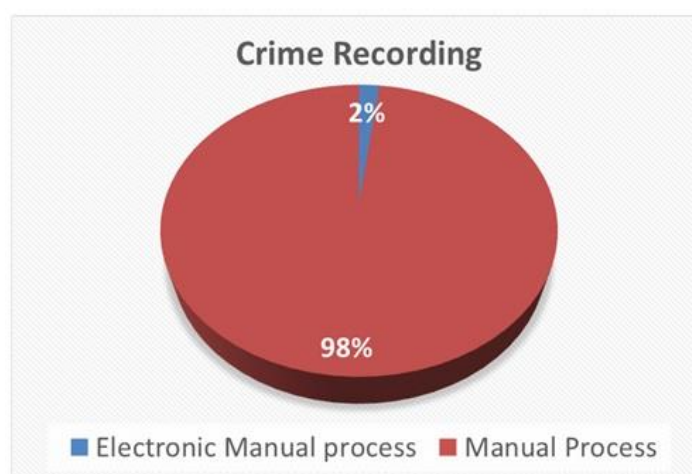


Fig. 8 Crime Recording Process

#### V.A.5 Utilisation of ICTs in Crime Reporting

The study also looked at utilization of ICTs in crime reporting, monitoring and capturing. The study results show that 32% of citizens use ICTs in any form of interaction with the police. In terms of ICT infrastructure, 50 % of police stations had computers, scanners and other multimedia devices. With regards he usage of ICTs in their daily works, only 30% of the police officers use technology in their work in form of video recorders, audio recorders and cameras. Fig 9 below shows the results.

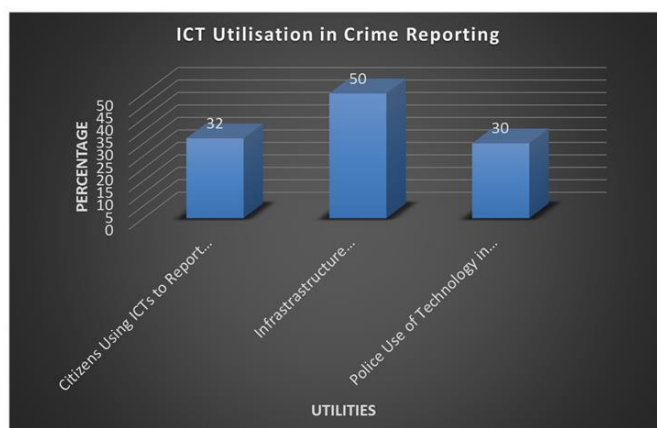


Fig. 9 Utilisation of ICTs in Crime Reporting and Monitoring

## B. Model Implementation Results

### V.B.1 Application Front End

Fig 16 below shows the login in screen for the mobile application .This window will allow the citizens to log in and be able to report a crime.

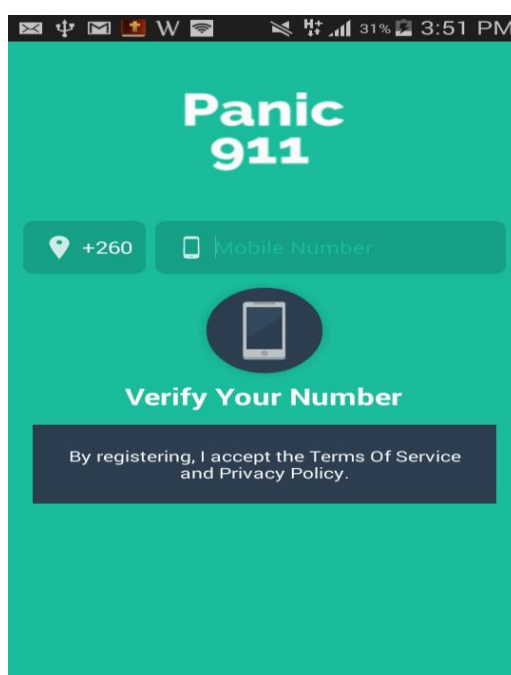


Fig 16 Number Verification Window

Fig 17 below shows the account creation for the mobile application .This window will allow the citizens to enter their details in the mobile application. The registration in the mobile application is a one off process after which the crime reporter just needs to send their crime reports.

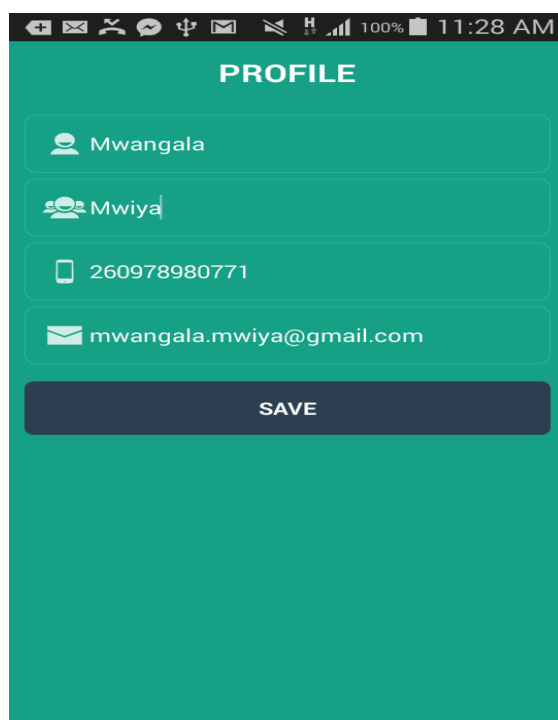


Fig 17 Account Creation Window

Fig 18 below shows the crime reporting window for the mobile application .This window will allow the citizens to select whether they are reporting an emergency crime or a normal crime.

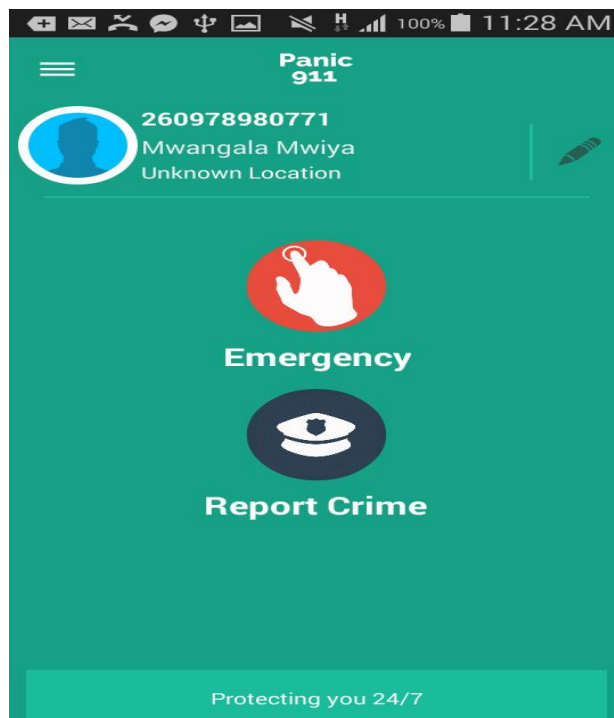


Fig 18 Crime Reporting Window

Fig 19 below shows the crime reporting window which will allow the citizens to enter crime details of the crime to be reported. This feature will mostly be ideal in non-emergency situation where the reporter's life is not in any danger and they can narrate the crime or give a tip to the police.

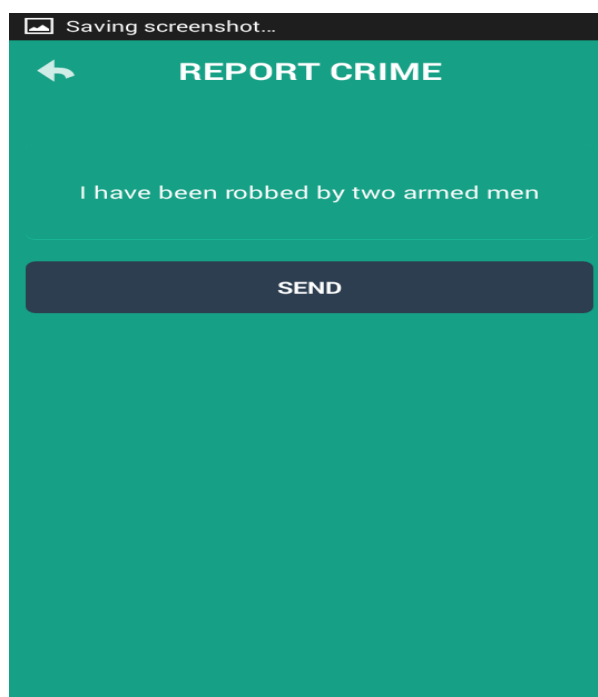


Fig 19 Crime Reporting Window

Fig 20 below shows crime report send confirmation window which shows the status of the crime report after it has been sent. This will give comfort to the crime reporter that their crime report has been sent.

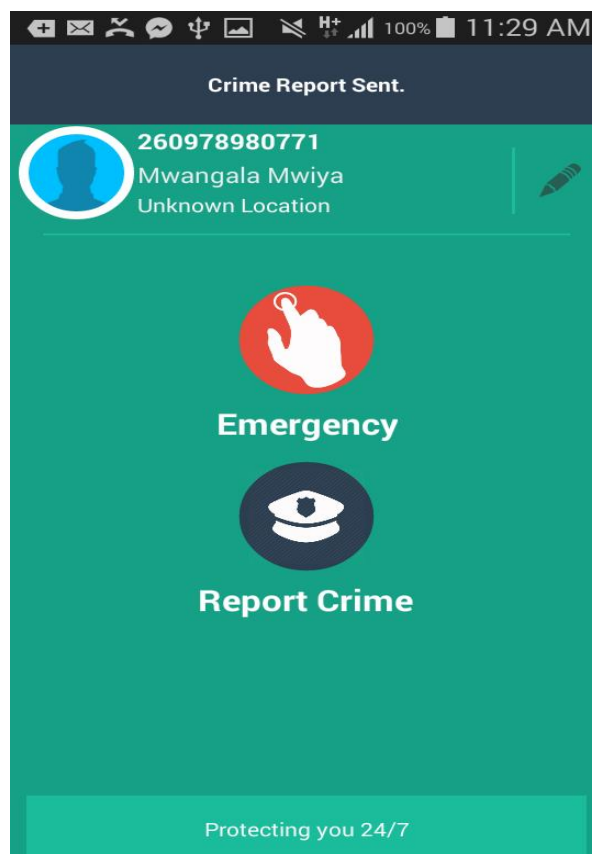
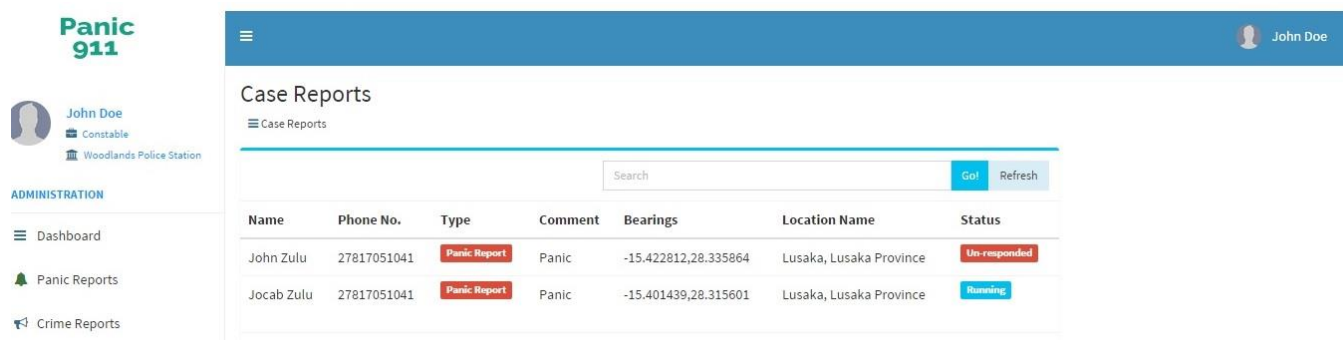


Fig 20 Crime Report Confirmation



## V.B.2 Application Back End

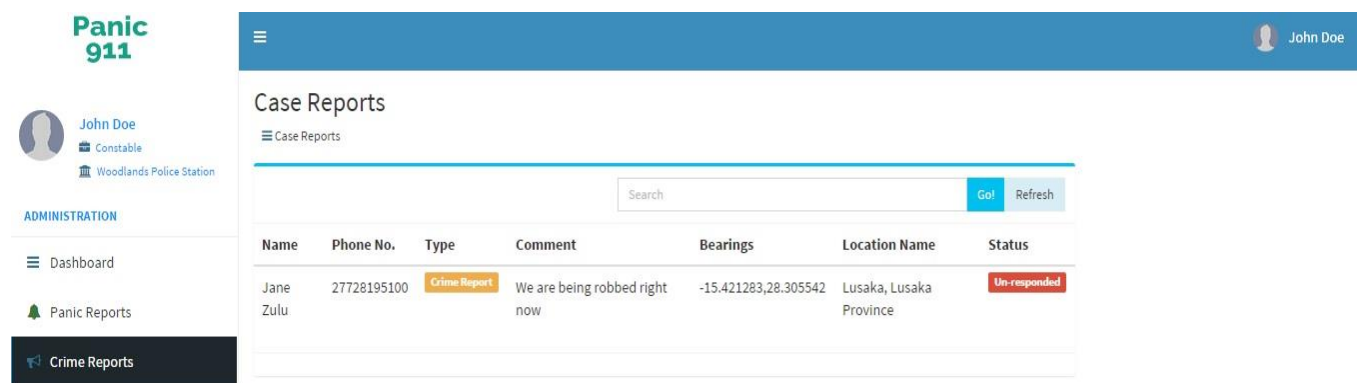
Fig 21 below shows a crime report reported in 'Panic' or 'Emergency' mode.



| Name       | Phone No.   | Type         | Comment | Bearings             | Location Name           | Status       |
|------------|-------------|--------------|---------|----------------------|-------------------------|--------------|
| John Zulu  | 27817051041 | Panic Report | Panic   | -15.422812,28.335864 | Lusaka, Lusaka Province | Un-responded |
| Jacob Zulu | 27817051041 | Panic Report | Panic   | -15.401439,28.315601 | Lusaka, Lusaka Province | Running      |

Fig 21 Panic Crime Report

Fig 22 below shows a screenshot for a normal crime report



| Name      | Phone No.   | Type         | Comment                       | Bearings             | Location Name           | Status       |
|-----------|-------------|--------------|-------------------------------|----------------------|-------------------------|--------------|
| Jane Zulu | 27728195100 | Crime Report | We are being robbed right now | -15.421283,28.305542 | Lusaka, Lusaka Province | Un-responded |

Fig 22 Normal Crime Report

Fig 23 below shows the location of the person who reported the crime.

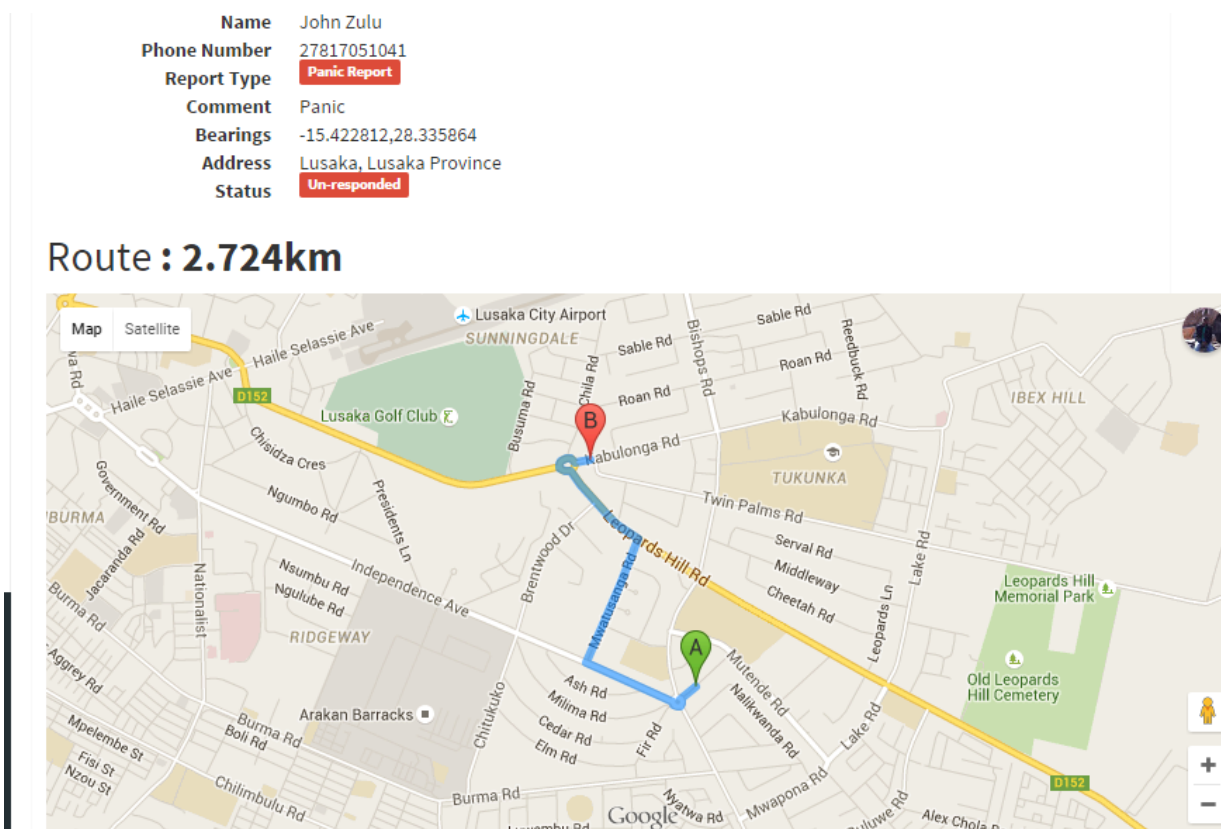


Fig. 23 Normal Crime Report

Fig 24 shows the direction display from police station to the location of the crime reporter. This window will help the police to easily to where the crime reporter is.

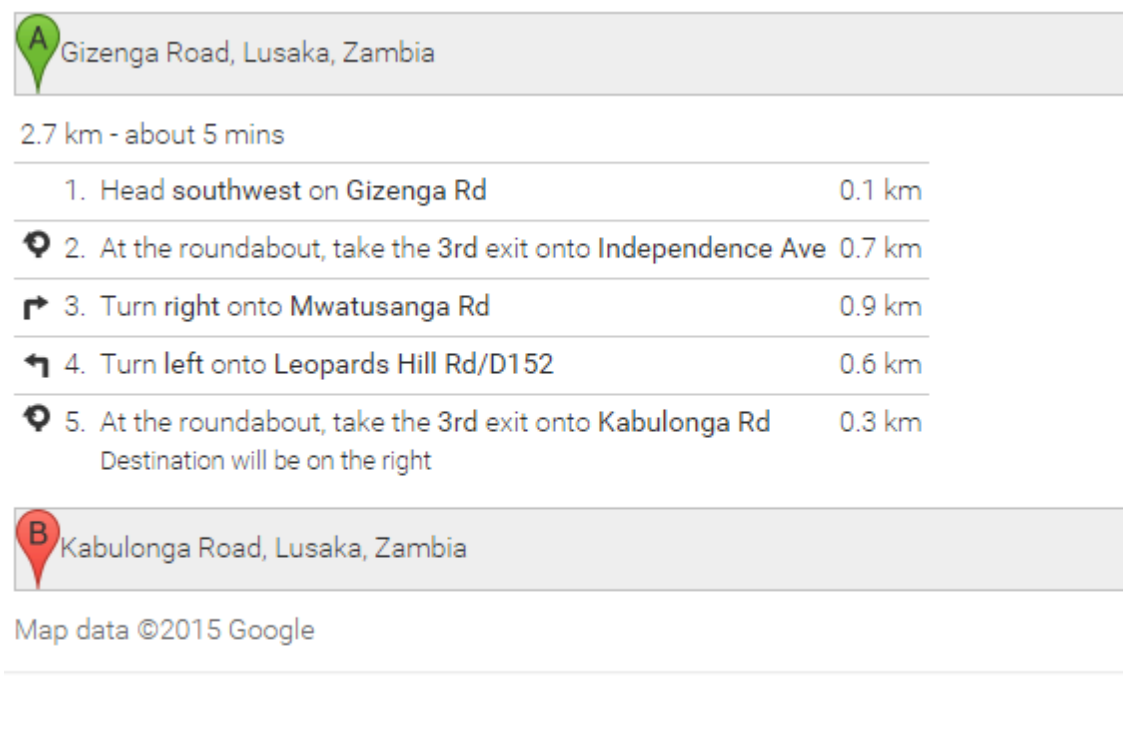


Fig. 25 Police Station Directions

## VI. DISCUSSION AND FUTURE WORK

From the survey that was also conducted to establish the type of mobile devices on the ground, The results show that 40% of the phones in the study run on android, 24% run on Blackberry IOS, 2% run on windows, 2% run on Apple IOS, 2% run on Symbian and rest which account for about 24% run on an unknown operating system. These results mean that in order to enable us reach most people, any tool to be used to fight crime should be developed in Android. The survey also looked at how many of those phones were internet enabled, the results showed that 74% percentage of the phones are internet enabled and the rest are not. The survey results indicate that most of the phones on the market are internet enabled which allows them to access resources on the internet. The study also looked at the different ways in which citizen's report crimes, the results show that 68% of the residents have to walk to the police station to report a crime, 30% make phone calls and the rest use other methods such as a texting, social media and internet. This results basically mean that most of the residents have to walk long distances sometimes and at awkward hours just to report a crime. This sometimes puts their lives in danger and gives criminals too much lead time before crimes are reported to law enforcement.

The study also aimed at establishing the various ways used by police to capture or receive crime incident reports. From the results of the study, the police receive 68% of crime reports via residents walking in and 30% by phone and 2% by other means. This basically means that most of the crimes reports that police document are done by a person having to walk into the police station. This means that for those that can't make it to the police, their crimes are never reported.

The study also looked at determining the utilization of ICTs in crime reporting. The results show that 32% of citizens use ICTs to report crimes. In terms of ICT infrastructures, 50 % of police stations had computers, scanners and other multimedia devices. ICT utilization in the police service is still quite low, only 30% of the police officers use technology in their work in form of video recorders, audio recorders and cameras.

The Mobile crime reporting tool can further be enhanced to enable multimedia attachments and sharing so that the police can have graphic, audio or video evidence of the crime being reported. In order to incorporate multimedia into the mobile app, we need to ensure that the carrier networks are able to transmit that content at acceptable speeds otherwise the whole crime reporting process will be jeopardised.

The other feature that can be incorporated into the application is a live chat option with the police. This will allow the crime reporters or tipsters to engage in live chats with the police. This feature will eliminate a lot of false negatives because a live chat will enable prior engagement with the crime reporter before the police move in. The online chat will also offer a platform for citizens to just find out general information about the police and community they live in. This will lead to reducing the mistrust that is currently there between the police and the general public.

The other enhancement that can be done is enable the crime reporting tool to develop to run on other operating systems apart from Android. Below are some of the operating system that the crime reporting tool can be developed for.

- Apple IOS: This is a proprietary operating system by Apple Inc.
- Blackberry OS: This is proprietary operating system by Research in Motion of Canada.
- Windows OS: This is proprietary operating system by Microsoft Inc.

The main aim of the research was to integrate Information and Communication Technologies (ICT) into crime reporting and monitoring. As part of the future enhancements for the crime reporting application, The Mobile crime reporting tool can further be enhanced to enable multimedia attachments and sharing so that the police can have graphic, audio or video evidence of the crime being reported. In order to incorporate multimedia into the mobile app, we need to ensure that the carrier networks are able to transmit the content at acceptable speeds otherwise the whole crime reporting process will be jeopardised.

The other feature that can be incorporated into the application is a live chat option with the police. This will allow the crime reporters or tipsters to engage in live chats with the police. This feature will eliminate a lot of false negatives because a live chat will enable prior engagement with the crime reporter before the police move in. The online chat will also offer a platform for citizens to just find out general information about the police and community they live in. This will lead to reducing the mistrust that is currently there between the police and the general public.

## VII. CONCLUSION

In this paper, we conducted a study of the mobile devices landscape in Lusaka, Zambia. The study also looked at the crime rates and crime of frequencies in the city. From results, we can deduce that Lusaka is actually a very violent city and its residents are exposed to high levels of crime. Residents experience a lot of challenges with regards reporting of the crime because of the long distances to police stations and the fact that very few citizens even know the phone numbers of police stations and can therefore not contact them in case of an emergency. The other reason is that the Zambia Police toll free lines hardly work and calls made to the toll free number go

unanswered. To safeguard people's lives and property, the integration of ICTs in crime reporting and monitoring process is key as this will effectively bridge the communication gap between the police and the general public in fighting crime. The ultimate result of this study is to therefore develop a mobile crime fighting application that will be used for crime reporting and monitoring.

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