PREPAREDNESS OF THE KENYA NATIONAL POLICE SERVICE TO ADOPT GEOGRAPHIC INFORMATION SYSTEMS TECHNOLOGY IN CRIME MEASUREMENT, MAPPING AND EVALUATION

BARAKA ELIUD GACHIE, BSC

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A RESEARCH PROJECT SUBMITTED TO SCHOOL OF SECURITY, DIPLOMACY AND PEACE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTERS IN SECURITY MANAGEMENT AND POLICE STUDIES, OF KENYATTA UNIVERSITY

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DECLARATION

This research project is my original work and has not been submitted to any institution of higher learning other than Kenyatta University for academic credit.

Signature…………………………………..

Date…02/11/2017…………………………..

Eliud Gachie Baraka, BSc

C159/CTY/PT/24640/2014

This research project has been submitted to School of Security, Diplomacy and Peace Studies with my consent as the appointed supervisor.

Signature…………………………………..

Date…2-11-2017…………………………..

Dr. Shadrack K. Murimi, PhD

Geography Department

Kenyatta University

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DEDICATION

I would like to dedicate this work to all soldiers and security officers who have paid the ultimate price of death while protecting Kenya's territorial integrity and national sovereignty as well as during provision of safety and security services within our state borders. They gallantly recognized the hazards of their chosen profession acknowledging that the call of service to the nation as security personnel has something that goes beyond the attached benefits. I also dedicate this project to all innocent victims of crime for theirs' is not only loss to their families and friends, but also to the state and fellow citizens.

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ABSTRACT

Emerging issues in law enforcement are becoming complex in today's society due to enhanced globalization and increased transnational crimes. To address these challenges, police agencies need to adopt and effectively apply more innovative analysis tools such as Geographic Information Systems (GIS) technology in law enforcement. However, the Kenya National Police Service (NPS) is still using occurrence books, paper-maps and push-pins (manual tools) to record, map and analyse crime. The goal of this study was therefore to assess preparedness of the NPS to adopt GIS Technology in crime measurement, mapping and evaluation. The study was guided by the following specific objectives (i) to determine Kenyan police officers' satisfaction with manual tools in crime measurement, mapping and evaluation, (ii) to establish Kenyan police officers' attitudes toward adoption of GIS technology in crime measurement, mapping and evaluation, (iii) to compare Kenyan police officers' user-perceptions toward manual tools versus GIS technology in crime measurement, mapping and evaluation and (iv) to identify challenges which NPS would encounter during adoption of GIS technology in crime measurement, mapping and evaluation. Survey research design was used where questionnaires, interviews and a focus group discussion were used to collect data at headquarter formations of NPS in Nairobi. Stratified sampling was used where the police population was grouped into four homogenous subgroups (Kenya Police, Administration Police, Directorate of Criminal Investigations and General Service Unit). Twenty five respondents were conveniently selected from each subgroup to have a sample size of 100 respondents. The study used descriptive statistics (frequencies and percentages), measures of central tendency (mean and mode), measures of dispersion (standard deviation) and inferential statistics (Pearson's correlation and t-test) to summarize and analyse survey data. The results were presented in tables, pie-charts and bar-graphs. Information obtained from interviews and the focus group was summarized using content analysis and incorporated in the discussion. The study revealed that 55.00% of Kenyan police officers were satisfied with manual tools in crime measurement, mapping and evaluation mainly because they were easy to use. The study also revealed that 63.50% of Kenyan police officers had an open attitude towards adoption of GIS technology by NPS. The study indicates that only 42.25% of Kenyan police officers found manual tools to be useful in crime measurement, mapping and evaluation while 70.00% believed GIS technology would be more useful. The study shows that 67.75% of the Kenyan police officers found manual tools to be easy to use in crime measurement, mapping and evaluation while 56.75% feared GIS technology might be difficult to use. The study revealed that there would be several challenges during the adoption of GIS technology by NPS but these could be mitigated by putting in place the necessary countermeasures. The study therefore concludes that although most Kenyan police officers were satisfied with manual tools in crime measurement, mapping and evaluation, they were willing to use GIS technology but NPS would have to address some challenges for successful implementation. The study recommends similar and/or related studies to be conducted with a sample comprising of professionals from the Kenya Defence Forces (KDF), National Intelligence Services (NIS) and private security providers across the country. This will provide a holistic perspective since security provision is a collaborative venture that requires combined effort from all stakeholders.

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LIST OF ACRONYMS AND ABBREVIATIONS

AP	Administration Police
CMRC	Crime Mapping Research Centre
COMPSTAT	Comparative Statistics
DCI	Directorate of Criminal Investigation
DOI	Diffusion of Innovation
GIS	Geographic Information Systems
GPS	Global Positioning System
GSU	General Service Unit
ICT	Information Communications Technology
KDF	Kenya Defence Forces
KP	Kenya Police
NIJ	National Institute of Justice
NIS	National Intelligence Services
NPS	National Police Service
POLNET	Police Network
SPSS	Statistical Program for Social Sciences
TAM	Technology Acceptance Model

DEFINITION OF TERMS

Crime analysis is the procedural study of crime incidents and related issues for instance demographic, location and time factors to assist in law enforcement.

Crime evaluation is the process of making a judgment about the number of crime incidents and their distribution in space and time to characterize and appraise them accordingly.

Crime hotspots refer to places in which the occurrence of crime is so frequent in space and time that it is highly predictable.

Crime mapping is the development of visual representation of an area highlighting relationships between elements of that space including but not limited to crime incidents, regions, and related themes.

Crime measurement is the process of acquiring descriptive data concerning type, locations and time of crime incidents.

Geocoding is the process of giving locations unique identity using longitude and latitude labels as well as recording and entering related data into computer drives for storage.

Geographic information systems are computer-based applications which capture, store, display, analyse and allow manipulation of descriptive information (crime data) and geographic information (digital maps), to produce pin- or density-maps which visually present crime distribution in a given area while pinpointing hotspots.

Police culture is a specific system of values, attitudes and beliefs that police officers adapt to their job, which may influence their lives and the decision they make while on duty.

Technical efficiency is the timely achievement of optimal productivity with minimum amount of resources.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Geographic Information Systems (GIS) are computer applications which capture, store, manage, analyse, and present data in a visual form (Huisman & By, 2009). GIS has been extensively utilised in natural sciences especially in environmental studies to link geographic information (where things are) with descriptive information (what things are). In social sciences, the initial use of GIS technology especially in law enforcement was back in 1960s. However, widespread use of computerized mapping technology in police duties occurred mostly after early 1990s when computer processing speed and storage capacity expanded rapidly. From mid 1990s to date, the acceptance and use of GIS technology in crime mapping, hotspots analysis, focused deployment, allocation of resources and strategic planning has grown immensely (Harries, 1999). Currently, developed countries including USA, Britain and Germany are utilizing GIS technologies in crime management with great success being witnessed (Ahmed & Salihu, 2013). Cities such as New York and Chicago have complex GIS technology for example CompStat program which is closely linked to crime analysis and police deployment programs (Getis *et al*., 2000). In Asia, Turkey is using GIS tools such as POLNET to fight crime (Yalcinkaya, 2007). In 1997, a study by the United States National Institute of Justice (NIJ) on application of GIS approaches in policing indicated that 36% of police departments with more than 100 officers used computer-based crime mapping (Mamalian & LaVigne, 1999). By the year 2001, 62% of police departments with more than 100 officers had adopted GIS tools (Weisburd & Lum, 2005). In Africa, Nigeria, South Africa and Egypt are among the few states that are using GIS tools in law enforcement (Ahmed & Salihu, 2013; Yelwa & Bello, 2012). However, Kenyan police officers are still using manual tools in crime measurement, mapping and evaluation in a world where more operations are technology-driven. This research therefore sought to assess preparedness of the NPS to adopt GIS technology in crime measurement, mapping and evaluation.

1.2 Statement of the Problem

Government commissioned reports on status of policing in Kenya by John Krigler 2007, Ransely 2008, Waki 2008 and Task Force on Police Reforms 2009 noted that NPS has poorly adapted to changes in the external environment especially on technological advancement (Nyongesa, 2013). However, Kenyan police officers are still using manual tools in crime measurement, mapping and evaluation in such a time when most operations are driven by technology. According to statistics by the Kenya Police Service, there were 77,851 crime incidents in 2011, 72,091 in 2012, 71,832 in 2013, 69,376 in 2014, 72,490 in 2015 and 73,221 in 2016. This fall and rise in crime trend from 2011 to 2016 can best be evaluated and explained using spatial-temporal attributes via geospatial tools embedded in such applications as GIS which offer accurate real-time analysis (Norris, 2015). In addition, the NPS Crime Situation Report of 2016 documented a 4.5% increase in crime incidents from 69,376 in 2014 to 72,490 in 2015, ascribing the upsurge to complexity in modus operandi by criminals. The report recommended an upgrade of the NPS ICT infrastructure to allow adoption of innovative technologies such as GIS to help address the complexity. NPS is however still employing manual tools in measuring, mapping and evaluating crime. The goal of this study was therefore to assess preparedness of the NPS to adopt GIS technology in crime measurement, mapping and evaluation.

1.3 Objectives of the Study

1.3.1 General Objective

The main goal of this study was to assess preparedness of the NPS to adopt GIS technology in crime measurement, mapping and evaluation.

1.3.2 Specific Objectives

i) To determine Kenyan police officers' satisfaction (in terms of usefulness and ease of use) with manual tools in crime measurement, mapping and evaluation.

ii) To establish Kenyan police officers' attitudes (in terms of perceived usefulness and ease of use) toward adoption of GIS technology in crime measurement, mapping and evaluation.

iii) To compare Kenyan police officers' user-perceptions (in terms of usefulness and ease of use) toward manual tools versus GIS technology in crime measurement, mapping and evaluation.

iv) To identify challenges (financial, technical and human) which the NPS will encounter during adoption of GIS technology in crime measurement, mapping and evaluation.

1.4 Research Questions

i) How satisfied are Kenyan police officers with manual tools in crime measurement, mapping and evaluation?

ii) What is the attitude of Kenyan police officers toward adoption of GIS technology in crime measurement, mapping and evaluation?

iii) What are the Kenyan police officers' user-perceptions toward manual tools versus GIS technology in crime measurement, mapping and evaluation?

iv) Which challenges will the NPS encounter during adoption of GIS technology in crime measurement, mapping and evaluation?

1.5 Justification of the Study

Emerging issues in law enforcement are complex in today's society due to enhanced globalization and increased transnational crimes thus police agencies need to adopt innovations such as GIS technology to address these challenges (Yelwa and Bello, 2012). In addition, the Kenya Police Service Annual Crime report of 2014 (Government of Kenya, 2015) and NPS Crime Situation report of 2015 (Government of Kenya, 2016) recorded an increase in criminal incidents noting emergence of complex trends in criminality. The reports therefore recommended an upgrade of the police ICT infrastructure to allow adoption of modern policing tools such as GIS.

According to Daoud (2011), resources have always been scarce owing to the unlimited nature of human needs; emerging issues in policing e.g. cybercrime, terrorism and other transnational organized crimes have increased competing claims for these scarce resources. As such, to gain and sustain a competitive advantage against security threats, prioritization aided by modern decision support tools such as GIS technology is inevitable to help address the most urgent security needs (Yelwa and Bello, 2012). In addition, learning the issues which influence police officers acceptance of a technology is important in predicting its effectiveness during and after implementation to avoid wastage of resources and frustrations by stakeholders (Colvin and Goh, 2005). This study therefore assessed preparedness of the NPS to adopt GIS technology in crime measurement, mapping and evaluation so as to eliminate negative experiences and thus ensure return on investment.

The study provides a feedback on the Kenyan police officers satisfaction with manual tools in crime measurement, mapping and evaluation thus contributes towards boosting the existing pool of strategic security management literature. The study also reveals Kenyan police officers' attitude toward adoption of GIS technology and hence helps reduce uncertainty of NPS to consider implementing the technology into the law enforcement strategy. The study compares police officers' user-perception for manual tools versus GIS technology and this helps explain why the former are still in use. In addition, the study identifies challenges which NPS would face during adoption of GIS technology and hence helps policy makers to consider putting in place the necessary countermeasures before implementation of such projects. The study, being a formative evaluation on pre-adoption stages, forms a foundation for future studies for instance on the success in, and effective use of GIS technology in measuring, mapping and evaluating crime in Kenya.

1.6 Scope and limitations of the Study

This research study concentrated on the NPS only, which is one of the three national security agencies provided for in Chapter Fourteen of the Constitution of Kenya 2010 (Government of Kenya, 2010). This was inspired by the close contact the NPS has with the Kenyan citizens in maintaining law and order. The KDF and NIS whose operations are covert were not considered for the study although they are key stakeholders in the national security value chain.

The study anticipated some level of non-cooperation from respondents owing to the police code of conduct which demands strict confidentiality. To overcome this, authority was sought from office of the Inspector General of Police, seeking to allow the study to be carried out at headquarter formations of NPS in Nairobi. The researcher was also forced to continuously persuade participants and assure them that the study would be used only for academic reasons and that their identities would remain undisclosed.

1.7 Chapter Summary

Chapter one presents the background to the study in terms of global, regional and local perspective as far as GIS application in policing is concerned. The chapter explains the research problem which inspired this study. The chapter then outlines the objectives of the study and research questions. The chapter goes ahead to present the significance of the study to various stakeholders, the scope of study as well as anticipated and emerging limitations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

The chapter presents the theoretical context, conceptual frameworks and a review of previous studies which supported the theme of research problem. Diffusion of Innovation (DOI) theory was used to guide the study. Technology Acceptance Model (TAM) was used to generate a conceptual framework which guided this study. The chapter also reviews previous studies on GIS technology in policing, and outlines the research gap which this study sought to address.

2.2 Diffusion of Innovation Theory

This research study made use of the Diffusion of Innovation (DOI) theory to predict and explain preparedness of the NPS to adopt GIS technology in crime measurement, mapping and evaluation. The theory by Everett Mitchel Rogers describes how, over time, new products, computer programs, and methods of operation such as GIS technology get into the market and spreads throughout an organization like the NPS (Rogers, 2003). According to Rogers (1983, 2003), there are four key issues during adoption of new technologies namely: technology itself, communication channels, social system/context and time. In addition, there are five key features of a technology which influence its adotion rate: complexity, compatibility, relative advantage, trialability and observability (Rogers 1983; 2003). Similarly, there are five key stages in the technology adoption process: knowledge stage, persuasion stage, decision stage, implementation stage, and confirmation stage (Rogers, 1983; 2003).

Concerning the five important traits of an innovation, relative advantage is explained as the extent to which a technology is seen as more useful compared to the one it substitutes

(Rogers, 2003); GIS technology should be seen as more useful than manual tools. Compatibility is the extent to which the new technology for instance GIS technology is perceived to be in line with the institutional culture, past encounters and present needs of potential users such as Kenyan police officers. If GIS methodologies are not reliable from Kenyan police officers' perspective, then the rate of adoption may be slowed down. As such, compatibility means that the innovation should be meaningful to users and easily adaptable into existing systems and social norms. Rogers (2003) describes complexity as the measure to which a technology is seen as easy to use. GIS technology should not be seen as complex by Kenyan police officers as they are likely not to accept it. GIS techniques should require minimal skills for the police officers to use. Trialability enhances the rate of adoption by reducing the uncertainty through observable pilot results. If GIS technology provides results which are visible to users, peer acceptance becomes easy and rapid (Rogers, 2003). These five attributes of innovations would therefore directly affect adoption of GIS tools by NPS.

Rogers (2003) portrays information seeking and processing as the two most important tasks in the innovation-decision process; they guide the stages in adoption of a technology. The innovation-decision process has five important stages namely: seeking and getting knowledge, persuasion, decision phase, reinvention and implementation. The first step in the stages of the adoption is seeking information about the new technology. According to Rogers (2003), this is a knowledge acquisition stage about the technology. Thus, individual police officers may enquire about GIS technology to understand what it is, why they need it and how it works. This mush needed information will guide and inspire the NPS to adopt GIS because as police officers acquire knowledge, doubt decreases. Moreover, an understanding of GIS benefits and related challenges is increased. The second step in the technology adoption process involves persuasion. Persuasion occurs when police officer form negative or positive attitudes toward GIS technology. The acquired knowledge shapes individual police officer's attitudes about GIS technology. Knowledge acquisition by police officers will enhance persuasion since doubt of GIS functions can impact on their opinions and attitudes. The third step in the technology adoption process is the decision stage, where police officers mentally make an informed choice whether to accept or reject GIS technology. In this stage, GIS technology may be put into pilot/temporary use as a trial, but doubt about its advantages and disadvantages may still be present, especially those pertaining to its efficiency and effectiveness (Rogers, 2003). Reinvention may therefore be necessary as the fourth stage to allow customizing of some GIS functions, in the hands of a Kenyan police officer. After reinvention, the fifth and the last stage is the implementation of GIS technology by putting it into permanent use in the security value chain. During implementation stage, the NPS may put GIS tools into use, and involve confirmation where stakeholders jointly evaluate its effectiveness and efficiency in crime measurement, mapping and evaluation. After going through the five stages, an individual police officer makes a user acceptance decision concerning his/her satisfaction or dissatisfaction with GIS usefulness and ease of use. The final decision is based mainly on the previous stages and the technology's ability to meet an individual user's needs (Sahin, 2006).

2.3 Technology Acceptance Model

This study made use of the Technology Acceptance Model (TAM) to determine Kenyan police officers' satisfaction with manual tools in crime measurement, mapping and evaluation and establish their attitudes toward adoption of GIS technology. In addition, a conceptual framework customized from the TAM as shown in Figure 2.1 was used to guide the study in predicting and explaining preparedness of the NPS to adopt GIS technology in crime measurement, mapping and evaluation. Vankatesh and Davis (1996**)** in the TAM suggest that system use can be explained by understanding user motivation. User motivation is however affected by system's features in terms of its usefulness and ease of use (independent variables) as well as organizational factors (intervening variables) as shown in Figure 2.1.

2.3.1 Conceptual Framework

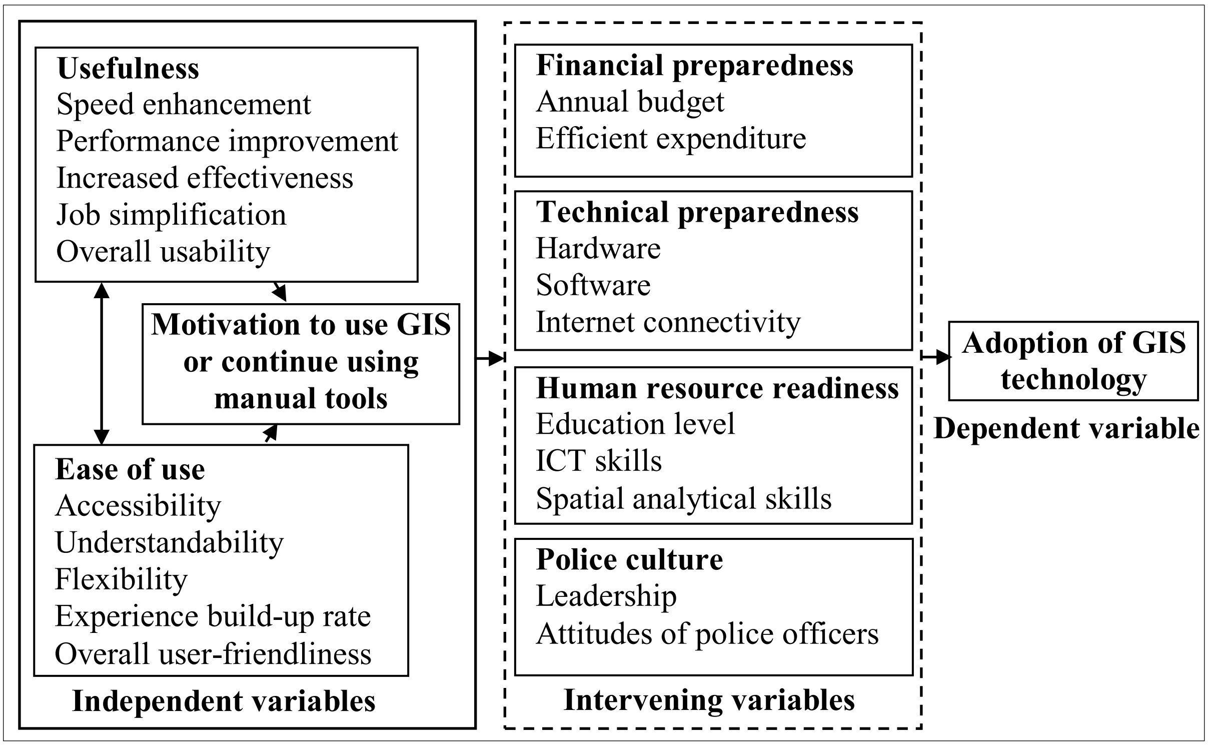

Figure 2.1: Conceptual framework customised from TAM (Vankatesh and Davis, 1996)

Figure 2.1 shows that police officers' satisfaction with manual tools and their attitudes toward GIS technology in terms of usefulness and ease of use (independent variables), the NPS may decide to adopt the later (dependent variable) in crime measurement, mapping and evaluation. The adoption process however must overcome corresponding internal and/or external challenges (intervening variables) for effective and efficient utilization of GIS technology by Kenyan police officers in measuring, mapping and evaluating crime. Independent variables therefore represent system (manual or automated) features while intervening variables represent NPS organizational factors.

Vankatesh and Davis (1996) in TAM explain that people such as police officers tend to use or ignore technologies for instance GIS based on the belief that it improves their job performance (usefulness). In addition, system usage behaviour is also influenced by the efforts required to utilize a technology such as GIS (ease of use). Usefulness is the extent to which users believe a technology for instance GIS technology will improve their job performance while ease of use is the extent to which users trust that using a technology for instance GIS will not require much physical or mental effort (Davis, 1985). According to Vankatesh and Davis (1996**),** a useful technology is therefore expected to be easy to use, give excellent results (effectiveness), save on resources through optimal utilization to curb wastage (economic efficiency), and obtain expected results in the shortest time possible (technical efficiency). Usefulness of a technology is therefore assessed based on its effectiveness and efficiency.

To predict and explain preparedness of the NPS to adopt GIS technology in crime measurement, mapping and evaluation, usefulness was broken down into five indicators namely: speed enhancement, performance improvement, increased effectiveness, job simplification, and overall usability as shown in Figure 2.1. In addition, ease of use was broken down into five indicators namely: accessibility, understandability, flexibility, experience build-up rate, and overall user-friendliness as shown in Figure 2.1. Usefulness and ease of use therefore directly affect user acceptance during and satisfaction after implementation thus may influence diffusion of innovation in terms of relative advantage, complexity and compatibility.

According to Lucas and Spitler (1999), compatibility with social norms, features of the job and organizational factors are the basis for internal and external challenges which also affect user acceptance. These challenges therefore form the intervening variables between user motivation to use a technology such as GIS (independent variables) and actual implementation of the system (dependent variable). Intervening variables shown in Figure 2.1, (financial preparedness, technical preparedness, human resource readiness and police culture) would therefore influence adoption of GIS technology by NPS. The intervening variables were broken down into individual indicators for clarity. Financial preparedness was broken down into the annual NPS budget and efficiency during expenditure. Technical preparedness was broken down into hardware, software and internet connectivity. Human resource readiness was broken down into police officers' level of education, their ICT skills and analytical capability. Police culture was broken down into leadership and attitudes of police officers.

According to Dillon and Morris (1996), usefulness of GIS technology, its ease of use and related challenges would directly influence Kenyan police officers' user motivation and acceptance to adopt the system as well as and satisfaction thereafter. User acceptance is the conspicuous willingness of individuals for example Kenyan police officers, to use a technology such as GIS in crime measurement, mapping and evaluation (Dillon and Morris, 1996). Central to user acceptance is the belief that it must be measured with noticeable level of evidence and not just a mere perception because this is the observable element in diffusion of innovation process. Observability therefore eliminates likely false accounts of acceptance based on coercion. Use of GIS technology should therefore be voluntary and hence users should exploit the technology for its intended use without intimidation (Hu, Lin and Chen, 2005).

Williams and Asheim (2005) in support of TAM explain that any individual user perceives a technology's usefulness or ease of use from a personal viewpoint. As such, while some Kenyan police officers may see GIS technology to be increasing the workload, others may perceive the same information system to be facilitating their duties thus easing the workload. To make GIS technology more useful and easy to use for Kenyan police officers over manual tools, system developers should therefore properly understand potential users' perceptions, expectations and needs (Akgul, 2008; Caker, 2011). The understanding promotes user-acceptance which in turns will affect an individual's ability to optimally exploit GIS tools in crime measurement, mapping and evaluation.

Issues of user acceptance or resistance are important in deciding whether to continue using present methodologies or to adopt a new technology such as GIS because performance for such systems only increases if they are actually put into the right use (Mathieson, 1991). In addition, to objectively evaluate the relative advantage associated with a new technology, users must accept and correctly use it (Agarwal and Prasad, 1997). As such, the more new technologies such as GIS are put into their intended use, the more productivity they yield and hence the greater the relative advantage.

Yalcinkaya (2007) studied acceptance of the Police Network (POLNET) system among the Turkish National Police officers. The study found that usefulness (relative advantage), and ease of use (complexity and compatibility) during diffusion of innovation, significantly affected intent to use. Police officers' attitude toward adoption of GIS technology by the NPS might therefore be greatly influenced by the organization's preparedness to successfully take up and optimally utilize the methodology.

2.4 GIS Technology in Crime Measurement, Mapping and Evaluation

GIS refers to computer-based system with mapping tools and an interface with datasets, such as crime incidents with associated descriptive information (Harries, 1999). GIS technology is therefore a computer-based application that captures, stores, analyses, displays, and manages data sets that are associated with locations. GIS technology can therefore effectively replace manual tools in crime measurement, mapping and evaluation. According to Murphy (1995), GIS technology links geographic information (where things are e.g. estates) with descriptive information (what things are e.g. homicide incidents). Since crime like all other events happens in specific space and time, it can easily be mapped using GIS tools for spatial visualization and analysis (Norris, 2015).

According to Murphy (1995), GIS technology links descriptive data about events to geographically referenced locations in a strategic problem solving pathway to produce informed decisions. GIS technology has the ability to analyze data with regard to their geographic positions and hence the user can make accurate situation assessment and produce effective solutions to a problem (Smelcer and Carmel, 1997; Yelwa and Bello, 2012) and therefore decreases the problem solving time by making critical analysis faster and more effective. Jarupathirun & Zahedi, (2007) and Speier (2006) acknowledge that many studies on the impact of GIS technology in law enforcement indicate that it is an approach that allows spatial visualization of data thus widening the perception of decision makers about certain issues which concerns the decisions they will make in solving problems.

Exploration from literature proposes key uses of GIS technology as computer-based crime mapping, analysis of hotspots, enhancement of command and control as in the case of CompStat project in the New York city, and geographic profiling during investigations especially those related to serial offenders (Chainey & Tompson, 2008; Leipnik & Albert, 2003; Ratcliffe, 2004). Computer-based crime mapping using GIS methodologies help in understanding the distribution of crime in a location, pinpoint area that have high crime incidents (hotspots) and guide resource allocation especially deployment of police officers. In Lowell, Massachusetts, Braga and Bond (2008) used GIS approaches in identifying crime hotspots to guide effective police response as a problem-oriented policing tool. In addition, Potchak, McGloin, and Zgoba (2002) established the geographic positions of 201 criminals who were detained for vehicle-related thefts in Newark, New Jersey in 2000. Robinson (2008) as well as Weisburd and Green (1995) used data from previous studies to superimpose layers of opportunities including land-use status, public housing and major highways in creating a detailed vehicle theft trend map. GIS technology therefore offers useful data on crime distribution and trends in a shorter timeline for informed and rapid response by police officers. Harries (1999) and Rich & Shively (2004) therefore deduce that while the hotspots analysis is inclined more towards deterring crime as a preventive strategy, profiling serial offenders aid in investigations as a reactive strategy. These studies have all their efforts directed towards actual use of GIS technology with minimum focus on feasibility for adoption.

Assertions of effective exploitation of computer-based mapping tools such as GIS technology in police operations are published across the world and of specific interest to this study is the CompStat GIS project in New York. CompStat GIS project was recognized for decreasing crime and hence improving life in New York City due to its instantaneous and thorough crime analysis which led to rapid deployment of resources, proactive policing and cooperation among stakeholders (Bratton, 1997, 1998; Kelling & Sousa, 2001; Silverman, 1999). Successful cases of GIS technology adoption by law enforcement agencies include police organizations in Lincoln, Nebraska (Casady, 2003), Phoenix, Arizona (Hill, 2003), Knoxville, Tennessee (Hubbs, 2003) and Spoke, Washington DC(Leipnik *et al*., 2003) in the United States, as well as Kano State (Ahmed & Salihu, 2013) and Katsina State (Yelwa & Bello, 2012) in Nigeria. All these recounts focus on the effectiveness of GIS technology after implementation with little publication on pre-adoption stages of the projects.

In the year 1997, during a survey by the Crime Mapping Research Centre (CMRC) of the NIJ in the United States, Mamalian and LaVigne (1999) studies which police departments made use of computer-based mapping tools such as GIS as well as their related experiences. Weisburd and Lum (2005) studied GIS applications by US police agencies and concluded there was an increasing trend in utilization of computer-based mapping tools. While assessing new tools for in crime measurement, mapping and evaluation, Vann and Garson (2003) state that GIS technology has become core to policing especially in guiding problem solving making process due to effectiveness of its many functions. Similarly, some pragmatic analyses of GIS-related programs have been carried out, mostly in the US for instance studies on: the contribution of CompStat project to crime reduction in New York city (Chilvers & Weatherburd, 2004; Eck and Maguire, 2000; Mazerolle, Rombouts & McBroom, 2006), the impact of GIS-based hotspots identification on crime management (Braga *et al.,* 1999; Sherman & Weiburd, 1995), the impact of crime visualization on people's perception (Paulsen, 2004), and the effects of geographic profiling on investigating criminal incidents (Canter *et al*., 2000; Rossmo, 1995). Amongst these studies, those on hotspots analysis are the most prominent. However, these studies did not investigate why many other police agencies continue to use manual tools in their policing activities.

2.5 Research Gap

From the above review, most studies have looked at which police organizations made use of GIS technology and how they utilised it. There was need to investigate police officers' satisfaction with manual tools and why some police agencies are still using them in law enforcement during this modern era when most operations are driven by technology. Most of the reviewed studies on the application GIS methodology in law enforcement concentrated on process and summative evaluation. As a result, formative evaluation which may forecasts user-acceptance and challenges before implementation of GIS projects to ensure successful implementation has been accorded minimum interest; a gap that ought to have been addressed. While GIS technology has been said to be an effective tool in law enforcement in the reviewed studies, little assessment has been conducted on pre-adoption factors which may affect user acceptance and successful implementation. Similarly, despite the above highlighted evaluative efforts being done in developed countries, few such studies have been conducted in developing countries and hence this study helped to address the gap; Kenya is one of the states in the later category.

2.6 Chapter Summary

Chapter two explains how DOI theory and TAM guided this study. It also discusses the use of GIS approaches in crime measurement, mapping and evaluation. The chapter then highlights the studies that have been carried out on GIS technology in crime measurement, mapping and evaluation. The chapter finally gives a summary of identified research gaps which the study sought to address.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

The chapter highlights the information about methods and materials which were used in this study. The study made use of a survey research design. The research population was the NPS officers while the study site was the headquarter formations of the organization in Nairobi, Kenya. The study made use of stratified sampling to identify homogenous study subgroups and select respondents. Structured questionnaire, interview guide and a focus group discussion were used to acquire data for this study. Data obtained from questionnaires was analysed using frequencies, percentages, mean, mode and standard deviation. Pearson's correlation coefficient analysis was used to establish relationships between variables while t-test was used to compare means for significant difference. The results were presented in tables, bar-graphs and pie-charts. Information from interviews and focus group discussion was summarized using content analysis and results incorporated in the discussion.

3.2 Data collection

Data for this study was generated from both primary and secondary sources. Questionnaires, interviews and focus group discussion were used to collect primary data. Existing literature (internet sources, journal and text books) provided secondary data to support the theme of the research problem.

3.2.1 Research Site and Population

The unit of analysis in this study was Kenyan police officers. The study site was the NPS headquarters in Nairobi, Kenya. Study subgroups included: Kenya Police (KP), Administration Police (AP), General Service Unit (GSU), and Directorate of Criminal

Investigations (DCI) in Nairobi. Map of the study area showing the location of Nairobi within Kenya (inset) and the four headquarter formations of NPS is included as Appendix iii. These NPS headquarters were purposely identified and selected for this study because they host strategic level systems and personnel; policy making is a practical mandate for strategic managers (Nyongesa, 2013). The four entities of the NPS were therefore the most suitable formations whose personnel could provide credible information with regard to national security strategies. In addition, strategic level personnel have experiences not only at the strategic level but also at operational and tactical levels, having risen through the ranks from junior service roles into corresponding senior positions.

3.2.2 Research Design

This study made use of survey research design. A survey is a technique of gathering information by administering questionnaires or conducting interviews to a sample of persons (Orodho, 2003). Descriptive survey was the most suitable design because the study sought to use a one-time data collection strategy to obtain data and describe reality concerning preparedness of the NPS to adopt GIS technology in measuring, mapping and evaluating crime in Kenya. According to Orodho and Kombo (2002), descriptive survey can be used to acquire information about human attitudes, opinions or habits. This study therefore aimed at obtaining Kenyan police officers' opinions and attitudes about preparedness of NPS to adopt GIS technology in crime measurement, mapping and evaluation.

3.2.3 Sampling Technique

The study made use of stratified sampling to identify homogenous subgroups of the NPS for full representation of the diverse policing roles. Kombo and Tromp (2006) define stratified sampling as a probability sampling method where the researcher divides the target population into homogenous subgroups from which respondents are then selected. This study divided the NPS into four homogeneous subgroups namely, KP, AP, GSU, and DCI. Convenient sampling was thereafter used to select an equal number of volunteer respondents from each of the four sub-groups.

3.2.4 Sample Size

A sample size of 30-500 is appropriate for most research studies (Roscoe, 1975). However, he recognises that the bigger the sample size, the lower the margin of error thus the more likely a normal distribution would be generated and vice versa. For this study, Fisher's formula was used to calculate the sample size as shown in Equation 3.1. Considering a 5% margin of error at significance level of 0.05, within 1.0 standard deviation of the mean and taking into consideration of a population with required features at 50%, a sample size of 100 police officers was arrived at as follows:

$\mathbf{n=Z^2pq/d^2}$ (Equation 3.1, (Fisher *et al.*, 1998)).

Where: **n** =the desired sample size,

Z=the standard deviation,

P=the proportion of police population with features being studied,

q=1-p and,

d=the level of statistical significance at 5% margin of error.

Therefore:

$\mathbf{n} = (1.0)^2(0.50)\ (0.50)/\ (0.05)^2 = 100$

Using equation 3.1, a sample size of one hundred (100) respondents was arrived at. Convenient sampling was used to select an equal number of twenty five (25) respondents from each of the four subgroups. Out of the 100 subjects reached, 94 responded to the questionnaires representing 94.0% response rate. 5 questionnaires were discarded for missing more than 25% of responses thus only 89 respondents were used for analysis. Interviews were conducted with 12 volunteer respondents as a follow up in responding to issues that required in-depth clarification. Five (5) key informants were brought together in a focus group discussion to comprehensively address the demands to the research questions.

3.2.5 Research Instruments

The study made use of questionnaires, structured interviews and a focus group discussion to collect data and information related to research questions and objectives. With the use of questionnaires, data collection bias was reduced as the respondents reacted to what was printed on paper while confidentiality was also upheld, as respondents remained anonymous. Questionnaires saved on time as they could be administered simultaneously to multiple respondents from the four subgroups of the NPS. One questionnaire was administered to each of the 100 respondents. 12 interviews schedules were conducted as a follow up to issues which needed clarification. According to Robinson (2002), interviews stimulate respondents to expose their feelings, hidden motivation, interests and decisions and as a result, they gave additional information without holding back. A focus group discussion was then organised for 5 key informants to generate deeper insights on the issues under investigation.

3.3 Data Analysis

The study used descriptive statistics (frequencies and percentages), measures of central tendency (mean and mode), measures of dispersion (standard deviation) and inferential statistics (correlation and t-test) to summarize and analyse survey data. Statistical Program for Social Sciences (SPSS) computer application was utilized to compute statistical summaries which display the characteristics of the sampled population. To do this, data acquired from questionnaires was coded, collated and summarized using tables, pie-charts and bar-graphs. Since responses were based on a 5-point Likert scale, computed means for each predictor were converted into their corresponding percentages to clearly understand the respondents' opinions and attitudes. In addition, Pearson's correlation coefficient analysis was used to establish the relationship between related indicators while t-test was used to compare means for significant difference. Information obtained from interviews and the focus group discussion was summarized using content analysis and the results incorporated in the discussion.

3.4 Reliability and Validity

Issues of reliability and validity are very important in the selection of the research instruments. Reliability is the extent to which research instruments give consistent feedback any time they are used in similar conditions (Case, 2007). The questionnaire was therefore carefully designed with reference to existing publication on technology acceptance to ensure both reliability and validity. The questionnaire was also subjected to a pilot study among non-participating NPS officers and survey questions were subsequently reviewed accordingly to ensure expectations of the specific objectives were met. In addition, the questionnaire consisted of items which were customized from already published literature.

Validity is defined as the degree to which the measurement procedures accurately correspond to the concepts under investigation (Case, 2007). Validity ensures that the researcher is able to defend the study findings without fear of contradiction (Mentzer and Flint, 1997). For this study, the questions were carefully customized guided by existing publications on diffusion of innovation and technology acceptance; whose content validity had already been established. In addition, interviews and a focused group discussion with key informants were done to get in-depth perspective about the issues which were under investigation.

3.5 Ethical Considerations

National security matters are very sensitive and hence confidential. Ethical issues including official clearance from relevant authorities, informed consent, voluntary participation by respondents and confidentiality were strictly observed. Authority was therefore sought from office of the Inspector General, seeking to allow the study to be carried out at headquarter formations of NPS. In addition, informed consent was sought from all respondents by a written invitation to participate providing them with the rationale for the study. Moreover, confidentiality was guaranteed by keeping undisclosed, the identity of respondents. An assurance was given to the NPS authorities and all respondents that information obtained would be used by the researcher purely for academic purposes. Ethical clearance was also sought from Kenyatta University Ethics Review Committee (KUERC) and National Commission for Science, Technology and Innovation (NACOSTI).

3.6 Chapter Summary

Chapter three presents information on the material and methods which were used during this research study. It outlines the data collection techniques in terms of research site, study design, sampling technique and sample size and research instruments. The chapter then discusses data analysis techniques in terms of how field data was summarized, analysed and presented. The chapter also highlights data management procedure in terms of validity and reliability as well as ethical considerations.

CHAPTER FOUR

4.0 RESEARCH FINDINGS

4.1 Introduction

To respond to the research questions and achieve the specific objectives of the research study, this chapter presents the results and a discussion about the findings of the survey. The objectives of this study were: (i) To determine Kenyan police officers' satisfaction with manual tools in crime measurement, mapping and evaluation, (ii) To establish Kenyan police officers' attitudes toward adoption of GIS technology in crime measurement, mapping and evaluation, (iii) To compare Kenyan police officers' user-perceptions toward manual tools versus GIS technology in crime measurement, mapping and evaluation, and (iv) To identify challenges which NPS would encounter during adoption of GIS technology in crime measurement, mapping and evaluation. The statistical summaries of control and exogenous variables are presented in tables, bar-graphs and pie-charts. Information gathered from volunteer respondents and key informants during interviews and the focus group was screened through content analysis and incorporated in the discussion.

4.2 Results

4.2.1 Socio-Demographic Characteristics of Respondents

The study grouped socio-demographic characteristics of respondents as NPS formation, respondents' rank, years of service, sex and educational level as shown in Table 4.1. Police formation and rank represented the structural nature of the NPS. Years of service, education level and sex represented the functional characteristics of the respondents. Table 4.1 is a summary of responses obtained from the research questionnaire which is included as Appendix 1.

Table 4.1: Frequencies and percentage distribution for socio-demographic characteristics of respondents

Variable	Attributes	Frequency (n=89)	Percent (%)	Cumulative (%)
Formation	KP	23	25.8	25.8
	AP	19	21.3	47.2
	DCI	23	25.8	73.0
	GSU	24	27.0	100.0
Rank	Constable/ Corporal	40	44.9	44.9
	Sergeant/ Senior sergeant	11	12.4	57.3
	Inspector/ Chief Inspector	20	22.5	79.8
	Gazetted Officers	18	20.2	100.0
Years of service	1-10 years	51	57.3	57.3
	11-20 years	24	27.0	84.3
	21-30 years	13	14.6	98.9
	Over 30 years	1	1.1	100.0
Sex	Male	57	64.0	64.0
	Female	32	36.0	100.0
Education level	Form 4	31	34.8	34.8
	Diploma	12	13.5	48.3
	Bachelors	40	44.9	93.3
	Masters	5	5.6	98.9
	PhD	1	1.1	100.0

(Field data, 2017)

The study categorized the NPS into four homogenous subgroups namely KP, AP, DCI and GSU. A summary of how each subgroup responded to the study is presented in a pie-chart as shown in Figure 4.1.

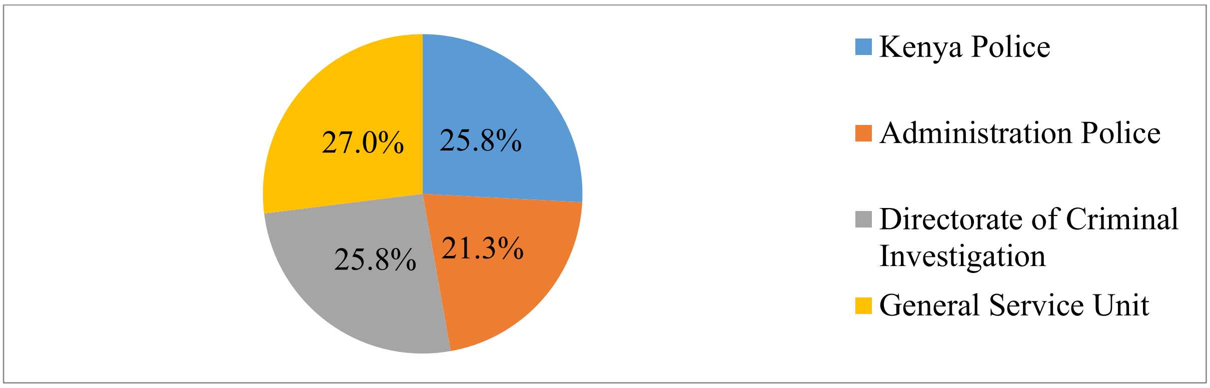

Figure 4.1: Responses in terms of police formations in NPS

Figure 4.1 shows there were 24 respondents (27.0%) from the GSU representing the highest response rate among the four subgroups. There were 23 respondents (25.8%) from the DCI and 23 respondents (25.8%) from the KP. The least number of responses were from the AP with 19 respondents representing 21.3% of the sample.

Respondents' rank was spread into four different classes to explain the seniority of respondents within the NPS. A summary of how each category of rank responded to the study is presented in a pie-chart as shown in Figure 4.2.

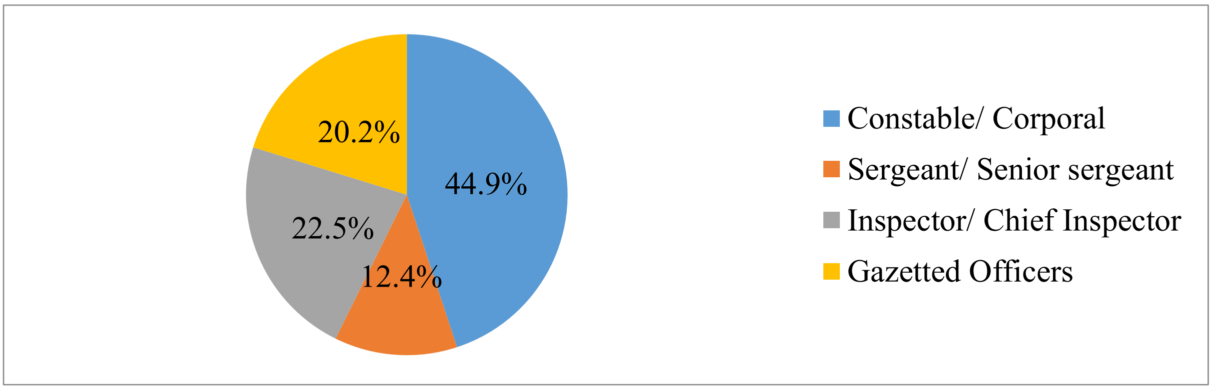

Figure 4.2: Responses in terms of rank within NPS

Figure 4.2 shows that 40 Police Constables and Corporals responded to the survey representing the biggest portion of the sample at 44.9%. 11 Sergeants and Senior Sergeants (12.4%) responded to the study. 20 Inspectors and Chief Inspectors (22.5%) participated in the survey while 18 Gazetted Officers (20.2%) participated in the study.

The study grouped respondents' years of service into four different categories to explain the respondents' level of experience. A summary of how police officers with various level of experience responded to the study is shown in Figure 4.3.

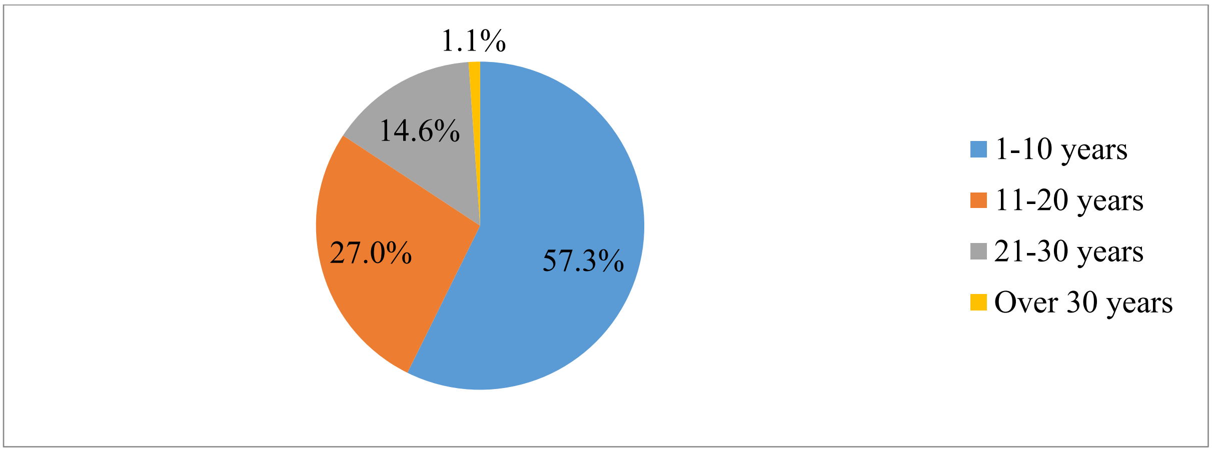

Figure 4.3: Responses in terms of years of service

Figure 4.3 shows that out of the 89 subjects, 51 respondents (57.3%) had served in the police service for 10 years or less, 24 respondents (27.0%) had served between 11-20 years, 8 respondents (14.6%) had served between 21- 30 years, and 1 respondent representing (1.1%) had served for more than 30 years. Police officers who had served for 1- 10 years constituted the largest portion of the sample; those who had served for more than 30 years represented the smallest portion.

The study also grouped respondents by sex to exhibit gender inclusion during the survey. A summary of how male and female police officers responded to the study is shown in Figure 4.4.

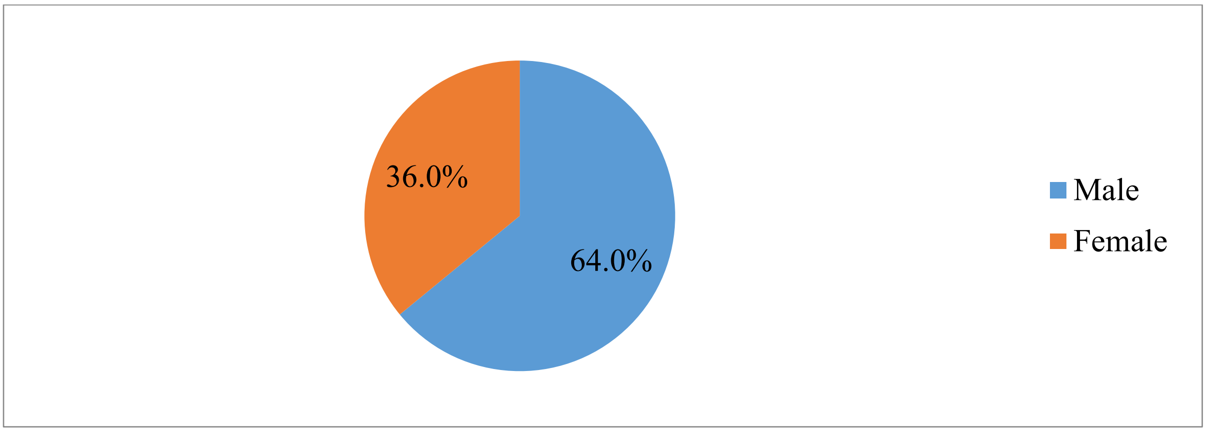

Figure 4.4: Responses in terms of sex

Figure 4.4 shows male respondents were more than their female counterparts. 57 respondents representing 64.0% of the sample were males while 32 respondents (36.0%) were females.

The study grouped respondents by their level of education to illustrate the diversity of knowledge within the sample size which was selected for this study. A summary of how respondents were represented in terms of their education level is shown in Figure 4.5.

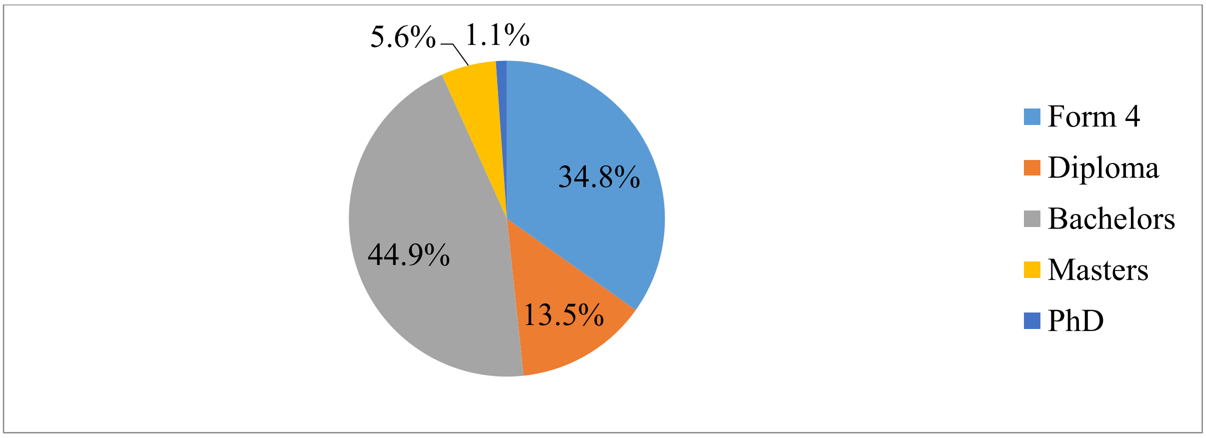

Figure 4.5: Responses in terms of academic qualification

Figure 4.5 shows that out of the total 89 subjects who participated in this survey, 40 respondents (44.9%) had Bachelor's degree qualification, 31 respondents (34.8%) had High School certificate, and 12 respondents (13.5%) had Diplomas. 5 respondents (5.6%) had Masters qualification while only 1 respondent representing 1.1% of the sample had a Doctorate degree. Majority of respondents were graduates though there was only one PhD holder in the sample.

4.2.2 Kenyan Police Officers' Satisfaction with Manual Tools in Crime Measurement, Mapping and Evaluation

Predictors of Kenyan police officers' satisfaction with manual tools in crime measurement, mapping and evaluation were usefulness and ease of use. Both usefulness and ease of use were further broken down into five indicators to diversify respondents' judgement on their satisfaction with manual tools.

4.2.2.1 Manual Tools' Usefulness in Crime Measurement, Mapping and Evaluation

Indicators of manual tools' usefulness in crime measurement, mapping and evaluation were speed increment, performance enhancement, improved effectiveness, job simplification and overall usability as shown in Table 4.2. Responses for each indicator were based on a 5-point Likert scale as follows strongly disagree=1, disagree=2, neutral=3, agree=4 and strongly agree=5. Table 4.2 and Figure 4.6 are a summary of responses obtained from the research questionnaire which is included as Appendix 1.

Table 4.2: Frequencies and percentage distribution for manual tools' usefulness

Variable	Attributes	Frequency(n=89)	Percent (%)	Cumulative (%)
Speed increment	Strongly disagree	19	21.3	21.3
	Disagree	28	31.5	52.8
	Neutral	24	27.0	79.8
	Agree	12	13.5	93.3
	Strongly agree	6	6.7	100.0
Performance enhancement	Strongly disagree	24	27.0	27.0
	Disagree	29	32.6	59.6
	Neutral	19	21.3	80.9
	Agree	10	11.2	92.1
	Strongly agree	7	7.9	100.0
Improved effectiveness	Strongly disagree	22	24.7	24.7
	Disagree	31	34.8	59.6
	Neutral	20	22.5	82.0
	Agree	12	13.5	95.5
	Strongly agree	4	4.5	100.0
Job simplification	Strongly disagree	18	20.2	20.2
	Disagree	29	32.6	52.8
	Neutral	19	21.3	74.2
	Agree	15	16.9	91.0
	Strongly agree	8	9.0	100.0
Overall usability	Strongly disagree	6	6.7	6.7
	Disagree	12	13.5	20.2
	Neutral	15	16.9	37.1
	Agree	32	36.0	73.0
	Strongly agree	24	27.0	100.0

(Field data, 2017)

Table 4.2 indicates that out of the 89 respondents who participated, 19 respondents (21.3%) strongly disagreed that manual tools in crime measurement, mapping and evaluation increased speed of policing activities, 28 respondents (31.5%) disagreed, 24 respondents (27.0%) were neutral, 12 respondents (13.5%) agreed while 6 respondents (6.7%) strongly agreed. 24 respondents (27.0%) strongly disagreed that manual tools enhanced their job performance, 29 respondents (32.6%) disagreed, 19 respondents (21.3%) were neutral, 10 respondents (11.2%) agreed while 7 respondents (7.9%) strongly agreed. 22 respondents (24.7%) strongly disagreed that manual tools improved effectiveness of their service delivery, 31 respondents (34.8%) disagreed, 20 respondents (22.5%) were neutral, 12 respondents (13.5%) agreed while 4 respondents (4.5%) strongly agreed. 18 respondents (20.2%) strongly disagreed that manual tools simplified their job, 29 respondents (32.6%) disagreed, 19 respondents (21.3%) were neutral, 15 respondents (16.9%) agreed while 8 respondents (9.0%) strongly agreed. 6 respondents (6.7%) strongly disagreed that manual tools were in overall usable in measuring, mapping and evaluating crime, 12 respondents (13.5%) disagreed, 15 respondents (16.9%) were neutral, 32 respondents (36.0%) agreed while 24 respondents (27.0%) strongly agreed.

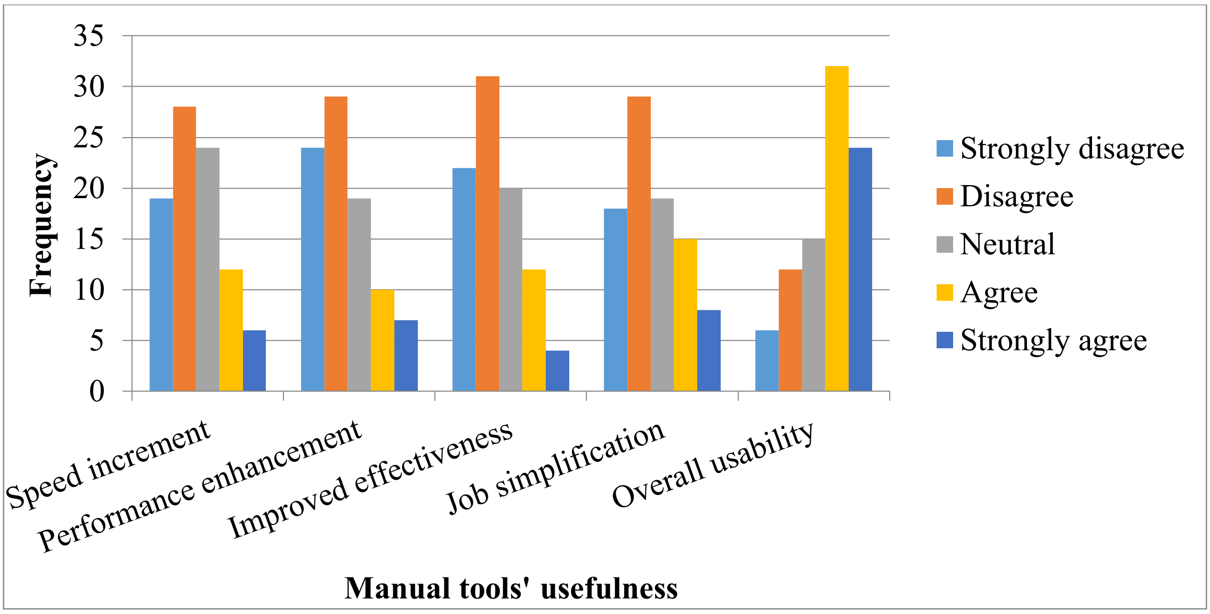

Figure 4.6: Responses for manual tools' usefulness

A summary of computed statistics for each of the five indicators of manual tools' usefulness in crime measurement, mapping and evaluation based on survey responses is presented in Table 4.3.

Table 4.3: Descriptive statistics for indicators of manual tools' usefulness

	Speed increment	Performance enhancement	Improved effectiveness	Job simplification	Overall usability
n	89	89	89	89	89
Mean	2.53	2.40	2.38	2.62	3.63
% of respondents	38.25	35.00	34.50	40.50	65.75
Mode	2	2	2	2	4
Std. Deviation	1.169	1.222	1.133	1.239	1.210

Table 4.3 shows that the mean for speed enhancement pertaining manual tools in crime measurement, mapping and evaluation was 2.53 representing 38.25% of respondents, mode of 2 and standard deviation of 1.17. Mean for Performance enhancement was 2.40 (35.00%), mode of 2 and standard deviation of 1.22. Mean for improved effectiveness was 2.38 (34.5%), mode of 2 and standard deviation of 1.13. Mean for job simplification was 2.62 (40.50%), mode of 2 and standard deviation of 1.24. Mean for overall usability was 3.63 (65.75%), mode of 4 and standard deviation of 1.21. The computed statistics indicate that data values for all responses concerning perceived GIS usefulness are within two standard deviations of the mean. The ccombined mean and standard deviation for all the indicators of manual tools usefulness were calculated and the results are shown in Table 4.4.

Table 4.4: Descriptive statistics for manual tools' usefulness

Manual tools' usefulness	
n	89
Mean	2.6921
% of respondents	42.25
Std. Deviation	0.97471

Summaries tabulated in Table 4.4 display the combined mean for the five indicators of manual tools' usefulness from all responses as 2.69 representing 42.25% of respondents and a standard deviation of 0.97. The mean for overall usability (3.63) was higher than the combined mean for all indicators of manual tools' usefulness (2.69). The computed statistics indicate that a data value for an average response concerning manual tools' usefulness is within one standard deviation of the mean. Mean for each indicator of manual tools' usefulness was also compared to the combined mean for all indicators to test significant difference and a summary of the results is shown in Table 4.5.

Table 4.5: Comparison of means for manual tools' usefulness

	Mean for manual tools usefulness = 2.6921					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Speed increment	-1.324	88	0.189	-0.164	-0.41	0.08
Performance enhancement	-2.220	88	0.029	-0.288	-0.55	-0.03

Improved effectiveness	-2.581	88	0.011	-0.310	-0.55	-0.07
Job simplification	-0.565	88	0.574	-0.074	-0.34	0.19
Overall usability	7.309	88	0.000	0.937	0.68	1.19

Table 4.5 shows that the mean for speed increment (2.53±1.17) was lower than the combined mean for all indicators of manual tools' usefulness (2.69), with a statistically significant difference of 0.16 (95% CI, 0.08 to -0.41), t(88)=-1.324, p=0.189. In addition, mean for performance enhancement (2.40±1.22) was lower than the combined mean for all indicators of manual tools' usefulness (2.69), with a statistically significant difference of 0.29 (95% CI, -0.03 to -0.55), t(88)=-2.220, p=0.029. Mean for improved effectiveness (2.38±1.13) was lower than the combined mean for all indicators of manual tools' usefulness (2.69), with a statistically significant difference of 0.31 (95% CI, -0.07 to -0.55), t(88)=-2.581, p=0.011. Similarly, mean for job simplification (2.62±1.24) was lower than the combined mean for all indicators of manual tools' usefulness (2.69), with a statistically significant difference of 0.07 (95% CI, 0.19 to -0.34), t(88)=-0.565, p=0.574. However, mean for overall usability (3.63±1.21) was higher than the combined mean for all indicators of manual tools' usefulness (2.69), with a statistically significance difference of 0.94 (95% CI, 1.19 to 0.68), t(88)=7.309, p=0.000. A correlation coefficient test for various indicators of manual tools' usefulness was done and a summary of the results is presented in Table 4.6.

Table 4.6: Correlation matrix for manual tools' usefulness

		A	B	C	D	E
Speed increment (A)	Pearson Correlation	1				
	Sig. (2-tailed)					
	n	89				
Performance enhancement (B)	Pearson Correlation	0.660**	1			
	Sig. (2-tailed)	0.000				
	n	89	89			
Improved effectiveness (C)	Pearson Correlation	0.618**	0.691**	1		
	Sig. (2-tailed)	0.000	0.000			
	n	89	89	89		
Job simplification (D)	Pearson Correlation	0.604**	0.621**	0.769**	1	
	Sig. (2-tailed)	0.000	0.000	0.000		
	n	89	89	89	89	
Overall usability (E)	Pearson Correlation	0.566**	0.495**	0.469**	0.450**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	n	89	89	89	89	89
**. Correlation is significant at the 0.01 level (2-tailed)						

Table 4.6 shows that the correlations of the five indicators for usefulness of manual tools range from 0.450 to 0.769. The values indicate there was a moderate to strong positive correlation among the five indicators of usefulness for manual tools, significant at the 0.01 level (2-tailed). This indicates how well the five indicators predict usefulness of manual tools. However, it may not give valid results concerning which indicators are redundant with respect to others. It should be noted that the above correlation matrix only shows a relationship among indicators of manual tools' usefulness but not the causal association among them.

4.2.2.2 Manual tools' ease of use in crime measurement, mapping and evaluation

Indicators of manual tools' ease of use in crime measurement, mapping and evaluation were accessibility, understandability, flexibility, experience build-up rate and overall user-friendliness as shown in Table 4.7. Responses for each indicator were based on a 5-point Likert scale as follows strongly disagree=1, disagree=2, neutral=3, agree=4 and strongly agree=5. Table 4.7 and Figure 4.7 is a summary of responses obtained from the research questionnaire which is included as Appendix 1.

Table 4.7: Frequencies and percentage distribution for manual tools' ease of use

Variable	**Attributes**	**Frequency(n=89)**	**Percent (%)**	**Cumulative (%)**
Accessibility	Strongly disagree	5	5.6	5.6
	Disagree	9	10.1	15.7
	Neutral	14	15.7	31.5
	Agree	35	39.3	70.8
	Strongly agree	26	29.2	100.0
Understand-ability	Strongly disagree	3	3.4	3.4
	Disagree	11	12.4	15.7
	Neutral	17	19.1	34.8
	Agree	31	34.8	69.7
	Strongly agree	27	30.3	100.0
Flexibility	Strongly disagree	6	6.7	6.7
	Disagree	15	16.9	23.6
	Neutral	22	24.7	48.3
	Agree	26	29.2	77.5
	Strongly agree	20	22.5	100.0

Experience buildup rate	Strongly disagree	3	3.4	3.4
	Disagree	10	11.2	14.6
	Neutral	15	16.9	31.5
	Agree	34	38.2	69.7
	Strongly agree	27	30.3	100.0
Overall user-friendliness	Strongly disagree	4	4.5	4.5
	Disagree	8	9.0	13.5
	Neutral	17	19.1	32.6
	Agree	28	31.5	64.0
	Strongly agree	32	36.0	100.0

(Field data, 2017)

Table 4.7 indicates that out of the 89 respondents who participated, 5 respondents (5.6%) strongly disagreed that manual tools were readily accessible for policing activities, 9 respondents (10.1%) disagreed, 14 respondents (15.7%) were neutral, 35 respondents (39.3%) agreed while 26 respondents (29.2%) strongly agreed. 3 respondents (3.4%) strongly disagreed that manual tools were easy to learn and understand, 11 respondents (12.4%) disagreed, 17 respondents (19.1%) were neutral, 31 respondents (34.8%) agreed while 27 respondents (30.3%) strongly agreed. 6 respondents (6.7%) strongly disagreed that manual tools were flexible to accommodate the diversity of policing duties, 15 respondents (16.9%) disagreed, 22 respondents (24.7%) were neutral, 26 respondents (29.2%) agreed while 20 respondents (22.5%) strongly agreed. 3 respondents (3.4%) strongly disagreed that manual tools had a fast rate of experience build-up, 10 respondents (11.2%) disagreed, 15 respondents (16.9%) were neutral, 34 respondents (38.2%) agreed while 27 respondents (30.3%) strongly agreed. 4 respondents (4.5%) strongly disagreed that manual tools were in overall user friendly, 8 respondents (9.0%) disagreed, 17 respondents (19.1%) were neutral, 28 respondents (31.5%) agreed while 32 respondents (36.0%) strongly agreed.

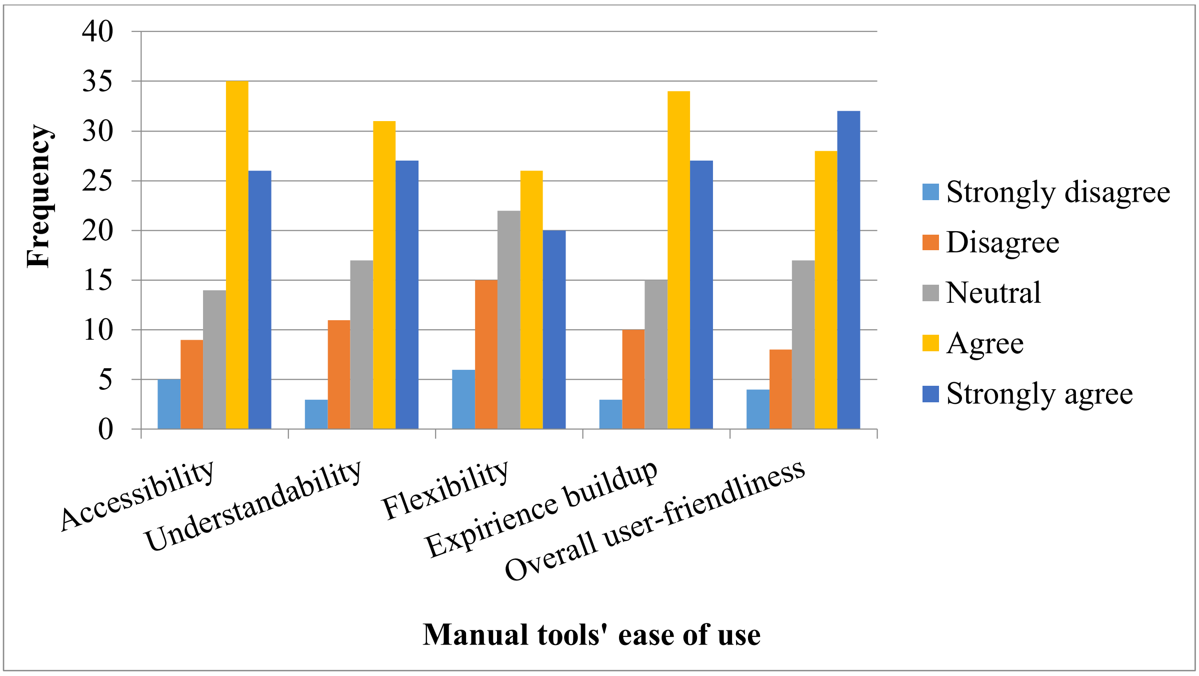

Figure 4.7: Responses for manual tools' ease of use

A summary of computed statistics for each of the five indicators of manual tools' ease of use in crime measurement, mapping and evaluation as obtained from the survey responses is presented in Table 4.8.

Table 4.8: Descriptive statistics for indicators of manual tools' ease of use

	Accessibility	Understand-ability	Flexibility	Experience buildup rate	Overall user-friendliness
n	89	89	89	89	89
Mean	3.76	3.76	3.44	3.81	3.85
% of respondents	69.00	69.00	61.00	70.25	71.25
Mode	4	4	4	4	5
Std. Deviation	1.148	1.118	1.206	1.096	1.144

Table 4.8 indicates that the mean for manual tools' accessibility in crime measurement, mapping and evaluation was 3.76 representing 69.00% of respondents, mode of 4 and standard deviation of 1.15. Mean for understandability of manual tools was 3.76 (69.00%), mode of 4 and standard deviation of 1.12. Mean for flexibility of manual tools was 3.44 (61.00%), mode of 4 and standard deviation of 1.21. Mean for manual tools' experience buildup rate was 3.81 (70.25%), mode of 4 and standard deviation of 1.10. Mean for manual tools user-friendliness was 3.85 (71.25%), mode of 5 and standard deviation of 1.14. The computed statistics indicate that data values for all responses concerning manual tools' ease of use are within two standard deviations of the mean. The combined mean and standard deviation for all the indicators of manual tools ease of use were computed and the results are shown in Table 4.9 below.

Table 4.9: Descriptive statistics for manual tools' ease of use

Manual tools' ease of use	
n	89
Mean	3.7124
% of respondents	67.75
Std. Deviation	0.94578

Table 4.9 indicates that the combined mean for the five indicators of manual tools' ease of use from all responses was 3.71 representing 67.75% of respondents and standard deviation of 0.95. The mean for flexibility (3.44) was lower than the combined mean for all indicators of manual tools' ease of use (3.71).The computed statistics show that a data value for an average response concerning manual tools' ease of use is within one standard deviation of the mean. Mean for each indicator was also compared to the combined mean for manual tools'

ease of use to test significant difference and a summary of the results is presented in Table 4.10.

Table 4.10: Comparison of means for manual tools' ease of use

	Manual tools' ease of use = 3.7124					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Accessibility	0.424	88	0.672	0.052	-0.19	0.29
Understandability	0.436	88	0.664	0.052	-0.18	0.29
Flexibility	-2.146	88	0.035	-0.274	-0.53	-0.02
Experience buildup rate	0.831	88	0.408	0.097	-0.13	0.33
Overall user-friendliness	1.167	88	0.246	0.142	-0.10	0.38

Table 4.10 shows that the mean for accessibility (3.76±1.15) was higher than the combined mean for all indicators of manual tools' ease of use (3.71), with a statistically insignificant difference of 0.05 (95% CI, 0.29 to -0.19), t(88)=0.424, p=0.672. Similarly, mean for understandability (3.76±1.12) was higher than the combined mean for all indicators of manual tools' ease of use (3.71), with a statistically insignificant difference of 0.05 (95% CI, 0.29 to -0.18), t(88)=0.436, p=0.664. However, mean for flexibility (3.44±1.21) was lower than the combined mean for all indicators of manual tools' ease of use (3.71), with a statistically significant difference of 0.27 (95% CI, -0.02 to -0.53), t(88)=-2.146, p=0.035. Mean for experience buildup rate (3.81±1.10) was lower than the combined mean for all indicators of manual tools' ease of use (3.71), with a statistically significant difference of 0.10 (95% CI, 0.33 to -0.13), t(88)=0.831, p=0.408. Moreover, mean for user-friendliness (3.85±1.14) was lower than the combined mean for all indicators of manual tools' ease of use

(3.71), with a statistically significance difference of 0.14 (95% CI, 0.38 to -0.10), t(88)=1.167, p=0.246. A correlation coefficient test for the various indicators of manual tools' ease of use was done and the results are summarized in Table 4.11.

Table 4.11: Correlation matrix for manual tools' ease of use

		A	B	C	D	E
Accessibility (A)	Pearson Correlation	1				
	Sig. (2-tailed)					
	n	89				
Understandability (B)	Pearson Correlation	0.691**	1			
	Sig. (2-tailed)	0.000				
	n	89	89			
Flexibility (C)	Pearson Correlation	0.478**	0.566**	1		
	Sig. (2-tailed)	0.000	0.000			
	n	89	89	89		
Rate of experience buildup (D)	Pearson Correlation	0.596**	0.658**	0.520**	1	
	Sig. (2-tailed)	0.000	0.000	0.000		
	n	89	89	89	89	
Overall user-friendliness (E)	Pearson Correlation	0.648**	0.915**	0.591**	0.603**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	n	89	89	89	89	89
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 4.11 shows that the correlations of the five indicators for manual tools' ease of use range from 0.478 to 0.915. There was a moderate to very strong positive correlation among

the five indicators of ease of use for manual tools significant at the 0.01 level (2-tailed). This indicates how well the five indicators predict usefulness of manual tools. However, it may not give valid results concerning which indicators of manual tools' ease of use are redundant with respect to others. The above correlation matrix only displays a relationship among indicators of manual tools' ease of use but not the cause-effect association among them. Results of the computed statistics for both manual tools' usefulness and ease of use were compared and used to predict police officers satisfaction as presented in Table 4.12 and Figure 4.8.

Table 4.12: Descriptive statistics for manual tools' usefulness and ease of use

	Usefulness	Ease of use	Satisfaction
n	89	89	89
Mean	2.6921	3.7124	3.2022
% of respondents	42.25	67.75	55.00
Std. Deviation	0.97471	0.94578	0.84194

Table 4.12 indicates that the combined mean for the five indicators of manual tools' usefulness from all responses was 2.69 representing 42.25% of respondents and the standard deviation of 0.97. The combined mean for the five indicators of manual tools' ease of use from all responses was 3.71 representing 67.75% of respondents and standard deviation of 0.95. Moreover, the mean for manual tools' usefulness (2.69) was lower than that of ease of use (3.71). Mean for Kenyan police officers' satisfaction with manual tools was 3.20 representing 55.00% of respondents and a standard deviation of 0.84. The computed statistics indicate that a data value for an average response about manual tools' usefulness and ease of use is within one standard deviation of the mean.

A summary of percentage responses for manual tools' usefulness, ease of use and user-satisfaction are visually presented in Figure 4.8.

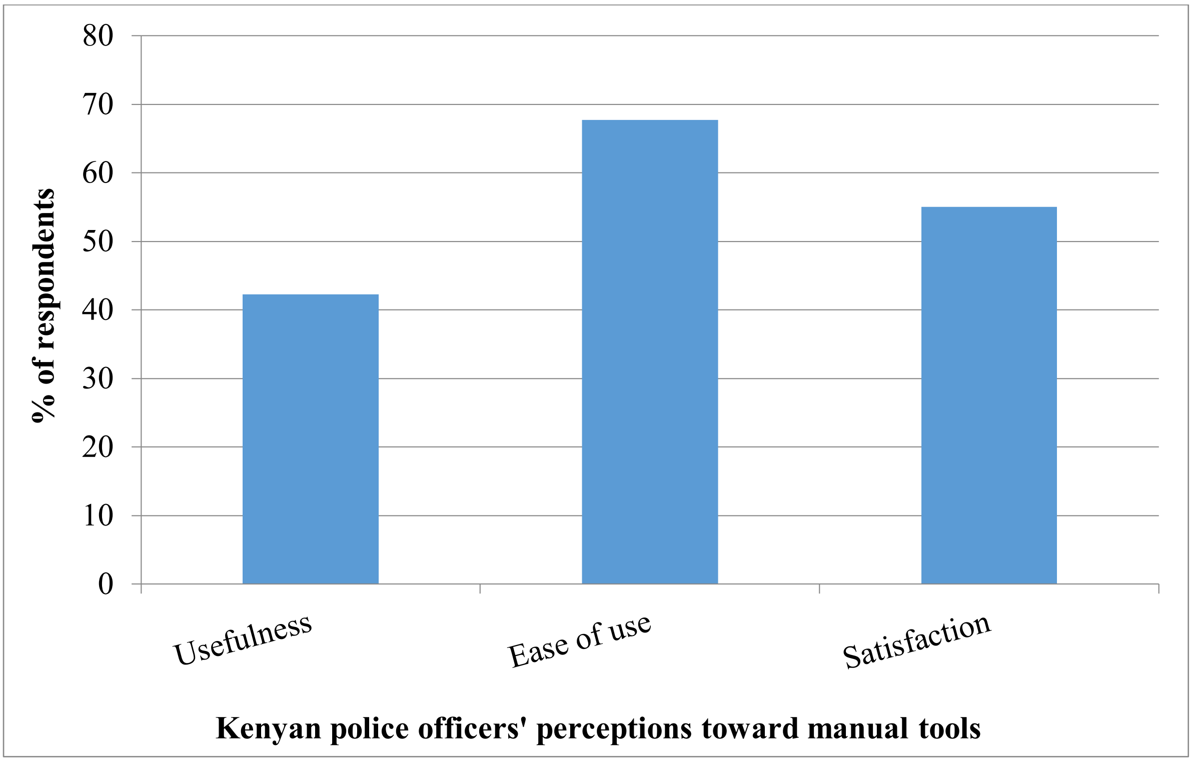

Figure 4.8: Responses for manual tools' usefulness, ease of use and user-satisfaction

Mean for manual tools usefulness was compared to the mean for manual tools ease of use for significant difference and the results are shown in Table 4.13.

Table 4.13: Comparison of means for manual tools usefulness and ease of use

	Manual tools' ease of use = 3.7124					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Manual tools' usefulness	-9.875	88	0.000	-1.02027	-1.2256	-0.8149

Table 4.13 shows that the mean for manual tools' usefulness (2.69±0.97) was lower than mean for manual tools' ease of use (3.71), with a statistically significant difference of 1.02 (95% CI, -0.81 to -1.23), t(88)=-9.875, p=0.000. A correlation coefficient test for manual tools' usefulness versus manual tools' ease of use was also done and a summary of the results is shown in Table 4.14.

Table 4.14: Correlation matrix for manual tools' usefulness versus ease of use

		Usefulness	Ease of use
Usefulness	Pearson Correlation	1	
	Sig. (2-tailed)		
	n	89	
Ease of use	Pearson Correlation	0.537**	1
	Sig. (2-tailed)	0.000	
	n	89	89
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 4.14 indicates that the correlation for manual tools' usefulness and ease of use was 0.537. As such, there was a moderate positive correlation between manual tools' usefulness and ease of use significant at 0.01 levels (2-tailed). This indicates how manual tools' usefulness and ease of use compare. However, it may not give valid results concerning which variable is redundant with respect to the other. The above correlation only depicts an association between manual tools' usefulness and ease of use but not the cause-effect relationship between them.

4.2.3 Kenyan Police Officers' Attitudes toward Adoption of GIS in Crime Measurement, Mapping and Evaluation

Predictors of Kenyan police officers' attitudes toward adoption of GIS technology in crime measurement, mapping and evaluation were usefulness and ease of use. Both usefulness and ease of use were further broken down into five indicators to diversify respondents' judgement on their attitude towards GIS technology adoption by NPS.

4.2.3.1 Perceived GIS Usefulness in Crime Measurement, Mapping and Evaluation

Indicators of GIS technology's usefulness were perceived speed increment, perceived performance enhancement, perceived improved effectiveness, perceived job simplification and perceived overall usability as shown in Table 4.15. Responses for each indicator were based on a 5-point Likert scale as follows, strongly disagree=1, disagree=2, neutral=3, agree=4 and strongly agree=5. Table 4.15 and Figure 4.9 are a summary of responses obtained from the research questionnaire which is included as Appendix 1.

Table 4.15: Frequencies and percentage distribution for perceived GIS usefulness

Variable	Attributes	Frequency(n=89)	Percent (%)	Cumulative (%)
Perceived speed increment	Strongly disagree	2	2.2	2.2
	Disagree	9	10.1	12.4
	Neutral	18	20.2	32.6
	Agree	35	39.3	71.9
	Strongly agree	25	28.1	100.0
Perceived performance enhancement	Strongly disagree	3	3.4	3.4
	Disagree	6	6.7	10.1
	Neutral	19	21.3	31.5
	Agree	29	32.6	64.0

	Strongly agree	32	36.0	100.0
Perceived improved effectiveness	Strongly disagree	3	3.4	3.4
	Disagree	10	11.2	14.6
	Neutral	18	20.2	34.8
	Agree	35	39.3	74.2
	Strongly agree	23	25.8	100.0
Perceived job simplification	Strongly disagree	2	2.2	2.2
	Disagree	5	5.6	7.9
	Neutral	19	21.3	29.2
	Agree	38	42.7	71.9
	Strongly agree	25	28.1	100.0
Perceived overall usability	Strongly disagree	4	4.5	4.5
	Disagree	11	12.4	16.9
	Neutral	19	21.3	38.2
	Agree	30	33.7	71.9
	Strongly agree	25	28.1	100.0

(Field data, 2017)

Summaries tabulated in Table 4.15 indicate that out of the 89 respondents who participated in this survey, 2 respondents (2.2%) strongly disagreed that GIS technology would increase the speed of policing activities, 9 respondents (10.1%) disagreed, 18 respondents (20.2%) were neutral, 35 respondents (39.3%) agreed, and 25 respondents (28.1%) strongly agreed. 3 respondents (3.4%) strongly disagreed that GIS would enhance their job performance, 6 respondents (6.7%) disagreed, 19 respondents (21.3%) were neutral, 29 respondents (32.6%) agreed, and 32 respondents (36.0%) strongly agreed. 3 respondents (3.4%) strongly disagreed that GIS would improve the effectiveness of service delivery, 10 respondents (11.2%) disagreed, 18 respondents (20.2%) were neutral, 35 respondents (39.3%) agreed, and 23 respondents (25.8%) strongly agreed. 2 respondents (2.2%) strongly disagreed that GIS would simplify their duties, 5 respondents (5.6%) disagreed, 19 respondents (21.3%) were neutral, 38 respondents (42.7%) agreed, and 25 respondents (28.1%) strongly agreed. 4 respondents (4.5%) strongly disagreed that GIS would generally be usable in measuring, mapping and evaluating crime in Kenya, 11 respondents (12.4%) disagreed, 19 respondents (21.3%) were neutral, 30 respondents (33.7%) agreed, and 25 respondents (28.1%) strongly agreed.

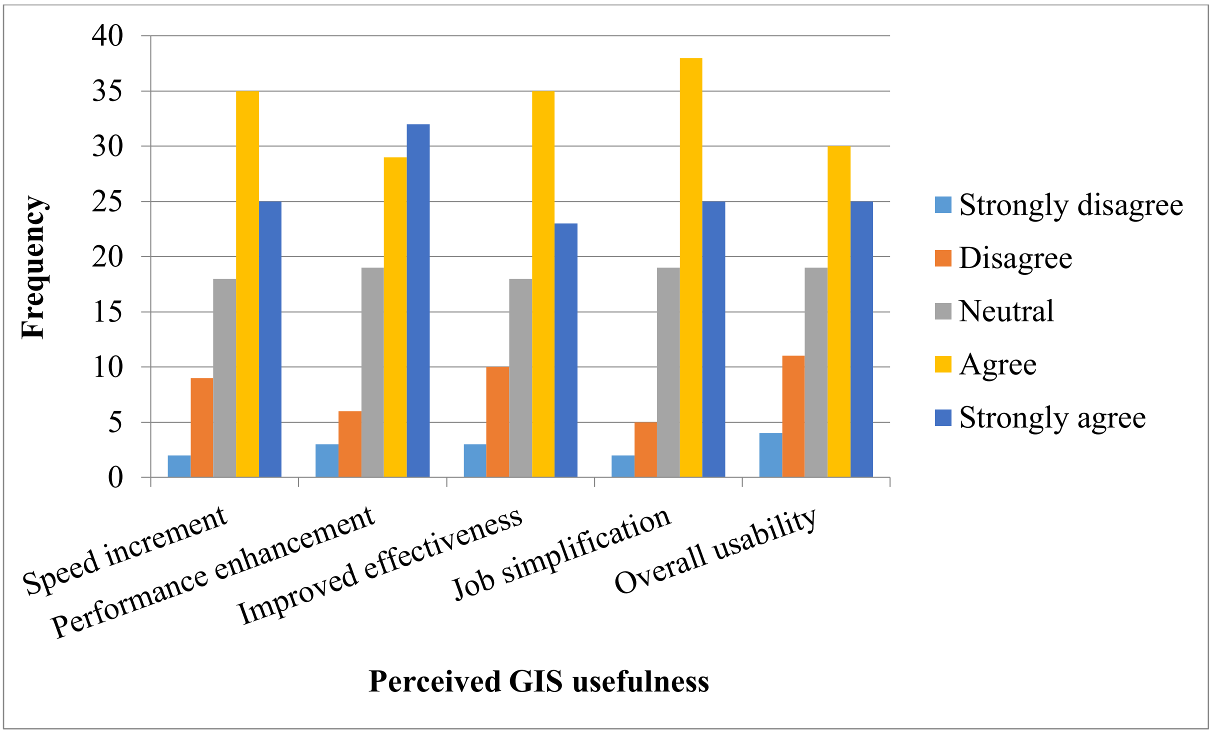

Figure 4.2: Responses for perceived GIS usefulness

A summary of computed statistics for each of the five indicators of perceived GIS usefulness in crime measurement, mapping and evaluation based on survey responses is presented in Table 4.16.

Table 4.16: Descriptive statistics for indicators of perceived GIS usefulness

	Speed increment	Performance enhancement	Improved effectiveness	Job simplification	Overall usability
n	89	89	89	89	89
Mean	3.81	3.91	3.73	3.89	3.69
% of respondents	70.25	72.75	68.25	72.25	67.25
Mode	4	5	4	4	4
Std. Deviation	1.03	1.07	1.07	0.96	1.14

Table 4.16 shows that the mean for perceived GIS speed increment in crime measurement, mapping and evaluation was 3.81 representing 70.25% of respondents, mode of 4 and standard deviation of 1.03. Mean for perceived GIS performance enhancement was 3.91 (72.75%), mode of 5 and standard deviation of 1.07. Mean for perceived GIS improved effectiveness in service delivery was 3.73 (68.25%), mode of 4 and standard deviation of 1.07. Mean for perceived GIS job simplification was 3.89 (72.25%), mode of 4 and standard deviation of 0.96. Mean for perceived GIS overall usability was 3.69 (67.25%), mode of 4 and standard deviation of 1.14. The computed statistic indicates that data values for all responses concerning perceived GIS usefulness are within two standard deviations of the mean. The ccombined mean and standard deviation for all the indicators of perceived GIS usefulness were computed and the results are shown in Table 4.17.

Table 4.17: Descriptive statistics for perceived GIS usefulness

Perceived GIS usefulness	
n	89
Mean	3.8045
% of respondents	70.00
Std. Deviation	0.94001

Table 4.17 shows that the combined mean for the five indicators of perceived GIS usefulness from all responses was 3.80 representing 70.00% of respondents and the standard deviation of 0.94. The means for improved effectiveness (3.73) and overall usability (3.69) were lower than the combined mean for all indicators of perceived GIS usefulness (3.80). The computed statistics indicate that a data value for an average response about perceived GIS usefulness is within one standard deviation of the mean. Mean for each indicator of perceived GIS usefulness was also compared to the combined mean to test significant difference and a summary of the results is presented in Table 4.18.

Table 4.18: Comparison of means for perceived GIS usefulness

	Perceived GIS usefulness = 3.8045					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Speed increment	0.041	88	0.967	0.004	-0.21	0.22
Performance enhancement	0.929	88	0.356	0.106	-0.12	0.33
Improved effectiveness	-0.651	88	0.517	-0.074	-0.30	0.15

Job simplification	0.818	88	0.415	0.083	-0.12	0.29
Overall usability	-0.982	88	0.329	-0.119	-0.36	0.12

As displayed in Table 4.18, mean for perceived speed increment (3.81±1.03) was equal to the combined mean for all indicators of perceived GIS usefulness (3.81), with a statistically insignificant difference of 0.00 (95% CI, 0.22 to -0.21), t(88)=-0.041, p=0.967. However, mean for perceived performance enhancement (3.91±1.07) was higher than the combined mean for all indicators of perceived GIS usefulness (3.81), with a statistically significant difference of 0.11 (95% CI, 0.33 to -0.12), t(88)=0.929, p=0.356. Mean for perceived improved effectiveness (3.73±1.07) was lower than the combined mean for all indicators of perceived GIS usefulness (3.81), with a statistically significant difference of 0.07 (95% CI, 0.15 to -0.30), t(88)=-0.651, p=0.517. Similarly, Mean for perceived job simplification (3.89±0.96) was higher than the combined mean for all indicators of perceived GIS usefulness (3.81), with a statistically significant difference of 0.08 (95% CI, 0.29 to -0.12), t(88)=0.818, p=0.415. In addition, mean for perceived overall usability (3.69±1.14) was lower than the combined mean for all indicators of perceived GIS usefulness (3.81), with a statistically significance difference of 0.12 (95% CI, 0.12 to -0.36), t(88)=-0.982, p=0.329. A correlation coefficient test was done for the various indicators of perceived GIS usefulness and a summary of the results is shown in Table 4.19

Table 4.19: Correlation matrix for perceived GIS usefulness

		A	B	C	D	E
Perceived speed increment (A)	Pearson Correlation	1				
	Sig. (2-tailed)					
	n	89				
Perceived performance enhancement (B)	Pearson Correlation	0.713**	1			
	Sig. (2-tailed)	0.000				
	n	89	89			
Perceived improved effectiveness (C)	Pearson Correlation	0.681**	0.778**	1		
	Sig. (2-tailed)	0.000	0.000			
	n	89	89	89		
Perceived job simplification (D)	Pearson Correlation	0.656**	0.708**	0.710**	1	
	Sig. (2-tailed)	0.000	0.000	0.000		
	n	89	89	89	89	
Perceived overall usability (E)	Pearson Correlation	0.661**	0.856**	0.836**	0.765**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	n	89	89	89	89	89
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 4.19 illustrates the correlations of the five indicators for perceived GIS usefulness range from 0.656 to 0.856. As such, there was a strong to very strong correlation among the five indicators for perceived GIS usefulness, significant at the 0.01 level (2-tailed). This shows how well the five indicators predict GIS usefulness. However, it may not give valid results concerning which indicators are redundant with respect to others. The above

correlation matrix only illustrates a relationship among indicators of GIS usefulness but not the cause-effect association among them.

4.2.3.2 Perceived GIS Technology's Ease of Use in Crime Measurement, Mapping and Evaluation

Indicators of perceived GIS technology's ease of use in crime measurement, mapping and evaluation were perceived accessibility, perceived understandability, perceived flexibility, perceived experience build-up rate and perceived overall user-friendliness as shown in Table 4.20. Responses for each indicator were based on a 5-point Likert scale as follows: strongly disagree=1, disagree=2, neutral=3, agree=4 and strongly agree=5. Table 4.20 and Figure 4.10 are a summary of responses obtained from the research questionnaire which is included as Appendix 1.

Table 4.20: Frequencies and percentage distribution for perceived GIS ease of use

Variable	Attributes	Frequency(n=89)	Percent (%)	Cumulative (%)
Perceived accessibility	Strongly disagree	5	5.6	5.6
	Disagree	15	16.9	22.5
	Neutral	28	31.5	53.9
	Agree	26	29.2	83.1
	Strongly agree	15	16.9	100.0
Perceived understandability	Strongly disagree	4	4.5	4.5
	Disagree	19	21.3	25.8
	Neutral	33	37.1	62.9
	Agree	23	25.8	88.8
	Strongly agree	10	11.2	100.0

Perceived flexibility	Strongly disagree	6	6.7	6.7
	Disagree	15	16.9	23.6
	Neutral	24	27.0	50.6
	Agree	28	31.5	82.0
	Strongly agree	16	18.0	100.0
Perceived experience buildup	Strongly disagree	2	2.2	2.2
	Disagree	21	23.6	25.8
	Neutral	37	41.6	67.4
	Agree	19	21.3	88.8
	Strongly agree	10	11.2	100.0
Perceived overall user-friendliness	Strongly disagree	7	7.9	7.9
	Disagree	13	14.6	22.5
	Neutral	25	28.1	50.6
	Agree	35	39.3	89.9
	Strongly agree	9	10.1	100.0

(Field data, 2017)

Summaries tabulated in Table 4.20 indicate that of the 89 respondents who participated in this survey, 5 respondents (5.6%) strongly disagreed that GIS technology would be easy to access, 15 respondents (16.9%) disagreed, 28 respondents (31.5%) were neutral, 26 respondents (29.2%) agreed, and 15 respondents (16.9%) strongly agreed. 4 respondent (4.5%) strongly disagreed that GIS would be easy to learn and understand, 19 respondents (21.3%) disagreed, 33 respondents (37.1%) were neutral, 23 respondents (25.8%) agreed, and 10 respondents (11.2%) strongly agreed. 6 respondents (6.7%) strongly disagreed that GIS would be flexible in its application for diverse policing activities, 15 respondents (16.9%) disagreed, 24 respondents (27.0%) were neutral, 28 respondents (31.5%) agreed, and 16 respondents (18.0%) strongly agreed. 2 respondents (2.2%) strongly disagreed that GIS would foster a fast rate of experience buildup, 21 respondents (23.6%) disagreed, 37 respondents (41.6%) were neutral, 19 respondents (21.3%) agreed while 10 respondents (11.3%) strongly agreed. 7 respondents (7.9%) strongly disagreed that GIS would be generally user-friendly to police officers, 13 respondents (14.6%) disagreed, 25 respondents (28.1%) were neutral, 35 respondents (39.3%) agreed, and 9 respondents (10.1%) strongly agreed.

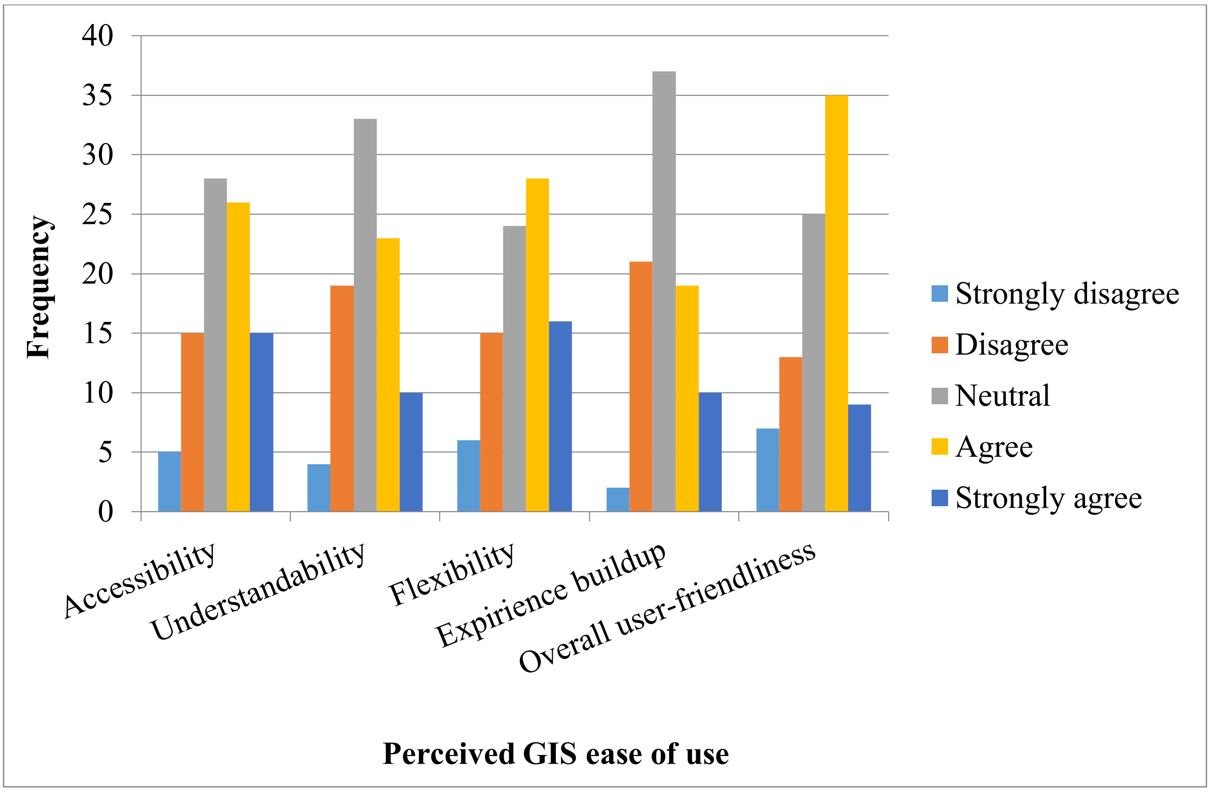

Figure 4.3: Responses for perceived GIS ease of use

A summary of computed statistics for each of the five indicators of manual tools' ease of use in crime measurement, mapping and evaluation is presented in Table 4.21.

Table 4.21: Descriptive statistics for indicators of perceived GIS ease of use

	Perceived Accessibility	Perceived Understandability	Perceived Flexibility	Perceived Experience buildup rate	Perceived overall user-friendliness
n	89	89	89	89	89
Mean	3.35	3.18	3.37	3.16	3.29
% of respondents	58.75	54.50	59.25	54.00	57.25
Mode	3	3	4	3	4
Std. Deviation	1.119	1.040	1.162	.987	1.089

Table 4.21 shows that the mean for Perceived GIS accessibility in crime measurement, mapping and evaluation was 3.35 representing 58.75% of respondents, mode of 3 and standard deviation of 1.12. Mean for perceived understandability GIS was 3.18 (54.50%), mode of 3 and standard deviation of 1.04. Mean for perceived GIS flexibility in use was 3.37 (59.25%), mode of 4 and standard deviation of 1.16. Mean for perceived GIS experience buildup was 3.16 (54.00%), mode of 3 and standard deviation of 0.99. Mean for perceived GIS user-friendliness was 3.29 (57.25%), mode of 4 and standard deviation of 1.09. The computed statistics indicate that data values for all responses concerning perceived GIS ease of use are within two standard deviations of the mean. The combined mean and standard deviation for all the indicators of perceived GIS ease of use were calculated and the results are shown in Table 4.22.

Table 4.22: Descriptive statistics for perceived GIS ease of use

Perceived GIS ease of use	
n	89
Mean	3.2697
% of respondents	56.75
Std. Deviation	0.84482

Table 4.22 shows that combined mean for the five indicators of perceived GIS ease of use from all responses was 3.27 representing 56.75 of respondents and standard deviation of 0.84. Means for understandability (3.18) and experience build-up rate (3.16) were lower than the combined mean for all indicators of perceived GIS ease of use (3.27). The computed statistics indicate that a data value for an average response about perceived GIS ease of use is one standard deviation of the mean. Mean for each indicator of perceived GIS ease of use was also compared to the combined mean to test significant difference and a summary of the results is shown in Table 4.23.

Table 4.23: Comparison of means for indicators of perceived GIS ease of use

	Perceived GIS ease of use = 3.2697					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Perceived accessibility	0.663	88	0.509	0.079	-0.16	0.31
Perceived understandability	-0.816	88	0.417	-0.090	-0.31	0.13
Perceived flexibility	0.821	88	0.414	0.101	-0.14	0.35

Perceived experience buildup rate	-1.074	88	0.286	-0.112	-0.32	0.10
Perceived overall user-friendliness	0.194	88	0.846	0.022	-0.21	0.25

Table 4.23 shows that, mean for perceived accessibility (3.35±1.12) was higher than the combined mean for all indicators of perceived GIS ease of use (3.27), with a statistically insignificant difference of 0.08 (95% CI, 0.31 to -0.16), t(88)=0.663, p=0.509. However, mean for perceived understandability (3.18±1.04) was lower than the combined mean for all indicators of perceived GIS ease of use (3.27), with a statistically significant difference of -0.09 (95% CI, 0.13 to -0.31), t(88)=-0.816, p=0.417. Mean for perceived flexibility (3.37±1.16) was higher than the combined mean for all indicators of perceived GIS ease of use (3.27), with a statistically significant difference of 0.10 (95% CI, 0.35 to -0.14), t(88)=0.821, p=0.414. Mean for perceived experience buildup rate (3.16±0.99) was lower than the combined mean for all indicators of perceived GIS ease of use (3.27), with a statistically significance difference of -0.11 (95% CI, 0.10 to -0.32), t(88)=-1.074, p=0.286. Nevertheless, mean for perceived user-friendliness (3.29±1.09) was higher than the combined mean for all indicators of perceived GIS ease of use (3.27), with a statistically insignificant difference of 0.22 (95% CI, 0.25 to -0.21), t(88)=0.194, p=0.846. A correlation coefficient test was done for the various indicators of perceived GIS ease of use and the summary of the results is shown in Table 4.24.

Table 4.24: Correlation matrix for indicators of perceived GIS ease of use

		A	B	C	D	E
Perceived accessibility (A)	Pearson Correlation	1				
	Sig. (2-tailed)					
	n	89				
Perceived understandability (B)	Pearson Correlation	0.493**	1			
	Sig. (2-tailed)	0.000				
	n	89	89			
Perceived flexibility (C)	Pearson Correlation					
	Sig. (2-tailed)	0.441**	0.424**	1		
	n	0.000	0.000			
Perceived rate of experience build-up (D)	Pearson Correlation	89	89	89		
	Sig. (2-tailed)	0.546**	0.769**	0.404**	1	
	n	0.000	0.000	0.000		
Perceived overall user-friendliness (E)	Pearson Correlation	89	89	89	89	
	Sig. (2-tailed)	0.428**	0.425**	0.749**	0.496**	1
	n	0.000	0.000	0.000	0.000	
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 4.24 illustrates the correlations of the five indicators for perceived GIS ease of use range from 0.40 to 0.77. As such, there was a moderate to strong positive correlation among the five indicators for perceived GIS ease of use, significant at 0.01 levels (2-tailed). This shows how well the five indicators predict GIS ease of use. However, it may not give valid results concerning which indicators are redundant with respect to others. The above correlation matrix only shows a relationship among indicators of GIS ease of use but not the

causal association among them. Computed statistics for both perceived GIS usefulness and ease of use were compared as shown in Table 4.25 and Figure 4.11.

Table 4.25: Descriptive statistics for perceived GIS usefulness and ease of use

	Perceived usefulness	Perceived ease of use	Perceived satisfaction
n	89	89	89
Mean	3.8045	3.2697	3.5371
% of respondents	70.00	56.75	63.50
Std. Deviation	0.94001	0.84482	0.78253

Table 4.25 shows that the combined mean for the five indicators of perceived GIS usefulness from all responses was 3.80 representing 70.00% of respondents and the standard deviation of 0.94. The combined mean for the five indicators of perceived GIS ease of use from all responses was 3.27 representing 56.75% of respondents and standard deviation of 0.84. The mean for perceived GIS usefulness (3.80) was higher than that of ease of use (3.27). Mean for Kenyan police officers' satisfaction with manual tools was 3.54 representing 63.50% of respondents and a standard deviation of 0.78. The computed statistics indicate that a data value for an average response concerning perceived GIS usefulness and ease of use is within one standard deviation of the mean.

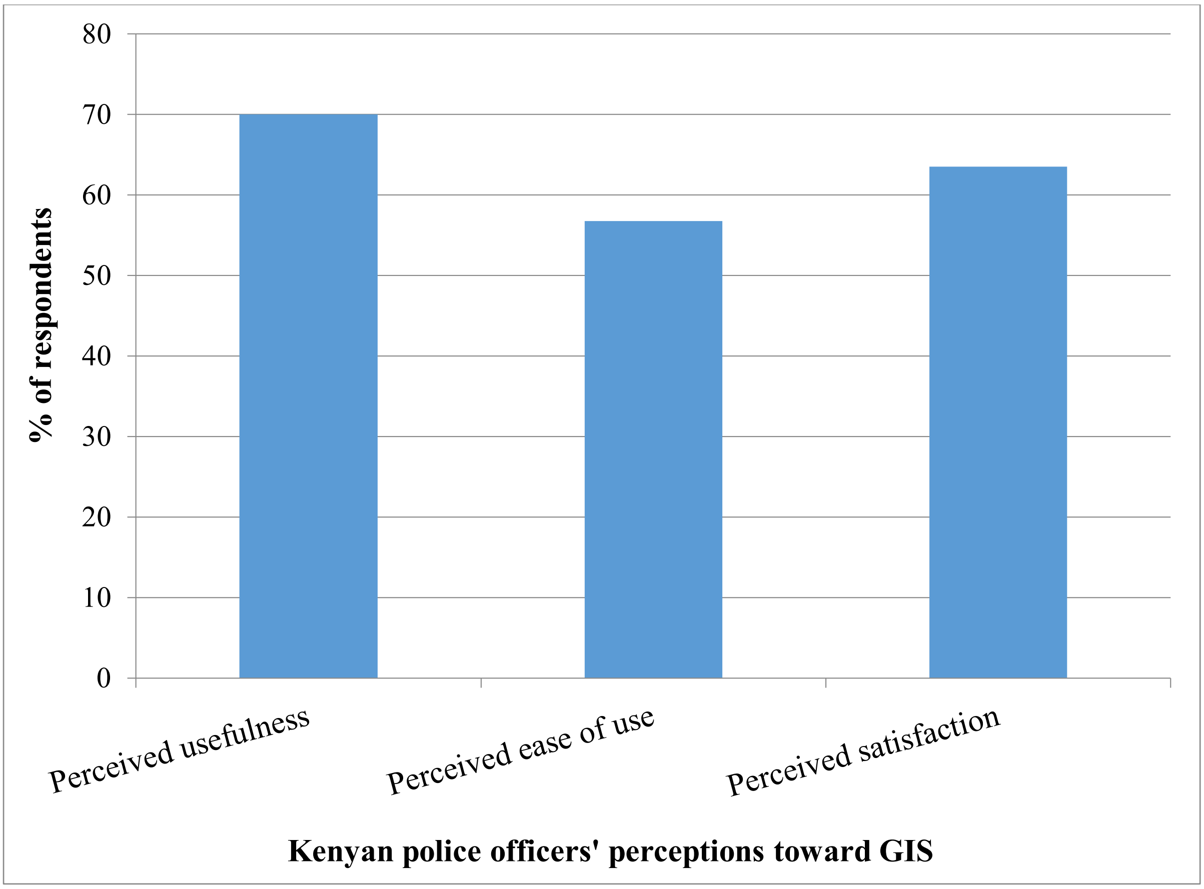

Figure 4.4: Responses for perceived GIS usefulness, ease of use and user-satisfaction

Mean for perceived GIS usefulness was compared to the mean for perceived GIS ease of use for significant difference and a summary of the results is shown in Table 4.26.

Table 4.26: Comparison of means for GIS usefulness versus ease of use

	Perceived GIS ease of use = 3.2697					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Perceived GIS usefulness	5.367	88	0.000	0.53479	0.3368	0.7328

As depicted in Table 4.26, mean for perceived GIS usefulness (3.80±0.94) was higher than the mean for perceived GIS ease of use (3.27), with a statistically significant difference of 0.53 (95% CI, 0.73 to 0.34), t(88)=5.367, p=0.000. A Correlation coefficient test for perceived GIS usefulness versus perceived GIS ease of use was done and a summary of the results is shown in Table 4.27.

Table 4.27: Correlation matrix for perceived GIS usefulness and ease of use

		Perceived usefulness	Perceived ease of use
Perceived usefulness	Pearson Correlation	1	
	Sig. (2-tailed)		
	n	89	
Perceived ease of use	Pearson Correlation	0.432**	1
	Sig. (2-tailed)	0.000	
	n	89	89
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 4.27 illustrates the correlation for perceived GIS usefulness and ease of use was 0.43. As such, there was a moderate positive correlation between perceived GIS usefulness and ease of use, significant at the 0.01 level (2-tailed). This indicates how GIS usefulness and ease of use compare. However, it may not give valid results concerning which variable is redundant with respect to the other. The above correlation only depicts an association between GIS usefulness and ease of use but not the causative relationship between them.

4.2.4 Comparison of Kenyan Police Officers' User-Perceptions for Manual Tools versus GIS in Crime Measurement, Mapping and Evaluation

Kenyan police officers' user-perceptions were derived by comparing their satisfaction with manual tools in crime measurement, mapping and evaluation against their attitudes toward adoption of GIS technology by NPS. This was achieved at three levels. First, a comparison of manual tools' usefulness versus perceived GIS usefulness in crime measurement, mapping and evaluation was done as shown in Table 4.28.

Table 4.28: Mean comparison for manual tools versus Perceived GIS usefulness

	n	Mean	Std. Deviation
Manual tools' usefulness	89	2.6921	0.97471
Perceived GIS usefulness	89	3.8045	0.94001

	Perceived GIS usefulness = 3.8045					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Manual tools' usefulness	-10.766	88	0.000	-1.11237	-1.3177	-0.9070

As shown in Table 4.28, mean for manual tools' usefulness (2.69±0.97) was lower than the mean for perceived GIS usefulness (3.8), with a statistically significance difference of 1.11 (95% CI, -0.91 to -1.32), t(88)=-10.766, p=0.000. A correlation coefficient test for manual tools' usefulness versus perceived GIS usefulness was done and a summary the results is shown in Table 4.30.

Table 4.29: Correlation matrix for manual tools versus perceived GIS usefulness

		Manual tools' usefulness	Perceived GIS usefulness
Manual tools' usefulness	Pearson Correlation	1	
	Sig. (2-tailed)		
	n	89	
Perceived GIS usefulness	Pearson Correlation	-0.009	1
	Sig. (2-tailed)	0.930	
	n	89	89

As shown in table 4.29, the correlation for manual tools' versus perceived GIS usefulness was -0.01. As such, there was a very weak and insignificant negative correlation between manual tools' and perceived GIS usefulness. The above correlation only depicts an association between manual tools' usefulness versus GIS usefulness but not the causative relationship between them. The association may not give valid results concerning which variable is redundant with respect to the other.

Secondly, manual tools' ease of use was compared against perceived GIS ease of use in crime measurement, mapping and evaluation as shown in Table 4.30.

Table 4.30: Mean comparison for Manual tools versus perceived GIS ease of use

	n	Mean	Std. Deviation
Manual tools' ease of use	89	3.7124	0.94578
Perceived GIS ease of use	89	3.2697	0.84482

	Perceived GIS ease of use = 3.2697					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Manual tools' ease of use	4.415	88	0.000	0.44266	0.2434	0.6419

As displayed in Table 4.30, mean for manual tools' ease of use (3.71±0.95) was higher than the mean for perceived GIS ease of use (3.27), with a statistically significant difference of 0.44 (95% CI, 0.64 to 0.24), t(88)=-10.766, p=0.000. A correlation coefficient test for manual tools' ease of use versus perceived GIS ease of use was done and a summary of the results presented in Table 4.31.

Table 4.31: Correlation matrix for manual tools versus perceived GIS ease of use

		Manual tools ease of use	Perceived GIS ease of use
Manual tools' ease of use	Pearson Correlation	1	
	Sig. (2-tailed)		
	n	89	
Perceived GIS ease of use	Pearson Correlation	0.212*	1
	Sig. (2-tailed)	0.046	
	n	89	89
*. Correlation is significant at the 0.05 level (2-tailed).			

As displayed in table 4.31, the correlation for manual tools' against perceived GIS ease of use was 0.05. As such, there was a very weak positive correlation between manual tools' and perceived GIS ease of use, significant at the 0.05 level (2-tailed). The above correlation only depicts an association between manual tools' ease of use versus GIS ease of use but not the causal relationship between them. The association may not give valid results concerning which variable is redundant with respect to the other.

Lastly, a comparison of police officers' satisfaction with manual tools versus their perceived satisfaction with GIS was derived and a summary of the results presented in Table 4.32. This comparison was meant to discover user-preference by Kenyan police officers as far as manual tools versus GIS technology in crime measurement, mapping and evaluation is concerned.

Table 4.32: Police officers' satisfaction with manual tools versus their perceived satisfaction with GIS

<table>
<tr><td></td><td colspan="3">n</td><td colspan="2">Mean</td><td colspan="2">Std. Deviation</td></tr>
<tr><td>Satisfaction with manual tools</td><td colspan="3">89</td><td colspan="2">3.2022</td><td colspan="2">0.84194</td></tr>
<tr><td>Satisfaction with GIS</td><td colspan="3">89</td><td colspan="2">3.5371</td><td colspan="2">0.78253</td></tr>
<tr><td rowspan="3"></td><td colspan="7">Satisfaction with manual tools = 3.2022</td></tr>
<tr><td rowspan="2">t</td><td rowspan="2">df</td><td rowspan="2">Sig. (2-tailed)</td><td rowspan="2">Mean Difference</td><td colspan="3">95% Confidence Interval of the Difference</td></tr>
<tr><td colspan="2">Lower</td><td>Upper</td></tr>
<tr><td>Satisfaction with GIS</td><td>4.037</td><td>88</td><td>0.000</td><td>0.33488</td><td colspan="2">0.1700</td><td>0.4997</td></tr>
</table>

As displayed in Table 4.32, mean for police officers' perceived satisfaction with GIS (3.54±0.78) was higher than the mean for their satisfaction with manual tools (3.20), with a statistically significant difference of 0.33 (95% CI, 0.50 to 0.17), t(88)=4.037, p=0.000. The combined mean for usefulness and ease of use were used to predict Kenyan police officers' satisfaction with either manual tools or GIS. A correlation coefficient test for manual tools' ease of use versus perceived GIS ease of use was done and a summary of the results presented in Table 4.33.

Table 4.33: Correlation matrix for Kenyan police officers' satisfaction with manual tools versus perceived satisfaction with GIS

		Satisfaction with manual tools	Satisfaction with GIS
Satisfaction with manual tools	Pearson Correlation	1	
	Sig. (2-tailed)		
	n	89	
Satisfaction with GIS	Pearson Correlation	0.073	1
	Sig. (2-tailed)	0.498	
	n	89	89

As shown in table 4.33, the correlation for manual tools' versus perceived GIS usefulness was 0.07. As such, there was a very weak and insignificant positive correlation between Kenyan police officers' satisfaction with manual tools' and their perceived satisfaction with GIS in crime measurement mapping and evaluation. The above correlation only depicts an association between police officers' satisfaction with manual tools' usefulness versus their perceived satisfaction with GIS technology but not the causative relationship between them. It should therefore be noted that the association may not give valid results concerning which variable is redundant with respect to the other.

A summary of computed statistics for manual tools' and GIS technology's usefulness, ease of use as well as user-satisfaction is presented in Table 4.34 and Figure 4.13. This was done to visually compare all responses for objectives (i), (ii) and (iii) as obtained from the research questionnaire which is included as Appendix 1.

Table 4.34: Comparison for manual tools versus GIS technology's usefulness, ease of use and user-satisfaction

		Usefulness	Ease of use	Satisfaction
Manual tools	n	89	89	89
	Mean	2.6921	3.7124	3.2022
	% of respondents	42.25	67.75	55.00
	Std. Deviation	0.97471	0.94578	0.84194
GIS Technology	n	89	89	89
	Mean	3.8045	3.2697	3.5371
	% of respondents	70.00	56.75	63.50
	Std. Deviation	0.94001	0.84482	0.78253

Summaries in Table 4.34 indicate that mean for manual tools' usefulness was 2.69 representing 42.25% of respondents with a standard deviation of 0.97, mean for manual tools' ease of use was 3.71 representing 67.75% of respondents with a standard deviation of 0.95 while mean for manual tools' satisfaction was 3.20 representing 55.00% of respondents with a standard deviation of 0.84. Mean for GIS technology's perceived usefulness was 3.80 representing 70.00% of respondents with a standard deviation of 0.94, mean for perceived GIS technology's ease of use was 3.27 representing 56.75% of respondents with a standard deviation of 0.84 while mean for perceived GIS technology's satisfaction was 3.54 representing 63.50% of respondents with a standard deviation of 0.78.

A summary of percentage responses for manual tools versus GIS technology's usefulness, ease of use and user-satisfaction is visually presented in Figure 4.12.

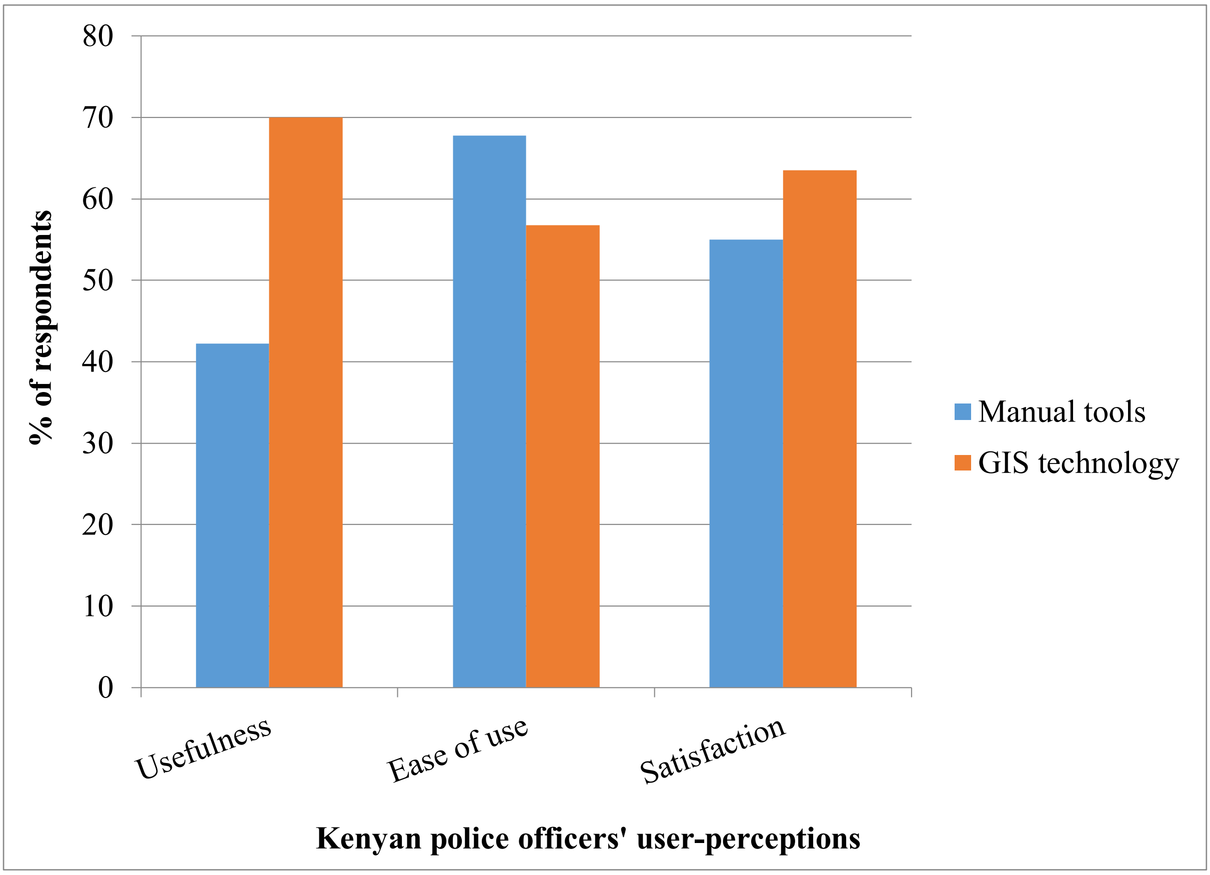

Figure 4.5: Responses for manual tools' versus GIS usefulness, ease of use and user-satisfaction

4.2.5 Challenges which NPS would encounter during Adoption of GIS Technology in Crime Measurement, Mapping and Evaluation

A summary of responses for challenges which NPS would face during adoption of GIS technology is presented in Table 4.35 and Figure 4.13. The responses were obtained from the research questionnaire which is included as Appendix 1.

Table 4.35: Frequencies and percentage distribution for challenges to GIS adoption by NPS

Variable	**Frequency(n=89)**	**Percent (%)**
Financial budget	69	77.5
Hardware availability	70	78.7
Level of education	50	56.2
Software availability	24	27.0
ICT skills	74	83.1
Funds misuse	65	73.0
Poor leadership	72	80.9
Internet connectivity	81	91.0
Spatial analysis skills	58	65.2
Conservatism	44	49.4

(Field data, 2017)

Summaries tabulated in Table 4.35 indicate that out of the 89 participants who responded to the study, 69 respondents (77.5%) felt that budgetary allocation to the NPS would hinder adoption of GIS in measuring, mapping and evaluating crime in Kenya. 70 respondents representing 78.7% of the sample believed that lack of necessary hardware to support GIS operations would be a deterrent to its adoption. 50 respondents (56.2%) were of the view that education level among Kenyan police officers would affect implementation and use of GIS technology in crime measurement, mapping and evaluation. Only 24 respondents (27.0%) were convinced that GIS software availability would be a challenge to its adoption. 74 respondents (83.1%) believed that ICT incompetence among Kenyan police officers would slow down adoption of GIS in measuring, mapping and evaluating crime in Kenya. 65 respondents representing 73.0% had a conviction that misuse of funds in the Police service would affect GIS implementation process. 72 respondents (80.9%) had an opinion that poor leadership would be one of the major challenges to GIS adoption by the NPS. 81 respondents (91.0%) were strongly convinced that internet connectivity would definitely affect adoption of GIS technology by NPS. 58 respondents (65.2%) had an opinion that insufficient spatial analysis skills among police officers would impact negatively on GIS adoption by NPS. 44 respondents (49.4%) did see conservatism among police officers as a major challenge to GIS adoption and had a view that this might affect the adoption process. Out of the GIS adoption challenges identified, internet connectivity was singled out as would be the greatest challenge at 91.0%. Software availability was seen as the least of the major GIS adoption challenges at 27.0%. About half of the respondents identified conservatism as a challenge to GIS adoption by the NPS.

A summary of percentage responses for each challenge which NPS would face during adoption of GIS technology is visually presented in Figure 4.13.

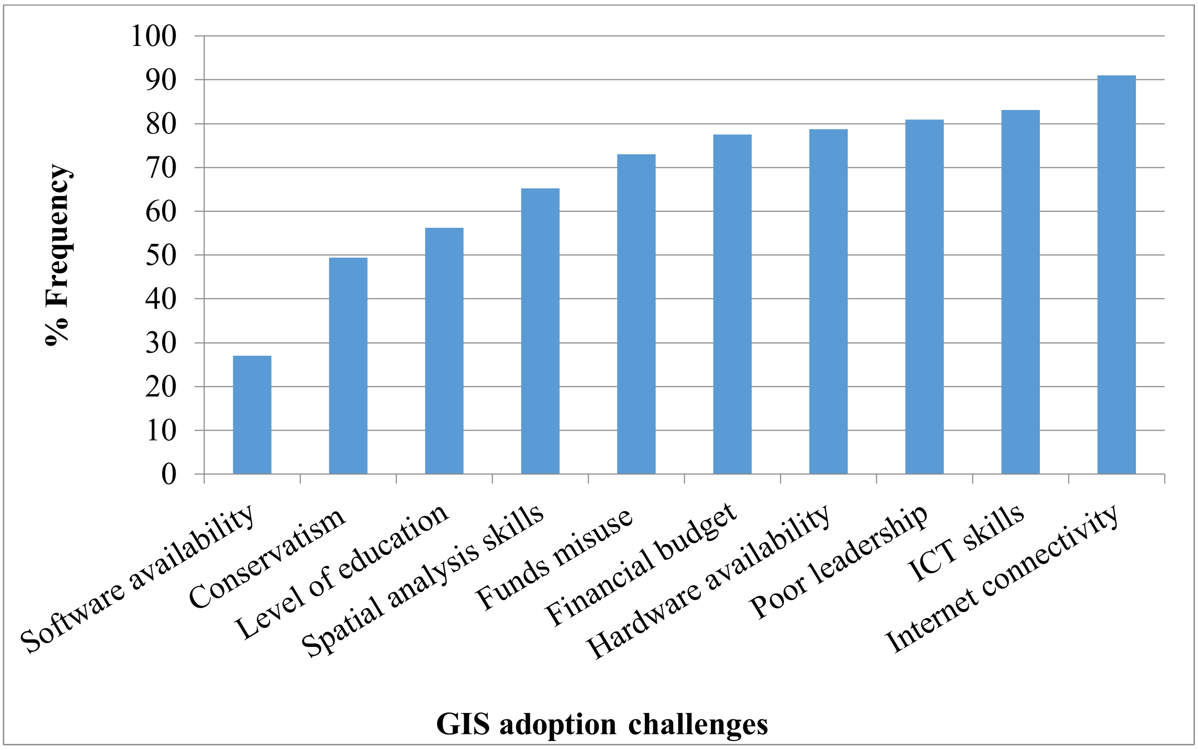

Figure 4.6: Responses for GIS adoption challenges

4.3 Discussion

The results presented were produced from the general objective of the study: to assess preparedness of the NPS to adopt GIS in crime measurement, mapping and evaluation. In order to achieve this, the study was guided by the following specific objectives (i) to determine Kenyan police officers' satisfaction with manual tools in crime measurement, mapping and evaluation, (ii) to establish Kenyan police officers' attitudes toward adoption of GIS in crime measurement, mapping and evaluation, (iii) to compare Kenyan police officers' user-perceptions toward manual tools versus GIS technology in crime measurement, mapping and evaluation, and (iv) to identify challenges which NPS will encounter during adoption of GIS technology in crime measurement, mapping and evaluation. Percentages for each mean value were calculated using Equation 3.2.

4.3.1 Kenyan Police Officers' Satisfaction with Manual Tools in Crime Measurement, Mapping and Evaluation

The survey responses indicate that manual tools did not increase the speed of crime measurement, mapping and evaluation. Similarly manual tools neither enhanced job performance nor improved effectiveness of measuring, mapping and evaluating crime. In addition manual tools did not simplify policing job. However, manual tools were said to be usable in the absence of other alternatives; the mean for overall usability (3.63) representing 65.75% of respondents was statistically significantly higher than the combined mean for all indicators of manual tools' usefulness (2.71) representing 42.75% of respondents.

The results also showed that manual tools were readily available for use, they were easy to understand, and had a fast rate of experience build-up. In addition, manual tools were user-friendly to police officers. However, it was evident that manual tools were less flexible to accommodate the diverse activities in law enforcement; the mean for flexibility 3.44 (61.00% of respondents) was statistically significantly lower than the combined mean for all indicators of manual tools' ease of use 3.72 (68.00% of respondents). Major strengths of manual tools were depicted as experience build-up rate and user-friendliness; mean for either of them 3.80 (70.00%) and 3.85 (71.25%) respectively was statistically significantly higher than the combined mean for all indicators of manual tools' ease of use 3.72 (68.00%).

Manual tools were therefore found by Kenyan police officers to be less useful in crime measurement, mapping and evaluation but were easy to use; the mean for manual tools' usefulness (2.71) representing 42.75% of respondents was statistically significantly lower than that of ease of use (3.72) representing 68.00% of respondents. Majority of Kenyan police officers were satisfied with manual tools in crime measurement, mapping and evaluation mainly because they were easy to use and hence considered them to be still usable in the absence of other alternatives; the mean for satisfaction was (3.20) representing 55.00% of respondents.

4.3.2 Kenyan Police Officers' Attitudes toward Adoption of GIS Technology in Crime Measurement, Mapping and Evaluation

Kenyan police officers showed an open attitude towards the adoption of GIS technology in crime measurement, mapping and evaluation. The study revealed that GIS technology would increase the speed of policing activities, enhance police officers' job performance, improve the effectiveness of service delivery, and simplify police officers duties. GIS technology would be therefore useful in measuring, mapping and evaluating crime in Kenya. Similarly, major strength for GIS technology would be in enhancing performance and job simplification; means for either of them 3.91 (72.75%) and 3.89 (72.25%) respectively was statistically significantly higher than combined mean for perceived GIS usefulness 3.80 (70.00%).

The results revealed that GIS technology might be hard to access, difficult to understand, less flexible in its applications, slow in experience build-up and less user friendly. In addition, GIS technology might not be easy to use for Kenyan police officers in measuring, mapping and evaluating crime. Understandability and experience build-up rate were singled out as would be major problems affecting GIS ease of use; mean for either of them 3.18 (54.5%) and 3.16 (54.00%) respectively were statistically significantly lower than the combined mean for all indicators of perceived GIS ease of use 3.27 (56.75%).

GIS technology was therefore perceived by Kenyan police officers as would be more useful but might be difficult to use; the mean for perceived GIS usefulness (3.80) representing 70.00% of respondents was statistically significantly higher than that of ease of use (3.27) representing 56.75% of respondents. Majority of Kenyan police officers were optimistic that GIS would be more satisfying than manual tools in crime measurement, mapping and evaluation; the mean for perceived GIS satisfaction was (3.54) representing 63.50% of respondents.

4.3.3 Comparison of Kenyan Police Officers' User-Perceptions for Manual Tools versus GIS in Crime Measurement, Mapping and Evaluation

The analysed data revealed that GIS technology was perceived as more useful than manual tools when responses for both were compared; mean for perceived GIS usefulness 3.80 (70.00% of respondents) was statistically significantly higher than that of manual tools' usefulness 2.69 (42.25% of respondents). Moreover, GIS technology was perceived to be more difficult to use than manual tools. The mean for perceived GIS ease of use 3.27 (56.75% of respondents) was statistically significantly lower than that of manual tools' ease of use 3.71 (67.75% of respondents). Manual tools were therefore found to be less useful but easy to use in crime measurement, mapping and evaluation while GIS technology was perceived as more useful but would be difficult to use.

Using usefulness and ease of use as predictors of Kenyan police officers' satisfaction, GIS was preferred to manual tools in crime measurement, mapping and evaluation. The combined mean for GIS usefulness and ease of use (3.54) representing 63.50% of respondents was statistically significantly higher than that of manual tools (3.20) representing 55.00% of respondents. This means that among those respondents who preferred GIS technology in crime measurement, mapping and evaluation, there are some who were still satisfied with manual tools but felt the former is an idea whose time has come.

During interviews and focus group discussion, key informants confirmed that crime in Kenya is recorded on paper-based occurrence books at the police stations/ posts level. In addition, they testified that crime mapping and evaluation is limited to push-pins on paper-maps. Key informants admitted having awareness of computer-driven mapping applications, and Google maps came out as the most popular among them. They were of the opinion that mapping applications would be useful in illustrating crime distribution and visualising crime hotspots thus GIS technology would enhance rapid response to crime incidents, promote informed deployment and ensure efficient resource allocation as well as utilisation. They affirmed that manual policing tools were neither effective in measuring, mapping and evaluating crime nor efficient in guiding NPS resource utilization. Moreover, they agreed that manuals tools were easy to use and thus still usable in crime measurement, mapping and evaluation, but clarified that this view was subjective in the absence of other alternatives for comparison.

4.3.4 Challenges which NPS would encounter during adoption of GIS Technology in Crime Measurement, Mapping and Evaluation

The study identified the following as would be challenges to adoption of GIS technology by the NPS: insufficient financial budget to fund GIS projects (77.5%), misuse of funds in the NPS (73.0%), absence of related hardware to support installation of GIS tools and sustain their utilization (78.7%), non-transformative leadership to spearhead GIS technology adoption (80.9%), poor internet connectivity to police stations/ posts (91.0%), as well as low level of education (56.2%), poor ICT skills (83.1%), and lack of spatial analysis skills among police officers (65.2%). Internet connectivity to police stations/ posts was brought out as the biggest hurdle to GIS technology implementation as put by 91.0% of the respondents. Software availability was seen as the least of the concerns among the identified challenges.

During interviews and focus group discussion, key informants alluded that the NPS annual budget would be adequate to support GIS technology adoption. Availability of funds would therefore not be a major challenge to adoption of GIS technology. However, slotting in a special budget item to specifically allocate a fraction of the total amount to GIS related projects would be difficult as it would need transformative leadership and stakeholders' goodwill. Software availability (27.0%), conservatism (49.4%) and education level (56.2%) were portrayed by key informants as lesser challenges to GIS technology implementation. Key informants confirmed there were open source GIS software including Quantum Geographic Information System (QGIS) which would not need monetary expenditure to acquire. In addition, key informants disputed education level among police officers as one of the major GIS adoption challenges; they were of the view that NPS has one of the most learned work-force due to the prevailing social economic conditions of high unemployment rate in Kenya. Key informants confessed that majority of graduates are seeking and getting employment opportunities in the NPS now than ever before. In support of the aforesaid, the study reveals that majority of police officers who participated in this survey, 46 (51.7%) were university graduates. Out of the total 89 subjects in the sample, 40 respondents (44.9%) had Bachelor's degree qualification, 5 (5.6%) had Masters and 1 (1.1%) had a PhD. Conservatism was also disputed as one of the key challenges to GIS technology adoption on the basis that, police population is now composed of liberal youths as the majority; they are quite receptive to change in the new era of police reforms. In addition, key informants underscored that strategic plans since the year 2008 and the Constitution of Kenya 2010 have all worked toward ensuring the police transforms from a security force to a community service organisation. However, they confessed that senior police leadership had been an impediment to the reform agenda and hence would be an obstacle to GIS adoption.

Key informants also confirmed that challenges internal and/or external to the NPS would affect the adoption of GIS technology. As such, financial budget to fund GIS projects, misappropriation of funds and poor leadership in the NPS would affect rapid adoption of the technology. Similarly, hardware availability and internet connectivity to support GIS technology installation would affect its compatibility with the current Police ICT infrastructure. Level of education, spatial analysis skills and ICT expertise among police officers would influence complexity of GIS from Kenyan police officers' view point. Finally, all these challenges would impact on the triability of GIS pilot projects before full implementation, as well as observability of its relative advantage in relation to manual tools.

4.4 Chapter Summary

Chapter four presents a summary of the results from 89 questionnaires, 12 interviews with volunteer respondents and a focus group discussion comprising of 5 key informants. It also provides a detailed explanation of how the findings helped to realize each specific objective in answering the research questions. The chapter also presents an explanation of how the specific objectives met the demands of the general objective which was to assess the preparedness of the NPS to adopt GIS technology in crime measurement, mapping and evaluation.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The research study sought to answer the following research questions (i) How satisfied were Kenyan police officers' with manual tools in crime measurement, mapping and evaluation? (ii) What was the attitude of Kenyan police officers toward adoption of GIS in crime measurement, mapping and evaluation? (iii) What were the Kenyan police officers' user-perceptions for manual tools versus GIS in crime measurement, mapping and evaluation? and (iv) Which challenges would NPS encounter during adoption of GIS in crime measurement, mapping and evaluation?

5.2 Summary of the Research Findings

This study reveals that majority of Kenyan police officers found manual tools not to be useful in crime measurement, mapping and evaluation even though they were easy to use and hence still usable in the absence of other alternatives. Only 42.75% of Kenyan police officers found manual tools to be useful in crime measurement, mapping and evaluation while 68.00% felt they were easy to use. 55.00% of Kenyan police officers were therefore satisfied with manual tools in crime measurement, mapping and evaluation mainly because they were easy to use. The study indicates that manual tools were still in use due to lack of other alternatives but they neither enhanced the effectiveness of service delivery nor improved efficiency of resource utilization.

The study reveals that Kenyan police officers had an open mind towards adoption of GIS technology in crime measurement, mapping and evaluation. Among Kenyan police officers 70.00% believed GIS would be useful in crime measurement, mapping and evaluation while

56.75% feared it might be difficult to use. 63.50% of Kenyan police officers were therefore optimistic that they would be satisfied with GIS tools in crime measurement, mapping and evaluation.

The study reveals that only 42.25% of Kenyan police officers found manual tools to be useful while 70.00% felt GIS methodologies would be more useful if adopted by NPS. In addition, 67.75% of Kenyan police officers found manual tools to be easy to use in crime measurement, mapping and evaluation while 56.75% feared GIS technology might be difficult to use. The study also revealed that 55.00% of Kenyan police officers were satisfied with manual tools in crime measurement, mapping and evaluation while 63.50% were optimistic that GIS technology would be more satisfying. This indicates that among those police officers who preferred GIS technology in crime measurement, mapping and evaluation, there are some who were satisfied with manual tools but felt the former is an idea whose time has come.

The study reveals that there would be several challenges during the adoption of GIS technology by NPS. 91.0% of respondents singled out internet connectivity as would be the greatest challenge to adoption of GIS technology. The study notes that these challenges could however be mitigated by putting in place the necessary countermeasures before implementing any GIS related project. The study therefore concludes that although most Kenyan police officers were satisfied with manual tools in crime measurement, mapping and evaluation, they were willing to use GIS technology. However, NPS would have to address some challenges for successful implementation and effective utilization of GIS methodologies in crime measurement, mapping and evaluation.

5.3 Conclusion

5.3.1 Empirical Conclusion

The study concludes that majority of Kenyan police officers found manual tools not to be useful in crime measurement, mapping and evaluation although they were easy to use and hence still usable in the absence of other alternatives. The studies reviewed looked at which police organizations, especially in the developed world, made use of GIS tools and how they utilized the technology (Ahmed & Salihu, 2013; Chainey & Tompson, 2008; Garson, 2003; Harries, 1999; Leipnik & Albert, 2003; Mamalian & LaVigne, 1999; Potchak, McGloin & Zgoba, 2002; Ratcliffe, 2004; Rich & Shively, 2004; Robinson, 2008; Smelcer & Carmel, 1997; Weisburd & Green, 1995; Weisburd & Lum, 2005; Yelwa & Bello, 2012;). This study assessed the satisfaction of Kenyan police officers with manual tools in crime measurement, mapping and evaluation, and revealed why the NPS was still using them in such a time when most operations are driven by technology.

The study also concludes that Kenyan Police officers had an open attitude towards adoption of GIS technology by NPS because they felt it would be useful in measuring, mapping and evaluating crime but they feared it might be difficult to use. They therefore believed that GIS technology would enhance effectiveness of service delivery and increase efficiency of resource utilization. The reviewed studies concentrated mostly on GIS user-acceptance during and after implementation (Akgul, 2008; Cakar, 2011; Davis, 1985; Dillon and Morris, 1996; Hu, Lin and Chen, 2005; Lucas and Spitler, 1999; Mathieson, 1991; Vankatesh and Davis, 1996; Yalcinkaya, 2007). This study explored Kenyan police officers' attitude toward GIS technology before adoption to help address user-acceptance issues and hence prevent and/or control possible resistance.

Unlike the studies mentioned above which focused on GIS technology alone, this study did a comparative analysis of Kenyan police officers' user-perceptions for manual tools versus GIS technology in crime measurement, mapping and evaluation. The study reveals that most Kenyan police officers preferred GIS technology to manual tools. The study also reveals that among Kenyan police officers who preferred GIS technology, some were satisfied with manual tools in crime measurement, mapping and evaluation.

The study similarly concludes that NPS would encounter challenges during adoption of GIS technology in crime measurement, mapping and evaluation but these could be mitigated by putting in place the necessary countermeasures prior to its implementation. Most of the reviewed studies, during their process and summative evaluations, explored GIS usefulness, its post-adoption impact on crime and its application challenges (Bratton, 1997, 1998; Braga *et al*., 1999; Canter *et al*., 2000; Chilvers & Weatherburn, 2004; Eck & Maguire, 2000; Jarupathirun & Zahedi, 2007; Kelling & Sousa, 2001; Mazerolle, Rombouts, & McBroom, 2006; Norris, 2015; Paulsen, 2004; Rossmo, 1995; Sherman & Weisburd, 1995; Silverman, 1999; Speier, 2006; Weisburd & Green, 1995). This study did a formative evaluation to examine GIS technology pre-adoption challenges to safeguard return on investment before its implementation.

5.3.2 Theoretical Conclusion

In order to assess preparedness of the NPS to adopt GIS technology in crime measurement, mapping and evaluation, the study used DOI theory and TAM. Like Davis (1985), Dillon and Morris (1996), Hu, Lin and Chen (2005), Vankatesh and Davis (1996), as well as Williams and Asheim (2005), this study confirmed that TAM's element of ease of use is as important as usefulness in assessing user-acceptance and satisfaction with both manual tools and GIS technology. As such, manual tools of policing were found to be easy to use though less useful in measuring, mapping and evaluating crime because they neither enhanced effectiveness of service delivery nor improved efficiency of resource utilization. In addition, GIS technology was perceived to be useful in measuring, mapping and evaluating crime but not easy to use.

As put forth by Lucas and Spitler (1999), Rogers (1983, 2003), Sahin (2006) and Yalcinkaya (2007), this study confirmed that challenges internal and/or external to the NPS would affect successful implementation of GIS technology. As such, these challenges would affect the ease of use (compatibility and complexity) of GIS technology and hence influence its trialability, observability of related results as well as its usefulness (relative advantage) in relation to manual tools of policing. Financial, technical and human resources preparedness as well as the police culture would directly affect GIS usefulness as well as ease of use.

The findings of this study therefore reveal that DOI theory and TAM are mutually complementing in determining police officers' satisfaction with manual tools and establishing their perceptions toward adoption of GIS technology by NPS. This is because the element of relative advantage in DOI theory is similar to the usefulness factor in TAM. In addition, the elements of complexity and compatibility in DOI theory are similar to the ease of use factor in TAM. Similarly, a technology's usefulness and ease of use as put forth in TAM would determine GIS technology's trialability and observability of related outcome as proposed in DOI theory. The conceptual framework which was adopted for this research study therefore support propositions of both DOI theory and TAM.

5.4 Recommendations

5.4.1 Policy Implications and Contributions of the Study

The study reveals that majority of Kenyan police officers found manual tools not to be useful in crime measurement, mapping and evaluation although they were easy to use and hence still usable in the absence of other alternatives. To this end, the NPS should consider implementing GIS technology pilot projects to provide an alternative to manual tools. These pilot projects will allow police officers to assess effectiveness of service delivery and efficiency of resource utilisation during law enforcement operations against two or more working platforms.

Many of Kenyan Police officers had an open attitude towards the adoption of GIS technology in measuring, mapping and evaluating crime. They believed it would be useful in measuring, mapping and evaluating crime though it might be difficult to use. NPS should therefore consider introducing ICT training, crime mapping tutorials and spatial analysis classes during the basic police training. Such training programs will nurture and sustain a technology-based approach to security operations and hence boost GIS technology's user-acceptance during implementation.

Most Kenyan police officers preferred GIS technology to manual tools in crime measurement, mapping and evaluation. NPS should therefore formulate an action plan to guide successful implementation and effective utilization of GIS technology and other computer based policing tools. This will ensure NPS progressively realize the strategic vision of being a world-class police service with people friendly, responsive and professional workforce.

The study reveals there would be challenges in the adoption of GIS technology by the NPS though they could be mitigated by putting the necessary countermeasures in place prior to implementation. The challenges foreseen included: insufficient financial budget to fund GIS projects, misuse of funds, hardware unavailability to support installation of GIS tools and sustain its utilization, non-transformative leadership, poor internet connectivity to police stations/posts, as well as low level of education, lack of spatial analysis skills and poor ICT expertise among police officers. To overcome these challenges, the NPS should set aside special projects' budget to support adoption of GIS technology. However, expenditure of the special projects' budget should be subjected to internal and independent financial audit for accountability to curb possible misappropriations. Similarly, the NPS should consider connecting all police stations/ posts to internet infrastructure for real time streaming of crime data into a central server for easy accessibility of all information related to crime. Moreover, the NPSC should recruit GIS experts, and consider training serving police officers and recruits on ICT and spatial analysis of crime using computer-based mapping applications such as GIS. This will allow optimal utilization of the many GIS functions during police operations. In addition, all police commanders should be trained on strategic management to have them adopt a transformative mind-set that can spearhead technology-driven law enforcement. Equally, the NPS should avail related hardware including flatbed scanners to digitize paper-maps and handheld Global Positioning System (GPS) to provide precise crime locations instead of address matching which has a higher margin of error. This will provide accurate identification of hotspots and hence account for displacement of crime within and across regions. Additionally, the police agencies in Kenya should also consider having vehicle-mounted computers for real-time crime analysis based on data streams from a central server. This would improve the effectiveness of service delivery through rapid response. Though software availability was seen as the least of GIS adoption challenges due to presence of open-source applications for instance QGIS, issues of information security must be considered. As such, secure platforms including but not limited to the Esri-powered ArcGIS software should be considered for police use to safeguard confidentiality, integrity and availability of crime-related data.

5.4.2 Areas for Further Research

The study engaged police officers at the NPS headquarter formations in Nairobi only. While police officers at headquarter formations are key to guiding strategic policy direction, those at lower levels are critical in the successful implementation of projects. Further research is therefore required to have a sample comprising of police officers across the entire country to determine whether user-satisfaction and perceptions can vary with reference to geographic space.

The study focused on the NPS only. There is need to carry out similar and/or related studies among all other security agencies including KDF, NIS and private security providers. This will provide a holistic perspective since national security is a collaborative venture that calls for combined effort from all stakeholders.

5.5 Chapter Summary

Chapter five provides the summary of the research findings. It also provides empirical and theoretical conclusions highlighting how the research findings address the identified research gap. In addition, the chapter outlines the contributions of this study by providing policy recommendations to NPS and suggesting areas for further research.

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APPENDICES

Appendix I: Research Questionnaire

Introduction

My name is Eliud Baraka, a graduate student at Kenyatta University pursuing Master of Security Management and Police Studies. In order to fulfil the program requirement, I am undertaking a research project on: ***Preparedness of the Kenya National Police Service to Adopt Geographic Information Systems in Crime Measurement, Mapping and Evaluation***. GIS is a computer application that links geographic information (digital maps) and descriptive information (crime data), to produce pin-maps and/ or density-maps which visually present crime distribution in a given area while pinpointing hotspots. The information you provide will be used for academic purposes only and shall be treated with extreme confidentiality.

Formation: KP ☐ AP ☐ DCI ☐ GSU ☐

Education level: ____________________________ Sex: Male ☐ Female ☐

Years of service: ___________________________ Rank: ____________________________

Would you like to participate in a one-on-one interview? Yes ☐ No ☐

SECTION A: Kenyan police officers' satisfaction while using occurrence books, paper-maps and push-pins (**manual tools**) in measuring, mapping and evaluating crime.

(i). Usefulness of manual tools in crime measurement, mapping and evaluation

1. **Using manual tools enables police officers to accomplish their job more quickly.**

   Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

2. **Using manual tools enhances police officers' job performance.**

   Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

3. **Manual tools improve police officers' effectiveness on the job.**

   Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

4. **Manual tools make it simple for police officers' to do their job.**

   Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

5. **Overall, manual tools are usable in measuring, mapping and evaluating crime.**

   Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

(ii). Ease of use of manual tools in crime measurement, mapping and evaluation

1. **Police officers find it easy to access manual tools to do their work.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

2. **Interacting with manual tools is clear and understandable.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

3. **Police officers find manual tools flexible to interact with.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

4. **It is fast for police officers to be skillful at using manual tools.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

5. **Overall, police officers find manual tools to be user-friendly.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

SECTION B: police officers' attitude toward adoption of GIS in crime measurement, mapping and evaluation in Kenya.

(i). Perceived usefulness of GIS in crime measurement, mapping and evaluation

1. **Using GIS will enable police officers to accomplish their job more quickly.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

2. **GIS will enhance police officers' job performance.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

3. **GIS will improve police officers' effectiveness in their operations.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

4. **GIS will make it simple for police officers to do their job.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

5. **Overall, GIS will be usable in measuring, mapping and evaluating crime.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

(ii). Perceived ease of use of GIS in crime measurement, mapping and evaluation

1. **Police officers will find it easy to access GIS while doing their duties.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

2. **Interacting with GIS will be clear and understandable to police officers.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

3. **Police officers will find GIS flexible to interact with during various policing duties.**

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

4. It will be fast for police officers to be skillful at using GIS.

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

5. Overall, police officers will find GIS to be user-friendly.

Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

SECTION C: What challenges will the NPS encounter during adoption of GIS in crime measurement, mapping and evaluation? (Tick all the possible challenges among the following options)

1. **Lack of adequate financial budget.** ☐
2. **Lack of appropriate hardware.** ☐
3. **Low education level among police officers.** ☐
4. **Unavailability of the necessary GIS software.** ☐
5. **Insufficient ICT skills among police officers.** ☐
6. **Misappropriation of funds.** ☐
7. **Lack of transformative leadership.** ☐
8. **Insufficient internet connectivity to various police posts.** ☐
9. **Lack of the necessary analytical skills for spatial analysis.** ☐
10. **Conservatism of police officers.** ☐

Other than the above highlighted challenges, please write other factors which you believe may hinder successful adoption and effective utilization of GIS by NPS:

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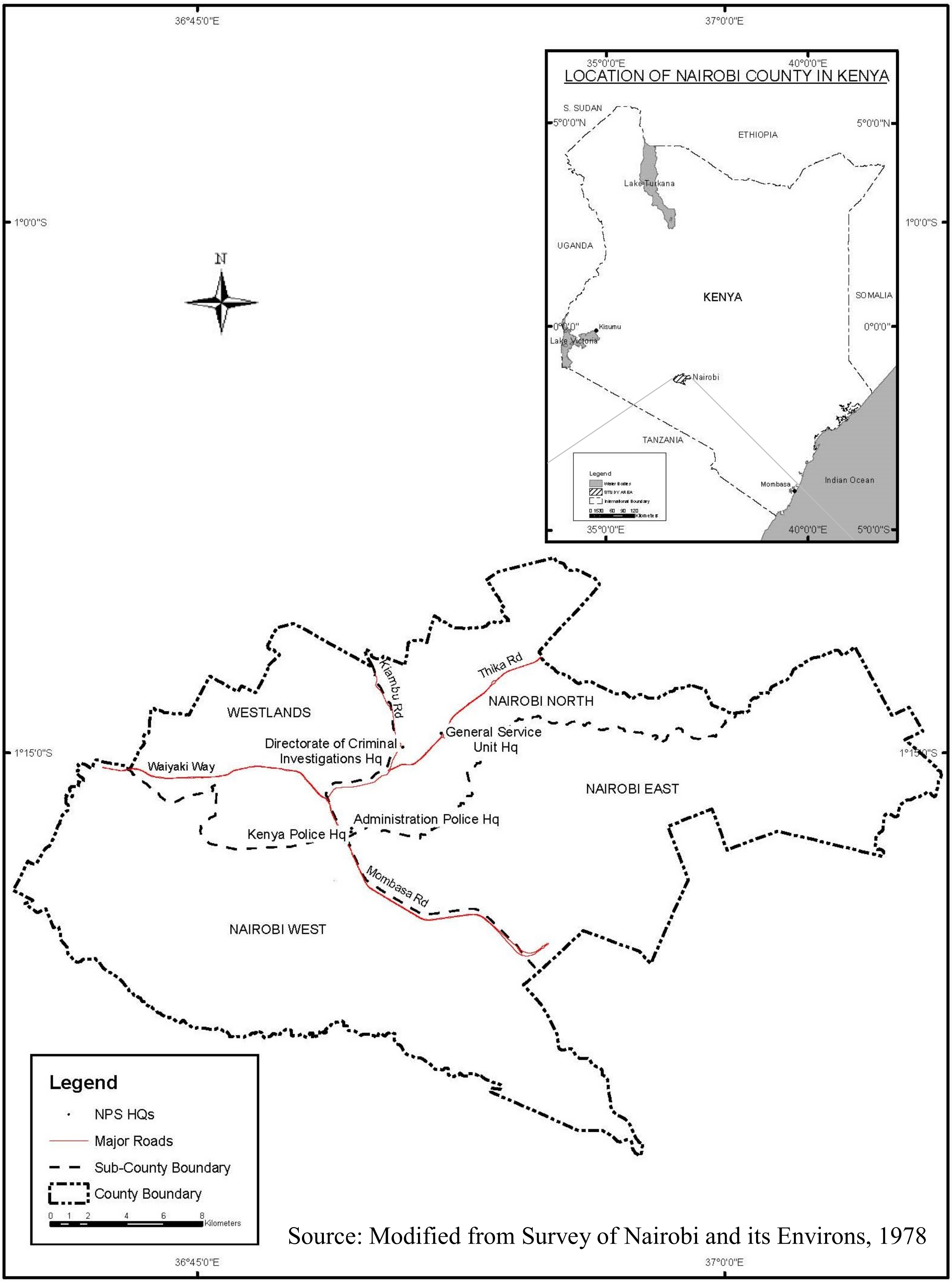
Appendix II: Interview Guide

Introduction

My name is Eliud Baraka, a graduate student at Kenyatta University pursuing Master of Security Management and Police Studies. In order to fulfil the program requirement, I am undertaking a research project on: ***Preparedness of Kenya National Police Service to Adopt Geographic Information Systems in Crime Measurement, Mapping and Evaluation.*** GIS is a computer application that links geographic information (digital maps) and descriptive information (crime data), to produce pin-maps and/ or density-maps which visually present crime distribution in a given area while pinpointing hotspots. The information you provide will be used for academic purposes only and shall be treated with extreme confidentiality.

1. What does the NPS use to record crime?
2. What does the NPS use to map crime?
3. What does the NPS use to evaluate crime?
4. Which computer-based mapping applications have you heard of?
5. How can mapping applications be used in crime measurement, mapping and evaluation?
6. How satisfied are Kenyan police officers with occurrence books, paper-maps and push-pins (manual tools) in crime measurement, mapping and evaluation?
7. What weaknesses internal to NPS may affect adoption of computer-based mapping applications like GIS?
8. What threats external to NPS may affect adoption of computer-based mapping applications like GIS?
9. How would police officers feel about adoption of GIS in crime measurement, mapping and evaluation?
10. Which strategies would be effective in helping to overcome the challenges which may arise during GIS adoption?
11. What is your personal view regarding manual tools versus GIS in crime measurement, mapping and evaluation?

Appendix III: Map of the Study Area (Location of Nairobi within Kenya and NPS HQs)



Source: Modified from Survey of Nairobi and its Environs, 1978

(Cartographer Kenya Institute of Survey and Mapping, 2017)

Appendix IV: Research Authorization by Kenyatta University

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 4150

Internal Memo

FROM: Dean, Graduate School

DATE: 15th June, 2017

TO: **Eliud Gachie Baraka**
C/o Security & Correction Science Dept.

REF: C159/CTY/PT/24640/2014

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

We acknowledge receipt of your revised Research Proposal as per our recommendations raised by the Graduate School Board of 7th June, 2017 entitled **"Preparedness of the Kenya National Police Service to Adopt Geographic Information Systems for Crime Measurement, Mapping and Evaluation".**

You may now proceed with your Data Collection, Subject to Clearance with Director General, National Commission for Science, Technology and Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking Forms per semester. The form has been developed to replace the Progress Report Forms. The Supervision Tracking Forms are available at the University's Website under Graduate School webpage downloads.

Thank you.

ANNBELL MWANIKI
FOR: DEAN, GRADUATE SCHOOL

C.c. Chairman, Department of Security and Correction Science

Supervisors:

1. Dr. Shadrack K. Murimi
   C/o Department of Geography Department
   Kenyatta University

AM/lnn

Appendix V: Authorization for Data Collection by Kenya Police Service

KENYA POLICE SERVICE

Telegraphic address: "VIGILANCE", Nairobi
Telephone: Nairobi 341411–6
Fax: 330495
When replying please quote

POLICE HEADQUARTERS
P.O. Box 30083–00100
NAIROBI

Ref. No. C/ORG/6/10 VOL III/9 and date 29th March 2017

The Commandant
General Service Unit
P.O. Box 49506
NAIROBI

RE: COLLECTION OF SURVEY DATA

In reference to National Police letter NPS/IG/ORG/6/10/VOL.1/40 dated 13/3/2017. The above named student has been authorised for the above named reference at Kenya Police Headquarters and General Police Service Headquarters.

Kindly find authorised application form for reference.

ISAIAH WAMBIA
FOR: DEPUTY INSPECTOR GENERAL
KENYA POLICE SERVICE

CC: Eluid Gachie Baraka
Kenyatta University
P.O. Box 43844-00100
NAIROBI

Appendix VI: Research Permit from NACOSTI

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.
2. Government Officer will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one (1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEACH CLEARANCE PERMIT

Serial No.A 12780

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MR. ELIUD GACHIE BARAKA
of KENYATTA UNIVERSITY, 0-20117 NAIVASHA,has been permitted to conduct research in *Nairobi County*

on the topic: *PREPAREDNESS OF THE KENYA NATIONAL POLICE SERVICE TO ADOPT GEOGRAPHIC INFORMATION SYSTEMS FOR CRIME MEASUREMENT, MAPPING AND EVALUATION*

for the period ending:
11th February,2018

Permit No : NACOSTI/P/17/91140/15400
Date Of Issue : 13th February,2017
Fee Recieved :Ksh 1000

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation