REVIEWED JOURNAL of INTERNATIONAL SOCIAL SCIENCE & HUMANITIES
[ISSN 2663-127X]

Vol. 4, Iss. 1 (2023), pp 50 – 61, March 18, 2023. www.reviewedjournals.com, ©Reviewed Journals

EXTENT TO WHICH GEOSPATIAL TECHNIQUES HAVE BEEN INTEGRATED IN POLICE RESPONSE STRATEGIES FOR CRIME PREVENTION IN NAIROBI CITY COUNTY, KENYA

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Accepted: March 5, 2023

ABSTRACT

The objective of this study was to assess the extent to which geospatial techniques have been integrated in police response strategies for crime prevention in Nairobi City County, Kenya. The study was underpinned on the situational crime prevention theory. In this study descriptive survey research design was adopted and the methodology aimed at gathering information utilizing the questionnaires and in-depth interviews. The choice of Nairobi City County as the area of study was informed by accessibility of the essential infrastructure that Geospatial techniques innovation can ride on. One hundred and fifty-two police officers formed the sample size of the study from a target population of 755. Stratified purposive sampling was adopted for the study where each stratum consisted of relatively homogeneous sub group that was randomly selected to reduce biases. Both quantitative and qualitative data was collected. Quantitative data was analyzed through statistical program for social sciences (SPSS) for computation of statistical summaries. The qualitative data was in the first place arranged systematically into text format and then exported into a spreadsheet. As revealed by the results of the study, Service delivery in terms of efficiency in police crime response strategies have improved with application of geospatial techniques in crime prevention in Nairobi City County. In order to create harmony in in dissemination of crime data obtained through geospatial techniques the study recommended for a policy to guide the sharing and protecting the information from non-intended dissemination. The researcher recommended two studies that can be conducted in the future.

Key Words: *Geospatial Techniques, Crime Prevention*

CITATION: Gichohi, J. W., Murimi, S., & Owino, G. E. (2023). Extent to which geospatial techniques have been integrated in police response strategies for crime prevention in Nairobi City County, Kenya. *Reviewed Journal of Social Science & Humanities*, 4 (1), 50 – 61.

INTRODUCTION

In Africa, application of geospatial technology in crime prevention is still in infancy stages. Few states have started using GIS tools in law enforcement (Ahmed & Salihu, 2013; Yelwa & Bello, 2012). According to Schmitz *et al.* (1999) a pilot study on the integration of GIS within policing in South Africa, enabled the law enforcement agency to realize how GIS could transform their mode of operation through mapping of crime. Most significant was the provision of crime mapping that assisted the police in the two cases of serial killing in the city of Johannesburg. Using the crime mapping of the cellular calls and crime scenes and the evidence from those maps, the SAPS were able to successfully prosecute and convict the two murderers and hijackers in the Brixton murder case and a murderer in the Dquad robbery case (Stylianides, 2000). Mswela (2019) claims that Malawi was the first country to deploy GPS technology to combat violent crimes committed against people who had albinism. Those with albinism were given the GPS devices in hotspot areas. When in peril, a knob on the device can be turned to activate an electronic panic button. According to Mswela (2017), this electronic monitoring system has made it possible to prevent and lessen violent attacks against people with albinism. In Kenya the use of GPS technology is evident in both the public and private sectors. The commercial application of location data is what makes GPS technology essential in our everyday lives. Kenya wildlife service has been using technology in the protection of endangered species such as elephants and rhinos since 1986 (Kenya Wildlife Service, [KWS], 2016). Wandera (2021) avers that to monitor the cessation of movement to and from the Nairobi metropolis in order to curb the spread of Covid-19, the police were using unmanned aerial vehicles equipped with high-density cameras to track remotely the movement along the busy Thika-Garissa highway.

The vision 2030 development blue print had envisioned that GIS would play a critical part in security operations in Kenya. The creation of the Integrated Command, Control and Communication (IC3) Centre by the National police service in 2015 was aimed towards embracing of this technology in crime prevention. The call for service and computer aided dispatch programs are managed from IC3. The police officers in the field are issued with GPS enabled walkie-talkie sets that are linked to IC3 making it easy to locate them to respond to calls for service. In the month of June, 2020, the National police service launched the digital occurrence book for use by the police officers. This was a huge step towards use of technology with the aim of improving operational performance of the police service. Each of the police officer in Nairobi was issued with a hand-held gadget that is GPS enabled for recording crime incidents. According to Okeyo (2021), advances in technology have opened many doors in the field of security. The new norm has become the driving force behind crime prevention in Kenya. This technology has aided law enforcement agencies in their efforts to fight crime and maintain public order. For example, the installation of 1800 CCTV surveillance cameras in Nairobi and Mombasa has contributed significantly to solving security problems. Reports indicate that, thanks to the surveillance system, police were able to recover 69 stolen cars in less than 24 hours. The police commanders and the police officers in operational areas are now able to generate real time crime maps that makes it easy for planning and execution of prevention strategies. It is for this reason that study was conducted on how the application of geospatial techniques had influenced police response strategies to prevent and reduce crime.

The National Police Service has in the recent past adopted new technologies and procedures into its system with aim of creating new policing strategies and improve on their performance and effectiveness. It was, therefore, important to find out if the application of Geospatial techniques had any influence on police response strategies to prevent and reduce crime in Nairobi City County.

Statement of the Problem

According to Harris (2007) use of technology has for a long time been considered as an important element to law enforcement strategies and tactics. The introduction of telephone, the automobile and two-way radios in the 20th century had created a paradigm shift in police performance enhancing their capabilities in responding

to requests for police assistance by the citizens. The emergence of more powerful technological advancements such as closed-circuit television (CCTV), automatic license plate readers (LPRs) and predictive policing software in the 21st century has witnessed increase in efficiency and improved outcomes by law enforcement agencies.

The National Police Service (NPS) crime situation report (2016) recommended for the enhancement of NPS ICT infrastructure to allow deployment of innovative technology like GIS to address the ever-changing modus operandi by criminals. Under the safer city programme, the partnership between Safaricom, Huawei and NPS saw establishment of Integrated Command, Control and Communication (IC3) centre in 2015. The implementation of this project whose objective was to develop police capabilities to become more proactive in the management of security situation and to professionalize the police response to incidents saw a reduction of crime rates decrease by 46% in 2015 in the areas covered by the project.

In the recent past, NPS has witnessed a departure from traditional methods where operations were carried out as a result of perceived or real threat and sometimes following a tip-off, to the use of advanced technology such GPS and GIS in the development of police response strategies to prevent and control crime. Despite the advancement in technology, crime continues to persist in major cities, especially in Nairobi County, Kenya. To effectively prevent and respond to crime, police officers need to apply more advanced technologies, such as geospatial techniques without which they will continue facing difficulties responding to and curbing criminal activities in Nairobi City County.

Objective of the Study

The objective of the study was to determine the extent to which geospatial techniques have been integrated in police response strategies for crime prevention in Nairobi City County, Kenya. The study was guided by the following research question;

- What is the extent of integration of geospatial techniques in police response strategies for crime prevention in Nairobi City County, Kenya?

LITERATURE REVIEW

Empirical Review

Extent in application of Geospatial techniques in crime prevention through police response strategies

In comparison traditional methods, Geographic information technology that includes Geographic Information System (GIS), Remote Sensing (RS) and Global Positioning System (GPS) facilitate the creation, manipulation, storage and use of spatial data much faster (Deneef,2014). The contemporary criminals are always devising new methods of committing crime hence posing a challenge to police agencies throughout the world. To fulfil the needs of policing in the twenty first century, the police should develop new policing models aimed at prevent and reducing crime. This is attributable to the reason approaches that were previously effective may not work today.

According to Lwin, Hashimoto, and Murayama (2013), improvements in computational power of handheld devices such as smartphones, tablet PCs, and web-based GIS systems have been used to collect, integrate, visualize, and analyzing data in real-time, in addition to wireless networking technologies. Faqir (2013) opines that any active police investigation necessitates the collection of evidence. He further argues that police can use GPS technology to collect data that reveals the location of a given person or item of interest. In today's industry, such technology is used in cars and mobile phones to assist in determining the directions and locations of suspects and accused persons. Investigators can precisely match evidence placement to crime scene or accident reconstruction diagrams using differential GPS (DGPS). Cases can be visually exhibited to highlight the chronological and spatial links of crime reports, witness testimonies, evidence, and crime scene drawings by connecting evidential material into a GIS format (Jaishankar, 2009).

Ekblom (1988) argues that crime analysis is fundamental in a series of activities that are pointed toward imagining, executing and assessing the measures to prevent crime. This is because the analysis of crime creates an opportunity to formulate preventive approaches to the prevailing crime problem and its physical and societal contexts. To support this view Boba, (2013) asserts that crime analysis enables the police agencies to gain meaningful information that can be used to reveal underlying meanings and patterns of relationships for operational and administrative purposes. The study by Daglar &Argun (2016) indicate that crime analysis is a policing role whose aim to find solutions to crime problems. Olajuyigbe *et al.* (2016) in another other study holds the view that the analysis of crime can be utilized to evaluate the effectiveness of crime reduction programs such as community policing. However, the two studies are in agreement that the purpose of crime analysis is to identify crime problems with a view of developing effective mitigating measures.

Various disciplines and occupations including policing have employed the use of GIS and crime mapping software in crime analysis. Several studies have cited the exceptional capability of GIS to overlay data from disparate sources such as call for service, arrest reports and spatial and temporal components of crime and displaying the analysis on a digital crime map as an important factor in crime prevention and planning (Kumar &Somashekar ,2012; Daglar & Argun, 2016; Kannan *et al.*2017).

Fahui (2012) argues that the transformation of geographic maps using GPS and GIS have made them even more useful in investigation of crimes and their prevention. The investigation of crimes requires meticulous piecing of evidence from the scene of crime. According to Ksenija &Jelena, (2017) some vital information from certain crime events cannot be well represented using the statistical textual reports and tables but can be revealed using the geographical maps. For instance, in geographic profiling of criminal, GIS is used to analyze spatially obtained information to generate a map that can help forecasting the likely location of serial criminal's residence (Rossmo, Laverty &Moore, 2005; Daglar &Argun, 2017).

According to (Lega *et al.* 2014), identifying environmental crimes and the perpetrators is critical in criminal investigations. They claimed that the availability of new technologies had enabled authorities to do so more quickly and accurately than ever before. Kelly and Kelly (2017) opined that law enforcement agencies have attempted to detect crime using remote sensing technologies. Using imagery obtained remotely from sensors aboard aircraft, unmanned aerial vehicles, and satellites, law enforcement are able to determine where and when specific sorts of crimes have occurred.

Eman *et al.* (2013); Townsley (2017) argue that crime as a social and spatial phenomenon requires adequate prevention to reduce its severity using information technology. A good example is the mapping of crime risk distributions using Geographic Information Systems (GIS). In addition to identifying crime hotspots (Nemeth *et al.,* 2014), Geographic Information Systems can be used to compare the locations of crime hotspots identifying areas with extreme crime patterns for police action. In addition, it can also indicate the direction in which specific crimes are shifting (Sheikh *et al.,* 2017), or the overlap of different types of crimes (2018) that require more detailed analysis at intersections.

Theoretical Framework

Situational Crime Prevention

According to Clarke, (1995) Situational crime prevention is a preventive approach that relies on reducing opportunities for crime rather than improving society or its institutions. This point of view contends that criminal behavior results from a confluence of character traits and environmental factors, and that an offender will decide whether to commit a crime based on the opportunities they perceive to exist. Situational factors can therefore contribute to crime, and addressing them can help to lower crime. Situational crime prevention necessitates a comprehension of how crimes are carried out (Eck &Clarke, 2019).

Situational crime prevention tactics, according to Clarke (1995), target specific crimes, such as environmental manipulations, and are aimed at lowering the possibilities and benefits for crime. According to Lee (2010), SCP, in its most basic form, involves manipulating criminal activities through surveillance, target hardening, and environmental management. Smith &Clarke (2012) argues that the approach looks to crime opportunities and seeks to generally alter the proximal causes of crime rather than distant causes. Situational crime prevention examines the contexts of criminal activities instead of focusing on the qualities of criminals (Eck & Clarke (2019)) and on very specific categories of crime or disorder, with special attention paid to crime concentrations (Clarke, 1995).

GIS is used to map the reported crime incidents and their location of occurrence. The ability of GIS to overlay crime data on other unrelated data such as demographics, roads and streets makes it a good tool for identification of crime hotspots and the analysis of their spatial relationship. The generated maps help to reveal crime patterns that help the policing agencies in developing relevant crime prevention strategies (Groff, 2007).

The Geographic information system impacts decidedly in planning of wrongdoing and policing. Roman (2005) contends that by thinking about the time the investigation can reveal insight into specific examples that may somehow or another would not have been recognized. GIS provides a wide range of benefits and opportunities for policing planning to the police agency. Law enforcement can understand the link between a crime, casualty, and the perpetrator thanks to this technology. This data is visualized in a map and layered with irrelevant data such as population changes and road networks. According to Groff (2007), a comprehensive understanding of the spatio-temporal settings of crime events aids in the improvement of approaches and the development of effective criminal countermeasures.

METHODOLOGY

Research Design: A survey research design which utilized both quantitative and qualitative data collection methods was adopted. This design was preferred because of its easily accessible way for respondents to express their perspectives on the topic of study.

Target Population: For the purposes of this study the target population comprised all serving police officers from Kenya Police Service and Directorate of Criminal investigations. The officers were considered because they are directly and indirectly involved in crime prevention and respond to criminal incidences in Nairobi City County; hence, would provide adequate information on the subject matter.

Sampling Techniques: Stratified purposive sampling was used and to reduce biases respondents from each stratum were randomly selected.

Data Collection Methods: Questionnaires were employed as the most suitable instruments to collect data in research because many respondents could be reached within a limited time and they were easy to use and administer.

With help of Ms Excel spreadsheet, nominal scales were utilized to analyze closed-ended inquiries into totally unrelated categories and frequencies.

Data Analysis: Both quantitative and qualitative data techniques were used to gather data. Before the analysis of the data the questionnaires were checked for completeness to ensure that they are usable or required to be discarded (Kent, 2015).

Validity: The supervisors assisted in determining the question content and whether they are correctly worded.

Reliability: The questions were subsequently reviewed to ensure that the expectations of the study are realized.

To achieve the levels of precision in this study the questions were derived from already available literature. The respondents were guaranteed of their discretion and in order to ensure the objectivity of the study.

RESULTS AND DISCUSSION

Extent of application of Geospatial techniques in crime prevention through police response strategies

This was the objective of the study where the researcher wanted to find out the extent of application of geospatial techniques in crime prevention through police response strategies. The results of the study revealed that geospatial techniques have been applied in all spheres of crime prevention. Geospatial technology was being used to capture, analyze and storage of spatially referenced data. Good examples of

According to the study quality of evidence obtained from the data was used in the investigation of cases. There was also efficiency in the analysis of crime data and eventual generation of crime maps.

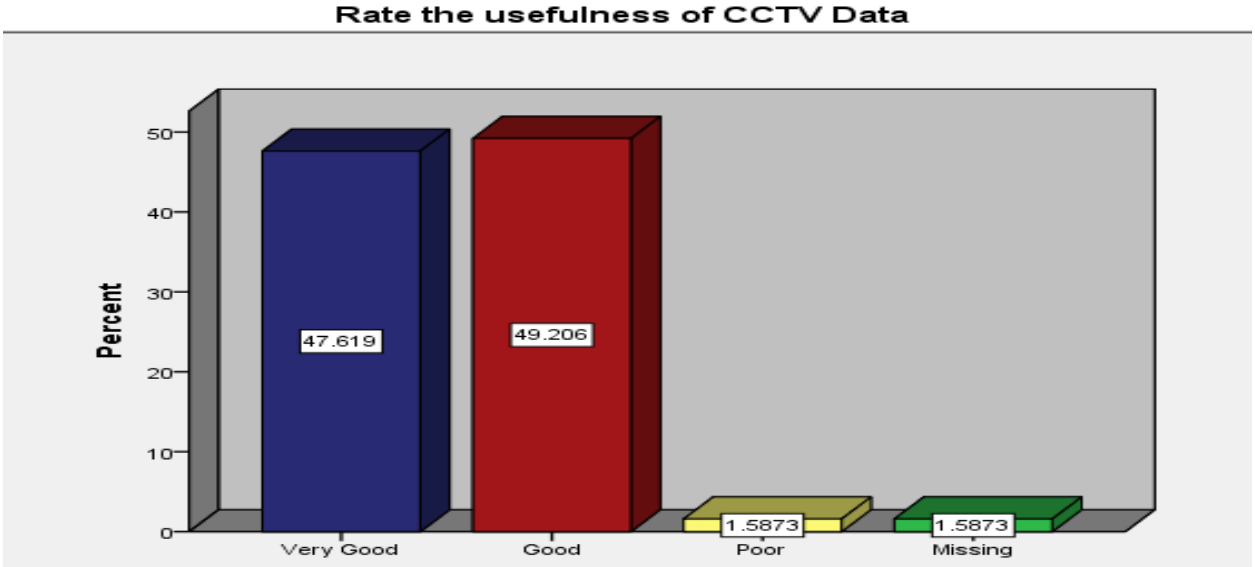

Figure 1: CCTV in data collection

According to Figure 1 above 96.82% of the respondents hold the view that the quality of crime data has improved with application of technologies like GIS and GPS. While a 1.59% of the respondents felt that the quality is poor a similar number did not respond to the question.

Table 1: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	47.070[a]	9	.000
Likelihood Ratio	25.889	9	.002
N of Valid Cases	115		

a. 12 cells (75.0%) have expected count less than 5. The minimum expected count is .03.

The output above shows a Pearson chi-square statistic of 47.07 and a p-value is 0.000. Since the p-value is less than our chosen significance level $\alpha = 0.05$, we can reject the null hypothesis, and conclude that there is an association between CCTV and collection of crime data.

Asked if the quality of crime data being collected has improved, a respondent during the in-depth interview replied: *"From my own observation there is massive improvement. For instance, each police officer is supplied with a tablet that has the digital Occurrence book. The GPS coordinates are already captured when the report is being made and this is a departure from the past where each and every report had to be entered*

manually into an OB stationed at the police station and the details of the place were in most cases captured generally.

Another respondent posed a hypothetical question *"how many crimes do you think would have gone unnoticed were it not for these surveillance cameras? Your guess is as good as mine".*

Table 2: Rate GIS in Crime Data storage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Good	24	20.9	20.9	20.9
	Good	73	63.5	63.5	84.4
	Neutral	10	8.7	8.7	93.1
	Poor	6	5.2	5.2	98.3
	Very Poor	2	1.7	1.7	100.0
	Total	89	100.0	100.0	

As shown in Table 2 above, 20.9% and 63.5% of respondents indicated that GIS is very good and good at storing crime data, respectively. While 8.7% of respondents were unsure whether this had improved or not, 5.2% thought GIS was poor. 1.7% said GIS was inadequate for storing crime data.

During one of the in-depth interviews a respondent in replying to the question whether GIS has improved the storage of crime data responded as follows: "*There have been instances where there is disappearance of case files as well as other information from our police records. What digitization of the occurrence book has done is to safeguard against these losses. Once a report has been made it cannot be deleted and therefore its retrieval for future usage is very easy. Bear in mind that the occurrence book is linked to GIS technology. This has also made it very easy to share the information whenever required to and it has also made it possible to preserve crucial data without fear of loss."*

Table 3: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	88.573[a]	16	.000
Likelihood Ratio	29.430	16	.021
N of Valid Cases	115		

a. 21 cells (84.0%) have expected count less than 5. The minimum expected count is .02.

The output above shows a Pearson chi-square statistic of 88.573 and a significance value which is less than 0.05. This leads us to reject the null hypothesis and indeed state that there is an association between the GIS data stored and crime mapping. This might be that one is able to follow up on past activities of suspects in previous recorded incidents. The crime mappings will help the police in apprehending suspects with more ease.

Table 4: Usefulness of GIS in crime analysis

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Good	30	26.1	26.1	26.1
	Good	68	59.1	59.1	85.2
	Neutral	11	9.6	9.6	94.8
	Poor	4	3.5	3.5	98.3
	Very Poor	2	1.7	1.7	100.0
	Total	115	100.0	100.0	

According to Table 4 above, 26.1% and 59.1% of the respondents thought geospatial techniques were excellent and good for analyzing crime data, respectively. While 3.5% said these methods for analysing crime were poor, an additional 1.7% thought they were very poor. 9.6% of the survey participants were unsure of the degree of improvement.

On being asked if geospatial techniques improved analysis of crime, Ci Matu OCS Langata replied as follows "Technology has created a paradigm shift in the manner at which crime data is analyzed. In the past this process was done manually. From the reported incidences a crime map showing various types crimes of crime occurring in an area would be portrayed on a wall map using pins of different colours each depicting the types. In order to generate a tread then a clock map would be generated. Now with this technology it is just a matter click of a button and you have all this."

Table 5: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.746[a]	10	.142
Likelihood Ratio	12.871	10	.231
N of Valid Cases	115		

a. 14 cells (77.8%) have expected count less than 5. The minimum expected count is .03.

The analysis output above gives a Pearson chi-square statistic of 14.746 and a significance value of 0.142 which is more than the assumed p-value of 0.05. This means that even if the GIS is helpful in making the reports, this will not guarantee that it will help in the crime analysis process. This shows that the geospatial information systems can be used to prevent crimes through reports and recording the activities of suspects.

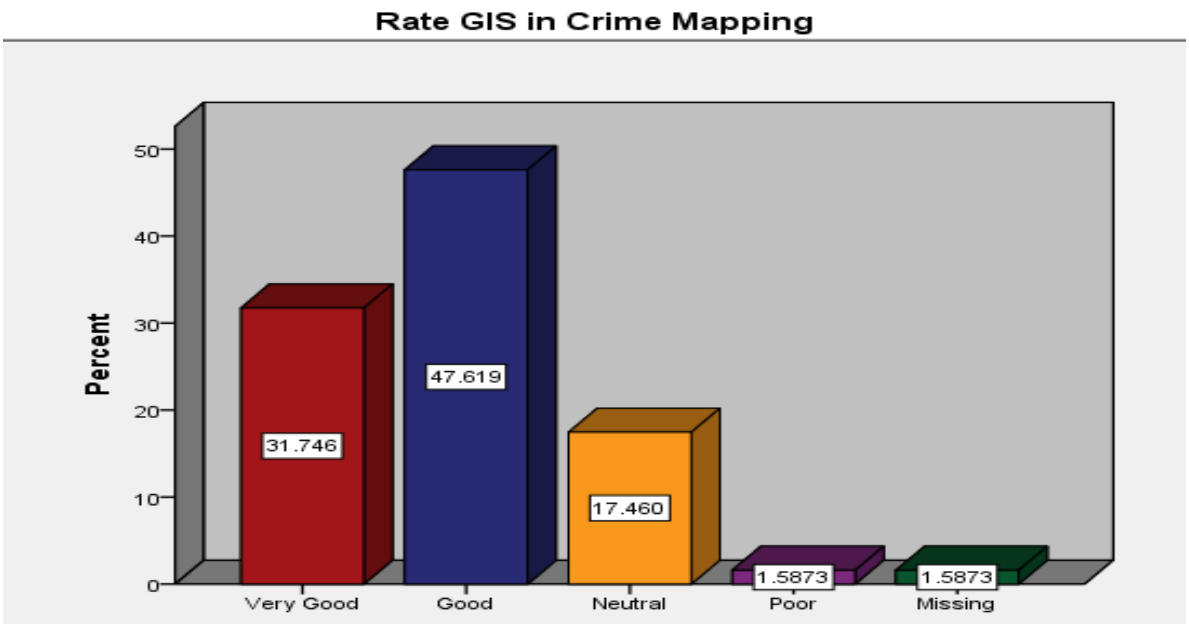

Figure 2: GIS in Mapping of crime

As shown in Figure 2 above 79.37% of the respondents indicated that GIS has made the generation of crime maps more efficient. In the same question 17.46% of the respondents did not see any change while a 1.59% of them held the view that GIS had made generation of crime poor.

Table 6: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	88.573[a]	16	.000
Likelihood Ratio	29.430	16	.021
N of Valid Cases	101		

a. 21 cells (84.0%) have expected count less than 5. The minimum expected count is .02.

The analysis output above gives a Pearson chi-square statistic of 88.573 and a significance value of 0.000 which is less than the assumed p-value of 0.05. Since the p-value is less than our chosen significance level α = 0.05, we can reject the null hypothesis, and conclude that there is an association between application of GIS and whether or not it improves mapping of crime.

Discussion of Results

Extent of application of Geospatial techniques in police response strategies in crime prevention

The findings of the study revealed that that GIS had improved the crime data storage in the police service. In the past there has been complains of loss of crucial reports including the sensitive casefiles this has been eradicated by the introduction of a digital occurrence book. The respondents argued that once a report is made it cannot be deleted and its retrieval has been made easy. Nwachukwu and Eke (2015) argued in a case study at Owerri Metropolis in Nigeria that loss of case files in manual systems can be eliminated by computerization of data storage. They also claimed that storing crime data in a database would result in more efficient data sharing within the force. This is only achievable by using advanced technologies such as of crime mapping information systems and geographic information system (GIS).

It was revealed by the findings of the study that application of Geospatial techniques has improved the analysis of crime in the Kenya police Service. The study's findings are consistent with those of Saravanakumar and Revathy (2016), who conducted a study in Madurai, India, and found that crime analysis identifies the distribution of crimes to obstacles faced by police departments attempting to deploy computerized crime mapping systems. Their study emphasized on the importance of identifying the thematic map generated for urban crime hotspots that the police department could use. The Geographic Information System (GIS) can be used to identify factors that contribute to crime, allowing authorities to intervene before things get out of hand.

From the findings of the study, it was revealed that GIS has made the generation of crime maps more efficient. The findings support the view held in another study conducted in India by Gupta (2012), who claimed that using GIS for crime mapping enables for the mapping, visualization, and analysis of crime hotspots as well as other trends and patterns. It is an important part of crime analysis and policing strategy. GIS is an interface for integrating and accessing massive amounts of location-based information that uses geography and computer-generated maps. GIS enables police officers to effectively plan for emergency response, establish mitigation priorities, analyze historical events, and forecast future events.

Chaturvedi (2019) as well observed that the production of briefing maps for beat-level patrol officers is the major means of delivering information to law enforcement officers on the front lines. If GIS and crime analysis are to help officers in the field, the analyst's and managers' strategic perspectives must be communicated to the tactical level.

CONCLUSIONS AND RECOMMENDATION

The objective of the study was to find out the extent of application of geospatial techniques in police response strategies for crime prevention. Under this objective the researcher the findings revealed that geospatial techniques in form of GPS, remote sensing and GIS have improved collection and storage of spatially

referenced crime data in NPS. From the findings it was also evident that GIS has greatly improved the analysis of crime.

The adoption of geospatial technology in police work has improved the collecting and preservation of crime data, according to the study's conclusions. The GIS-enabled tablets that police officers use to record incidents prevent the loss of vital information. Furthermore, crime mapping has vastly improved because to the usage of GIS. The use of this technology, which overlays other factors on a crime map, allows law enforcement authorities to discover factors that contribute to crime and, as a result, respond early to prevent or minimize crime.

To address the objective of this study on identifying the strategies in police response that have already incorporated geospatial techniques in crime prevention. The findings of the study revealed that adoption of geospatial technology in police work has improved the collection and preservation of crime data as well as the analysis and mapping of crime data. This study recommended that there should be continuous training on police officers on the use of geospatial techniques in the fight against crime. Because of the ever-increasing rate of innovation, as with any other technology, georeferencing of crime data results in a technological imbalance in terms of the amount of power held by fewer individuals who understand technology versus those who do not, especially as technology becomes more difficult to understand and use.

The study recommended that the government should come up with a policy to guide on the installation of remote sensing devices such as CCTVs and utilization of the data obtained thereof from the private individuals and public entities. This will create harmony in the sharing of information that could be crucial in the detection of crime, apprehension of the offender and beneficial to the investigators while protecting the information from non-intended dissemination.

Areas of Further Research

Since the researcher could not conduct a study that would exhaustively cover all aspects of Geospatial techniques in the prevention and reduction of crime, it is prudent to recommend the following:

- The only other county that is connected to the integrated command and control centre is Mombasa. This study is mostly applicable to the case of Nairobi and therefore it should be replicated by any future scholars and researchers in Mombasa County to assess if it would achieve the same results.
- In the recent past there are several road traffic accidents in Nairobi that has been reported in Nairobi. A study should be conducted on the use of Geospatial technology to identify the accident hotspots.

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