

## A GIS-based analysis of open space and the likelihood of crime hotspot in Abuja city centre

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### Abstract

In recent times, reported incidences of crimes in Abuja City Centre have taken a worrisome dimension with attendant socio-economic impacts including loss of lives and properties. The occurrence of some of these crimes are possible because of the presence of some open spaces around the crime locations. As cities grow, one feature that easily get altered is the open space. Some open spaces lose their original plans, others become abandoned and overgrown with bushes thus serving as hideouts for criminals. Open spaces play a major role in the development of modern cities and are usually prioritized in planning such cities. Using geospatial techniques: kernel density analysis, average nearest neighbour analysis on ArcGIS, as well as the statistical analysis of the questionnaires, this study identified and examined the characteristics of open spaces in Abuja City Centre and their likelihood of being crime hotspots. The study used both primary and secondary data. Primary data used were responses from questionnaires and interviews as well as the geographic coordinates of the locations while the shapefile of the study area, road network and waterway data, all sourced from Grid<sup>3</sup> databank constitute the secondary data. Hotspot analysis using ArcGIS 10.4.1 was carried out to identify crime hotspots. The study reveals that theft, mischief, assault, robbery and pick pocketing were the dominant types of crime occurring within Abuja City Centre especially around some open spaces accounting for 100%, 81%, 78%, 69% and 58% of the crimes respectively. The results further revealed that theft was prevalent in all the open spaces examined. Also, using average nearest neighbour analysis, this study discovered that the spatial pattern of crime in Abuja City Centre was dispersed. The study also highlights the application of geospatial techniques in crime modeling in urban centres like Abuja City Centre.

**Keywords:** Open space; Crime; Hotspot; City; Design

### 1. Introduction

Open space (OS) is an important component of the ecosystem in urban settings as it helps to stabilize the ecosystem. According to [1], Open Space refers to a range of different public spaces including parks, gardens, greened areas, sporting fields and ovals. The United States' Housing Act of 1961 on the other hand see open space as any undeveloped or largely undeveloped land within an urban area with the value for park and recreational purposes, conservation of land and other natural resources, or historic or scenic purposes [2]. Some earlier authors also considered open space as important urban design features that provide unique health benefits for local residents which include filtering and sequestering airborne and waterborne toxins [3], [4]. Also, among the benefits of open space is the protection of land and other natural resources, as well as the worth of history or scenery. The physical characteristics of the open space is

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also important to examine in this perspective. Although open space is intended for people but the activities that occur there vary in nature. Open space is also viewed as a health-promoting element of urban environments, and has been connected to a number of benefits. these include mental fatigue recovery [5], positive childhood development [6], and neighbourhood social cohesiveness. Regrettably, it is also believed to be haven for criminal activities [7].

One of the major problems that come with modern city development is crime, [8]. [9] on the other hand asserted that crimes undermine the social fabric of society by first eroding the sense of safety and security. Nigeria, like many developing nations have inadequate crime analysis strategies. Good crime analysis provides, first of all, a preventive strategy for crime control and as well, provides effective remedial strategies to combat crime. Geospatial and other statistical techniques provide for analytical modelling and real-world representation. This interplay integrates different data types such as, crime statistics, location of crime and socio- demographic data in order to improve on crime analysis for effective crime prevention and control thus becoming a valuable tool in the hands of security experts. Generally, there is a growing concern in the relationship between open space and crime, yet how a particular open space contributes to crimes remains largely unexplored. The findings of this study will contribute to the extant literature on the subject matter by demonstrating how open space type and its utilization as well as the neighbourhood infrastructure affect crime rates.

This study focused on Abuja City Centre because of its importance to the nation as it houses critical infrastructure of the country like the offices of the three arms of government- the Aso Rock Villa, the National Assembly and the Supreme Court complexes for the executive, the legislature and the judiciary respectively.

### **1.1. Statement of the Problem**

Open space is an integral part of the development of a modern city largely because of the many benefits it provides. In designing and planning of sustainable cities, open spaces are provided for to achieve scenic beauty, provide social cohesion, spaced neighbourhoods, lower gross population densities, preserve precious monumental artefacts or historic sites, manage the population of the city, to serve public functions, and enhance the quality and economic value of the environment. However, as cities grow, their land use patterns deplete and encroach on these open spaces with attendant impacts on the social life of the city. In certain instances, some open spaces lose their original design intension, others become abandoned and overgrown with bushes thus serving as hideouts for criminals. Study on open spaces and their likelihood to crime is scanty. Several authors have discussed open space from different perspectives, including visual characteristics of open spaces [10]; visual description and aesthetics of open spaces [11]; pattern of people behaviour and space quality [12]; and evaluation of the quality of open space [13], design characteristics of open space that help to prevent crime [14] among others. This study however tries to identify and examine the open spaces within Abuja City Centre and their likelihood to crime based on their utilization.

#### *Aim and Objectives*

The aim of this study is to analyze open space utilization and the likelihood of crimes in Abuja City Centre with the specific objectives to; identify and examine the characteristics of open spaces within Abuja City Centre as well as analyze the likelihood of crimes based on utilization of the open spaces within the study area.

### **1.2. Study Area**

Abuja City Centre lies between latitude 8.927763 and 9.112138N and longitude 7.424761 and 7.589795E. It is predominantly a built-up area comprising of Garki, Wuse, Maitama, Asokoro and Central Business Districts with the presence of numerous government institutions and diplomatic infrastructure. The region houses the most exclusive neighbourhoods in Nigeria as such real estate in this region attracts a premium. Houses in the area are believed to be some of the most beautiful and at the same time most expensive in Africa. The city centre experiences large influx of people during the day and yet has a very active night life due to the aforementioned characteristics. Like most modern cities, the area is a bee-hive of activities 24hours day and 7days a week. This makes it vulnerable to crimes especially around public areas like the open spaces within the town.

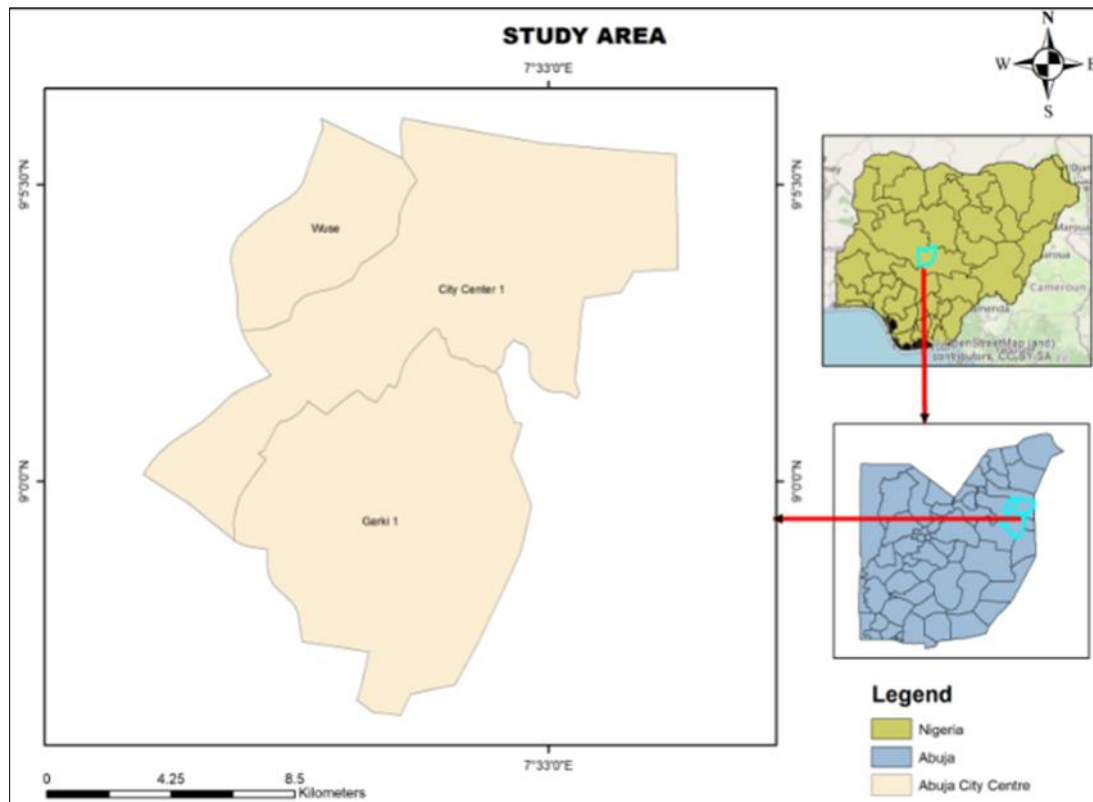


Figure 1 Study Area Map

## 2. Materials and Method

This study made use of both primary and secondary data. The primary data were sourced from questionnaire administration, interviews and reconnaissance survey. The respondents were selected from the users and neighbours of open spaces in Abuja City Centre. Accidental sampling was employed for the selection of respondents. The reasons for collecting data via the questionnaire is to allow the collection of data without any interference while the interview is for confirmation of the information in order to ensure the accuracy of the information collected. Information on the types and uses of the open spaces vis-à-vis the types of crime associated with each open space were elicited using this medium. Reconnaissance survey was conducted to identify the open spaces within the study area and to get their locational coordinates. On the other hand, GRID<sup>3</sup> data were used as the secondary data for this study. The GRID<sup>3</sup> data were used as base map of the study area. It was used in identifying the location of the various open spaces within the study area. See table 1 below.

Table 1 Data types and sources

| Data                    | Data type | Data source                   |
|-------------------------|-----------|-------------------------------|
| Open space coordinates  | Primary   | Google Earth                  |
| Respondents responses   | Primary   | Questionnaires and interviews |
| Shapefile of Study area | Secondary | GRID <sup>3</sup> Nigeria     |
| Road network            | Secondary | GRID <sup>3</sup> Nigeria     |

### 2.1. Materials

Both hardware and software materials were used for processing data in this study. The hardware include computer, Smart phone and printer while the software used are: ArcGIS version 10.4.1, Microsoft word and Microsoft Excel.

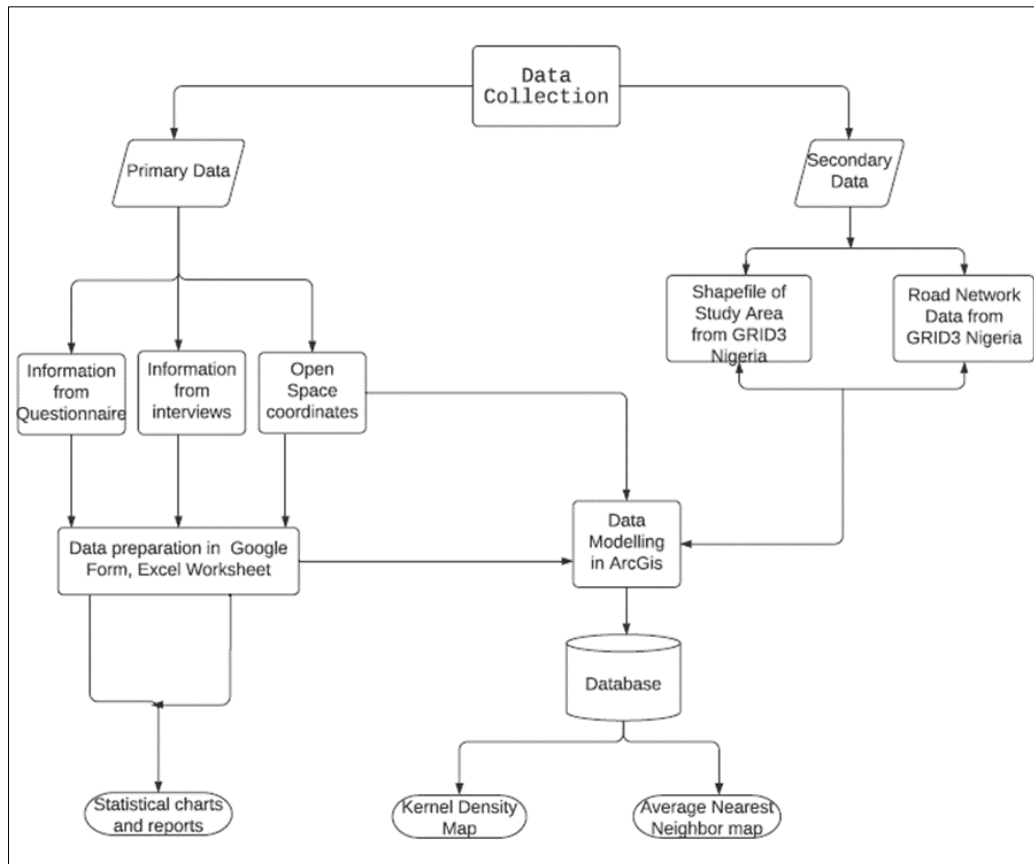
**Table 2** Hardware used for the study

| Hardware    | Use  |
|-------------|--|
| Computer    | For data entry, processing, analysis and information presentation. |
| Printer     | For printing of maps and project write up.                         |
| Smart phone | For questionnaire development and circulation                      |

**Table 3** Software used for the study

| Software        | Use                                       |
|-----------------|---|
| Google Earth    | For acquisition of locational coordinates |
| ArcGIS 10.4.1   | For spatial analysis and map production   |
| Microsoft Word  | For word processing                       |
| Microsoft Excel | For tabulations and statistical analysis  |

**2.2. Data Analysis**



**Figure 2** Methodology Work Flow

The first objective of this work is to identify and examine the characteristics of open spaces within Abuja City Centre. To achieve this, responses received from the questionnaires distributed to users and neighbours of some open spaces were aggregated and analyzed. In addition, responses from the interviews conducted on personnel of the Nigeria Police Force from different stations within the study area were analyzed. This analysis was based on simple statistics and was useful in identifying the different classes of open space in terms of their present utilization. Also, overlay analysis was

done by overlaying the coordinates of the identified locations on Google Earth application to have a geographic view of the locations.

The second objective is to analyze the likelihood of crimes based on utilization of the open spaces within the study area. The responses received from the questionnaires distributed to users and neighbours of open spaces as well as the responses from the interviews conducted on members of the Nigeria Police Force were used in collaboration with secondary data retrieved from GRID<sup>3</sup> Nigeria in the form of shapefiles to do Kernel Density and Average Nearest Neighbour analysis on ArcGIS version 10.4.1 software to give a graphic overview of crime concentration per location.

### 3. Results and Discussion

Abuja City Centre is a well-designed modern city that is predominantly a built up area with the presence of numerous open spaces. To help identify these locations and to examine their characteristics, a total of 104 feedbacks from respondents comprising of 70 questionnaires and 34 oral interviews were analyzed and their responses are shown in table 4 below:

**Table 4** Selected open spaces in Abuja City Centre

| S/n | Location                  | Latitude    | Longitude   | Open space type | Present utilization                |
|-----|---------------------------|-------------|-------------|-----------------|------------------------------------|
| 1   | IBB Golf Course           | 9.081952778 | 7.506286111 | Controlled      | Exclusive sporting site            |
| 2   | Opposite WAEC             | 9.079069444 | 7.492144444 | Uncontrolled    | Staff car park                     |
| 3   | Mabushi bridge            | 9.077608333 | 7.458136    | Uncontrolled    | Bus Stop                           |
| 4   | Wuse 2 Junction           | 9.076227778 | 7.474977778 | Uncontrolled    | Bus Stop                           |
| 5   | National Aboretun         | 9.072852778 | 7.517583333 | Controlled      | Regulated entry                    |
| 6   | Millenium Park            | 9.07135     | 7.498227778 | Controlled      | Leisure and public relaxation      |
| 7   | Wuse Market Garden        | 9.069277778 | 7.463372222 | Uncontrolled    | Leisure and public relaxation      |
| 8   | Berger Junction           | 9.067777778 | 7.454347222 | Uncontrolled    | Leisure and public relaxation      |
| 9   | Wuse Market bridge        | 9.066736111 | 7.467194444 | Uncontrolled    | Bus Stop                           |
| 10  | Sky Memorial bridge       | 9.066652778 | 7.457919444 | Uncontrolled    | Bus Stop                           |
| 11  | Unique World              | 9.063786111 | 7.461802778 | Controlled      | Leisure and public relaxation      |
| 12  | Thisday Dome              | 9.063519444 | 7.495536111 | Controlled      | Public events and large gatherings |
| 13  | Zone 3 bridge             | 9.063452778 | 7.471866667 | Uncontrolled    | Bus Stop                           |
| 14  | Riverplate Park           | 9.063336111 | 7.490830556 | Controlled      | Leisure and public relaxation      |
| 15  | Zone 3 by Post Office     | 9.061697222 | 7.469222222 | Uncontrolled    | Car wash/open market               |
| 16  | Zone 4 Junction           | 9.061191667 | 7.479583333 | Uncontrolled    | Bus Stop                           |
| 17  | Eagle Square              | 9.060936111 | 7.499752778 | Controlled      | Large outdoor events               |
| 18  | National Mosque Junction  | 9.058158333 | 7.483480556 | Uncontrolled    | Farming                            |
| 19  | Finance Ministry Junction | 9.0564      | 7.497147222 | Uncontrolled    | Farming                            |
| 20  | GSM Village               | 9.053819444 | 7.4695      | Controlled      | Open Market                        |
| 21  | Zone 1 Amusement Park     | 9.053502778 | 7.463716667 | Controlled      | Relaxation/amusement               |
| 22  | Asokoro by bridge         | 9.051238889 | 7.526538889 | Uncontrolled    | Bus Stop                           |

|    |                               |             |             |              |   |
|----|-------------------------------|-------------|-------------|--------------|---|
| 23 | PDP Secretariat               | 9.050122222 | 7.483208333 | Controlled   | Abandoned construction site                 |
| 24 | Behind Buhari Campaign Office | 9.048966667 | 7.485952778 | Controlled   | Temporary residence                         |
| 25 | Behind Nikon Luxury           | 9.047261111 | 7.492383333 | Uncontrolled | Unoccupied, empty and bushy                 |
| 26 | Bolingo Junction              | 9.045183333 | 7.480538889 | Uncontrolled | Bus Stop                                    |
| 27 | Old Parade Ground             | 9.042483333 | 7.487911111 | Controlled   | Sporting events and large outdoor gathering |
| 28 | Space behind FCID             | 9.039783333 | 7.485794444 | Uncontrolled | Food canteen and Police Station car park    |
| 29 | Diplomatic Plot by UN         | 9.037186111 | 7.467477778 | Uncontrolled | Unoccupied, empty and bushy                 |
| 30 | Stadium Area                  | 9.036286    | 7.462475    | Uncontrolled | empty and bushy                             |
| 31 | Area 1 Garden                 | 9.031758333 | 7.473372222 | Uncontrolled | Car wash/open market                        |
| 32 | Area 1 Junction               | 9.029747222 | 7.468586111 | Uncontrolled | Bus Stop                                    |
| 33 | Blakes Garki 2                | 9.027758333 | 7.492102778 | Controlled   | Leisure and public relaxation               |
| 34 | Area 3 Junction               | 9.025391667 | 7.476766667 | Uncontrolled | Bus Stop                                    |
| 35 | Apo bridge                    | 9.021080556 | 7.481338889 | Uncontrolled | Bus Stop                                    |
| 36 | Gudu Cemetery                 | 9.012886111 | 7.487038889 | Controlled   | Burial and solemn events                    |

Source: Authors, 2021

Further analysis of the results reveals the likelihood of assault in 28 locations representing 77.78% while culpable homicide and murder are likely in 2 locations each representing 5.56% of the sampled open spaces respectively. Drugs on the other hand is likely in 19 open spaces representing 48.72%, pick pocketing is likely in 21 locations representing 58.33%, rape is likely in 4 open spaces representing 11.11% and robbery is likely in 25 locations representing 69.44% while snatching is likely in 6 locations representing 16.67%. Mischief is likely in 29 open spaces representing 80.56%, trespass is likely in 2 locations representing 5.56% while theft is likely in 36 locations representing 100% of the sampled open spaces.

### 3.1. Characteristics of Open Spaces in Abuja City Centre

**Table 5** Types of open space based on the ease of access

| Type         | No | Percentage |
|--------------|----|------------|
| Controlled   | 14 | 38.89      |
| Uncontrolled | 22 | 61.11      |
| Total        | 36 | 100.00     |

Source: Authors, 2021

A total of 36 open spaces were analyzed for this study. The result reveals that open spaces within Abuja City Centre are broadly grouped into two types – controlled and uncontrolled types based on their ease of access. Out of the 36 locations, 14 locations representing 38.89% are controlled open spaces while 22 locations representing 61.11% of the sample locations are uncontrolled see table 5 above. The controlled open spaces are spatially located at an average distance of 1.20km apart while the uncontrolled ones are about 1.24km apart. Further analysis reveals that these open spaces function either as abandoned construction sites, cemetery, green areas/waterways, neighbourhood parks, nodal points, open spaces for commerce, organized sport centres, secured event centres, undeveloped plots and undeveloped public infrastructure spaces. Nodal points constitute the highest in number with 33.33% of the 36 open spaces analyzed. Others include neighbourhood parks 19.44%, undeveloped plots, secured event centres and green areas/water ways with 8.33% each. Open spaces for commerce and cemetery are the least in number with 2.78% each.

### 3.2. Open Space and Crime

The results of the questionnaires administered and interviews conducted in the course of this study indicate that a total of 25 respondents (representing 24%) hold the view that the uncontrolled type of open space with uncontrolled access is responsible for the increased crime rate around these locations which is in tandem with [15]. 19 other respondents representing 18.3% blame absence of light in and around these open spaces especially at night for the crime rate in the study area as corroborated by [16]. On the other hand, 15 respondents representing 14.4% identified absence of security surveillance as one of the leading factors responsible for the prevalence of crimes in Abuja City Centre. Other factors identified include nearness to difficult terrains as indicated by 12 respondents representing 11.5% and illegal occupation of uncompleted or abandoned construction sites as opined by 10 respondents representing 9.6%. While 8 respondents representing 7.7% of the sampled population were not sure of the factors responsible for crimes in the area, 5 respondents representing 4.8% attributed the factors responsible for acts of criminality in the area to low activities in such open spaces and another group of 5 respondents attributed the prevalence of crimes in the area to unemployment. 3 other respondents representing 2.9% said crime rate in the study area was due to the fact that some of these open spaces are located in hidden locations that were either overgrown with thick vegetation or isolated from residences. This is in agreement with the study of [16] while 2 other respondents representing 1.9% said the crime rate was due to lack of infrastructures in the open spaces.

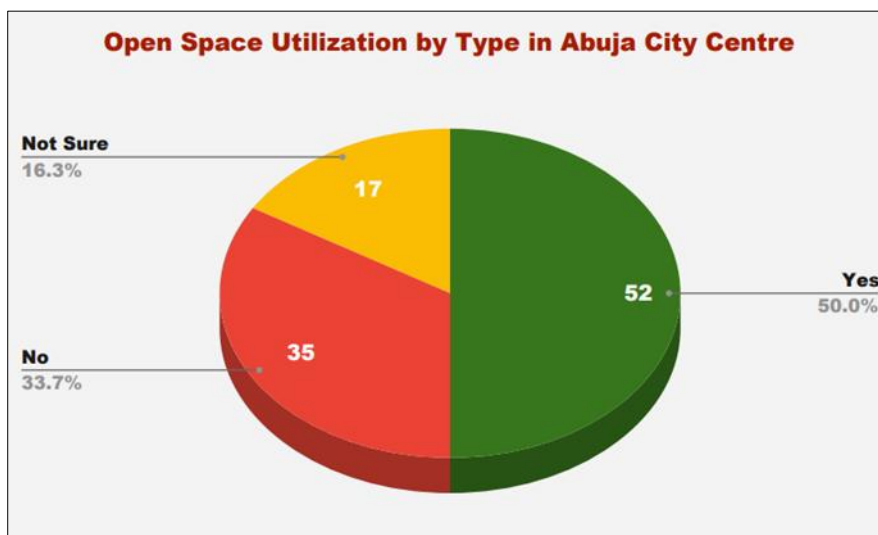


Figure 3 Pie chart showing the open space utilization by type

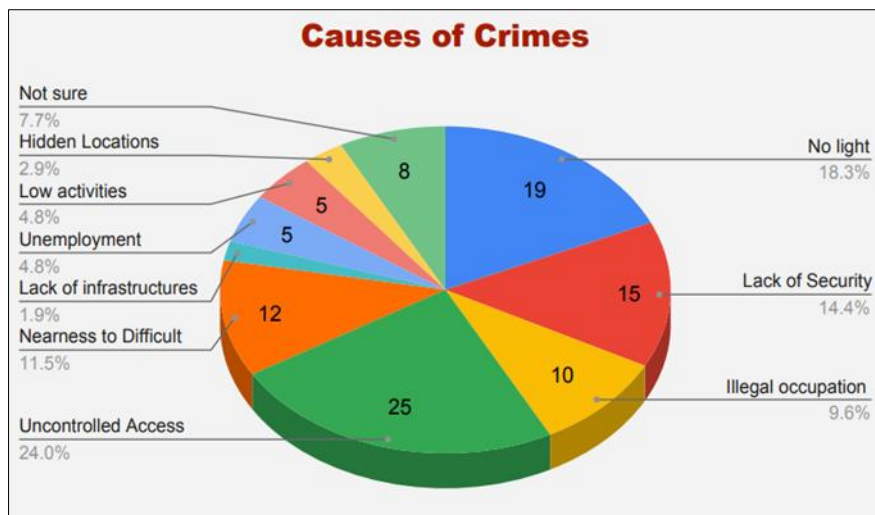


Figure 4 Pie Chart showing the factors responsible for the prevailing crime rate

Generally, the respondents are of the opinion that most organized open spaces in Abuja City Centre are believed to conform to their original design or approved purposes. This is evident in their knowledge of the ones closest to them. 52 respondents representing 50% of the sampled population confirmed that the open spaces nearest to them were being used for their designed or approved purposes. This does not negate the fact that some might be used for other unlawful or illegal purposes as confirmed by 35 respondents representing 33.7% of the sampled population. However, 17 respondents, representing 16.3% of the population sample could not confirm if the open spaces nearest to them are being used for their designed or approved purposes, see Figure 3 above. The respondents also hold the view that uncontrolled access, poor light condition, lack of security surveillance and nearness to difficult terrains are the leading drivers of crimes around these open spaces, see Figure 4 above.

### 3.3. Analysis of Crime Hotspots

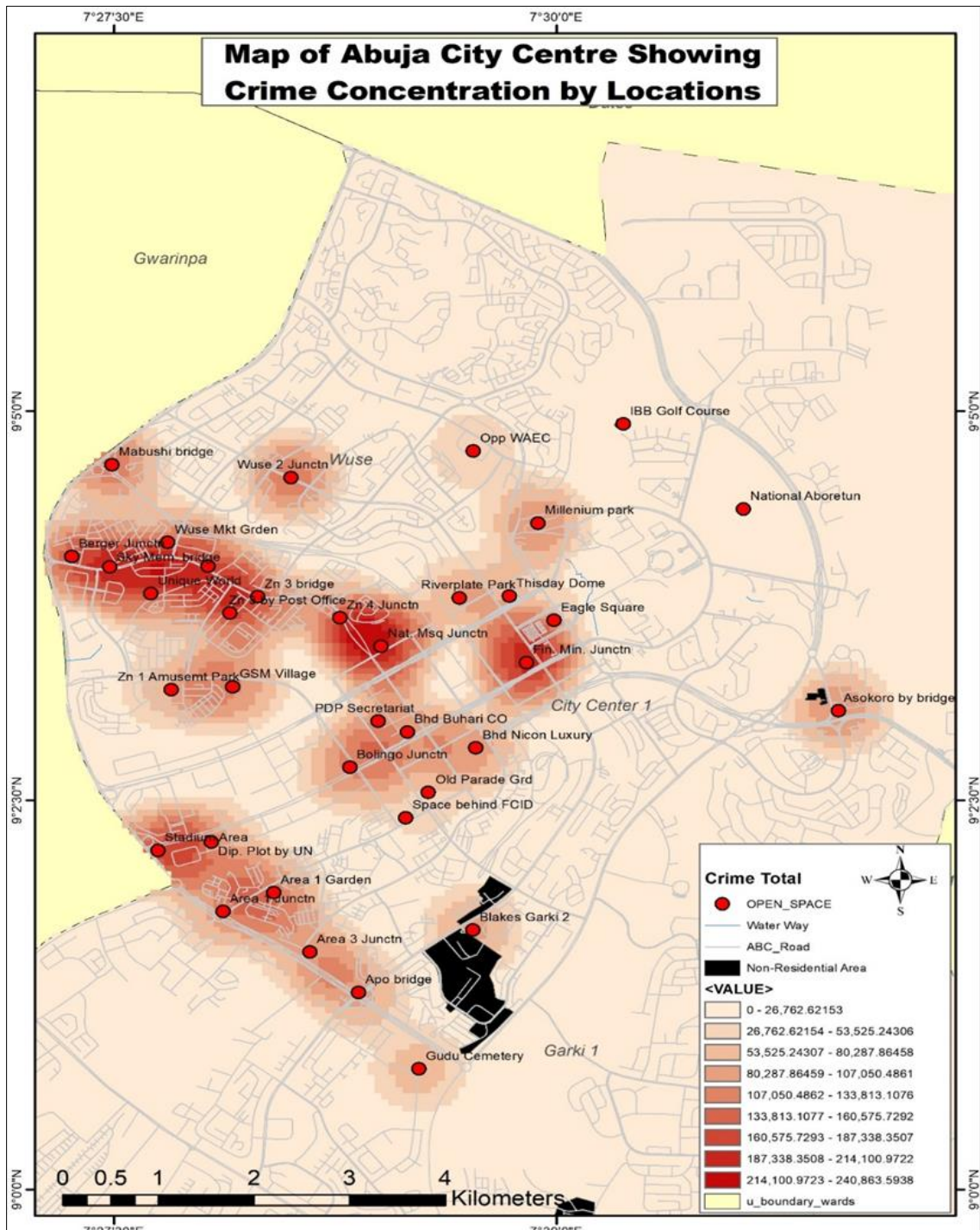


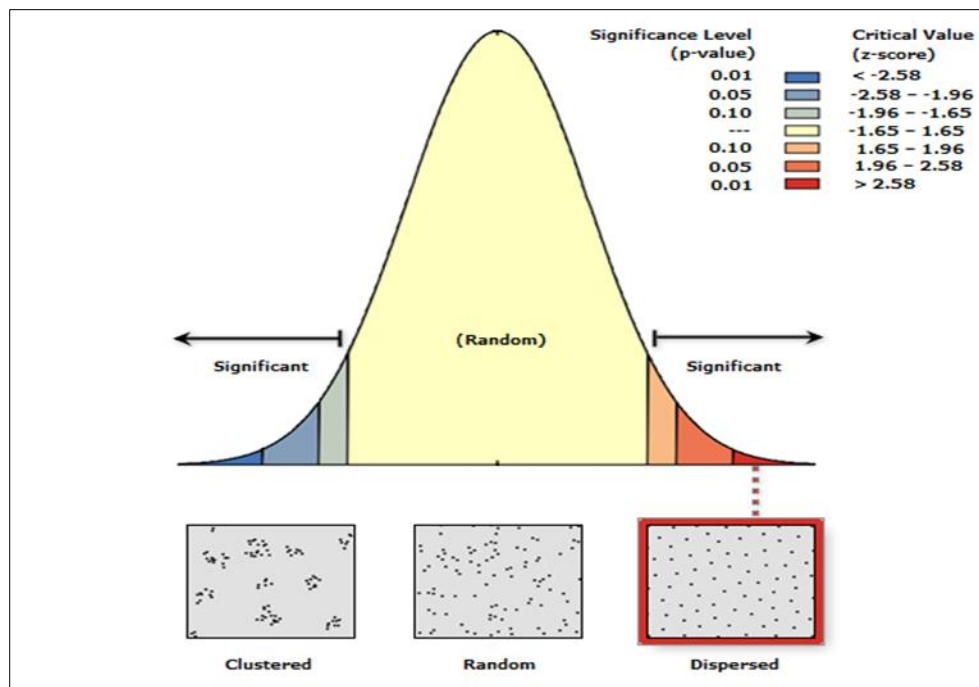
Figure 5 Map of study area showing overall crime concentration per location



From the hotspot analysis, Figure 5 above, crime concentration around Ministry of Finance junction, National mosque junction, Berger junction through Wuse market bridge and stadium area through Area 1 roundabout tend to be highest making these areas general crime hotspots that require special security patrol and surveillance. Obviously, this is in agreement with the work of [15].

### 3.4. Spatial Pattern of Crimes in Abuja City Centre

The Average Nearest Neighbour analysis of crimes in Abuja City Centre reveals that the pattern of crimes is dispersed. Dispersed pattern of crime refers to a form of crime hotspot in which the sources of the hotspot are spread throughout the area. It is dependent on availability of opportunities for such crimes to be committed. That is, whenever an opportunity presents itself, there is every likelihood that crime would be committed. Invariably, the presence of open spaces, especially the uncontrolled type, in different parts of Abuja City Centre is a likely causative factor for this type of crime pattern, see Figure 6 below.



**Figure 6** Pattern of Crimes in Abuja City Centre

## 4. Conclusion and recommendation

This study addresses the relationship between open space and crimes. Crime place plays a key role in understanding and tackling crime problems. Abuja City Centre has a lot of open spaces that are believed to contribute to the increasing rate of crime in the city. From their poor physical designs to poor amenities and outright abuse of design and approved purposes, a lot of them have become havens for illegal and unauthorized occupation thus serving as criminal hideouts. So many green areas and waterways in the city have become danger zones both at night or in the day time. A lot of uncompleted buildings, undeveloped plots, neighbourhood parks and gardens in the city centre are unfenced with overgrown bushes and of course, without light, thus making them citadels of crimes and criminal activities. The findings of this study show that so many open spaces in Abuja City Centre largely do not conform to the requirements of a defensible space which is hinged on territoriality, surveillance, image, milieu and safe adjoining areas. This is a pointer to the negative contributions of open spaces to crimes in the city centre. It is important to note that the vulnerability of an open space or its adjoining areas to crime does depend on the type, location and amenities of the open space itself. These results can be of interest to different stakeholders, for instance; homeowners or buyers, open space managers, security agencies, safety professionals and practitioners. Homeowners and potential buyers can use this research to decide whether to invest money when buying an apartment or property near a high-crime open space or not. For open space managers, these findings are useful in thinking about where to channel resources to improve the condition of the open spaces so as to improve overall city safety. For the safety experts and the police, these results will be useful in deciding how to invest resources for example, new lighting strategies at crime concentration points, and also to build

and maintain some targeted programmes in open spaces, and on a practical level, to put more emphasis on proactively reducing or ultimately eliminating crimes in and around open spaces.

Considering the importance of open space in modern cities, this study recommends that an open space administration system should be developed to serve as a veritable database for the ownership, design and management of open spaces in Abuja City Centre. The owners of open spaces should be adequately sensitized on the contributions of such locations to the overall safety of their neighbourhoods as well as the entire city centre and be made to conform with the approved design and purpose. The design of open spaces should be in tandem with the concept of defensible space which is hinged on territoriality, surveillance, image, milieu and safe adjoining areas. Furthermore, open space management framework should incorporate a host of innovative approaches; among which could be the involvement of a handful of community-driven approaches such as the use of neighbourhood or street wardens. The use of technology in surveillance such as closed circuit television cameras, the use of unmanned aerial vehicles (UAVs) or drones should be noticeable in open spaces to deter criminals from taking advantage of unsuspecting members of the public. Physical human surveillance by police and other authorised custodians of open spaces should be strategically improved upon. These approaches will be effective in surveillance of shared open spaces to detect undesirable or criminal behaviours.

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## Compliance with ethical standards

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### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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