100 YEARS OF URBANIZATION IN NIGERIA

Editors:
Y.A. Sanusi
A.M. Junaid
O.O. Morenikeji
S.N. Zubairu
R.A. Jimoh
O.F. Adedayo

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Telecommunication Infrastructures and Urban Developmental Trend in Nigeria: A Case Study of Minna Town.

Alenoghena Caroline O.[1,*] and Emagbetere Joy O[2,*]

[1]Dept. of Telecommunications Engineering, Federal University of Technology Minna

[2]Dept. of Electrical/Electronic Engineering University of Benin, Nigeria

Introduction

The past one hundred years in Nigeria has been one of massive urban migration and development characterized by emergence of new cities and expansion of existing ones beyond erstwhile boundaries. Growth of these urban centers has been labeled as poor in organization which include the placement of key infrastructures (Ayedum, 2011). Developmental efforts in urban environments are measured by the provision of infrastructures to the inhabitations, with the provision of communication service becoming an accepted means of urban classification. The provision of good communication system requires the deployment of modern infrastructures in a worrisome urban developmental trend. Report shows that 45.9% of the 120.9 million (2002 estimates) strong population of Nigeria resides in urban centers with a forecast for over 50 % by 2015 (United Nations, 2012). Urbanization characterized by the growth of cities in Nigeria has been found to be mostly uncontrolled leading to several problems in urban development. (Opoko and Oluwatayo, 2014), Issues of concern include soil degradation, rapid deforestation, urban air and water pollution, desertification, etc. Industrialization fuelled by urbanization can be fully profitable if it is well organized in a sustainable manner. (Babanyara et al, 2010). The birth of wireless communication has brought about an unprecedented increase in access to communication services, leading to the availability of communication means to regions hitherto deprived. Since the introduction of the Global System for Mobile telecommunications (GSM)

which is a wireless communication technology based on cellular technology, mobile phone users have grown steadily.

The deployment of GSM service to all parts of Nigeria necessitated the deployment of telecommunication infrastructures which involved erecting several base stations within the country. As the number of mobile subscribers increase, the need for more GSM base stations (BTS) to be able to meet the demand for services increases. The growth in the number of GSM subscribers has resulted in the multiplication of the number of base station in Nigeria. While there is a shortfall of BTS to meet the telecommunication need of Nigeria, we witness the shutting down of BTS sites based on their violation of environmental regulations. This occurrence leads to revenue loss for the provider and has its attendant impact on network quality of service. As more BTS's are needed, the issue of appropriate location for siting becomes paramount to the regulatory body to ensure environmental safety and efficient and effective coverage and better service delivery by the operator. In the remaining part of this paper we chronicle the growth of telecommunication in Nigeria and its influence on human and economic development. The state of telecommunication infrastructure deployment in our urban developmental efforts as a nation is analyzed using Minna town as a case study.

Telecommunication service delivery

The advent of telecommunications can be traced to the year 1838, when the first telex system was invented by Samuel Morse, and the subsequent invention of the first wireless communication device by Bell in 1880. The mobile telecommunication industry experienced a great leap with the release of the first handset in UK by Vodaphone in 1985. The concept of geographical clusters 'cells' was first proposed by Bell laboratories in 1947. This concept which is today referred to as cellular technology was done to improve communication capacity of a wireless system (Mischa, 2005). Since the introduction of GSM technology, mobile phone users have grown steadily and this can best be described as a revolution. The world mobile cellular subscribers have risen from less than 1 million in 1991 to over 6.8 billion subscribers in 2012 (ITU, 2013). Figure 1 shows the global mobile subscriber growth from 1994 to 2012.

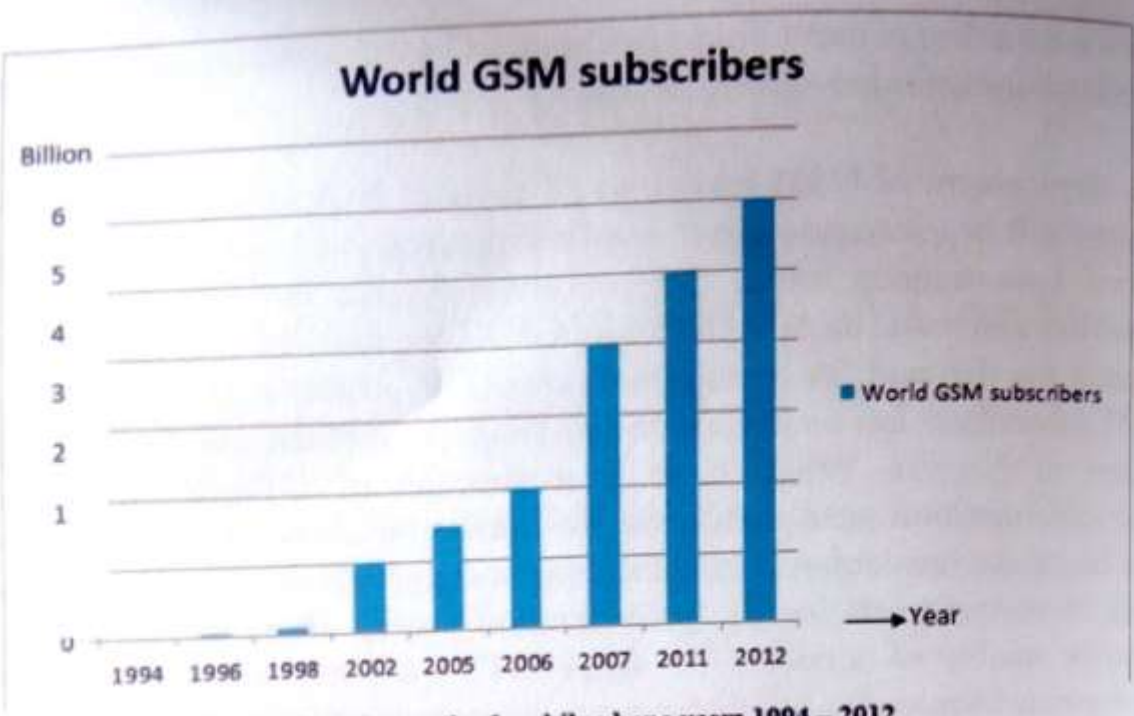

Fig. 1. Global growth of mobile phone users 1994 – 2012
source:[http://www.gsma.com]

Telecommunication Service delivery and Urbanization in Nigeria

Telecommunication service delivery in Nigeria has spanned well over a century. Like urbanization trends, what started with a cable network link between Lagos and London in 1886 during the colonial era, has grown to a vast network becoming more sophisticated by the day (Ajayi et al 1999). The organization and development of the telecommunication sector became focused after independence with the establishment of the Nigerian External Telecommunications (NET) Limited. The telecommunications arm of the Department of Posts and Telecommunications was merged with the Nigerian External Telecommunications (NET) to form Nigerian Telecommunications Ltd. (NITEL) in 1985. Over the years telecommunication service has evolved through the use of twisted paired cables in 1900, Nigerian Satellite Communications earth station at Lanlate in 1975, to mobile phones in year 2000. In the past century, telecommunication have concentrated in providing services in urban centers, specifically state capitals which is a major contributing factor for the huge rural - urban migration witnessed.

This huge urban population has greater demand on the provision of telecommunication services resulting in the concentration of infrastructures in urban cities. Prior to the introduction of GSM service, less than 500,000 persons had access o telecommmunication service, with one telephone to 1,000 persons. The introduction of GSM service led to an increase in the number of telecommunication users from about 500,000 in 2001 to over 120 million in 2013 with prospect for more market. As at March 2013, 97.36% of telecommunication users in Nigeria rely on the GSM platform (NCC, 2013). With the provision of other services other than voice, through the years, telecommunication has been evaluated to have had brought positive impact in the different sectors of the Nigeria people. Its impact is felt in the areas of education, health, transport, entertainment, agriculture, enterprises productivity (Pyramid, 2010). The contribution of telecommunication sector to the gross domestic product of Nigeria rose from 0.62% in 2001 to 8.53% in 2013 (NCC, 2013).

The operation of GSM services in Nigeria can be traced to 1985 when the government embarked on a deregulatory drive of the whole economy, including the telecommunications sector. This drive led to the establishment of the Nigerian Communications Commission (NCC) in 1992. The NCC was to supervise the activities of stakeholders and operators in the Nigerian telecommunication industry. This allowed the participation of private sector in the development of telecommmunication infrastructure. The full liberalization of the sector was witnessed in February 2001 by the award of digital mobile licensed in the GSM900 and GSM1800 band to four companies: MTN, Communications investment Limited (CIL), Econet Wireless (formally V-mobile, Celtel, Zain and now Airtel) and Mobile Telecommunications Limited (Mtel Ltd). The deployment of GSM networks across the 36 states and the federal capital territory (FCT) of Nigeria started with MTN and Zain in May and August 2001 respectively. Since then, other operators have entered the GSM market, Glo and Etisalat were issued digital mobile GSM licenses in September 2002 and October 2008 respectively (Pyramid, 2010). Fig 2 shows a graph depicting exponential growth trend in mobile subscriptions from 2001 to 2009.

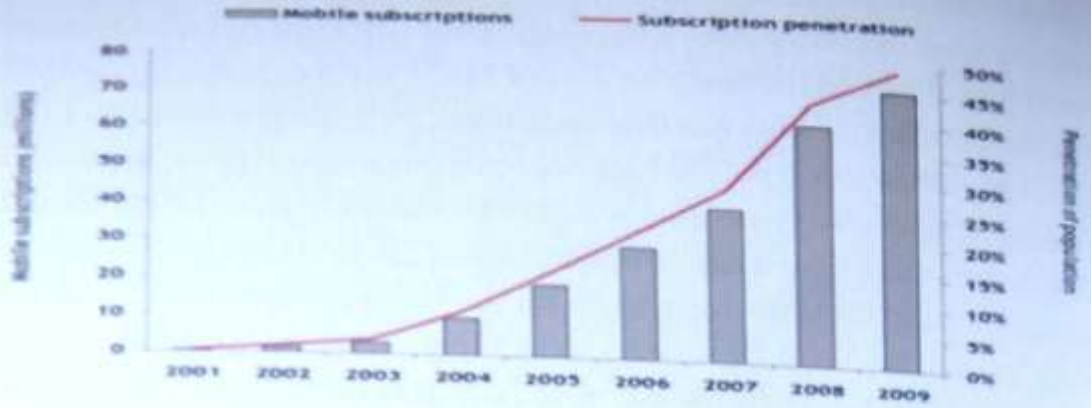

Figure 2.: Mobile subscriber growth in Nigeria form 2001 – 2009
Source: Pyramid Research

Telecommunication Infrastructure Deployment

Telecommunication service delivery requires the deployment of necessary infrastructures. The GSM network which is the major telecommunication technology in use in Nigeria is made up of separate subsystems. These are the Mobile Station (MS), the Network Switching System (NSS), the Network Management System (NMS) and the Base Station System (BSS).

The base station subsystem (BSS) is the unit responsible for managing the radio network. The BSS main function is to provide control and radio coverage functions for one or more sites and their associated mobile stations (MS). The base transceiver station (BTS) most times generally referred to as the base station is the major hardware components of a GSM network. The BTS is the equipment provided at a cell site by which means network coverage is provided over a given region. The BTS facilitates wireless communication between a mobile subscriber and the GSM network. Figure 3 shows the position of the BTS in the GSM Network.

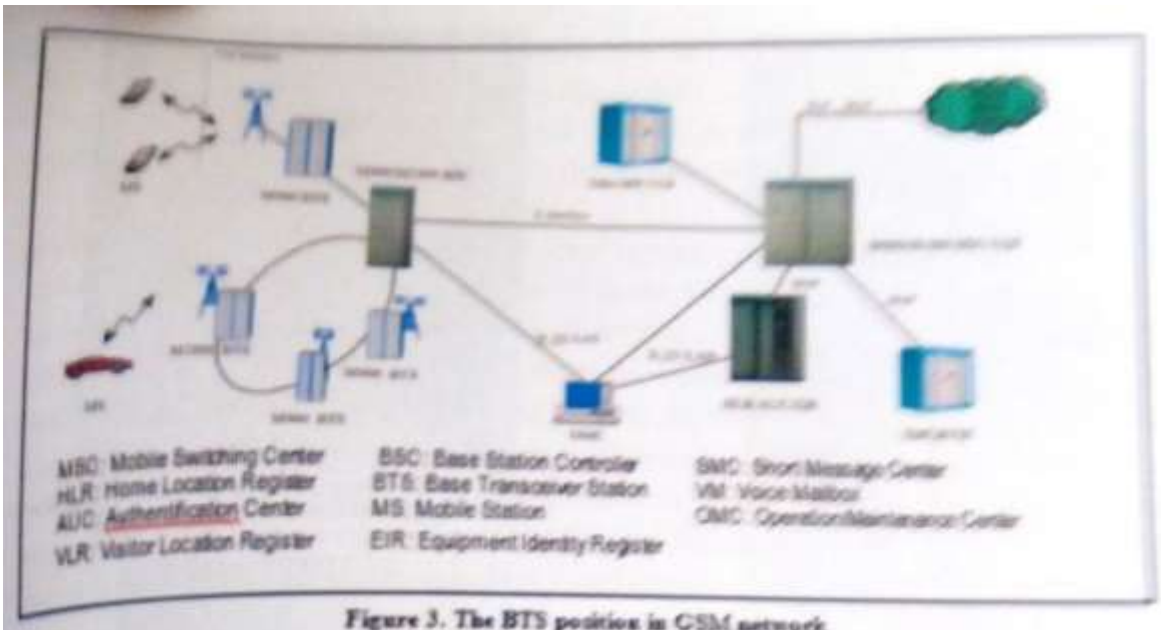

Figure 3. The BTS position in GSM network
Source: Huawei Technical manual

The hardware components of a typical BTS consists of the BTS interface equipment (BIE), Frame Processing Unit (FPU), Carrier unit, Antenna feeder system, the clock unit and operations/maintenance unit (OMU). The units are encased in a cabinet compartment.

An appropriate site is selected for the installation of the BTS which is usually at the center of the cell. The BTS equipment is usually housed in a shelter. This is to protect the telecommunications equipment from environmental factors such as dust, corrosion, rain etc, that may hinder proper operation. Air conditioners are also provided in the tropics for cooling the electronic equipment which generate a lot of heat during operation. Other facilities found in the base station include an integrated power unitconsisting of a site transformer for the public utility service, an automatic mains failure panel (AMF), a battery bank, generator unit with a 200 - 400 litre diesel holding tank and in a some cases green energy source like a solar panels and wind mills. Figures 4, 5 and 6 are pictorial views of typical BTS sites taken in Minna, Nigeria in September, 2013.

Fig 5: BTS site with mast view

Fig 4: BTS cabinet showing the digital equipment air conditioners and power unit.

Fig 6: GSM Mast with micro wave and sector antennas mounted typically found in a BSC/BTS site

Telecommunication Base Station Deployment in Urban Environment

In cellular telecommunication system, deciding where to place the base station is a very important issue during the process of cell planning (Ajay, 2004). The BTS for a given geographical area has to be well positioned for maximum coverage and minimal interference which are the indexes for measuring the quality of any mobile service (Kia et al, 1998). However, if coverage is the only issue of contention in cell planning then the BTS would have been placed anywhere. As at 2011 there were

17,000 base stations to over 80 million active mobile phone against 66,000 base station serving 62 million population of Britain (PanAfrica, 2011). Nigeria therefore requires over 60,000 base stations to be built to boast quality of service which is presently not at its best (Techloy, 2013).

Where these BTS are placed in our urban environment becomes a very critical issue. The scenario in the Nigeria mobile cellular communication industry is that 98% of (GSM) base stations (cell sites) are sited within 20 meters from residences, offices, schools, business buildings, petrol stations and public arenas (Okonoghene 2010). According to the environmental regulatory body [nesrea.org] this is a violation on environmental safety. The presence of a BTS is always felt by the surrounding structures, human and material, irrespective of the fact that the BTS may stand alone on a space with the minimum space as specified by regulations.

Challenges in Base Station Deployment

The BTS towers seem to have grown everywhere overnight. They are found in commercial centers, schools, along highways and majorly in our residential quarters. Some existing base stations especially in our urban centers are the source of agitation by residents, interest groups as well as regulatory bodies. Objections raised range from visual impacts, noise from generator sets, perceived health risk and violation of environmental safety standards.

In recent times, the National Environmental Standards and Regulations Enforcement Agency (NESREA) has had cause to shut down some base stations that pose threat to public safety (ngrguardiannews.com). This shut down is a consequent of complaints from neighbours of base stations in residential environments. The base stations concerned have the approval of the Nigerian Communication Commission (NCC) resulting in a conflict of interest between the two bodies. The conflicts between the NCC and the environmental body NESREA was born out of the attempt by the environmental body to implement its guidelines on environmental requirement for base station placement. The NESREA guideline was gazetted in 2011 and is about ten years after the massive deployment of most telecommunications infrastructure in Nigeria. This may be the reason for

the conflicts. The NCC which is the body in charge of telecommunication regulation in the country has categorically stated in its news letter of December 2011 that "no base, station no communication".

A survey on base station placement challenges carried out in major towns in Nigeria acknowledged space acquisition as a major hindrance to the optimal placement of base stations with the outdated and outmoded land use act used in the country seen as a contributing factor (Alenoghena, 2012). This challenge has adverse effect on the location of base stations as some prospective sites have been abandoned following issues of no clear certificates of ownership, family tussle and land disputes. The huge amount of money paid by telecommunications operator for land acquisitions makes most landlords susceptible. Safety requirements are flaunted with no consultation with prospective neighbours in the placement of base station in our environments.

Brief Description of the Measurement Environment, Minna

The measurement environment, Minna, located between latitude 09^0 25'N and 09^0 45'N; and longitude 06^0 15'E and 06^0 35' E is the capital city of Niger state, and it is about 150 km to the Federal Capital Territory (FCT) Abuja. This proximity has attracted more investment and people, making it an administrative centre of increasing importance. The town is widely dispersed along the main spin from Chanchaga in the south to Bosso in the north where one of the University campuses is located. The total population of Minna as at 2006 census was 350,287 (made up of Bosso, Minna and Chanchaga Local Government Areas) with an annual growth rate of 3%. . Minna like most urban towns in Nigeria, has two diverse types of settings; the planned urban settlement like GRA, Tunga and the unplanned settlements like Kpakungu, Sauka Kauta and Barikin Sale. Fig 7. shows a scanned copy of the topography of Minna and Fig 8 & 9 shows satellite imagery of some locations in Minna town.

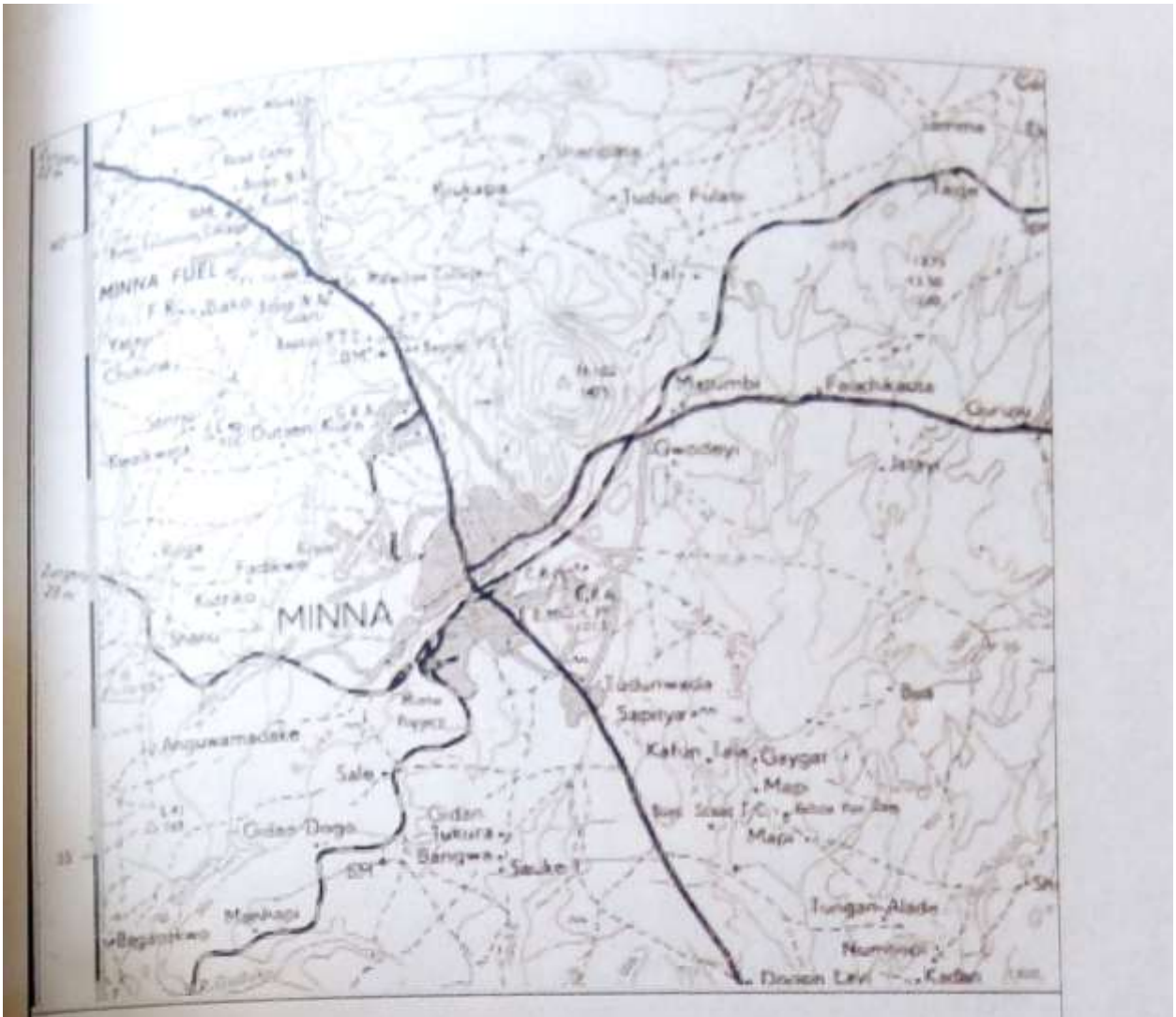

Fig 7: Minna Topographic map

[Source: Federal Surveys, Nigeria 1985 1000/478/10-85 MINNA SHEET 164]

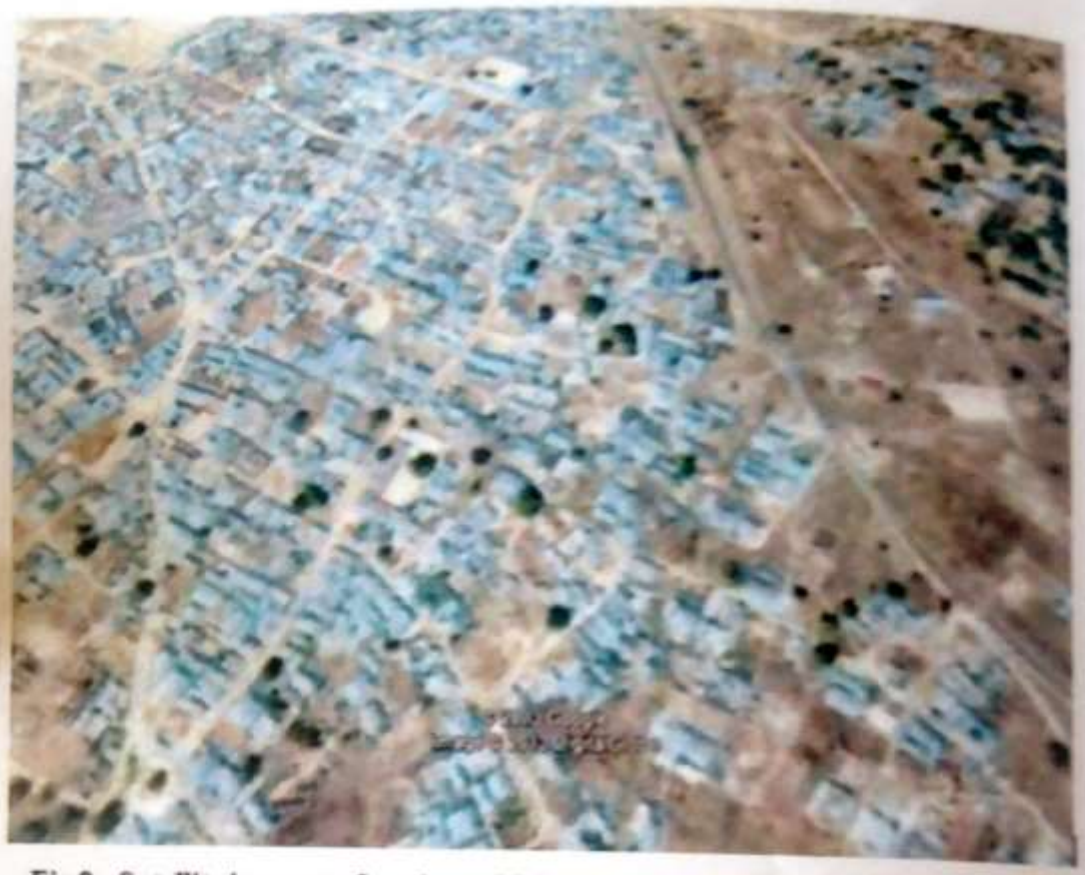

Fig 9: Satellite imagery of sections of Minna town (unplanned settlement)
[Source: Google earth 2013]

Minna like most developing countries have seen fast demographic growth in areas such as kpakugun, Barinkin Sale and Gbedenu lacking any appreciable trace of proper town planning efforts. The urban developmental efforts in Minna have been characterized by exponential increase in the number of base stations in the town. Information from the Niger State Urban development Board (NUDB) indicate that as at 2001 there was only one base station owned by the Nigeria telecommunication limited (NITEL) located in the hill top area of the state. This has since changed as at 2013 there were about sixty approved base stations in Minna town with several others in different stages of processing awaiting approval.

Base Station Distribution in Minna Town

There are five Telecommunications companies with four of the companies operating mobile telecommunication network fully in Minna. The

operational networks are MTN Nigeria Limited, Airtel Nigeria Limited, Globacom Limited, and Etisalat Nigerian Limited. These mobile network companies have telecommunication infrastructure, base transceiver stations which they use in providing services to the people of Minna. Survey report information point out that all the base station in the town have high rise steel structures (mast) with a height range of 30 – 45 meters. These BTS's have standby generators with fuel holding tanks. Table 1 shows the distribution of some base stations within Minna town and their class of location. The geo referenced map of Minna town is presented in Fig. 10 with an analysis of the distribution given in Fig 11.

Table 1: Base Station locations within Minna town

S/N	Location Address	Class	Network operator
1	Bosso Estate	Commercial	A
2	Sauka Kahuta	Residential	A
3	Angwan biri	Residential	A
4	Bosso	Educational	A
5	Dutsen Kura	Residential	A
6	Bosso	Residential	A
7	Tunga	Residential	A
8	GRA	Commercial	A
9	F-layout	Residential	A
10	Ladi kwali road,	Vegetation	A
11	Angwan roka	Commercial	A
12	Tunga lowcost	Residential	A
13	Bannkin Sale	Residential	A
14	Shango	Civic	A
15	Chanchaga	Educational	A
16	Hill top,	Residential	A
17	Matumbi	Commercial	A
18	Dutsen kura	Residential	B
19	Kpakungu	Residential	B
20	F-layout	Residential	B
21	Sabongari	Residential	B
22	Bosso Estate	Residential	B
23	Oshioye Estate	Civic	B

24	Tudun Fulani	Civic	C
25	F-layout	Residential	C
26	Tunga lowcost	Residential	C
27	Kpakungu	Commercial	C
28	Kongila	Residential	C
29	Maitumbi	Residential	C
30	Angwan roka	Residential	C
31	Dutsen kura	Residential	C
32	Zarumai road	Residential	C
33	Dutsen kura	Residential	C
34	Ladi kwali road,	Commercial	C
35	Angwan biri	Residential	C
36	Bosso	Residential	C
37	Tudun Fulani	Residential	D
38	Angwan biri	Residential	D
39	GRA	Educational	D
40	Maitumbi	Residential	D
41	Nigerian prisons	Civic	D
42	Dutsen kura	Residential	D
43	Kpakungu	Residential	D
44	Angwan roka	Residential	D
45	Bosso Estate	Residential	D
46	Kuta road	Residential	D
47	Stadium road	Residential	D
48	Ladi kwali road,	Residential	D
49	Total (Mobile)	Commercial	D
50	AP roundabout	Civic	D
51	Sabon gari	Residential	D
52	Zarumai road	Residential	D

(NOTE: A, B, C, D are the different network operator's owners of the base stations)

(Source: Niger State Urban Development Board (NUDB) and Survey report Alenoghena (2014))

Fig. 10: Geo-referenced Map of Minna
Source: Author

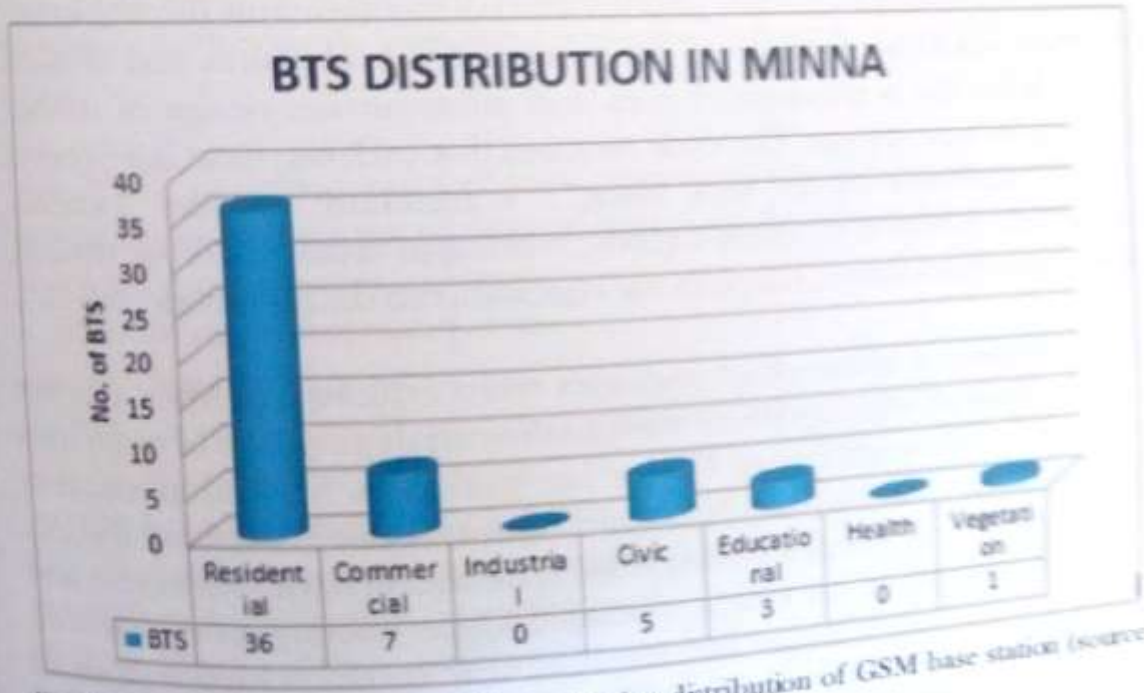

Fig 11: Geo referenced map of Minna showing distribution of GSM base station (source: Alenoghena 2014)

Figure 11 showed that 69.2% of BTS sited in Minna town are in residential areas. This collaborates the working of Okonighene, 2010 that 98% of BTS in Nigeria are sited within residential areas and his call for a review of these trend for health reasons. The need to strengthen institutional regulation for telecommunication infrastructure placement was stressed by Hart et al (2012) when they found the BT's in Port Harcourt city occupy 7.7 % of the total land mass causing such areas to be inhabitable.

Legal and Policy Framework Guiding Base Station Placement

The International Telecommunication Union (ITU) in collaboration with other relevant bodies like World Health Organization (WHO), International Commission on Non-Ionizing Radiation Protection (ICNIRP), have come up with radio regulations bordering on safety to guide the operation of telecommunication industry. Institutions in-charge of telecommunications regulations in various countries developed their legal and policy frameworks to guide the operation of telecommunication services.

The country of Australia for instance, has a comprehensive industry code for the deployment of mobile phone base station. The industry code is aimed at assisting local communities to use precautionary approach in planning, installing and operating mobile phone radio communications Infrastructure. The code amongst other things has a stipulated procedures and detailed approach for the acquisition of sites and infrastructure design of mobile phone radio base station. The code requires that each site must have regard for the likelihood of an area being a community sensitive location. Community sensitive locations include; residential areas, childcare centres, schools, aged care centres, hospitals and regional icons (Industry code, 2011).

The guidelines of some other countries were explored to have a better understanding of the policy frame work guiding the deployment of radio base stations. The Government of Ghana has guidelines for communication towers issued by the countries National Communication Authority (NCA). In its guidelines the maximum height for base station mast and towers and their minimum setback are clearly stipulated. Other country codes reviewed include that for Egypt, Kenya and Rwanda. One common emphasis in all these regulation is the need to take environmental safety in critical consideration in the placement of telecommunication infrastructures.

The placement of base stations has witnessed tremendous debate on issues in safety and health implications. A study of base station regulatory frame work in five European countries (France, UK, Switzerland, Belgium and Spain) revealed the presence of agitation and public concerns for the installation of base stations in residential areas (Oliver and Danielle, 2005). In these countries however there is cooperation between the ministries of environment or health and the ministry involve with telecommunications regulation in putting in place an acceptable legal and regulatory frame work.

Urban developmental trend and Telecommunication regulation in Nigeria

The Nigerian Communication Commission (NCC) is the body with the responsibility of regulating and monitoring of telecommunication operation in Nigeria. Established in 1992, NCC was charged with the responsibility of regulating the supply of telecommunication services and facilities, promoting competition, and setting performance standards for telephone services in Nigeria [ncc.org, 2013]. The telecommunication service operators also have to comply with environmental standards stipulated by the Nigerian Environmental Standards and Regulation Enforcement Agency (NESREA) of the Ministry of Environment, a body set up to enforce compliance with laws, guidelines, policies and standards on environmental matters. Both regulatory bodies work to making telecommunication service available and safe.

The NCC guideline on technical specifications for the installation of telecommunications mast and towers covers areas such as; [www.ncc.org]

1) Types of towers and mast,
2) Sitting of towers and mast,
3) Design and construction,
4) Specifications of structures, earthling and lighting protection,
5) Maintenance and testing,
6) Environmental requirements,
7) Application to the commission for permits.

In addition, specifications are given on the requirement in terms of minimum distance from a BTS to existing structures [NCC guidelines]. Table 2 is an extract from the Guidelines on Technical Specifications for the Installation ofTelecommunication Mast and Towers Issued on 9th April 2009 by NCC.

The regulation specifies a distance of 5 meters from any demised property excluding the fence. The distance specified as a potential hazard area by the designer of the structure should be adhered to. The guideline specifies that guy wire anchors and accessory structures shall not encroach into the mandatory setbacks, and should be located within the build-able area of the property and not within the front, rear, or side building setbacks. The guidelines requires that all towers in excess of 150 metres in height shall be set back by a minimum of 50 metres from the right-of-way of all controlled access, Federal and State Roadways designated as freeways, in order to provide unobstructed flight paths for helicopters.

Under the guideline, the maximum height for a telecommunication tower shall not exceed 150 meters. The open space available at the site of a proposed mast or tower installation, shall be, at least three times the space required by the base of the structure. However, telecommunications towers above 25 meters in height would not be permitted within districts delineated as residential. The minimum spacing between two or more towers in excess of 55 meters in height shall be 1 (one) kilometer. No tower or mast shall be installed in close proximity to High Voltage electrical power transmission lines. The nearest distance of a tower to a high voltage electrical power transmission line shall be the equivalent of 120% of the height of the mast.

Table 2: Guidelines on Technical Specifications for the Installation of Telecommunication Mast and Towers Issued on 9th April 2009 (Extract)

S/N	ITEM	REQUIREMENT/SPECIFICATION
1	Maximum height of towers	Not exceed 150 meters
2	spacing between two or more towers	One kilometer
3	space available at the site of a proposed mast or tower installation	Three times the space required by the base of the structure
4	Towers above 25 meters in height	Not permitted in residential districts
5	Towers over 150 meters	set back by a minimum of 50 meters from the right-of-way of all controlled access, Federal and State Roadways designated as freeways.
6	The nearest distance of a tower to a high voltage electrical power transmission line	120% of the height of the mast.

Environmental Regulation for Telecommunication Operation in Nigeria:

The Nigerian Environmental Standards and Regulation Enforcement Agency (NESREA) of the Ministry of Environment, is the body set up to enforce compliance with laws, guidelines, policies and standards on environmental matters in Nigeria. They issued a gazette on national environmental standards for telecommunication and broadcast facilities regulation in 2011. This was necessitated by the increasing numbers of BTS in the environment and growing concern for public safety. The gazette has the following objectives and specifications;

a) Ensure that the installation and operation of telecommunication and broadcast base stations and mast do not constitute public nuisance and/or have negative impacts on public health and safety.

b) Restrict and prohibit environment impacting activities which are dangerous to health, safety, life and property due to activities of the telecommunication and broadcast industry operators.

c) Address concerns about public safety, safety of personnel and equipment in the sectoral operations and set out the corporate and individual responsibilities of owners, operators, designers and fabricators of telecommunications and broadcast mast, towers and auxiliary facilities.

d) Ensure conformity with applicable international codes and environmental best practices in telecommunication and broadcast industry facilities and operations.

e) Stipulate appropriate sanctions for offences on non-compliance with the mandatory provision of these regulations.

f) Encourage the sharing or co-location of telecommunication/broadcasting mast and

g) Achieve any other purpose deemed necessary or appropriate to effectuate the objectives of these regulation.

The regulation covers issues on:

a) Environmental requirements for siting and installation.

b) Environmental impact assessment requirement.

c) Environmental audit.

d) Additional requirements for new facilities.

e) Abandoned telecommunication/broadcasting base stations, mast and towers.

f) Environmental monitoring and inspection.
g) Permissible radiation level.
h) Guidelines and standard for the use of power generators.
i) Enforcement and sanctions.

The requirement for new telecommunication facilities taking effect from 2011, issued by the body is presented in Table 3.

Table 3: NESREA Environmental Requirement Foe Siting Telecommunication Mast and Towers (Extract)

S/N	ITEM	REQUIREMENT/SPECIFICATION
1	Primarily choice of sites	Industrial, commercial and business areas,
2	Minimum setback to fence of residential/ business premises. Schools, and hospitals	Ten meters
3	Minimum setback for residential/ business premises. Schools, and hospitals without fences	Twelve meters

Conclusion

The introduction of GSM services to Nigeria has impacted positive in the urban development of the nation; with the deployment of its infrastructures compromising our environmental safety and comfort. After a hundred years of urban development, Nigeria should take its rightful place in the committee of nations to do what is right. This modest suggestion is therefore directed particularly to the Ministries of Communications, Environments and the National Communication Commission (NCC).

- Appropriate GSM cell planning mostly in our urban environment must be given utmost priority with strict adherence to regulatory guidelines.
- The implementations of the right-of-way for communication facilities. Town planning to include allowance for communications facilities
- Develop digital spatial data-base for our cities in line with the smart cities concepts. The provision of digital database of a city will enable intelligent choice of optimal locations of facilities which include the BTS.

- Engage research institutions by way of funding and participating in research presentation of doctoral students so that together we can work out solutions for optimal facility locations that will be beneficial to all.

The collaboration of the different units concerned with the provision of infrastructure in our country is necessary for sustainable development.

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