INFLUENCE OF LOCATION INTELLIGENCE IN LAW ENFORCEMENT: A CASE OF NATIONAL POLICE SERVICE, NAIROBI COUNTY; 2010-2019

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DECLARATION

The research project is my original work and has not been submitted for the award of a Master's degree or other award in any other University.

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SUPERVISOR DECLARATION

The research project has been submitted for examination with my approval as University supervisor:

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ABBREVIATIONS AND ACRONYMS

APS	Administration Police Service
BI	Business Intelligence
CoK	Constitution of Kenya
DCI	Directorate of Criminal Investigation
GIS	Geographic Information Systems
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
IC3	Integrated Communication, Command & Control
KPS	Kenya Police Service
KNCHR	Kenya National Commission on Human Rights
KNBS	Kenya National Bureau of Statistics
LI	Location Intelligence
LD	Location Data
NPS	National Police Service
NSDI	National Spatial Data Infrastructure
PEV	Post-Election Violence
PDA	Personal Digital Assistants
RFID	Radio-Frequency Identification
SDI	Spatial Data Infrastructure
USA	United States of America
VGI	Volunteered Geographic Information

ABSTRACT

The study examines the influence of location intelligence to law enforcement and in particular National Police Service focusing on Nairobi County for the period between 2010 and 2019. The research was necessitated by a perceived increase in crime statistics even after introduction of structural and operational reforms which were aimed to bring efficiency and effectiveness within NPS. The specific objectives of the study was to examine the extent location data supported NPS operations; to evaluate policy frameworks guiding collection, processing and storage of location data by law enforcers; and to find out NPS experiences after integrating location aware technology to its operations. To conceptualize the study in a broader context, the study made use of Crime Pattern and Rational Choice theories. The study also adopted a qualitative study approach in order to obtain subjective attitudes of respondents. Structured questionnaires and key informants formed primary data collection tools while secondary data was collected through review of relevant literature. The target population for the study was 800 employees of NPS deployed to criminal intelligence departments within Nairobi County while the sample size engaged was 260 respondents. The qualitative data collected was edited, coded and tabulated using Microsoft Excel statistical package before carrying out analysis. The study established that NPS understood the value of LD processing in ensuring success of its mission. The Service also had adequate location datasets at its disposal which was predominantly applied for predictive policing, fleet management and operational awareness. However, drawback to this asset was inadequate skilled personnel to collect and process the location data. The study further found that although there were adequate policy frameworks to support data collection and processing by NPS, the country lacked a national Spatial Data Infrastructure (SDI) to facilitate access and sharing of geographic information among government departments. Privacy concerns were also observed by respondents as they interacted with location intelligence platforms. To ensure NPS maximally utilized LD to meet its law enforcement needs, the study recommended that there is need to capacity build its human resource in LI concepts and invest in appropriated LD processing platforms. The Service further need to create awareness among its staff on the importance of embracing technology for law enforcement. Finally, to realize full potential of LI technology, the government need to regard location data as an asset or infrastructure that needs to be managed in the national interest by fast tracking development of National SDI as stipulated in Vision 2030 development blue print. In view of the above findings, the study suggests further research on the influence of LI on operations of other national security organs. The study ought to bring out various operational practices of the technology that can be shared among them to enhance their effectiveness in the fight against crime and national defense. Other studies may also be carried out on influence of national policy frameworks on law enforcement.

CHAPTER ONE

INTRODUCTION

The chapter covers the background of the study, the statement of the problem, the objectives of the study and corresponding research questions. The chapter further explains the justification and scope of the study.

1.1 Background to the Study

Law enforcement is an essential organ of any government across the world. It is generally charged with maintenance of law and order, linkage to criminal justice system and overall provision of internal security. As such, Kenya's laws enforcement agency is identified as National Police Service (NPS). The NPS is one of the national security agencies established by Article 239(1) of the Constitution of Kenya, 2010 and its main goal is to promote national security against internal threats to Kenya stability and prosperity. The Service is composed of Kenya Police Service (KPS) and Administration Police Services (APS). Section 28 of NPS Act also establishes Directorate of Criminal Investigations which is under the direction, command and control of Inspector-General of Police (IGP). The IGP is the head and exercises independent command over the NPS for a single four-year term in line with Article 245 of the constitution of Kenya while the KPS and the APS are each headed by a Deputy Inspector-General.

The formation of Kenya Police Service (KPS) can be traced between 1887 and 1902 when Sir William McKinnon an entrepreneur associated with Imperial British East Africa (I.B.E.A.) Company recruited a workforce composed of Indians and some Africans to offer security for his business empire which was spread along the Kenyan coastal line. Construction of Kenya-Uganda railway in 1902 gave an impetus for growth of the police force to protect railway property and personnel. KPS became officially constituted in 1906 through Police Ordinance although its training and structure remained military in nature. After 1926, KPS began to establish specialized units such as Railway Police, Criminal Police, and Air Wing Units among others to undertake specific mandates that needed expertise (Sommer, 2007). Sections 24(a) to (j) of National Police Service (NPS) Act outlines functions of KPS which includes but not limited to; protection of life and property, investigation of crimes, collection of criminal intelligence among others.

APS on the other hand began its operations in 1902 following coming to effect of Village Headman Regulation. The objective of the guidelines was to allow the colonial powers to infiltrate into indigenous villages which were not contributing into the economy through contemporary tax system and to monitor both human and livestock migration. Consequently, community elders selected through the regulation enlisted services of village 'toughs' who later became the Native Police to enforce the colonial administration detested policies (Muthondeki, 2009). In 1958, Administration Police Act (Cap 85) established Administration Police Force and the Minister responsible for security matters was the Commandant of the Force.

Section 27 (a) to (k) of the National Police Service Act 2011 enumerates the roles of APS and key among them being "provision of border patrol and border security, provision of specialized stock theft services, collection of criminal intelligence, carrying out investigations, protection of life and property and protection of vital installations and strategic points". Article 243 (2) (a) and (b) of the Constitution of Kenya, 2010, establishes KPS and APS Services respectively within National Police Service (NPS).

The first endeavor to reform Police in Kenya began in 2002 when the government of Kenya formed a taskforce that comprised of representatives from both National Government and Non-Governmental Organizations (NGOs). The move aimed to redeem the waning image of the law enforcement agencies which were accused of human rights violations, corruption and general inefficiency. The momentum was, however, lost when the findings of the task force was not made public (Amnesty International, 2013).

Subsequent attempts to reform the Police forces re-emerged after political instability created by the 2007/2008 Post-Election Violence (PEV) (KNCHR, 2015). While handling violence that broke out at the time, police forces were blamed of major human rights violations. The Waki Commission tasked to investigate into the conduct of the police made a number of recommendations as such: "to establish an independent police commission, review roles and definition of Administration Police, review laws and issues related to security and policing, recruit and train more police officers to raise police to population ratio to UN standards". The same recommendations were upheld in a report authored by Philip Ransley and his team in 2009 (Bruce, 2014).

The review of the Constitution of Kenya in 2010 incorporated recommendations from the two task forces and led to renaming the Police Forces to Police Services besides creating independent

offices. One such institutional reform was establishment of the office of Inspector General of Police which was mandated with coordination of Administration Police and Kenya Police Services operations that were seen to be overlapping and in conflict with each other. Other operational and logistical reforms related to the study was acquisition of Information and Communication Technology equipment and Infrastructure. The Safaricom implemented integrated command, communication, surveillance and control (IC3) system became a flagship project for the National Police Service (Douglas et al, 2013).

Additional structural changes within National Police Service were introduced through an Executive order on September, 2018. The restructuring aimed at eliminating duplication of roles through a unified command, enhance efficient use of resources by abolishing parallel regional and county APS, KPS and DCI commands. The changes also targeted improving police-public relationship by remunerating officers of all cadres with housing allowance to enable them integrate into the community as opposed to living in police camps. The policy framework saw the KPS focus on public security and safety, APS assigned to protective and border security while Directorate of Criminal Investigations (DCI) to concentrate on criminal investigations (GoK, 2018).

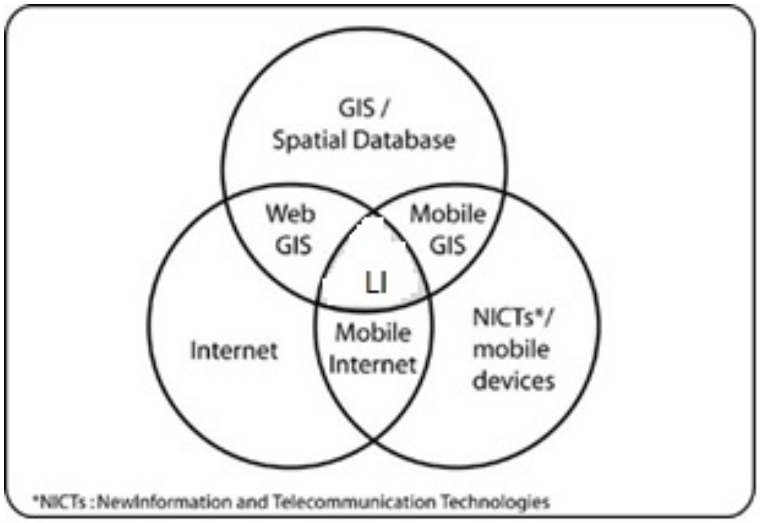
1.2 Location Intelligence (LI)

According to Benner (2011), LI existed from the stone-age period when hunters drew in the sand to illustrate the location of game and how best to use the terrain to approach them. The knowledge was, however, primitive and limited to helping individuals get to their desired destinations. In 1854, John Snow used Cholera Map to understand and stop health epidemics hence bringing a paradigm shift to LI (Gilbert, 1958). The importance of location has further been emphasized by Chinese military strategist Sun Tzu who described six different types of terrains in his theses on the Art of War.

Despite technology transforming the images on sand to become paper and finally electronic maps, the concept has continuously remained the same. What has changed are the tools used by cartographers to explore location data. By the 1970s, there was a remarkable transition from use of desktop mapping applications to client-server technology in order to serve a growing user base while keeping down operational costs. In the 1980s, increased Internet speed, launch of google maps and web 2.0 became game changers in the industry. The Internet allowed users to access

remote geographically referenced contents while websites provided a platform to amalgamate location data from a diversity of collection points. Modern day LI is therefore a convergence of the three technologies i.e. the internet, mobile messaging devices such as smart phones and Geospatial Information Systems (GIS) as shown in figure 1.1 below (Shiode et al. 2004).

Figure 1.1: LI as an intersection of technologies.



Source: Shiode et al, 2004

Although Geospatial Information Systems (GIS) were previously confined to mapping experts and specialist government entities such as military, current development shows that the technology has opened to the larger public. Giraldo (2017) observes that the launch of smartphones especially iPhone 3 in 2009 which was integrated with a Global Positioning System (GPS) helped to contribute millions of location data as users began sending information from their mobile devices. Additionally, the inter-connectedness of smart devices such as sensors, watches, phones and computers also referred as the Internet of Things (IoT) played a key part in collection of massive location data. It is estimated that close to tens of billions of connected smart objects were in use worldwide by end of 2017, up by 31 per cent from 2016 (Gartner, 2018).

Giraldo (2018) further observes that the US Census Bureau is one of the earliest pioneers of GIS technology along with the Canadian government, who established the Canadian Land Inventory. In Kenya, Ushahidi platform demonstrates application of the technology for humanitarian advocacy purposes. Ushahidi is an open source project that allows the general public to

crowdsource crisis information through location-enabled mobile devices. The platform became popular during the Post-election violence in 2007/08 that resulted from disputed election results in Kenya (Ushahidi, 2018).

1.2.1 The Cores of Location Intelligence

Actors in business sector placed more emphasis on location intelligence after the advent of Big Data and more precisely at a period when mobile Internet brought about integration of information, time and location. The location of an individual at any particular time became of interest to organizations business processes. Therefore to achieve full potential of the location element in data, basics of LI becomes vital to understand. According to Galigeo (2018), there are three phases of LI and includes; location discovery, location analytics and finally location optimization. Location discovery otherwise called 'data refining' refers to that process of converting a place name into a pair of geographic coordinates (x, y) in a database. Once the absolute location of an object has been resolved, it then becomes possible through intersection of spatial information to assign attributes to it. For instance, if a location of a town has been established absolutely, it then inherit attributes such as a name, population, economic status among others. The process therefore enhances the value of a dataset in a database.

The second phase is location analytics which also has three components i.e. visualization, spatial analysis and prediction. Visualization of LD entails simple representation of geocodes in form of points, lines or surfaces on a map. The representation can further be enhanced by introduction of color codes, data clustering, heat maps and temporal aspect which helps to bring out spatial disparities and trends that ordinarily would not have been possible with normal charts or data tables (Esri, 2012). Spatial analysis on the other hand brings new insights and answers into LD through superimposing various data layers and exploiting such functions as proximity (Intersect, Cross, disjoint etc.), map filtering, bi-directional interaction among others. Lastly, forecast entails use of location contest postulates like *the Type, the Extent and the frequency* of events to help make deductive and inductive conclusions.

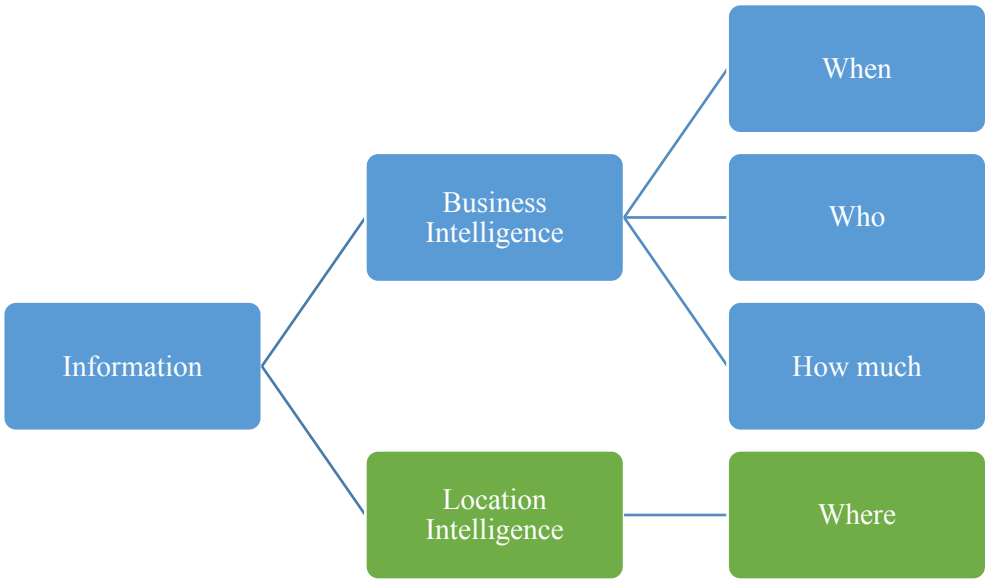
Location optimization is the final phase in location intelligence implementation and entails embedding operatively LD residing in a database with real time business processes. Routing a police patrol car to respond to an incoming emergency call within its beat area is an example of LI optimization in law enforcement. In conclusion, for an organization to get value from its data, it

has to ensure that the LD in its possession is well structured right from the database to presentation stage. In Galigeo (2018) own words, location Intelligence starts at the Back End of the data and not at the Front End.

1.2.2 Business Intelligence Vs Location Intelligence

According to Esri (2012), analytics in today's business world was heightened by a notion sold through publication of Thomas Davenport and Jeanne Harris's book titled C*ompeting on Analytics: The New Science of Winning* in 2007. The perception implied that both public and private sector institutions need to leverage analytics on their data to gain insight and drive decision making. Business Intelligence (BI) therefore refers to the process by which enterprises use strategies and technologies to analyze current and historical data with the aim of improving strategic decision-making and providing a competitive advantage (Frankenfield, 2019). Simply put as organization and analysis of massive datasets in companies' possession in order to establish unforeseen relations, patterns, and discernments that can be turned into actions. Typical output of BI is in the form of statistical reports that summarize tabular data and sometimes presents this data in graphs and charts.

Figure 1.2: Location Intelligence Vs Business Intelligence



Source: Galigeo, 2018

Desire by organizations to dig deeper into data in their backyards trying to attain an edge against their competitors gave rise to Location Intelligence (LI). LI, therefore, refers to incorporation of location data residing in organizations databanks to already existing business intelligence. A white paper published by Pitney Bowes observed that about 80% of the data stored and maintained by organizations have a location component. A parameter that is completely untapped. Consequently, there is a growing realization that by adding geographic location to business data and mapping it, institutions can radically improve their insights into tabular data. Maps and spatial analytics provide a whole new context that is simply not possible with tables and charts. BI and LI are inter-linked as shown in figure 1.2 above.

1.3 Statement of the Research Problem

After promulgation of the Constitution of Kenya 2010, NPS was reformed structurally and operationally to make it efficient and effective. Equally, substantial amount of resources was allocated to the agency to redeem its deteriorating image and restore public confidence by making it effective in service delivery (KNCHR, 2015).

However, annual crime statistics published since 2010 by various government departments such as National Crime Research Center (NCRC), KPS and Kenya National Bureau of Statistics (KNBS) shows that much is yet to be achieved despite the investments. Crime trends from 2010 to 2018 indicates a rising crime prevalence across the country as shown in figure 1.3 below.

Comparative crime figures for the periods 2015/2016, for example, indicated that there was an increase in serious crimes offences: vehicle theft by 22%, corruption 16%, traffic offences 16%, dangerous drugs 11%, stealing and criminal damages 8%, and other offences against persons increased by 5% (NCRC, 2016). The crime trend worries more by observation that Nairobi and Kiambu Counties which are Country's commercial hubs feature among top three in crime prevalence. For instance, in 2015/2016 Kiambu and Nairobi had 6006 and 4954 crime incidents respectively (NCRC, 2016).

Insecurity created by rising criminal incidents has a potential to scare away local and foreign investments which the country desires most in pursuit of her National Interests. The Big Four Development Agenda and Kenya Vision 2030 which are short and long term progression blueprints for the country aimed at improving the living standards of Kenya citizens and make the

county's economy modest by 2030 could only be achieved by guaranteeing security to all within the country's territorial boundaries.

The NPS IC3 flagship project, street surveillance cameras among others have location aspects that can potential be harnessed to fight crime. It is against this background, the study intends to examine the influence of location intelligence in law enforcement.

1.4 Research Questions

a) How does law enforcement utilize location data to support its operations?
b) What policy frameworks guide collection, processing and storage of location data for law enforcement?
c) What is law enforcement experience on integrating location aware technologies to its operations?

1.5 Objectives of the Study

1.5.1 General Objective of the Study

The broader goal of the study was to investigate the influence of location intelligence to law enforcement and in particular NPS in Nairobi County.

1.5.2 Specific Objective of the Study

The detailed objectives of the research were:

a) To examine the extent location data support law enforcement operations.
b) To evaluate policy frameworks guiding collection, processing and storage of location data by law enforcer.
c) To find out law enforcer experiences after integrating location aware technology to its operations.

1.6 Justification of the Study

In its endeavor to seek answers to the problem statement, the research was guided by the following academic and policy justifications.

Academic Justification

Location Intelligence is a developing frontier in the country's law enforcement landscape introduced by Constitution of Kenya 2010 reforms. The reforms in the law enforcement led to revamping of Police Information, Communication and Technology (ICT) systems and infrastructure to supplement manual systems previously used. Much has been written on police historical evolution, community policing, security sector reforms and other operational aspects of police leaving out emerging technical facets. For instance, Bruce (2014) wrote on *Challenges related to police reforms in Kenya*, Gichuki (2016) on *Dismantling the corruption sector in Kenya*, Muthondeki (2009) authored *Evolution of modern policing,* Sommer Hans-Martin (2007) on *History of the police in Kenya* among others. This study, therefore, focused on LI because it is a gray area and a contemporary technical front that apparently impacts heavily on the law enforcement mandate. The study, thus, aims to bring out scholarly insights on best practices of location intelligence as embraced by other security and emergency services regionally and across the world.

Policy Justification

Sections 24, 27 and 35 of the National Police Service Act of 2011 and other related legislations empowers National Police Service to gather and share intelligence related to law and order; investigate crime; and identification, arrest and prosecution of delinquents. The study intends to evaluate existing laws regulating collection, processing and storage of location data to identify gaps if any. The recommendations from the study will aid policy makers design better solutions to plug into identified gaps to bring about efficiency and effectiveness in the NPS.

1.7 Scope and Limitations of the Study

The study was restricted to location aware technologies within the Service and did not cover other tools such as Emergency Short Message Service (SMS), digital human resource databases and other communication technologies. Crime is committed at a location and criminals reside in a locality thus making LI the best tool to fight crime and subject of the study.

Restricted access and confidentiality of information within the NPS could have limited data collection for the study. However, the researcher sought authority from National Commission for Science, Technology and Innovation (NACOSTI) which is a body legally mandated to control and

assure quality in research in the country. Similarly, permission was sought from NPS leadership to make the study credible and gain respondents confidence.

The study was also limited to the period between 2010 and 2019 because this was the time when structural and operational security reforms were introduced and implemented in the NPS after proclamation of the Constitution of Kenya, 2010. It was within this period that Integrated Communication and Command (IC3) Center was established by NPS and acquisition of police vehicles fitted with car tracking system.

The research was restricted to Nairobi County due to cost and time constraints. Further, Nairobi and Mombasa were the pilot counties for key projects such as the IC3 hence could provide comprehensive data for the study. The financial constraints was resolved by sticking to the estimate budget and planned time frame as shown in appendix I and II respectively. Funding was sourced from personal savings and research grant from the employer.

1.8 Definition of Concepts

Law enforcement

Refers to a system by which some members of society act in an organized manner to enforce law by discovering, deterring, rehabilitating, or punishing people who violate the rules and norms governing that society (Kaplan et al, 2010). Generally, law enforcement becomes a society's formal attempt to obtain compliance with the established rules, regulations, and laws of that society.

Operationally, law enforcement means police agency established through NPS Act, 2011 and is composed of APS and KPS Services. Also refers to the Service established under Article 243 (1) of the Constitution of Kenya, 2010.

Location Intelligence

According to Esri (2016), LI is a system that lets you get critical business insights through processing, enrichment, and spatial analysis on top of geospatial data.

The study defines LI as the process of deriving meaningful insight from geographic data relationships to resolve a particular business problem such as establishing location of a criminal, a motor vehicle etc.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant literature critically focusing on LI application areas, infrastructure and policy framework for collection and processing of location data and finally users experiences after implementation of LI technologies. These issues have been discussed from both global, regional and Kenyan perspective. The objective of review is to identify knowledge gaps in literature to be addressed by the study.

2.2 LI application areas

Gearey et al (2014) in their article, "Utilizing Location Intelligence for the placement of corporate services" observed that in an increasingly competitive market, optimization of location in which a business operates has become paramount. He also notes that decision makers are embarking on utilization of data and technology to reduce hazards and authenticate their location decisions. Some of the risks to be avoided could be crime hotspots while searching for a residential home or finding a business zone with the right population and appropriate purchasing power to establish a retail shop. Although the findings of the study demonstrated that location intelligence has replaced Von Thunen's concentric ring theory in location optimization, the researcher did not give a step by step account of data layers, instruments and processes involved in the methodology section. Further, while the research shows that there is well proven approaches to use of location intelligence for residential real estate management, its application for security sector and support for back office corporate procedures is not well acknowledged.

Bachner (2013) posit that the history of quantitative crime analysis as a tool to prevent crime is as old as crime itself. She gives an example of London's' Metropolitan Police who had been using pattern recognition to solve and prevent crime since 1842. The scholar also gives a case of US federal government which in 1900 began collecting national crime data that helped to advance crime statistics. Limited technical and skilled personnel is however cited as a drawback to police institutions integrating the technology into their operations. While the study indicated that there was a crime decline when crime mapping was adopted by police departments, burglary incidents went down to 51 from 70 in Santa Cruz, California, this statistics could still be brought down.

Maps when integrated with Global Positioning System (GPS) and Internet enabled smartphones become powerful decision making tools for officers on patrols or operations. In Kenya law enforcement sector, there are limited studies enquiring how data residing in law enforcement repositories are used to gain awareness of crime trends and design possible solutions to deter future criminal occurrences. The research thus seek to address this knowledge gap.

Xu et al (2010) in their article, "Location Based Service (LBS) disaster and emergency management" argues that in the wake of climate change, natural disasters have become the order of the day and China has not been an exception. To address the challenge, the scholars advocate use of LI applications to provide solution as opposed to mobile communications networks which become limited when ground communication facilities are severely destroyed by disasters. In the study, they observed that satellite communication and wireless communication are the two forms of communication in response to different circumstances. Whereas the problem statement agreed with the title of the paper, the authors did not bring out the concept of location intelligence clearly. Both satellite and mobile terrestrial communication are wireless in nature and can both give location of a caller in distress. However, satellite communication are used as an alternative when ground mobile communication infrastructure are non-existent or high level of accuracy is required on location of the caller in distress. Overall, the paper was well written and brings significant contributions to the field of study. NPS officers according to establishing legislation get deployed to search and rescue missions yet there are gaps in literature on how they carry out such missions.

After observing exponential growing markets for smartphones and other mobile devices, Retscher and Hecht (2012) carried out investigations on navigation capability of different brands of smartphones which included Nokia, HTC, Samsung and iPhone fitted with global positioning capabilities. The study was informed by the intelligence behavior exhibited by smartphones based on low cost and compact sensors that were integrated with them. The main sensors of interest were accelerometer, GPS and gyroscopes which provided navigation and positioning functionality. According to the study findings, the locating accuracies of the smartphones was on the few meter level hence proving the feasibility for navigation and positioning purposes. This was a very in-depth researched journal article although it got a little bit complicated in the reporting of data possibly due to intricate statistical approaches used. Based on the study, there is need to find out

the use of mobile devices as navigation aid to NPS officers during patrols and other mission related operations.

In their journal article, "Tracking of police patrol", Wain and Ariel (2014) argue that although directed and preventive police patrols are as old as present day policing, use of technology to precisely and meticulously manage them has not gained popularity in the recent past. The scholars observed that tracking mechanisms of patrols have been gradually advancing from Fixed Point and Beat Systems to more advanced appliances with video and GPS capabilities either to be held or worn by police officers on patrols. They further contend that although reconnaissance devices may not be liked by law enforcers due to perceived security concerns, monitoring of patrols helps to improve individual and institutional responsibility which is the desired objective.

Sherman (2013) agrees with Wain and Ariel (2014) that evidence-based policing is a policy matter that helps to find out what policing practices and policies accomplish police missions in a cost effective manner. It further gives assurance that police are not involved in crime or wasting public resources. Wain and Ariel (2014) listed three objectives in their study which were answered by testing a simple hypotheses. The article, however, had no clear review of literature but had several appropriate references relevant to this field of study. One of NPS mandate is to maintain law and order which is achieved through beats and patrols. Thus there is need to find out contribution of location intelligence to NPS patrols roles.

2.2 LI infrastructure and policy framework

According to Warnest (2005), States are increasingly recognizing that viable developments can only be achieved through controlling of location information as a national resource. Consequently, Spatial/Location Data Infrastructure (SDI) ought to be managed and efficiently coordinated in the interest of the nation. He further argues that although this is the case, stakeholders in location data have no legislative framework to enable them cooperate to build a national SDI. Smits et al (2005) agrees with Warnest (2005) that SDI allow location data community to access, discern, view, comprehend, and interrogate geospatial information for planning, disasters preparedness, environmental policy development etc. In their article, Smits et al (2005) contends that technological interoperability are some of the challenges limiting development of SDIs.

Crompvoets and Bregt (2001) while evaluating the world status of spatial data clearinghouses at national level observed that, there has been progressive growth of in their numbers since 1994 with United States in the lead. They further noted that over 50% of countries in North and South America as well as Europe have established clearing houses while less than 5% countries in Africa have done so. Although the study recognizes this as a global activity, main effort apparently comes from the Anglo-Saxon countries with Africa and Middle-East showing least interest. The authors attribute this gap to social, monetary, technical and historical factors which vary from one country to the other. This was a well-researched article with data collection methods well explained, and reliability co-efficient of various tests given. The authors' objective was answerable but had no clear review of literature. However, there was some bias in reporting where the authors spilt the world into North and South with the South (Africa, Asia and Latin America) perceived as least committed to development of NSDI.

In the journal article, "a review of the status of spatial data infrastructure implementation in Africa", Smit (2010) observes existence of great commercial prospects to be realized when spatial data is made widely available. However, he discerns that although governments across the world are investing heavily in National Spatial Data Infrastructures (NSDI) upon realizing its value, Africa is implementing the same at a notably snail's pace. After carrying out a survey in 29 African countries in which the continent was split into four regions, it was found out that most African countries that had invested in NSDI development were still at their infant stages. Guigoz et al (2016) support Smit et al (2010) argument by observing that Africa scored relatively weak against fourteen SDI indicators in their study when matched to other countries in the globe. However, it was also noted to exist a variant score for African countries when ranked against each other. While the two studies used different methods in their surveys, their findings were quite similar. The use of internet searches by Guigoz et al (2016) in their survey, however may not have yielded satisfactory results because most African countries rarely publish their data online due to underdeveloped infrastructure.

Kiema (2007) while assessing Kenya's readiness to GDI take-off observed that little political support, non-existence of active GIS professional organization, absence of sustainable funding policies as well as lack of long term strategy towards implementing the same have undermined development of GDI. The study evaluated country's achievements on components such as

institutional framework, data, and technology, policies and personnel skills. The author notes that there is inconsistence of geospatial datasets across organizations which are also not up-to-date. Upon realization of the above shortcomings, the government of Kenya in 2002 joined hands with some of her development partners such as Japan International Cooperation Agency (JICA) in providing technical assistance to Survey of Kenya (Maruyama et al, 2003). Okuku et al (2014) is in agreement with Kiema (2007) that while there are many public and private institutions dealing in production and use of location data, the status of National Spatial Data Infrastructure development in Kenya is unknown or ad hoc and fragmented due to the reasons stated above. The findings of the three articles were reported objectively and recommendations given on how the government could resolve the challenges.

Nevertheless, Boes and Pavlova (2008) posit that development of traditional SDIs have been challenged by the internet which has provided new business prototypes such as collaborative geospatial web. The authors further predicted a merger between web applications and the traditional SDI which are driven by user demands to form a knowledge infrastructure. According to Masser (2005), current SDI strengths and weaknesses as well as other concerns hold key to the future of SDI. The four identified concerns were: adoption of open data standards to allow for interoperability, training of geospatial data users, development of suitable SDI governance controls and ensuring easy access to datasets. However, Kok, and Loenen (2005) argues that since the various components of SDIs keep changing, it is the institutional component that need to be realigned in order to respond to SDI development. Thus, they acknowledged organizational management, vision and its desire to initiate new inventions as important organizational aspects in NSDI development. Overall, the studies were well written and predicted the future of SDI which most of it have come to pass a decade later. For instance, the web and traditional SDI have merged to form national spatial data clearinghouses. However, there was need for short review of literature to grow research hypothesis.

2.3 Experiences of implementing LI technology

Michael et al (2008) argue that people tracking and monitoring have become the focus of operators and service providers as they seek to power their infrastructures towards the advanced location intelligence applications. The study give examples of radio-frequency identification (RFID) and GPS use in healthcare sector applications to track and disclose location of patients. They further

observed that little assessment has been carried out regarding the socio-ethical implications of the technologies. Moreover, the LI applications is observed to have given government an upper hand in collecting individuals' data to perform clandestine surveillance.

Anuar and Gretzel (2011) while agreeing with these views recognized that privacy concerns are often raised in relation to location intelligence applications but has never been addressed in any researched literature. According to Xu & Teo (2004), privacy is defined as an individual's right coupled with ability to oversee how information about them is collected, processed, kept in data repositories and distributed to third party. The two studies concluded satisfactorily on the subject of privacy of location intelligence applications with recommendations to develop standards, regulations and laws on the subject. However, the authors failed to bring out the discourse on when and for whom privacy should be a concern and possibly how LI applications can address it. The studies also dwelt on the privacy issues relating to tourism industry and little on security sector. It is this gap that this study intends to fill with reference to NPS officers.

In the journal article "positioning in environment where GPS fails", Rizos et al (2010) observes that most LI applications work well when the skies are clear and away from built up urban environment because satellite signal interference is minimal. According to the study, accuracy is vital for positioning, navigation and timing (PNT) applications. To improve accuracy of mobile devices in such environments, Assisted Global Navigation Satellite System (GNSS)/GPS or Wireless Fidelity (Wi-Fi) could be used as alternative technologies. Liu, et al (2013) also observes that wide use of LI applications have been inhibited by inaccurate position estimates and high energy consumption incurred by GPS module in mobile devices. Unlike Rizos et al (2010), they proposed a social-aided cooperative location optimization scheme to address the challenges which worked satisfactorily both indoors and outdoors. The studies problem statement was correctly aligned with the title of the article and adequate references were used in the background section which made the article more informative. However, although the methods used to test the research variables were clearly explained, they remained technical and could not stand alone for an average reader.

Additionally, Vecchio et al (2005) observes that there are challenges designing and developing location intelligence interoperable software applications. They argue that performing tuning and

installation processes for indoor or outdoor LI applications become problematic operation due to non-standardized features inherent in network connection or terminals in mobile device. In the study, the authors proposed a hybrid solution that makes use of a generic Application Programming Interface (API) that is of low cost, compliant to evolving positioning principles and for variant mobile devices. Benford (2005) in his study, 'Future Location Based Experiences' admits that there exist heterogeneous devices, networks and location-sensors used to develop LI applications globally. Consequently, technical challenges such as interoperability of networks makes roaming between different network providers using a single experience a nightmare. To address the challenge, Benford (2005) gives a similar solution to Vecchio et al (2005) by advocating development of a flexible middleware to enable users to effortlessly combine devices, networks and sensors.

The two studies approached the same subject in different perspectives: Vecchio et al (2005) identifies the interoperability challenge but goes ahead to design own solution through experimentation which was guided by a well-documented methodology. Benford (2005) on his part sited existing research platforms which offers solutions to the interoperability challenge. Moreover, the researcher while reviewing the literature did not come across studies on how Kenyan law enforcement agencies tackled the devices and telecommunication networks interoperability issues. It is this gap that this study intends to bridge.

2.4 Theoretical Framework

The research was modeled on the following theoretical frameworks; Crime Pattern and Rational Choice theories. The two theories complement each other in spatial-temporal analysis. Rational Choice theory helps to explain '*why'* individuals in a society engage in crime but it falls short of mentioning the locations prone to criminal activities. This limitation is bridged by crime pattern theory which answers the question '*where'*. The two theories become important tools for law enforcers in identification of criminal incidents patterns, forecasting and preventing security vulnerabilities in the society through equitable distribution of limited law enforcement resources.

Rational Choice theory is the works of Clarke and Cornish whose objective was to help in discerning crime deterrence in the society. The model makes an assumption that individuals engage in criminal acts after making a cost-benefit analysis of participating in lawbreaking. The criminality is mostly motivated by personal and environmental factors. Personal motivations could

be desire to seek vengeance for a wrong done or to gain monetary benefits from the act. On the other hand, presence of police or guardians near a crime victim or target constitute environmental factor. This, therefore, makes crime a personal choice.

Keel (1997) similarly describes major assumptions of the model by observing that people are rational in nature and hence their activities whether deviant or conforming is dictated by potential discomfort and pleasure they are likely to achieve. However, in most instances the choice is aimed at bringing more pleasure to involved parties. Another assumption is that the government is responsible for maintenance of law and order through a system of enacted legislations. As a result, the speed with which law enforcers react to distress calls and harshness of penalty meted to delinquents are key to controlling people behavior.

The model is relevant to this study because it apportions State the responsibility of protecting its citizenry. It also suggests that through proper deployment of law enforcement resources such as personnel, police stations and patrol vehicles, crime can be deterred since criminals will find it a risk to engage in crime. Kenya has laws that prescribe severe punishment to capital offences such as robbery with violence, murder, sexual offences among others. However, law enforcers need to strategically deploy themselves in crime hotspot areas to enhance their response to emergency calls. Critics of rational choice theory have argued that the theory has been too simplified and has limited variables to carry out research tests hence cannot be applied broadly. For instance, although severe punishment of offenders is perceived as a deterrence to criminality, it is argued that long years of imprisonment as a severe punishment tend to harden criminals.

Crime pattern theory, on the other hand was advanced by Paul and Patricia Brantingham and the theory was used to complement Rational Choice theory to answer the question '*where'*. Brantingham (1993) argued that there is a stronger nexus between geography and the thought process of committing crime. The theory assumes that a crime is committed when offender and victim spaces overlap. Consequently, areas that bring large crowds together such as shopping centers become potential crime areas because it attracts both offenders and victims in equal measures.

Crime pattern theory, therefore, affords law enforcers a structured way to discover patterns of unlawful conduct in a society. Location dataset analysis through GIS supports proactive policing

through disciplines such as intelligence, investigations and security resource planning. Various criminal analytical techniques such as crime mapping and geographic distribution analysis help crime trends identification and assist decision makers in resource sharing as well as planning. The main weaknesses of the theory is that it neglects the role of inequality in the broader social environment as well as dependence on "informal social control" notion which in most cases is not well defined nor its variables determined.

2.5 Research Hypothesis

This study was designed to test the following hypothesis;

a) Spatial analysis of location data enhanced effectiveness of law enforcement operations.
b) Management of location data by law enforcement is guided by appropriate national policy framework.
c) Law enforcers are proficient in collection, processing and application of location data.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter describes the methodology used to carry out the study and covers the; research design, site of study and sampling design. Moreover, the chapter also covers the research instruments, ethical considerations observed and highlights of data management practices adopted by the study.

3.2 Research Design

The study adopted a descriptive research design and specifically longitudinal type of research covering the period 2010 to 2019. This was the period that coincided with introduction of operational and structural reorganizations in the National Police Service and revamping of Police Information and Communication Technology (ICT) systems and infrastructure. According to Salkind et al (2010), longitudinal study is the one that measures the characteristics of the same entity on at least two or more occasions over time. The study also assumed a qualitative study approach because the focus of the study was to obtain subjective attitudes of respondents in order to provide the scholar with usable statistical details about human behavior. The behavior of NPS officers towards location aware technologies was therefore best studied using qualitative approach. The approach aided in designing recommendations to the research problem outlined in the study.

3.3 Site of Study

The research was conducted in Nairobi County (see Addendum V). Nairobi is the capital city and most administrative and commercial interests are hosted by the County. NPS headquarters is located right at the heart of the Nairobi City. The County was a target of the study because Nairobi and Mombasa Counties were the first to launch Police ICT projects and hence possessed the relevant characteristics to be investigated by the study. The study population was National Police Service officers deployed to criminal intelligence departments and IC3 center. The population was composed of head of directorates, analysts and general duty police officers assessed to be using the technology in their day to day operations without regard to ranking, experience and gender.

3.4 Sampling Design

Kothari (2004) argues that a good sample design results to a negligible error and feasible in view of existing budget. The sample frame for the study was officers deployed to Law enforcement Intelligence Departments with a population of eight hundred (800) personnel. The researcher adopted a mixed sampling approach combining both probability and non-probability sampling methods. Stratified sampling was adopted by grouping the respondents into three sub-groups consisting of Supervisors, Analysts or Data practitioners and General Duty officers. Random sampling on each sub-group was then used to pick representative respondents to fill in questionnaires. The scholar also adopted purposive sampling to pick Supervisors/Commanders within the sample size in order to obtain detailed and varied knowledge or experiences about the subject matter through interviews.

To determine the sample size, the scholar made use of precision rate and confidence level approach. According to Johnson and Siskin (1976), the approach helps to reduce sampling error through a mathematical algorithm. As such, the sample size (n) of NPS officers in Nairobi County who participated in the study were determined using the following formulae.

$$n = \frac{z^2 \cdot N \cdot \sigma_p^2}{(N-1)\, e^2 + z^2\, \sigma_p^2}$$

Where;

N = size of the population/universe

n = size of the sample

e = the acceptable error (the precision)

σ_p = standard deviation of the population

z = the value of the standard variate at a given confidence level (to be read from the Appendix VI) and it is 1.96 for a 95% confidence level.

For purposes of this study, the target departments had an approximate strength (N) of eight hundred (800) personnel, the researcher sets a confidence level of 95% with a marginal error on 5%, to give sample size needed (n) for the study as two hundred and sixty (260) respondents.

3.5 Data Collection

Driscoll and Brizee (2017) acknowledges that research studies involves collection of primary or secondary data or both. Primary data refers to data collected by researcher from original sources with a project in mind. It is often collected through surveys, experiments, interviews and focused groups. Although quite expensive and time consuming to obtain, this type of data is important because of its currency, originality, reliability and is explicitly tailored to respond to research questions. The primary data for this study was collected from NPS officers deployed to criminal intelligence directorates and IC3 center within Nairobi County.

The scholar designed and used questionnaires and personal interviews schedules as tools for collecting primary data. A questionnaire refer to a survey form with a list of enquiries probed from respondents to obtain statistically suitable information on the research area. For this study, the survey form (See Appendix IV) made use of both open and closed ended questions to accurately capture participants' attitudes and behaviors. In some instances, the participants were required to give their responses on a pre-designed scale of agreement.

Questionnaires as method of data collection was preferred because it lowers the costs where the population understudy is relatively large and distributed as in the case of NPS. Conversely, there is a risk of collecting incomplete and wrong information mainly due to respondents' inability to understand questions properly. This challenge was addressed by carrying out a pre-trial study to test the questionnaire and helped in improvement of the tool. Further, the researcher's contact details was availed on the questionnaire to enable respondents make clarifications when need be.

Personal interviews was another primary data collection tool deployed for the study. According to Aminuzzaman (1991), interview is a step by step approach in which the researcher establishes a rapport with identified respondents to provide required information to be used for study purposes. The scholar interviewed heads of criminal intelligence directorates because they were knowledgeable about operational and human resource needs thus suitable for intensive investigation. As such, the scholar used a set of predetermined questions in the order prescribed in Appendix III. A notebook was used to record responses. Interviews were time consuming and required special skills on the part of the interviewer. Nevertheless, this method allowed collection of more information and in greater depth.

Secondary data on the other hand refers to that data which is gathered from other research studies conducted by scholars in the past. The scholar also used secondary information sources so as to acquaint him with knowledge on research concepts and formulation of questions. The data was obtained from journal articles and reports from relevant online databases and university library. Although this type of data provided access to best scholarly works material and adds value to the study, the scholar exercised some caution since secondary data has the potential of distorting the results of the study resulting from time lapse thus rendering the data or information obsolete.

3.6 Data Analysis and Presentation

This formed the subsequent stage after primary data was collected. The data was processed to remove ambiguity and bring out clarity where necessary before final computation. Processing entailed a number of steps such as editing, classification, creation of codes and organization of collected data in tables. Analysis involved computation of conceptual variables to determine relationships that exists among data elements. Scholars differ on whether data processing and analysis are similar or distinct from one another. Selltiz et al (1959), for example, refers the two as one process that culminates with analysis whereas Giles (1969) deals with the two as separate entities. In this study, Selltiz et al (1959) approach was adopted on the premise that processing of data is part of closely related steps of data analysis which are carried out with the ultimate goal of summarizing collected data and organizing them in a way to provide answers to the research questions.

Once questionnaires were returned from the field, editing was done to detect errors and omissions and remedy them where applicable to guarantee accuracy and consistency with other collected data. Since the study's approach was qualitative, the next step entailed coding of responses to assign them symbols and reduce the numerous responses into a handful number of categories. This was done by transcribing the responses from the survey forms into coding sheets. To facilitate the process of comparison and other statistical computations, the coded data was tabulated in rows and columns using Microsoft Excel statistical package. The researcher preferred the software package because of its capacity to analyze large volume of data and easy accessibility in most computers without extra costs. The analyzed data was visualized using different tools such as bar graphs, pie charts and frequency distribution tables.

3.7 Ethical Concerns

Ethics refers to standards for conduct that help to differentiate between conforming and deviant behavior (Resnik, 2011). Ethical consideration was important in the study because it guarded against data falsification hence help in promoting the pursuit of truth and knowledge. Permission was sought from National Commission for Science, Technology and Innovations (NACOSTI), a state corporation mandated by law to regulate and assure quality in research (see Appendix V). Moreover, before distribution of questionnaires and administration of interviews, the researcher sought approval from NPS leadership to grant access to officers under its command (See Appendix VI). Respondents were further assured in the questionnaires that data collected is purely for academic use and would be kept confidential where appropriate.

Due to sensitivity of nature of information to be collected, respondents were required to provide their responses anonymously to avoid victimization. Lastly, to ensure objectivity in data collection given that the researcher worked in the NPS, the scholar remained in civilian attires while interacting with respondents and also sought help of research assistants to distribute questionnaires to minimize contact with respondents.

3.8 Validity and Reliability

The study embraced Messick (1989) definition of validity which refers to the "degree to which empirical evidences and theoretical rationales support the adequacy and appropriateness of interpretations based on test scores". Reliability, on the other hand, is the extent to which results of an experiment or calculation is free from measurement errors (Neumann, 2003). From the definitions above, it is evident that validity relates to accuracy while reliability relates to precision.

To ensure accuracy of data collected, the study made use of respondent's verification by inviting them to make comments on interview scripts and also confirm whether the themes or codes generated by the researcher reflected their state of mind. The researcher also achieved consistency in the study by keeping records to provide decision trail while acknowledging for personal biases that may have influenced the findings.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.1 Introduction

The chapter presents the results of the study in line with analysis of collected data. The main aim of the study was to look into the influence of location intelligence to law enforcement in Nairobi County with an emphasis on operational utility, policy framework and users experience with the technology. Questionnaires and Key informants within NPS formed primary data collection instruments for the study.

Out of two hundred and sixty (260) questionnaires distributed by the researcher, two hundred and thirty five (235) were returned indicating a response rate of 90.4%. According to Mugenda and Mugenda (2003), this response rate is satisfactory and representative of the study population. Since the research design was qualitative, the responses collected were collated and coded by the researcher to reduce the numerous responses into a handful number of categories that could be visually presented.

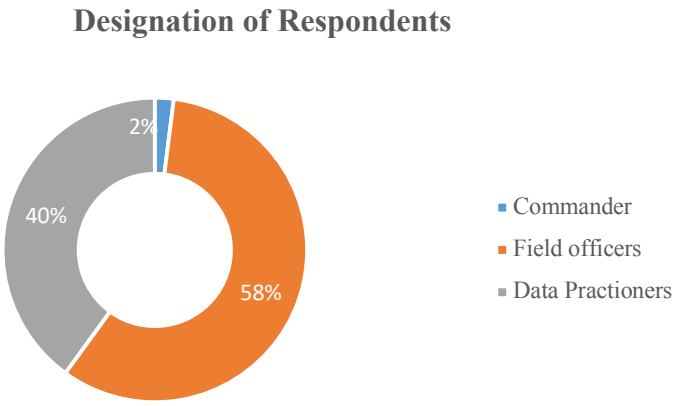
4.2 Background Information

The respondents' background information was examined in relation to positions they held in the Service and their level of training with respect to LI technologies. This information was important to enable the researcher determine how respondents influenced adoption of the technology. Figure 4.1 and 4.2 below presents the findings.

4.2.1 Job Designation

The results of the study brought out three categories of designations that included commanders, data practitioners and field officers. Respondents with Commanders designation assumed managerial roles, data practitioners worked on data processing in most cases while field officers performed operational duties using or guided with the technology. Figure 4.1 below shows that majority of the respondents were field officers at 58% followed by data practitioners at 40%. Commander category formed 2% of the engaged respondents. It is generally observed that the universe under study was comprehensive and covered various categories of respondents.

Figure 4.1: Respondents Designation



Source: Field Research, 2020

4.2.2 Level of Training

Knowledge of extent of training of respondents was necessary for the study for it helped in determining the degree to which they could execute complex tasks using spatial datasets. Collecting and analyzing huge amount of LD can be frightening since it involves new technology and methods. Findings in table 4.1 below indicates that fewer respondents at 9% possessed an Expert level kind of training compared to their counterparts who formed the bulk of the study and had a Basic level of training at 70%. However, 21% of the respondents attained Intermediate level of training.

Table 4.1: Level of Training

Training Level	Frequency	Percentage
Expert	21	8.9
Intermediate	49	20.9
Basic	165	70.2
Total	**235**	**100.0**

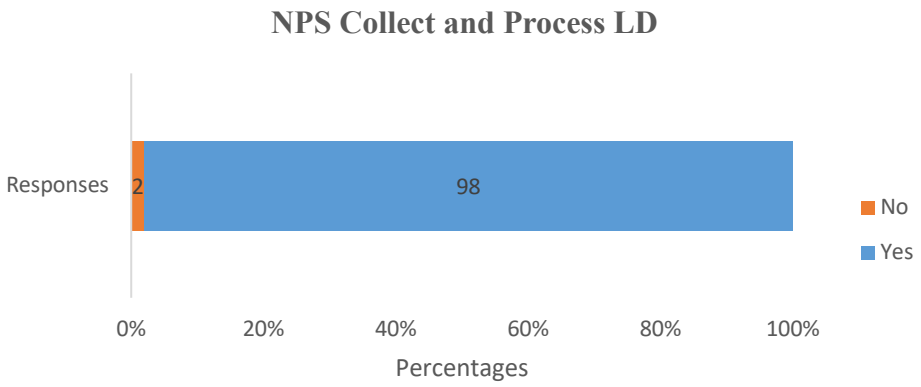
Source: Field Research, 2020

4.3 Integration of LI into NPS Operations

4.3.1 Collection and Processing of Location Data (LD)

The study also enquired whether NPS gathered and processed LD to support its core operations. The results collected revealed that an overwhelming majority of the respondents answered affirmatively at 98% while minority at 2% disagreed as show in figure 4.2 below. The response is supported by one of the Directors acknowledgement that most of reports received by police stations contain location component. The huge difference is perhaps an indicator that NPS relied more on its own data as opposed to that acquired in collaboration with third parties. Most of the crime data submitted by field commands possessed location components hence the overwhelming agreement by the respondents.

Figure 4.2: Collection & Processing of LD

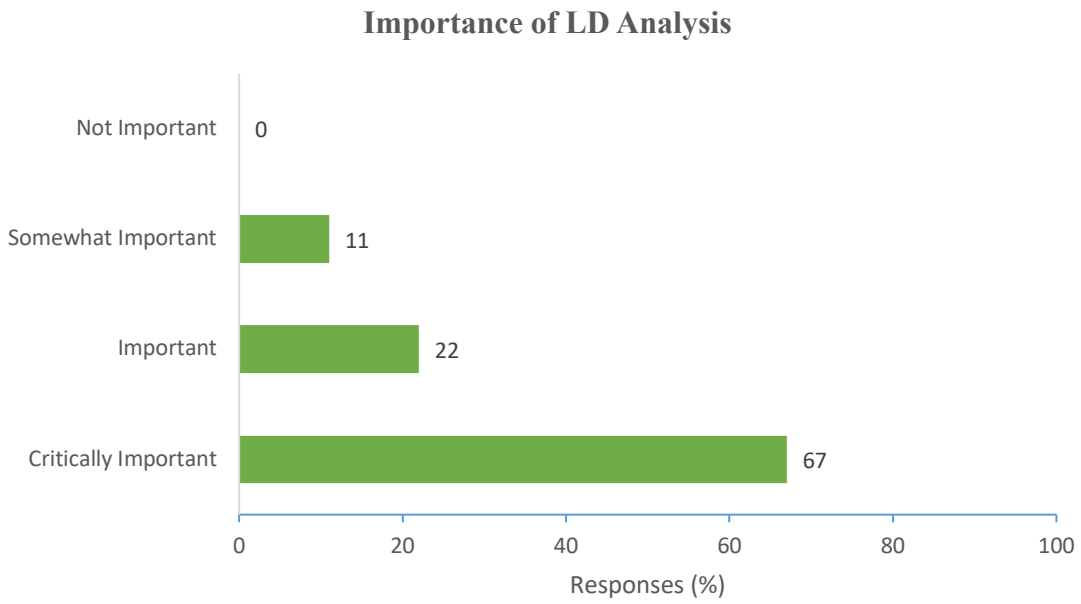


Source: Field Research, 2020

4.3.2 Importance of Location Data Analysis

Perceived value of LD analysis by respondents was felt by the scholar as having an impact on NPS realization of its constitutional mandate. 67% of the respondents said LD analysis was 'critically' important while 22% said it was important for the organization. 11% of the respondents somehow had reservations regarding the same as illustrated in fig 4.3. There was general concurrence among respondents that analysis of location data was vital for the success of law enforcement.

Figure 4.3: Importance of Location Data

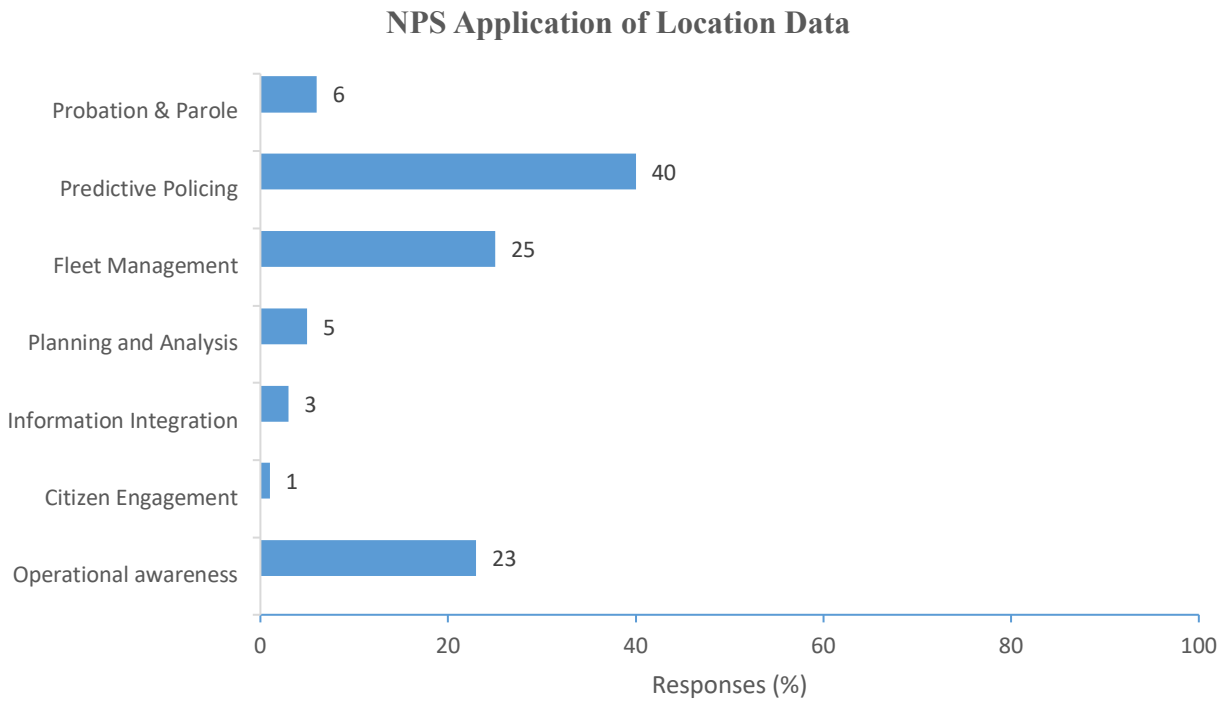


Source: Field Research, 2020

4.3.4 How NPS use LD to Support Operations

The study sought to find out how NPS applied LD in its operations because there was a feeling that complete adoption of LI would help it become effective and efficient. Responses from the study showed that LI is predominantly applied in the following areas; predictive policing at 40%, fleet management at 25% and operational awareness at 23% as illustrated in Fig. 4.4 below. Other functions that found partial use of LD was in probation & parole at 6%, planning and analysis at 5% and Information and Integration at 3%.

Figure 4.4: Use of LI by NPS



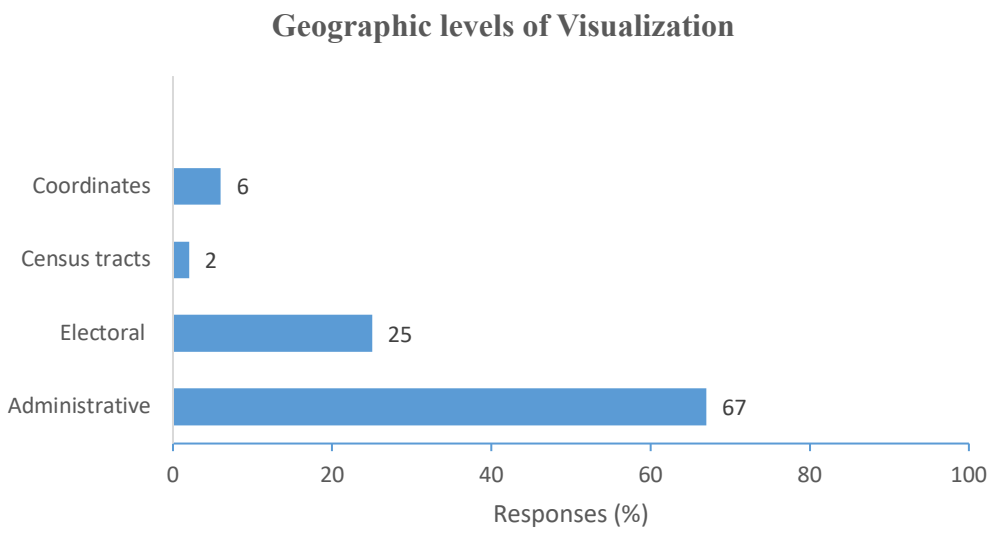
Source: Field Research, 2020

Three application areas stood out from the study i.e. predictive policing, fleet management and operational awareness. Predictive policing involved use of analytical techniques to process statistical historic data to enable identification of localities with potential increased criminal activity. Operational awareness on the other hand refers to knowledge of current situational elements and events by law enforcers with respect to location and time such that in case of any change in the mentioned elements it becomes easy to detect. Fleet management is the practice by organizations to exploit technology to coordinate movable assets such as vehicles in order to attain efficiency and reduce operational costs while ensuring their safety.

4.3.5 Geographic levels for Data visualization

The level an organization visualizes and enriches its LD helps to determine how detailed and accurate it can solve a spatial problem at hand or suitability of the datasets for a task. Findings in Fig.4.5 shows that Administrative and Electoral geographic boundaries were predominantly used by respondents at 67% and 25% respectively. Other were Geographic coordinates (longitudes/latitudes) at 6% and Census tracts at 2%.

Figure 4.5: Data Visualization Levels

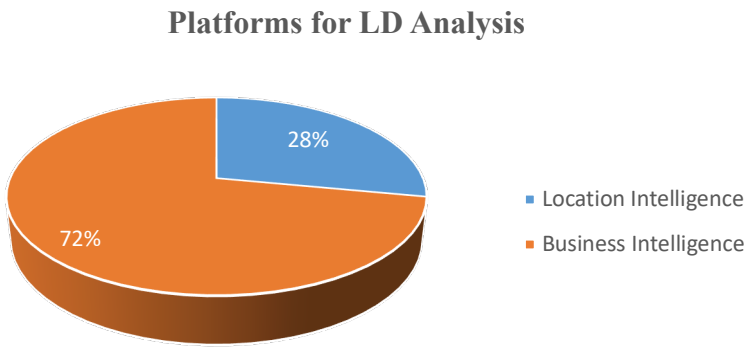


Source: Field Research, 2020

4.3.6 Tools for Data Analysis

The scholar also believed that the choice of data analysis tools had an impact on the kind of products generated and their precision in decision making. When asked how they performed LD analysis, 72% of the respondents said they used Business Intelligence (BI) platforms while 28% said they used location intelligence (LI) platforms as shown in fig. 4.6 below. The two platforms differ in the sense that although both refer to applications and practices for collection, integration and presentation of information, BI tools have no capacity to process location component of data like the LI platforms. Traditional business intelligence tools often neither asks nor answers the question of 'where' hence are unable to answer location-based questions such as; where are crimes occurring, where do probation suspects reside and so on.

Figure 4.6: Analysis Tools



Source: Field Research, 2020

4.4 Legislative and Policy Framework

4.4.1 Legal and Policy Framework on LI

Ethical practices surrounding collection, processing and storage of data requires an organization to be guided by some legal framework. Based on this understanding, the scholar enquired from the respondents the frameworks guiding NPS in its operations. Table 4.2 below illustrates that majority of the respondents primarily relied on NPS Act, the Constitution of Kenya and Prevention of Terrorism Act at 51%, 22% and 16% respectively.

Table 4.2: Legal & Policy frameworks

Legal framework	Frequency	Percentage
Computer Misuse & Cybercrime Act	4	1.7
Kenya Information & Communication Act	9	3.8
Security Laws (Amendment) Act	7	3.0
Prevention of Terrorism Act	38	16.2
The Constitution of Kenya 2010	52	22.1
National Police Service Act	120	51.1
Data Protection Act	5	2.1
Total	**235**	**100.0**

Source: Field Research, 2020

4.4.2 Respondents concerns on Legislative and Policy Framework

Privacy and currency concerns of the policy frameworks guiding collection and processing of location data were the main concern of respondents. As demonstrated in table 4.3 below, 51% of respondents cited privacy issues while 40% raised inadequacy or currency issue resulting from non-up to date policies. From the responses, it was also evident that relevance of the laws and policies was a non-issue as shown by a 21% score below.

Table 4.3: Respondents concerns on policy frameworks

Concern	Frequency	Percentage
Policy currency	95	40.4
Privacy	119	50.6
Relevance	21	8.9
Total	**235**	**100.0**

Source: Field Research, 2020

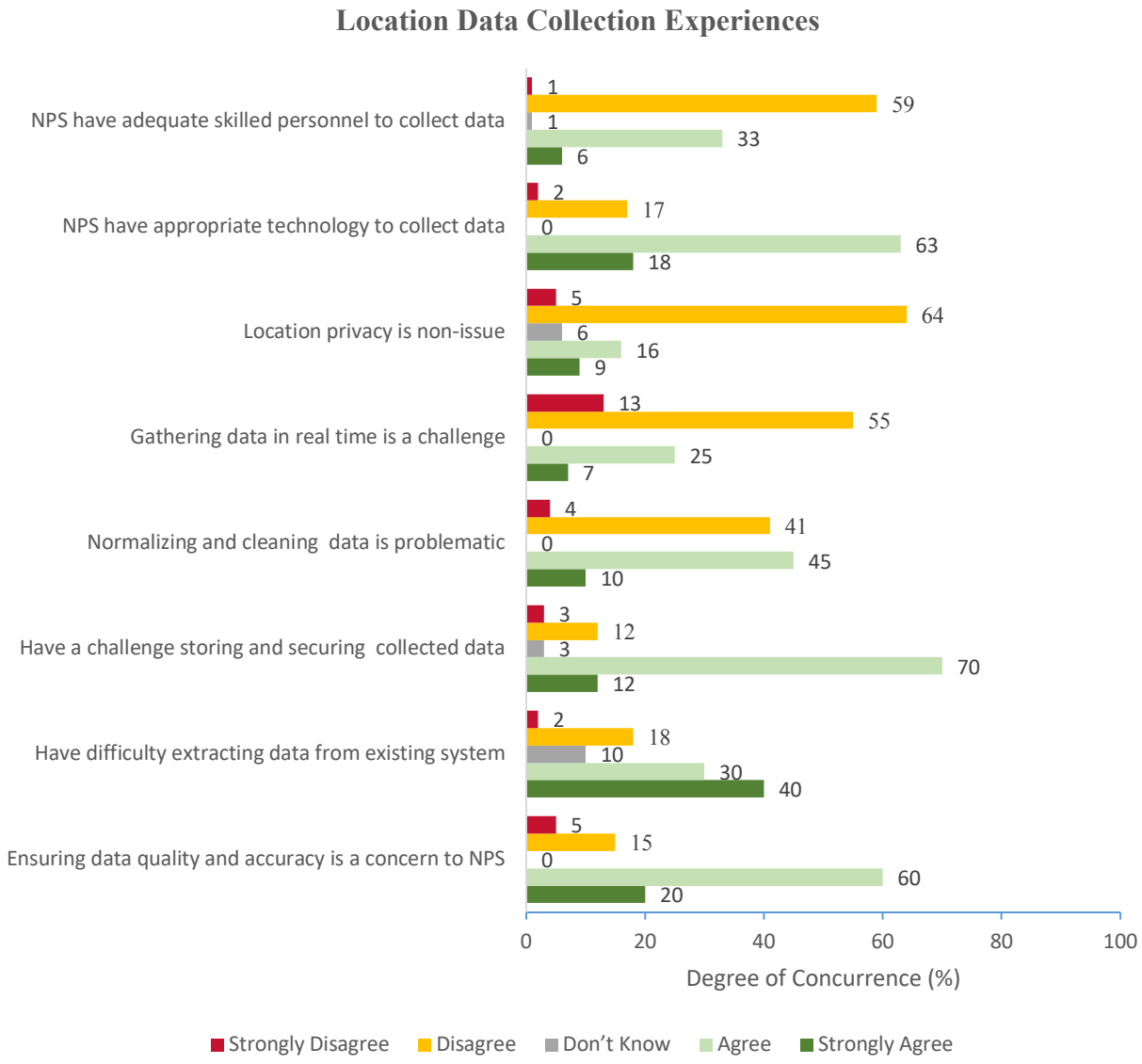
4.5 Respondents experiences with LI technology

4.5.1 Experiences in respect to LD Collection

The scholar sought from respondents the extent to which they agreed or disagreed with provided statements regarding their perceived experiences in data collection. The responses as demonstrated in fig. 4.7 below indicated that 60% of respondents disagreed that NPS had skilled personnel in data collection while 39% replied to the contrary; An overwhelming 81% agreed existence of appropriate data collection technology while 19% disagreed; regarding location privacy issues, 69% of respondents agreed that it is a concern for them while 25% were not worried; 68% of respondents agreed that gathering data in real time was not a challenge while 32% disagreed.

Normalizing and cleaning of collected data was also perceived a challenge with 55% of respondents affirming and 45% disapproving; a majority at 82% of respondents agreed that storage and security of data was a concern issue which was disapproved by 15% of respondents; Extraction of data from existing systems and ensuring its quality and accuracy was a challenge as demonstrated by 70% and 80% affirmative responses respectively.

Figure 4.7: Data Collection Experiences



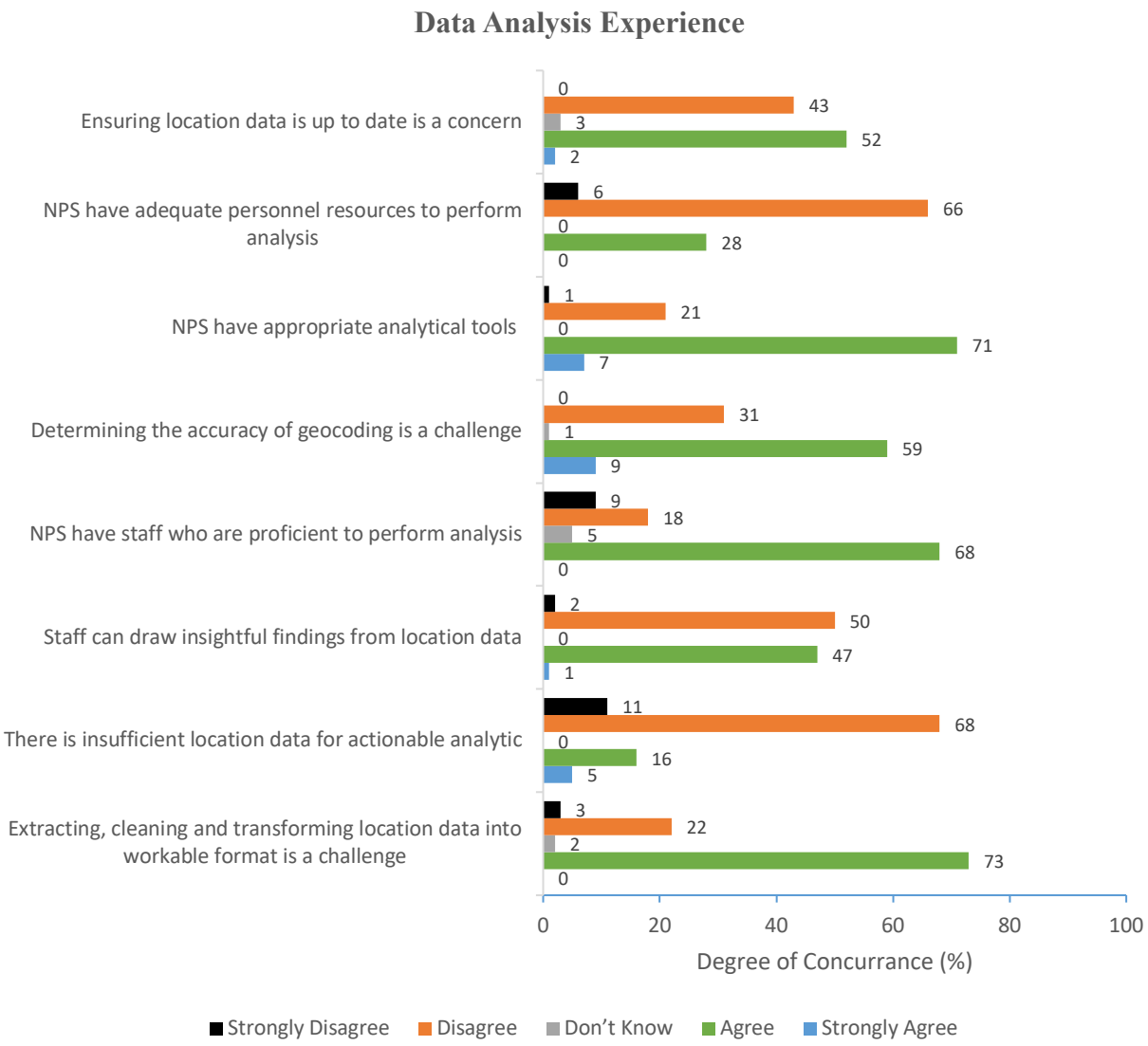
Source: Field Research, 2020

4.5.2 Experiences in respect to Data Analysis

Figure 4.8 below illustrates responses sought concerning respondents' experiences with regard to analysis of location data. 54% of respondents agreed that ensuring location data is up-to-date was a challenge while 43% disagreed; 78% agreed that NPS have appropriate analytical tools for use by analysts but 22% responded to the contrary. Respondents at 68% also agreed that NPS have staff who are proficient to carry out analysis but were not adequate as indicated by 72% of responses. Further, respondents (68%) agreed that determining the accuracy of geocoding was a

challenge but drawing insightful findings from the data was not (52%). Finally, majority of respondents at 79% agreed that NPS have sufficient location data available for analytics although extracting, cleaning and transforming them into workable format was a challenge as shown by 73% of responses.

Figure 4.8: Data Analysis Experiences



Source: Field Research, 2020

4.5.3 Cross-Department Accessibility of Location Data

The scholar sought to find out existence of cross departmental location data access because of the feeling that the ease with which various government departments share their datasets have an impact on adoption of the technology. Responses in table 4.4 below indicates that a significant portion of respondents at 93% believed that LD was either not accessible or was restricted for sharing among various government departments. However, a minority at 7% felt that the datasets were accessible.

Table 4.4: Cross-Departmental LD Access

Accessibility	**Frequency**	**Percentage**
Accessible	17	7.2
Restricted	86	36.6
Not accessible	132	56.2
Total	**235**	**100.0**

Source: Field Research, 2020

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The study sought to examine the influence of location intelligence on law enforcement in Nairobi County. This chapter therefore give details of the summary of identified outcomes, the study conclusions, recommendations and suggested areas for further research.

5.2 Summary of findings

NPS adopted structural and operational reforms in 2010 after promulgation of the Country's Constitution. These reforms were accompanied by allocation of resources to make the Service efficient and effective. However, annual crime statistics for nine consecutive years gathered from KPS and KNBS did not reflect that desired outcome as the crime was still in an upward trend. From two hundred and sixty (260) questionnaires distributed by the researcher to NPS staff, two hundred and thirty five (235) were returned by respondents indicating a response rate of 90.4%. This section therefore discusses the findings based on research objectives and research questions.

5.2.1 NPS operations supported by LI

The study established that NPS gathered and processed location data from its day to day operations. This finding is supported by respondents who observed that most crime data in possession by law enforcers inform of reported cases have a location component and are collected in a rhythm guided by standing orders. The practice is perhaps informed by understanding that analysis of LD was critically important to the success of NPS mission as demonstrated by a general concurrence among respondents.

The study also found that NPS predominantly applied LI for predictive policing, fleet management and operational awareness. Although the mentioned areas were significant to law enforcement, other equally important application areas were not fully exploited as shown by low responses for Probation & parole, planning and integration of information. From Esri (2012) perspective, LI as a platform allows institutions to share knowledge through workflows for effective communication, collaboration and coordination. The platform has a potential to link local communities and the law enforcement hence could be a vital citizen outreach tool. The power of location intelligence thus

comes from its ability to collate together data from various sources and relate them geographically. This, therefore, demonstrates that the Service selectively limited its capability to a small spectrum of LI applications. A similar observation was made by Bowes (2017) who noted that limiting the use of LI to crime analysis and reporting is something that is all too common in law enforcement agencies.

Another finding by the study was that NPS preferred to visualize its location data using administrative and electoral boundaries and to a less extent using geographic coordinates. The use of such boundaries for data visualization are important when looking at general trends of data but may not give detailed and accurate insights to solve a geospatial problem the way geographic coordinates does.

Finally, the study established that NPS predominantly used business intelligence (BI) platforms compared to location intelligence (LI) platforms to process its location data. Although the two platforms could integrate, process and present data, BI tools commonly visualize data in form of charts or graphs and have no capacity to present location referenced data in maps as likened to the LI platforms. Locale (2018) considers BI platforms as traditional and obsolete but are in used by organizations that are still at their infancy in adoption of LI platforms.

5.2.2 Policy frameworks guiding collection and processing of LD

The study further found that there were sufficient number of statutes that guided NPS in the practice of collection and processing of location data. However, three legislative frameworks were popular with respondents; the NPS Act, the Constitution of Kenya, 2010 and Prevention of Terrorism Act (2012). Sections 24 (f), 27 (Ja), 35 (a) of NPS Act empowered law enforcers to collect and provide criminal intelligence. Sections 34 and 36 of Prevention of Terrorism Act conferred to National Security organs authority subject to accountability to gather information and intercept communication for the purposes of detecting, deterring and disrupting terrorism in accordance with laid down procedures. Other laws that were little mentioned by respondents but grant powers for LD collection and processing are Security Laws (Amendment) Act of 2014, Kenya Information and Communications (Amendment) Act (2013), Data Protection Act (2019) and Computer Misuse and Cybercrimes Act (2018).

The findings of the study also indicated that privacy concerns was a fundamental issue among respondents. Although the laws allowed law enforcers to collect data to detect crime, the

enforcement officers were also not immune to similar treatment while in the course of their duties. Article 24(5) of the CoK states that through a legislation, the state may limit the application of the rights or fundamental freedoms in some provisions to persons serving in the Kenya Defense Forces or the National Police Service. Right to privacy which includes privacy of communications and information relating to their family or private affairs unnecessarily required or revealed is one of them. The practice is however subject to discussion since tracking of law enforcers may be done to enhance accountability in their duties.

The study further found that there was no framework that coordinated location information acquisition and access in the country since there was no mention of the same by the respondents. This is usually in the form of National Spatial Data Infrastructure (SDI) and its overriding objective is to maximize use of geographic information held by a wide range of stakeholders in both public and private sector. Rhind (2000) identifies central governments as one of the most important players with interest in SDI matters. According to Murage et al (2008) the Republic of Kenya first came close to developing its first National SDI in 2002 through a National Development Plan of 2002-2008 in collaboration with various stakeholders. However, a review done in 2006 and 2008 revealed that there were no concrete results due to what was termed as inadequate capacity of the national mapping agency. The same sentiments are shared by Okuku et al (2014) who stated that the developmental status of Kenya National SDI is unknown. As a result of lack of such framework, data integrity is compromised and cross-departmental access to location data is not possible or become restricted as discussed in subsequent section.

5.2.3 NPS experiences with location aware technology

The study further found that NPS had appropriate data collection technology and gathering location referenced data in real-time was never a challenge. It was also established that there were inadequate skilled LD collection personnel. Despite inadequacy of skilled personnel, the study also noted that respondents faced challenges normalizing or cleaning datasets, as well as extracting data from systems. The level of training of location data collection staff is further put to task by respondents' admission that they could not guarantee quality and accuracy of data they collected. A failure to cleanup extracted data implies that any errors and anomalies inherent in the data will be transmitted to processing stage and ultimately influenced decision making negatively. The study

therefore assessed that limited understanding and implementation of LI platform by NPS has potential to result to inefficiency in execution of mission specific tasks.

Data storage was also identified as a challenge by respondents since data resided in several unintegrated structured and unstructured databases. Investing in appropriate data storage and management platforms is beneficial to an organization as it accords data practitioners ample opportunity to manage data and achieve optimal utility from massive databases. Lastly, the study established that respondents were concerned about their privacy in the course of interaction with location aware technology.

With regard to location data processing, the study found that although respondents indicated that NPS had appropriate analysis tools and had sufficient LD for carrying out analytics, the finding however, seem to contradict with another observation that suggested that NPS significantly used BI platforms compared to LI platforms. This variation is a possible indicator that there is a gap in the understanding of the two data processing platforms concept among respondents. Other challenges that pointed towards inadequate capacity of processing personnel included; inability to determine accuracy of geocoding, ensuring currency of location data; and difficulty to transform the data into workable formats. However, there was a general agreement among respondent that NPS had competent staff to carry out spatial analysis but were not sufficient.

In respect to cross departmental data access, the study established that majority of location referenced data had either a restricted access or were not accessible at all. NPS is composed of two constituent Services and a directorate that all collect location data in the course of their operations. Restricted information flow among such entities implies that there will be an information gap to be exploited to by criminal elements. Conversely, sharing of location data among entities with similar functions makes them effective in accomplishing their operational mission even with finite resources. Lack of collaboration among departments and absence of coordination by higher authorities are the main obstacles to location data sharing (Masser, 2005). Another potential hindrance to cross-departmental data sharing is lack of data quality assurance regime which is widely recognized by all stakeholders. Consequently, various agencies may not have trust on the quality of datasets distributed by willing partners.

5.3 Conclusion

Based on the above findings, this study concludes the following:

Firstly, NPS understands the value of LD processing in achieving its operational mission success either at tactical or strategic levels. The Service also has adequate location data to perform statistical analysis. The capability is however limited by inadequate appropriate LD processing platforms and low capacity of its staff to derive meaningful insights from the data. This is demonstrated by limitations such as inability to determine accuracy of geocoding, ensuring accuracy and quality of data among others.

Secondly, NPS predominantly applied LI for predictive policing, fleet management and operational awareness. This suggests that the Service is not fully exploiting maximum potential of LI technology to solve its law enforcement needs thus has a potential of making it inefficient in its operations.

Thirdly, a significant number of NPS staff dealing with location data collection and processing possessed basic level of training on LI concepts. This is supported by respondents experiences related to capacity building such as challenges normalizing and cleaning of data, extracting data from systems and transforming them into workable formats that could easily be resolved by competent staff.

Further, there are adequate relevant legal and policy frameworks that empower NPS to gather and process LD. However, privacy anxieties and failure to regularly update them remained a concern. With growth of mobile technology and social media which require communication devices to be constantly online, individuals become visible as they move through the landscape and this tend to challenge individuals right to privacy.

Lastly, the Republic of Kenya so far has not developed a national SDI framework. As such, national public institutions may not realize ensuing benefits such as quality location datasets, coordinated sharing and integration of location information or enhanced security and defense infrastructure.

5.4 Recommendations

To resolve issues identified above related to use of Location Intelligence technologies, the study recommends the following:

Firstly, to remain relevant in the fight against dynamic crime and anti-social behavior, NPS need to overcome the challenges associated with collection and processing of location data that keep the organization from realizing full potential and practical application of LI. This can be achieved through capacity building its staff on GIS concepts and investing in appropriate LD processing platforms. Alternatively, due to limited resources required for training and possibly long period it takes to train employees into competent professionals, NPS may need to acquire and deploy mission specific applications that require minimal training yet providing specific functionality based on the role of an employee. Generally, qualified personnel are required by NPS to effectively leverage the value of location data. When LI is properly implemented, law enforcement officers should be able to identify criminal threats in advance in order to optimize patrol deployment for successful intervention.

Secondly, to appreciate the value of location data, NPS need to shift focus and begin visualizing and analyzing the data at a deeper geographic level. Location data should be captured at the lowest level of granularity i.e. coordinate pair of latitude and longitude which can accurately be modelled to resolve specific needs such as mapping crime hotspots. This will greatly improve organization decision making and internal communication all done concurrently. As such there is need for NPS to place emphasis on the role of cartographic and data presentation skills because cartography remains an interface through which data explosion is spatially interpreted.

Thirdly, an audit ought to be carried out on policy frameworks so as to identify gaps, challenges and the recommendations thereof be submitted to relevant government departments for considerations. There is also need to create awareness among NPS officers working on information processing about the existence of various legal and policy frameworks since the focus currently is on three statutes i.e. the Constitution of Kenya 2010, NPS Act and Prevention of Terrorism Act 2012.

To enhance accessibility of LD across departments, NPS need to create awareness among its staff on the value of sharing data. It should be clear to NPS officers that no single organization has capacity to single handedly meet location information requirement except through partnerships. Bridging the gap through collaboration and coordination among departments will provide a significant chance to enrich existing and future location datasets and associated reduced operational costs. Further, Law enforcement agencies through community engagement may take the opportunity to leverage on increasing amount of crowdsourced location data by private and Volunteered Geographic Information (VGI) community and integrate them into their own. The latter option will however require development of standards and tools to assure quality and provide authority to the VGI location data.

Further, collection and processing of data by law enforcement is often based on legitimate reasons related to performance of a mandate established under national law. For instance, NPS may collect GPS trail of officers on patrol to enable it determine what locations have been visited and which ones have not. This is vital information for planning and administrative purposes. However, to gain Data Subjects confidence regarding security and privacy concerns of their personal data collected and processed alongside LD by the organization, the study recommends that NPS ought to create awareness regarding the purpose for which data is collected. Further, NPS where necessary and when circumstances allow, should provide information to Data Subjects either orally or on writing regarding the processing of such personal data. In summary, NPS should establish an internal data protection policy consistent with Data Protection Act of 2019, in case none is in place, to streamline contentious issues that may arise such as data security, data retention period, rights of data subjects, internal data sharing procedures among others.

To realize full potential of location technology, NPS and other relevant government departments need to regard location data as an asset (infrastructure) that needs to be managed in the national interest through development and implementation of National SDI as stipulated in Vision 2030 development blue print. LD management just like other public assets require coordination of various stakeholders both in public and private sectors, substantial financial resources to establish clearance data warehouses and maintain accuracy of the data, and most importantly political goodwill to keep things rolling.

Finally, NPS through relevant government agencies needs to promote adoption and use of location information technologies and also take steps towards overcoming institutional barriers such as restrictions on data availability and access that impede potential exploitation of LD. Access to quality and reliable location datasets means improved decision making processes by individuals and institutions and ultimately increased demand for LI services. By enhancing education and advocacy among decision and policy makers heading government institutions, these category of employees will have a full understanding and the potential of location data solving mission critical organizational needs.

5.5 Areas of further research

The study recommends further research to be carried out on the influence of LI on operations of other national security organs described in Article 239 of the constitution of Kenya since they operate on different doctrines and are guided by various legislative frameworks. This will help to bring out various operational practices of the technology that can be shared among the security organs to enhance their effectiveness in the fight against crime and boost national security.

Other research studies may also be conducted on the implications of various policy frameworks to law enforcement. Such studies will hypothetically identify gaps and make recommendations to relevant government entities. Relevant and unambiguous policies will effectively support the fight against crime while adhering to acceptable international human rights practices.

BIBLIOGRAPHY

Administration Police Service (2017) History of APS. Available at: http://www.administrationpolice.go.ke/2015-02-16-09-14-42/history.html. Accessed on: [14/07/18].

Aminuzzaman, S. M. (1991). *Introduction to social research*. Bangladesh publishers.

Amnesty International (2013). *Police Reform in Kenya:" A drop in the ocean.* London: Amnesty International

Anuar, F., & Gretzel, U. (2011). Privacy concerns in the context of location-based services for Tourism. In *ENTER 2011 Conference, Innsbruck, Austria*.

Bacastow, T. S., & Bellafiore, D. (2009). Redefining geospatial intelligence. *American* Intelligence Journal, 27(1), 38-40.

Bachner, J. (2013). *Predictive policing: preventing crime with data and analytics*. IBM Center for the Business of Government.

Benford, S. (2005). Future location-based experiences. *JISC: Technology & Standards Watch*, 1-17.

Bernard, L., Kanellopoulos, I., Annoni, A., & Smits, P. (2005). The European geoportal—one step towards the establishment of a European Spatial Data Infrastructure. *Computers, environment and urban systems*, *29*(1), 15-31.

Brantingham, P. L. & Brantingham, P. J. 1993. Environmental, routine, and situation: Toward a pattern theory of crime. *Advances in Criminological Theory 5*: 259-294)

Brimicombe, A. J., (2002). GIS - Where are the frontiers now? *In: Proceedings GIS 2002. Bahrain*.33-45.

Bruce, A. (2014). *The challenges related to police in Kenya*; M.A thesis. Nairobi: Kenyatta University.

Boes, U., & Pavlova, R. (2008). Is there a Future for Spatial Data Infrastructures? *Proceedings GI-Days, Muenster, Germany*, 305-314.

Clarke, D. (2011) "Initiatives and challenges of spatial data infrastructure in South Africa" PositionIT.

Crompvoets, J. W. H. C., & Bregt, A. K. (2003). World status of national spatial data clearinghouses. *URISA journal*, *15*(2), 15-22.

Daily Nation (2018). *Mulot, the Unlikely Hotbed of Rising Mobile Telephone Fraud*. Available at: https://www.nation.co.ke/news/Mulot--the-unlikely-hotbed-of-rising-mobile-telephone-fraud/1056-4675302-183jvr/index.html. Accessed on: [22 July, 2018].

di Flora, C., Ficco, M., Russo, S., & Vecchio, V. (2005, June). Indoor and outdoor location based services for portable wireless devices. In *25th IEEE International Conference on Distributed Computing Systems Workshops* (pp. 244-250). IEEE.

Dobson, J. E., & Fisher, P. F. (2003). Geoslavery. *IEEE Technology and Society Magazine*, *22*(1), 47-52.

Douglas, L. & Casty, G. (2013). The Achilles'heel of Police Reforms in Kenya. *Social Sciences*.Vol.2, No. 6, 2013, pp. 189-194.

George Moon (c. 2008). "*Location Intelligence – Meeting IT Expectation*". Pitney Bowes.

Giles, G. B. (1969). Marketing. M and E Handbooks.

Gilbert, E. W. (1958). Pioneer maps of health and disease in England. *The Geographical Journal*, *124*(2), 172-183.

Government of Kenya (2009a). National Task Force on Police Reforms. Available at: https://www.scribd.com/doc/245815329/Ransley-Report. Accessed on: [14/07/18].

Government of Kenya (2011b). *National Police Service Act 2011*. Available at: http://www.kenyalaw.org/lex//actview.xql?actid=No.%2011A%20of%202011#part_IV. Last Accessed: [21 August, 2018].

Government of Kenya (2010c). *The Constitution of Kenya, 2010*. Available at: http://kenyalaw.org/kl/index.php?id=398. Accessed on: [21/08/2018].

Government of Kenya (2008d). *About Vision 2030.* Available at: https://vision2030.go.ke/about-vision-2030/. Accessed on: [09/11/2018].

Government of Kenya/National Police Service. (2018). *A Policy Framework for Strategy for Reorganization of the National Police Service and Provision of Decent and Affordable Housing for Police officers and Integration with Communities and Neighborhoods.* Kenya Literature Bureau.

Government of South Africa (2013) *South Africa Spatial Data Infrastructure.* Available at: http://www.ngi.gov.za/index.php/what-we-do/sa-spatial. Accessed on: [17/09/2018].

Guigoz, Y., Giuliani, G., Nonguierma, A., Lehmann, A., Mlisa, A., & Ray, N. (2016). Spatial data infrastructures in Africa: A gap analysis. *J. Environ. Inf.*

Hempel, S. (2014). *The medical detective: John Snow, Cholera and the Mystery of the Broad Street Pump*. Granta Books.

International Conference on Data Protection and Privacy Commissioners (2015). *International Standards on the Protection of Personal Data and Privacy.* Available at: http:// globalprivacyassembly.org/wp-content/uploads/2015/02/The-Madrid-Resolution. pdf?mc_phishing_protection_id=28047-br1tehqdu81eaoar3q10. Accessed on: 30/09/2018].

Johnson, R. D., & Siskin, B. R. (1976). *Quantitative techniques for business decisions*. Prentice Hall.

Keel RO, 1997. *Rational Choice and Deterrence Theory.* Available at: http://www.umsl.edu/~rkeel/200/ratchoc.html. Accessed on: [11/09/2019].

Kothari, C.R. (2004). *Research Methodology: Methods and techniques.* New Age International Publishers, New Delhi.

Kok, B., & Van Loenen, B. (2005). How to assess the success of National Spatial Data Infrastructures?. *Computers, environment and urban systems*, *29*(6), 699-717.

Li, B., Dempster, A. G., & Rizos, C. (2010). Positioning in environments where GPS fails.

Liu, K., Huang, Q., Wang, J., Li, X., & Wu, D. O. (2013). Improving GPS service via social collaboration. In *2013 IEEE 10th International Conference on Mobile Ad-Hoc and Sensor Systems* (pp. 393-401). IEEE.

Masser, I. (2005). The future of spatial data infrastructures. In *ISPRS Workshop on Service and Application of Spatial Data Infrastructure, Hangzhou, China* (Vol. 36, No. 4/W6, pp. 14-16).

May, T. (2011). *Social Research: Issues, Methods and Research*. McGraw-Hill International.

Michael, M. G., Fusco, S. J., & Michael, K. (2008). A research note on ethics in the emerging age of überveillance. *Computer communications*, *31*(6), 1192-1199.

Meijer, A., & Wessels, M. (2019). Predictive policing: Review of benefits and drawbacks. *International Journal of Public Administration*, *42*(12), 1031-1039.

Merriam-webster (2018). Police Force definition. Available at: https://www.merriam-webster.com/dictionary/police%20force. Accessed on: [30/11/2018].

Messick, S. (1989). Meaning and values in test validation: The science and ethics of assessment. *Educational researcher*, *18*(2), 5-11.

M Musinguzi, G. Bax, and S Tickodri-Togboa, "*Opportunities and challenges for SDI Development in developing countries* - A case study of Uganda," in Proc. 12th Int. Conf. on Geoinformatics Geospatial Information Research: Bridging the Pacific and Atlantic, Sweden, June 2004, pp. 789-796.

Mulaku, G. C., Kiema, J. B. K., & Siriba, D. N. (2007). Assessment of Kenya's readiness for geospatial data infrastructure take off. *Survey review*, *39*(306), 328-337.

Mugenda, A. (2003). Research Methods Quantitative and Qualitative Approaches. *Nairobi, Kenya*.

Murage, E. M., Gitimu, P., & Sato, J. (2008). The project for strengthening survey of Kenya for GIS promotion in the Republic of Kenya. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *37*, 117-22.

Muthondeki, D. (2009). *Evolution of modern policing.* Nairobi*:* Kenyatta University Repository.

National Police Service (2018). *Annual Crime Reports*. Available at: http://www.nationalpolice.go.ke/crime-statistics.html#. Accessed on [09/11/2018].

Neuman, W. L., & Kreuger, L. (2003). *Social work research methods: Qualitative and quantitative approaches*. Allyn and Bacon.

Norwegian Data Protection Authority (2018). *Artificial intelligence and privacy*. Available at: https://www.datatilsynet.no/globalassets/global/english/ai-and-privacy.pdf. Accessed on: [15/03/2019].

Qekaj-Thaqi, A. (2015). Integration of GIS & GPS Systems on Vehicle Monitoring. In *HAICTA* (pp. 44-52).

Okuku, J., Bregt, A., & Grus, L. (2014). Assessing the development of Kenya national spatial data infrastructure (KNSDI). *South African journal of geomatics*, *3*(1), 95-112.

Reichenbacher, T. (2004). *Mobile cartography: Adaptive Visualization of Geographic Information on Mobile Devices* (pp. 36-42). München: Verlag Dr. Hut.

Resnik, D. B. (2011). What is ethics in research & why is it important. *National Institute of Environmental Health Sciences*, *1*(10).

Retscher, G., & Hecht, T. (2012, November). Investigation of location capabilities of four different Smartphones for LBS navigation applications. In *Indoor Positioning and Indoor Navigation (IPIN), 2012 International Conference on* (pp. 1-6). IEEE.

Rhind, D. (2000). Funding a NGDI. *Geospatial data infrastructure: Concepts, cases, and good practice*, 39-56.

Ruteere, M. (2011). *More than political tools: The police and post-election violence in Kenya*. *African Security Review*, *20*(4), 11-20

Salkind, N. J. (Ed.). (2010). *Encyclopedia of research design* (Vol. 1). Sage.

Selltiz, C., Cook, S. W., Deutsch, M., & Jahoda, M. (1959). *Research Methods in Social Relations. Revised One-Volume Edition*.

Sherman, L. W. (2013). The rise of evidence-based policing: Targeting, testing, and tracking. *Crime and justice*, *42*(1), 377-451.

Shiode, N., Li, C., Batty, M., Longley, P., Maguire, D., (2004). The Impact and Penetration of Location Based Services. *In:* Karimi, H. A., Hammad, A**.**, ed. *Telegeoinformatics*. CRC Press, 349-366.

Smit, J., & Makanga, P. (2010). A review of the status of Spatial Data Infrastructure Implementation in Africa. *South African computer journal*, *2010*(45), 18-25.

The EastAfrican (2018). *Kenya in Major Police Reforms*. Available at: https://www.theeastafrican.co.ke/news/ea/Kenya-in-major-police-reforms/4552908-4757974-h7e3nmz/index.html. Accessed: [09/01/2019].

Tsou, M. H. (2004). *Integrated Mobile GIS and Wireless Internet Map Servers for Environmental Monitoring and Management.* Cartography and Geographic Information Science, 31(3), 153-165.

Une, H., Nyapola, H., Mbaria, C., & Maruyama, H. (2003, February). Towards the establishment of Kenya national spatial data infrastructure. In *Proceedings of the 21st International Cartographic Conference (ICC)* (pp. 1678-1687).

Ushahidi (2018). *About Ushahidi*. Available at: https://www.ushahidi.com/about. Accessed: [27th September, 2018].

United States Government (2018). *Advancement of the National Spatial Data Infrastructure*. Available at: https://www.fgdc.gov/nsdi/nsdi.html. Accessed on: [15/09/2018].

United States Government (2018b). *Kenya 2018 Crime & Safety Report.* Available at: https://www.osac.gov/Pages/ContentReportDetails.aspx?cid=23745. Accessed on: [09/11/2018].

UN High-Level Committee on Management (HLCM) (2018). *UN Principles on Personal Data Protection and Privacy*. Available at: https://www.unsystem.org/ personal-data protection-and-privacy-principles. Accessed on: [30/09/2018].

Veenendaal, B., & West, G. (2011). Transforming location intelligence through geospatial web-based technologies. In *Proceedings of 2nd ISPRS Workshop on Pervasive Web Mapping, Geoprocessing and Services: Our Complex World: Representation, Analysis and Modelling*.

Virrantaus, K., Markkula, J., Garmash, A., Terziyan, V., Veijalainen, J., Katanosov, A., & Tirri, H. (2001, December). *Developing GIS-supported location-based services*. In *Web* information systems engineering, 2001. Proceedings of the Second International *Conference on* (Vol. 2, pp. 66-75). IEEE.

Wain, N., & Ariel, B. (2014). Tracking of police patrol. *Policing: A Journal of Policy and Practice*, *8*(3), 274-283.

Warnest, M. (2005). *A collaboration model for national spatial data infrastructure in federated countries* (Doctoral dissertation).

Xu, H. & Teo, H. H. (2004). Alleviating Consumers' Privacy Concerns in Location-Based Services: A Psychological Control Perspective. *In Proceedings of the 25th International Conference on Information Systems, Washington, D.C.*

Xu, Y., Chen, X., & Ma, L. (2010, June). LBS based disaster and emergency management. In *Geoinformatics, 2010 18th International Conference on* (pp. 1-5). IEEE.

APPENDICES

APPENDIX I: PROJECT TIME-FRAME

	Proposal &Defense	Data Collection	Data Analysis	Report Writing	Project Defense	Project Submission
OCT&NOV/2019						
JAN&FEB/2020						
MAR&APR/2020						
MAY&JUN/2020						
JUL&SEP/2020						

APPENDIX III: INTERVIEW SCHEDULE

I am a post graduate student undertaking Master of Arts degree in Strategic and Security Studies at the University of Nairobi. As part of the course requirement, I am carrying out a study titled "*the influence of Location Intelligence in Law Enforcement: a case of National Police Service, Nairobi County"*.

The following questions will be asked during the interview to be conducted with you. The schedule consists of three sections and all questions will be asked during the interview. Interviews may be recorded with a voice recorder (if acceptable) to ensure that the correct version of your interview is transcribed. Your responses will be treated with confidentiality and will only be used for academic purpose.

Section I: Integration of location intelligence (LI) into NPS operations

a) What is your general familiarity of location intelligence?
b) Does NPS collect and process location data?
c) How important do you believe analysis of location data is important to NPS success?
d) How does NPS use location data to support its operations?
e) What geographic levels does NPS use to visualize/analyze spatial data collected?
f) What tools does NPS use to analyze its location data?
g) How likely is your directorate to embrace LI applications? (*only applies where LI is not in use*)

Section II: Legislative & policy framework

a) What legal and policy framework(s) guide NPS in collection and analysis of location data?
b) What is your opinion on the framework(s) mentioned in (a) above?

Section III: Experience on use of LI

a) What is NPS experience in respect to Data Collection?
b) What is NPS experience in respect to Data Analysis?
c) How accessible is cross-departmental location information within NPS?

Thank you very much for taking the time to answer my questions

APPENDIX IV: RESEACH QUESTIONNAIRE

I am a post graduate student undertaking Master of Arts degree in Strategic and Security Studies at the University of Nairobi. As part of course requirement, I am carrying out a survey titled "*the influence of Location Intelligence in Law Enforcement: A case of National Police Service, Nairobi County"*. The study is designed to gain the experience of NPS officers as they interact with location data to enforce laws. The responses you provide will be will be treated with confidentiality and will be solely used for academic purpose. In case of any clarification kindly contact me on 0723 777 667.

SECTION A: DEMOGRAPHIC INFORMATION

Please answer the following questions by ticking your choice of answer where applicable.

Job designation

[ ] Supervisor/Commander [ ] Data Practitioner [ ] other

Level of training on location data collection and analysis

[ ] Basic [ ] Intermediate [ ] Expert

SECTION B: INTEGRATION OF LOCATION INTELLIGENCE (LI) INTO NPS OPERATIONS

Does NPS collect and store location data?

……

How important do you believe analysis of location data is important to NPS success?

……

……

How does NPS use location data to support its operations?

……

……

……

What geographic levels does NPS use to visualize/analyze spatial data collected?

……

……

……

What tools does NPS use to analyze its location data?

……

……

SECTION C: LEGISLATIVE & POLICY FRAMEWORK

What legal and policy framework(s) guide NPS in collection and analysis of location data?

……..……

……

……

What is your opinion on the framework(s) mentioned above?

……

……

SECTION D: LOCATION INTELLIGENCE EXPERIENCE

Please tick as appropriate the extent of agreement with the following statements on a scale of 1-5 (where 1- Strongly Agree, 2-Agree, 3- Don't Know, 4-Disagree, 5- Strongly Disagree)

Challenges faced by NPS in respect to Data Collection	1	2	3	4	5
1. Ensuring data quality and accuracy					
2. Extracting data from existing system in a usable way					
3. Storing and securing the collected data					
4. Normalizing and cleaning the data					
5. Gathering data in real time					
6. Maneuvering location privacy issues					
7. NPS have appropriate technology to collect data					
8. NPS have skilled personnel to collect data					

Challenges faced by NPS in respect to Data Analysis	1	2	3	4	5
1. Extracting, cleaning and transforming location data into workable format					
2. Ensuring sufficient data is available for actionable analytic					
3. Drawing insightful findings from the data					
4. NPS have staff who are proficient to perform analysis					
5. Determining the accuracy of geocoding					
6. Having appropriate analytical tools					
7. NPS have adequate personnel resources to perform analysis					
8. Ensuring location data is up to date					

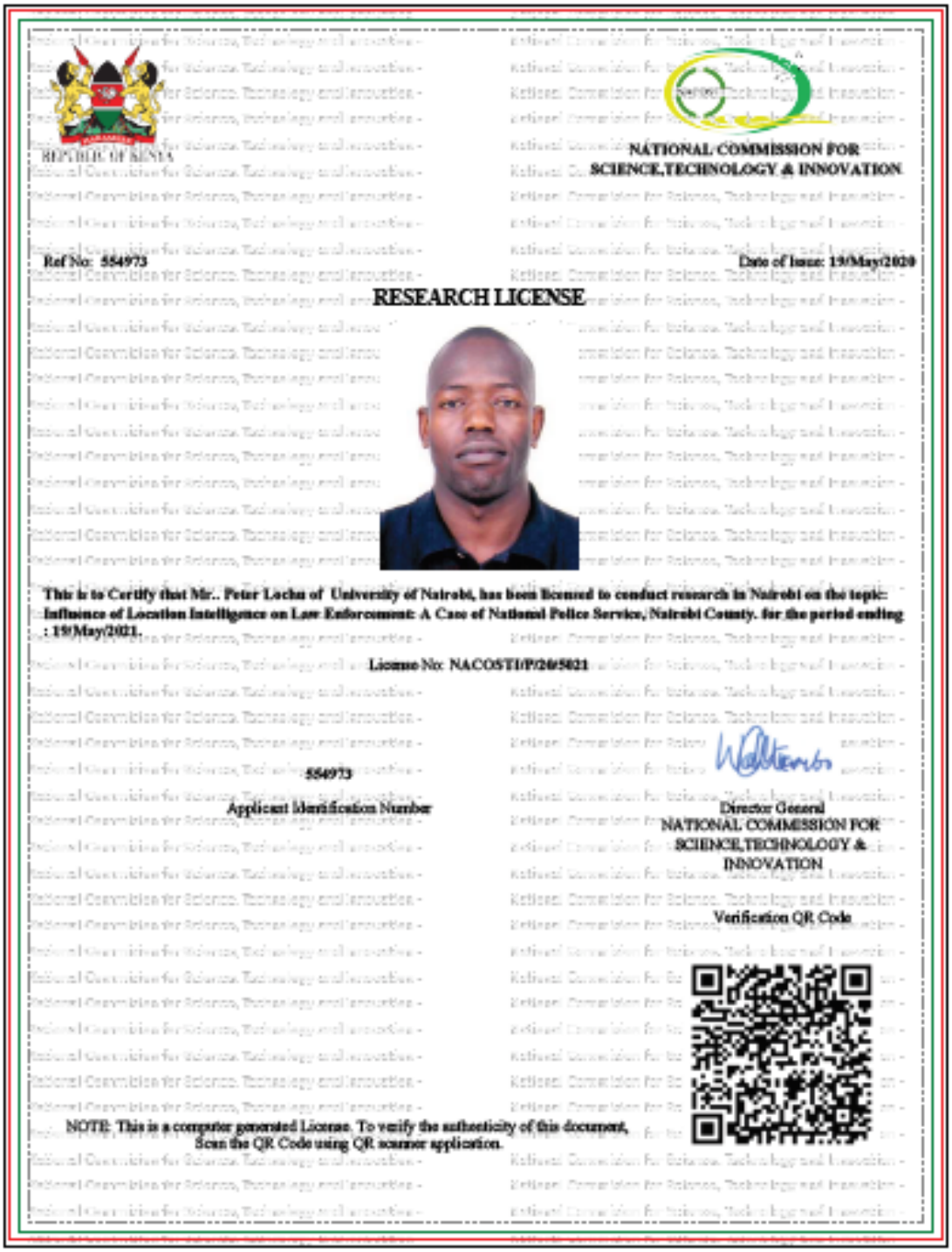
How accessible is cross-departmental location information within NPS?

.....

.....

THE END

APPENDIX V: NACOSTI RESEACH LICENCE



REPUBLIC OF KENYA

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Date of Issue: 19/May/2020

RESEARCH LICENSE

This is to Certify that Mr.. Peter Locha of University of Nairobi, has been licensed to conduct research in Nairobi on the topic: Influence of Location Intelligence on Law Enforcement: A Case of National Police Service, Nairobi County. for the period ending : 19/May/2021.

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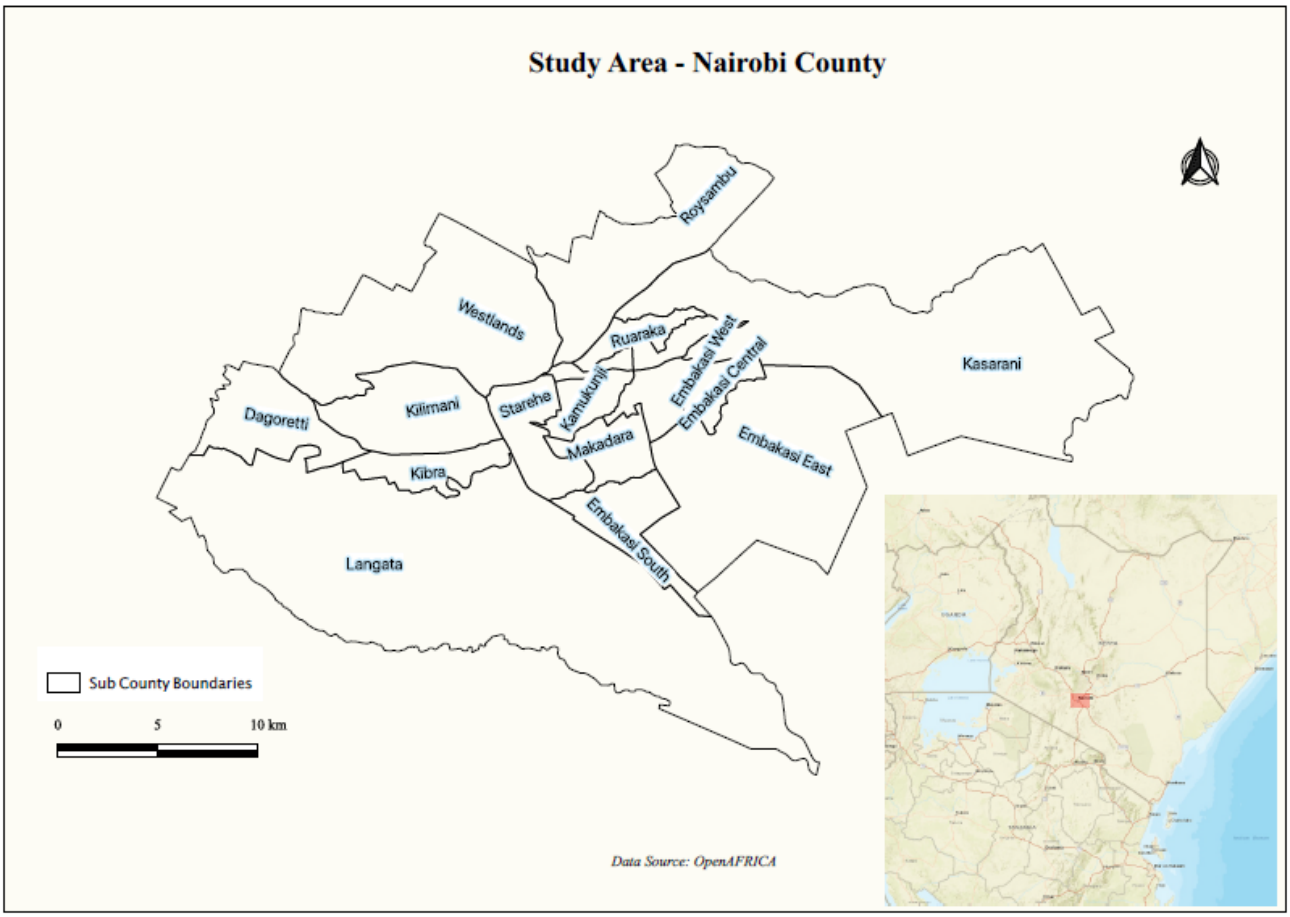
APPENDIX VI: MAP OF NAIROBI COUNTY



Source: Author, 2020

APPENDIX VI: STANDARD VARIATE VALUES

Table 1: Area Under Normal Curve

An entry in the table is the proportion under the entire curve which is between $z = 0$ and a positive value of z. Areas for negative values for z are obtained by symmetry.

Areas of a standard normal distribution

z	.0	0.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
.7	.2580	.2611	.2642	.2673	.2903	.2734	.2764	.2794	.2823	.2852
.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

Source: Kothari, 2004