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Research Article

Spatial Distribution of Telecommunication Base Station in Ilorin South Local Government area of Kwara State, Nigeria Using GIS

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ABSTRACT

Information management has become a very important topic in recent times and technological advancement depends more and more on the amount of information that is available in real time. Great nations of today are characterized by the amount of information they harness and how well and efficient this information is being dispersed to its citizen. The growing demand for mobile services has necessitated the increase in communications infrastructure such as towers; which are needed to ensure that there are adequate network coverage and access which guarantee minimum quality of service. The importance of telecommunication masts towards actualizing the effectiveness in communication cannot be underestimated. This study however focused on application GIS in proffering solution to telecommunication masts distribution and their locations in Ilorin South Local Government area, Kwara State, Nigeria. GIS analytical capability was harnessed on some selected telecom masts in the study area, this includes; MTN, GLO, 9MOBILE, AIRTEL, MULTILINK and GOTV. Other features such as roads, buildings, health facilities, fire stations and police stations were all brought to a common reference point for the purpose of analyses. Findings and results from the analyses showed that average height of the telecom masts is 45m while some buildings close to the location of the telecom masts violate the 10m gap distance of Nigeria Communication Commission (NCC) and National Environmental Standard Regulatory Enforcement Agency (NESREA). The distribution of GSM Base stations in Ilorin South LGA are in clustered form. This implies that, masts are sited randomly close to each other when viewed against the background of the area perimeter. The study therefore recommends a distance of 65m or more of telecom masts location from public area and the use of collocation should be encouraged on like the HIS and American Tower Company that enables multiple use of telecommunication mast by several telecom operator both in urban and suburban area.

Keywords: Telecommunication, Location, Distribution, GIS, Ilorin South

INTRODUCTION

The world is fast becoming a Global village and the necessary tool for this is "communication" of which telecommunication is the key player. Cell phone therefore, serves as a tool for social connection and managing social relationships among people. This necessitates the need for development of GSM facilities in order to provide the required services, which will at one point or another required planning approval to ensure order and efficiency (Banjo, Hu & Sundar 2008).

Telecommunication was defined as a technology whose domain is communicating from a distance (Tarmo, 2003). Telecommunications, also known as telecom, is the exchange of information over significant distances by electronic means and refers to all types of voice, data and video transmission. This is a broad term that includes a wide range of information transmitting technologies such as telephones (wired and wireless), microwave communications, fiber optics, satellites, radio and television broadcasting, the internet and telegraphs. It shows one possible view of the different sections of

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telecommunications. Telecommunications networks make up the most difficult network in the world. Let us think only of the telephone network, which includes more than 3 billion fixed and cellular telephones with universal access. When any of these telephones requests a call, the telephone network is able to create a connection to any other telephone in the world. More so, many other networks are interconnected with the telephone network. This gives us a view of the complicacy of the global telecommunications network and no other system in the world exceeds the complexity of telecommunications networks.

GSM communication system was introduced in Nigeria in August 2001. This changed the face of Information and Communication Technology (ICT) in the country. At its launch, there were only two operators in Nigeria, these are: MTN and Econet which metamorphous to Vmobile, Zain and now Airtel. Today, there are several operators across the nation, among the existing ones in Ilorin South Local Government Area include: 9Mobile, Globacom, Startcomms, Airtel and MTN.

The factors influencing the location of base stations in Nigeria as obtained from the telecom operators are ten (10) key factors and these include: accessibility, land value, size of land area, topography, population, security, availability of power/ electricity, proximity to other base stations, regulatory standards and technical specifications. These factors were ranked based on their importance. Population was ranked first, followed by topography, technical specifications, land value, security level of the location, accessibility to the location, availability of power, size of the land, regulatory standard (Planning/NCC) and lastly proximity to other base stations (Omole 2006).

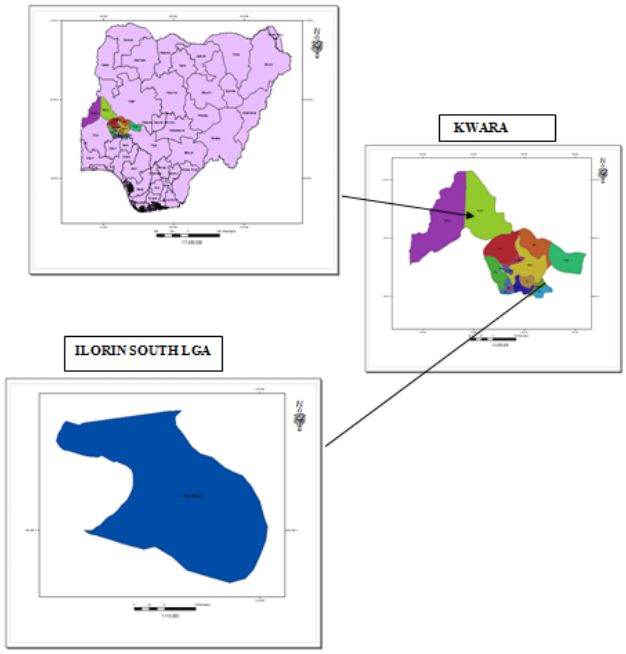
Location of masts has effect on the resident around it; there are silent long-term problems that may affect the resident's health. Masts have been associated with cancer and other grave illnesses. Occurrence like tiredness, headache, decreased concentration, dizziness, local irritation, tumor induction, sperm motility, morphology and viability, cancer, especially brain tumor and leukemia, viral and infectious diseases has been blamed on living within 1-5km distance from masts. There has also been some problem related to the fact that some of the mast that are erected are not very strong and there have been cases of towers that have fallen down to cause fatal accident and other inconveniences to the environment. The vibration, noise and fumes from the generators in the host neighborhood also impair the resident's peaceful living.

THE STUDY AREA

Ilorin is the capital city of Kwara state, it is geographically defined on latitude 8 °24' and 83°6' North of the equator and longitude 4°10' and 4°36' East of the Greenwich meridian. The city marks the transition between the northern savannah and southern forest zone of Nigeria. Ilorin South Local Government is one of the local government areas in Kwara State, North Central of Nigeria and it is in Kwara Central Senatorial Zone. It has a total land mass of about 174km2 with its administrative headquarters situated at Fufu. Ilorin South Local Government Area is bounded to the North by Ilorin East Local Government Area, to the East and South by Ifelodun Local Government Area and West by Ilorin West Local Government Area. The total population of Ilorin South Local Government Area is 282,500 according to the National Population Census, 2016. Ilorin

South Local Government Area is subdivided into eleven (11) electoral wards. The wards are Akanbi I, Akanbi II, Akanbi III, Akanbi IV, Akanbi V, Balogun-fulani II. Balogun-fulani III, Balogun-fulani I, Okaka I, Okaka II, Oke-ogun. Figures 1.1 showing the study area.

Figure 1: Diagram of the Study Area.



MATERIALS AND MERHODS

The materials used in this study are from two major sources and they are:

Primary source and Secondary source

Primary Sources of Data

Primary sources involve direct acquisition of data through

- Reconnaissance (also called Recce) survey of the study area, location of existing Base Station and to determined their heights (easting, northing and height).
- Handheld GPS and data acquired are coordinates of telecommunication mast, fire station, hospital and police station.
- Observation for ground truthing was done in order to validate secondary data acquisition.
- Social survey and data acquired are Attribute data of telecommunication masts, road and building.

Secondary Sources of Data

Secondary sources of data used for this study include the following:

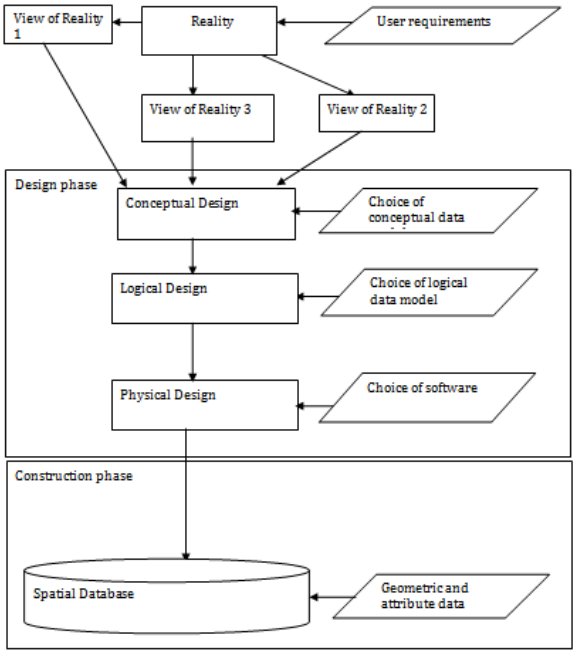
- Updated, Google Earth Pro Version Satellite imagery 2009 of Ilorin South Local Government Area.
- Ikonus imagery (2003) of the study area.
- Demographic Map of the study area and
- Data on GSM base stations record from the service providers and Nigeria Communication Commission (NCC). The data include the following: Name of the various GSM Base Station, The address and location of the Base Stations, The heights of the Base Stations, The Cell ID of the Base Stations, The type of fence and Status functionality of the Base Stations.

The methods used to accomplish this work includes, the acquisition of satellite imagery of the study area, georeferencing and digitizing the features therein, database design, creation and information presentation.

DATABASE DESIGN AND IMPLEMENTATION

Database is the collection of interrelated data that is stored in a computerized information system so as to save one or more applications and is independent of the computer programmers that uses it. Kufoniyi, (1998) explained GIS data modeling as the process by which the real-world entities and their interrelationships are analyzed and modeled in such a way that maximum benefits are derived. Reality refers to the phenomenon that actually exists including all aspects, which may or may not be perceived by individuals. It is the actual abstract of real situation for a particular application. The view of reality is the mental abstraction of all entities, as they actually exist within the project area. The reality serves as the input in the design phase. The design consists of three phases as; Conceptual design, Logical design and Physical design.

Figure 2: Design and Construction Phase of Spatial Database (adapted and modified from Kufoniyi, (1998).

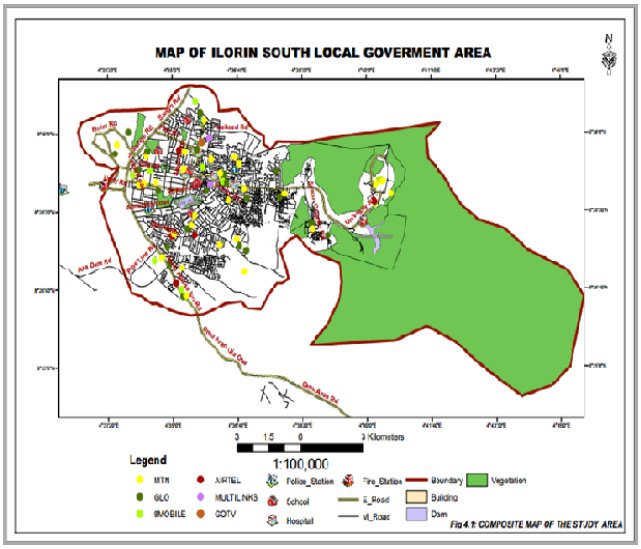


RESULTS

The results of the analysis of the data collected during the field work are composite map of the study area and spatial analysis from the database.

The composite map of the study area consists of the location of 9 Mobile, Airtel, Globalcom, MTN, Multilinks, and GOTV telecommunication masts. Also included in the composite map are buildings, health facilities, police stations, fire stations, schools, rivers, dams and road network. Below is the composite map of the project area.

Figure 3: The Composite Map of the Study Area.



Spatial Analysis

As observed by Burrough (1986) and Idowu (2012), the element which distinguishes GIS from other forms of spatial data handling activity, such as automated cartography and remote sensing is emphasis on spatial analyses. This explains spatial analyses performed under the following subheadings:

- Statistical Analysis
- Buffering Operation
- Network Operation
- Neighbourhood Operation

Statistical Analysis of GSM Base Station

Spatial distribution of all GSM base stations in Ilorin South Local Government Area.

This table below shows the breakdown of Telecommunication Service Providers and their mast number in Ilorin South Local Government Area

Source: Field Survey (Researcher) 2019.

TELECOMMUINCATION SERVICE PROVIDER AND THEIR MASTS		
S/NO	PROVIDERS	NUMBER OF MAST

1.	MTN	30
2.	GLO	25
3.	9MOBILE	9
4.	AIRTEL	7
5.	MULTILINKS	2
6.	GOTV	1
	TOTAL	74

Buffering Operation

Buffering operation is used mostly in vector-based GIS to determine the extent of influence of geographical occurrence from the target area. Features for buffering include points, lines and polygons. Buffering around points creates circular buffer zones, buffering around lines creates a series of elongated buffer zone while buffering around polygons creates buffer zones that extend outward from the polygon boundaries. Buffering analysis is a very important aspect of this project; this is because the effective service distribution is taken into account, the following buffers show an essential part of the whole analysis which will serve as a basis for the corrections and suggestions made in the following work.

This shows a buffer of 10 m, 15 m and 20m in order to depict their level of compliance since it was stated by the Nigeria Communication Commission (NCC) that a mast should be sited at a minimum of 10m gap away from buildings and Masts with a height more than 25 m are not allowed within a residential district, so a query is carried out to depict their level of compliance. Also, the average height of telecom mast in the study area is 45m; so, a buffer of 10m to 65m was carried out on each of the mast of telecommunication service providers considering the multiplier effect in case of a fall of telecom masts which can be more than 45m of the telecom mast height. The igure below shows buffering analysis involving all service provider base station in the study area.

Figure 4: 10m Buffer of Telecommunication Masts Base Station.

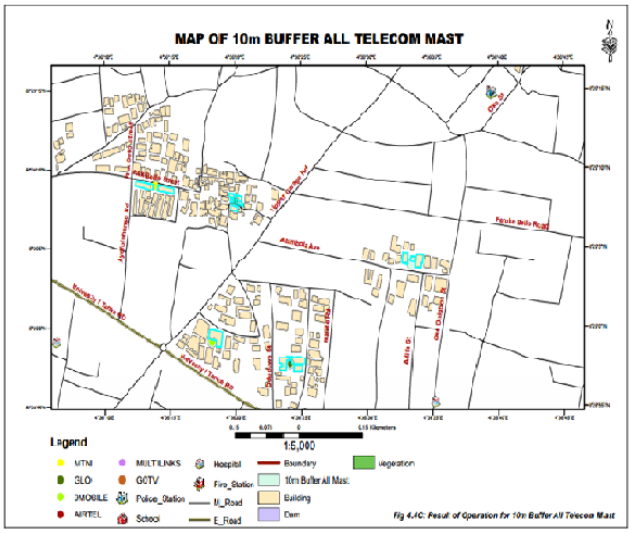
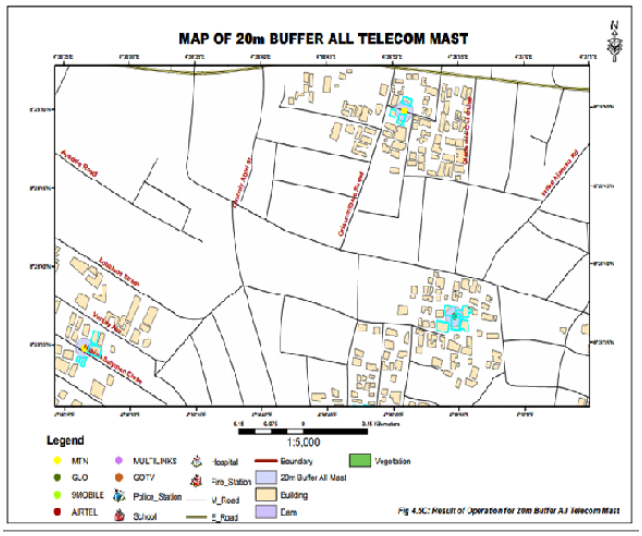


Figure 4 above shows operation of 10m buffer from all Telecom masts (base station). As shown , 82 buildings fall within the 10m radius and this implies that 47 Telecom masts violate the 10m distance gap regulation of NCC to buildings. These masts were constructed without taking cognizance of the setback of 10meter rules.

Figure 5: 20m Buffer of Telecommunication Masts Base Station.



The above figure shows a buffer of 20m of all the Telecom masts. The result of the 20m buffer shows that 172 buildings fall within the 20m radius, which involves all the Telecommunication service provider masts that violate 20m gap from building and public area. The map depict the level of compliance.

Figure 6: 65m Buffer of Telecommunication Masts Base Station.

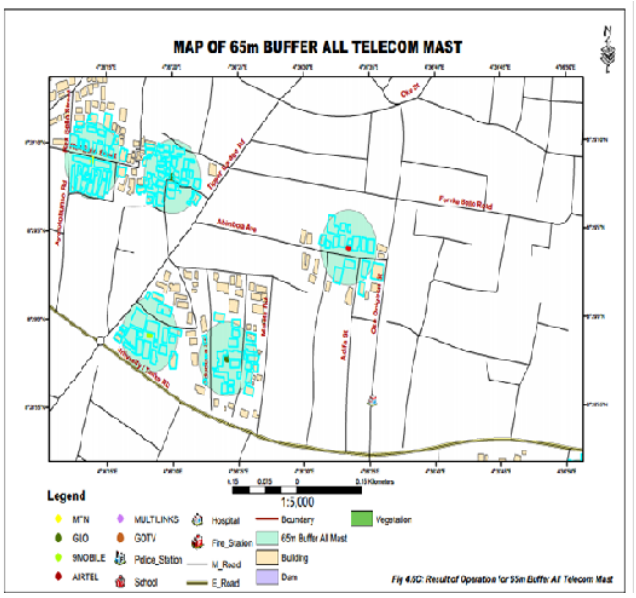


Figure 6 show a buffer of 65m of all Telecom masts. The result from the 65m buffer shows that 611 buildings fall within 65m radius. The implication is that any of the buildings within the radius of 65m are likely to feel more hazardous impact from mast with 65m height. This map of 65m buffer depict buildings that are affected within the radius.

Table 2: Summary of the Total Number of Building that are within 10m to 65m radius of All Telecom Masts.

Buffering value	MTN	GLO	9MOBILE	AIRTEL	MULTILINK	GOTV	TOTAL
10m	35	30	6	5	3	3	82
15m	44	41	11	9	5	4	144
20m	72	60	14	13	8	5	172
65m	275	215	51	47	17	6	611
Total	426	346	82	74	33	18	979

Source: Field Survey, 2019.

From table 2, the total number of buildings in the project area that falls within 10m to 65m radius of the service provider is 979 representing 49% of the total buildings in the project area.

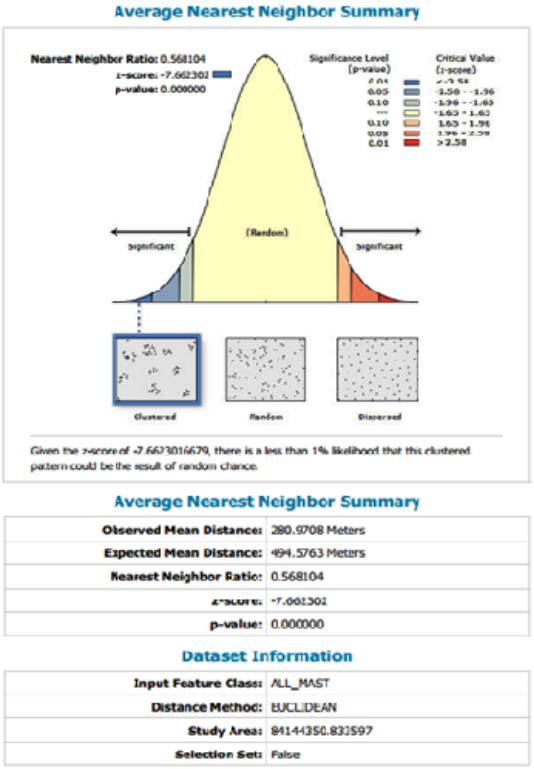
Neighbourhood Operation

A neighbourhood operation in GIS involves a focal cell and a set of its surrounding cells. It involves stating which locations are of interest to analyst and its spatial extent. These include defining how to determine the neighbourhood for each target and well-defined the characteristics that must be computed.

Spatial Pattern of the Location of Base Stations

To explain the degree of regularity, randomness or clustering, the nearest neighbor analysis was done and the result of the analysis is shown in fig 4.10. The Nearest neighbour ratio value calculated was 0.568104 and the negative z scores with the value of -7.662302 and the p-value is 0.000000 which shows that they are in clustered form. This implies that masts are sited in a cluster form when viewed against the background of the area perimeter, the implication of this can be much. Some buildings would fall within intersections of danger zones and may be prone to multiple effects that may accrue from mast. The window period may be hastened and the effects of the rays from the masts be felt sooner than expected especially on residents in the houses within intersection of danger zones.

Figure 7: Spatial Pattern of the Location of the Base Stations.



Source: Field Survey and Arc GIS 10.5

CONCLUSION AND FINDINGS

The use of Geographic Information System (GIS) is indeed a useful tool and decision support system in telecommunication industry. GIS is a useful tool prior, during and after the siting of telecom base station, the study has proving that indiscriminate siting of telecom masts and violation of law can be monitor with GIS based system to support environmental impact assessment in the industry. GIS has become panacea for solving urgent problem and ensuring compliance of standard by the GSM provider.

Based on NCC and NESREA distance of 10m gap of the telecom mast from buildings and public areas, a total number of 46 masts violate the 10m gap distance from built up area were MTN has 23 masts, GLO 19 masts, 9MOBILE 4 masts and AIRTEL with 4 masts. 82 buildings were affected under the 10m radius danger zone.

The distribution of Base station in Ilorin South LGA are in clustered form with Rn value 0.568104 and negative z-score -7.662302 shows that they are in clustered form. This implies that, masts are sited clustered close to each other when viewed against the background of the area perimeter.

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