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# Telecommunication Masts/Base Transceiver Stations and Regulatory Standards in Abia State, Nigeria

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**Abstract**

Global System for Mobile Communications (GSM) was introduced in Nigeria in May, 2001. Since then, GSM subscriber base has grown astronomically leading to the indiscriminate installation of Masts and Base Transceiver Stations across the country. The Nigerian communications commission (NCC) and the National Environmental Standards and Regulations Enforcement Agency (NESREA) established environmental standards in 2009 and 2011 respectively to regulate the installation of BTSs and Masts. This study examined the compliance of GSM service providers with the established guidelines for the mounting of BTSs and Masts in Abia State, Nigeria. The study adopted geometric survey technique, and relied mainly on primary data which were collected through direct observation and measurements. Cluster and simple random sampling techniques were used to proportionately select BTSs/Masts that were surveyed. Data collected were analyzed with appropriate parametric tests using SPSS for Windows, Version 17. Specifically, the *t* test for paired samples, and Analysis of Variance (ANOVA) were used to test the hypotheses of the study. The results show that there is significant difference between the mean value of the number of BTSs/Masts surveyed and the mean value of the number that complied with regulatory standards. The study further revealed that there were no significant differences between the telecommunication networks in their application of the environmental standards. The researchers therefore recommend that both NCC and NESREA be made to devolve their supervisory and monitory responsibilities to Town Planning Authorities at the local government level to ensure effective enforcement of the regulatory standards.

**Keywords:** base transceiver stations, regulatory standards, telecommunication masts

## 1. Introduction

Global System for Mobile Communications (GSM) phones are sophisticated two-way radios that use ultra high frequency (UHF) radio waves to communicate information. The introduction of GSM phones and the subsequent rapid increase in the number of users of cellular phones, laptop computers, and tablets in the last decade has increased the need for greater telecommunications coverage across Nigeria and beyond. This demand has in turn led to the indiscriminate erection of telecommunication masts and Base Transceiver Stations across the country (Nigeria communication commission [NCC], 2014). Base Transceiver Stations (BTSs) and Masts form part of the infrastructure required for an effective telecommunication system. In order to have optimal network coverage, BTSs are often located in close proximity to the target users; the reason telecom operators also site their masts in residential neighbourhoods (Michael, Nnaemeka, & Matthew, 2013).

A mast is a freestanding structure which supports antennas at a height where they can transmit and receive radio waves (Bello, 2010). Telecommunication masts may be of several types, and range in height from 30 to 300 meters or more. When a call is made, the GSM phone transmits signal to the nearest base station. The signals are received by the antenna of a base station and passed from one cell to another through an underground fibre optic cable or via a “point- to –point” fixed microwave beam, which require a direct line of sight (Residents’ and Environmental Services Policy Overview Committee [RESPOC], 2013). A base station is a wireless telephone exchange, designed to provide local connections with wider links to other national and international networks. Each base station provides coverage over a limited area, or cell, around its location. The cell covered by a base station depends on the call usage and the physical terrain of the area (Bello, 2010). To offer comprehensive network coverage, the cells must overlap each other like a patchwork quilt, so that users can move from one cell to another without breaking connection. As each cell can only handle a limited number of calls, the density of base stations has to be high in areas of heavy use (RESPOC, 2013).

Global System for Mobile Communications (GSM) was introduced in Nigeria on May, 2001 following the liberalization of the telecommunication sector of the economy. Since then, GSM has dominated the Nigerian telecom industry, accounting for about 98% share of the market (Nigerian National Communications Commission [NCC], 2014). Four GSM operators: MTN, AIRTEL, ETISALAT, and GLOBACOM control the industry in Nigeria (Aderoju *et. al.,* 2014). As at May 2014, the four major GSM operators had collectively grown the telecom subscriber base from 260,416 in 2001, to over 131 million active lines. Following this rapid growth in subscriber base, the number of deployed transceiver stations (BTSs) grew from less than 80 in 2001 to about 44,000 in May 2014 (NCC, 2014). For GSM service providers, the primary consideration when locating BTS sites is finding sites that provide the best possible coverage in the area without causing interference with other “cells” and one that causes the least amount of environmental impact on the surrounding area (Sandy, Si-Yeoul, Pornsiri, & Nick, 2003).

There have been growing concerns over the proliferation of telecom BTSs and masts, due to the perceived harmful effects of radio frequency radiation produced by these devices on human health (Kwan-Hoong, 2003), and danger associated with the fall zone of the masts (Bello, 2010). There is obviously conflicting information from the various scientific sources and environmental groups with respect to health hazards associated with GSM telephony (Michael, Nnaemeka, & Matthew, 2013). According to Cherry (2000), cell sites are risk factors for cancer, specifically brain tumours and leukaemia; heart attack and heart disease, particularly arrhythmia; neurological effects including sleep disturbance, learning difficulties, depression and suicide; reproductive effects, especially miscarriage and congenital malformation; viral and infectious diseases because of reduced immune system competency associated with reduced melatonin and altered calcium ion homeostasis. Lai (2004) in considering the health effect of radiation from BTSs, stated that people who live, attend school, or work close to BTSs are constantly being exposed to the radiation for months or years. He was of the opinion that, though the level may be low, it would matter if the effects of radiofrequency radiation turn out to be cumulative. Small doses cumulated over a long period of time will eventually lead to harmful effects. Bello (2010) examined the variation in the satisfaction of people living around GSM base stations with samples drawn from Akure, Nigeria, and found that residents’ satisfaction increases with distance away from the base station. This was because of the reported incidences of collapse of some masts in different towns in Nigeria, most of them with catastrophic consequences.

The concern for the fall zone has made most cities and municipalities to insist on a sufficient set back between a tower and the nearest property line (Bello, 2010; Akindele & Adeniji, 2014). Given the potential environmental risks and health impacts of BTSs and Masts, the National Communications Commission (NCC) and the National Environmental Standards and Regulations Enforcement Agency (NESREA) established both technical specifications and environmental guidelines for telecommunications and broadcasting facilities in Nigeria in 2009 and 2011 respectively. The environmental guidelines provided for: the Space requirements, height, set-back, residential areas, screening, tower to tower spacing, nearness to power lines, and co-location requirements. There have been growing concerns that the GSM operators do not comply with these guidelines in the construction of BTSs and masts after they have duly secured approvals from the relevant authorities (Akindele & Adeniji, 2014). These scholars discovered that masts are often installed closer to homes, signifying non-adherence to the minimum setback standard which is 10m as required by NESREA regulations. In recent years both the NCC and NESREA have taken court actions against some GSM operators, as well as threatened to shutdown some BTSs. Unfortunately the level of compliance of telecommunication masts and base stations to regulatory standards in Nigeria has not been empirically determined. Using Geometric Survey Techniques and samples drawn from the seventeen local government areas of Abia State, this study therefore examined compliance of GSM service providers with the established guidelines for the mounting of BTS and Masts in Abia State, Nigeria. The specific objectives were to: examine the location and spatial distribution of BTSs and masts in Abia State; ascertain the environmental standards for the regulation of BTSs and masts; and determine the level of compliance of the BTSs and masts to environmental standards.

## 2. The Study Area, Abia State

Abia State is situated between latitudes 04°45' and 06° 07' north, and longitudes 07° 00' and 08° 10' east. Abia State is located in the south-eastern geo-political region of Nigeria, and is bounded at the west by Imo State, at the south by Rivers State, at the north by Anambara State and Ebonyi State, and at the east by Cross-River State and Akwa-Ibom State. Abia State is composed of seventeen local government areas while the State capital is Umuahia. The State has two major cities: Aba and Umuahia, though there are about twelve other towns. Aba is a very influential city in Nigeria as it is a major economic hub for not only Nigeria but the entire West African sub-region. Abia State is the pivot of communication in south-eastern Nigeria, and very strategic for the operations of all telecommunications industries in Nigeria. This informed our choice of the State for this enquiry. The four major GSM operators: MTN, AIRTEL, ETISALAT, and GLOBACOM have their offices and facilities in all the cities and towns, and in all the seventeen local government areas of the state. Figure1 is the political map of Nigeria showing the thirty-six states and federal capital territory Abuja; and Abia State showing the seventeen local government areas.

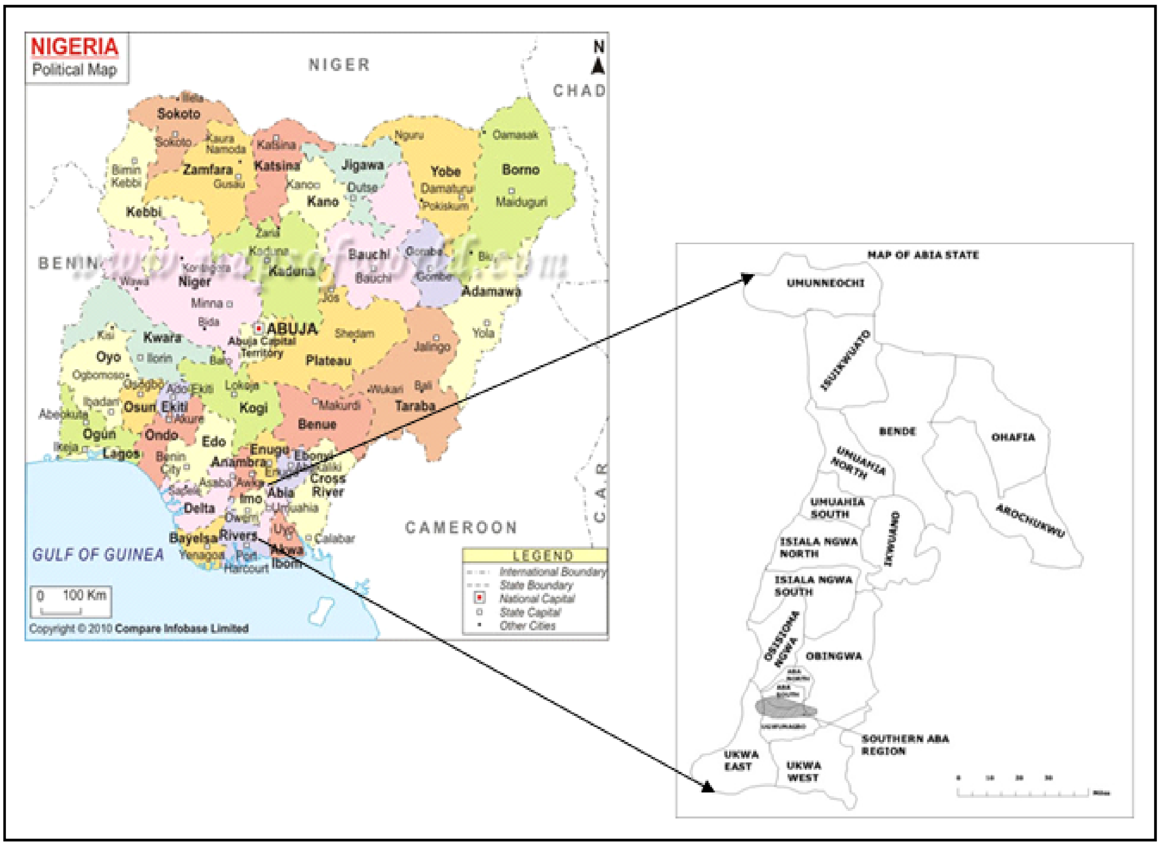


Figure1. Map of Nigeria showing the 36 States and FCT Abuja, and map of Abia state showing the 17 local government areas

Source: Ministry of Lands and Urban Planning Abia State, Nigeria

## 3. Materials and Methods

The researchers adopted the geometric survey design. This approach utilized direct measurement of geometric variables of the BTSs and Masts using a Handheld Distance Laser (SPECTRA QM55), Handheld GPS, and Measuring Wheels. The population of study comprises of all the BTSs and Masts installed in Abia State which amounts to 625. This figure represents the sum of the already commissioned BTSs and Masts in the seventeen local government areas of Abia State as provided by the Town Planning Authorities in those Local Governments. The Town Planning Authorities maintain database of all BTSs and Masts which have been issued with development approval in their domain. The sample size of approximately 125 was estimated from the population using the following model derived by Miller and Brewer (2003).

$$n = \frac{N}{1+N(\propto)^2} \quad (1)$$

Where: N= study population; n = required sample size; and α = margin of error (0.08).

Cluster sampling technique was used to divide the study area into seventeen regions following the local government territorial structure, and a given number of BTSs and Masts were selected from each region proportionately, with regard to their respective populations. Simple random sampling method was then used to select the BTSs and Masts where measurements were carried out. The study was based on both primary and secondary data. The primary data were collected through direct observation, and through direct measurement of geometric variables of the BTSs and Masts. The secondary sources of data include government publications from NCC and NESREA, and official documents from the Town Planning Authorities in Abia State, Nigeria. Data collected were analyzed with appropriate parametric tests using SPSS for Windows, Version 17. Specifically, the *t* test for paired samples, and Analysis of Variance (ANOVA) were used to test the hypotheses of this study. *P* value of $\leq 0.05$ was considered statistically significant.

## 4. Results and Discussion

### *4.1 The Location and Spatial Distribution of BTSs and Masts in Abia State*

The survey revealed that there are 625 Base Stations and Masts in Abia State, spread across the seventeen local governments. Table 1 shows that the BSTs/Masts are more concentrated in the urban areas of Aba-North, Aba-South, Osisioma, Umuahia-North, Umuahia-South, and Ikwuano. The local government areas that are mainly rural have less number of BTSs/Masts, with the least being Umunneochi, Isuikwuato, and Ukwa-west.

Table 1. Distribution of BTS/Masts by local governments in Abia State

| S/N | Local Government | Number of Base Stations/Masts | Percentage |
|---|---|---|---|
| 1 | Aba North | 54 | 8.64 |
| 2 | Aba South | 61 | 9.76 |
| 3 | Arochukwu | 29 | 4.64 |
| 4 | Bende | 36 | 5.76 |
| 5 | Ikwuano | 48 | 7.68 |
| 6 | Isiala –Ngwa North | 33 | 5.28 |
| 7 | Isiala –Ngwa South | 39 | 6.24 |
| 8 | Isuikwuato | 21 | 3.36 |
| 9 | Obingwa | 36 | 5.76 |
| 10 | Ohafia | 27 | 4.32 |
| 11 | Osisioma | 41 | 6.56 |
| 12 | Ugwunagbo | 28 | 4.48 |
| 13 | Ukwa –East | 27 | 4.32 |
| 14 | Ukwa –West | 25 | 4.0 |
| 15 | Umuahia –North | 53 | 8.48 |
| 16 | Umuhia –South | 49 | 7.84 |
| 17 | Umunneochi | 18 | 2.88 |
| | TOTAL | 625 | 100 |

Source: Authors' Field Survey, 2016

Table 2 shows the distribution of the BSTs/Masts in Abia State by network provider. There are four major GSM network providers in Abia State: AITEL, ETISALAT, GLOBACOM and MTN. Other Masts are owned by STARCOM, Banks, TV stations, and Radio Stations. Figure 2 illustrates that MTN has about 34% of the base stations, while the other networks have as follows: ETISALAT (25.92%), GLOBACOM (19.84%), AITEL (18.4%), and other (1.76%).

Table 2. Distributions of BTSs/Masts by Network Provider

| S/N | Network Provider | Number of Base Stations/Masts | % |
|---|---|---|---|
| 1 | AITEL | 115 | 18.4 |
| 2 | ETISALAT | 162 | 25.92 |
| 3 | GLOBACOM | 124 | 19.84 |
| 4 | MTN | 213 | 34.08 |
| 5 | OTHERS | 11 | 1.76 |
| | Total | 625 | 100 |

Source: Authors' Field Survey, 2016

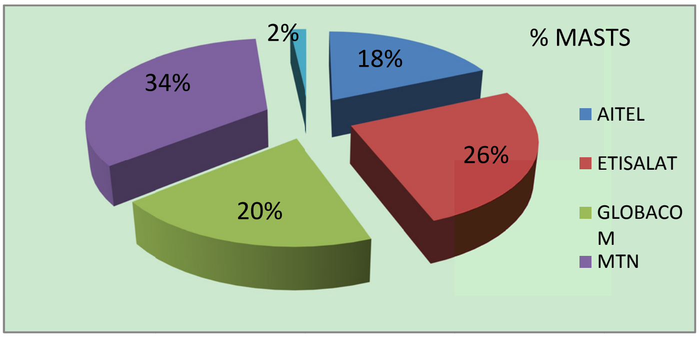


Figure 2. Percentage Distributions of BTSs/Masts by Network Provider

*4.2 The Environmental Standards for the Regulation of BTSs and Masts in Nigeria*

The environmental standards for the regulation of BTSs and Masts in Nigeria are part of the general regulatory framework for the telecom sector enacted by the national assembly for the Nigerian Communication Commission (NCC regulations 2009), as well as the National Environmental Standards and Regulations Enforcement Agency (NESREA regulations 2011). Some of the standards are as stated below.

1) Setbacks**:** All telecommunication towers as well as guys and guy anchors shall be located within the buildable area of the property and not within the front, rear, or side building setbacks. Telecommunication towers in excess of 150 meters in height shall be set back a minimum of 50 meters from the right- of-way of all controlled access, federal and state roadways designated as freeways, to provide unobstructed flight paths for helicopters. Towers shall be set back the greater distance of: 10 meters from any residential or used property; 25 percent of the height of the tower; the distance specified as a potential hazard area by the designer of the structure. Guy wire anchors and accessory structures shall not encroach into the mandatory setbacks listed above.

2) Space requirements: One parking/loading space shall be required to serve a telecommunication tower site. Any tower site lying 50 meters or less from a paved road shall be paved. If the site is more than 50 meters from a paved road, hard-surfacing of parking/loading spaces and driveways shall not be required for those portions of the site lying more than 50 meters from any paved road. Stealth and/or camouflage design of towers and antennas are encouraged to reduce the visual impact of the structure.

3) Residential Areas: Telecommunications towers above 25meters in height are, as a general rule, not permitted within districts delineated as residential. Where they are by exception allowed, they must be placed a minimum ratio of 3 to 1 distance to height, to the nearest residential property.

4) Height of Structure: Free standing masts should not exceed 150meters in height. Structures above 30 meters in height may only be installed with a clearance certificate issued by the Nigeria Airspace Management Authority (NAMA). Towers and masts shall be designed and located such that should any structure fall, it will avoid habitable structures and public streets. This shall be the major determinant factor in the issue of setbacks from adjacent existing structures.

5) Tower to Tower Spacing: Any new telecommunications tower in excess of 55 meters in height must be located a minimum of one kilometre from any other existing tower in excess of 55 meters in height.

6) Screening: An opaque screen at least 2.5meters in height must surround the base of a telecommunication tower. The screening shall also include landscaping provisions for any portions of the development visible from adjacent residential or used property or right-of-way.

7) Co-location: Towers shall be designed and built to accommodate a minimum of three service providers on the same structure, if over 25meters in height.

8) Proximity to Power Transmission line: No tower shall be installed in close proximity to high voltage electrical power transmission lines. The closest distance shall be 120% of the height of the mast.

*4.3 The Level of Compliance of the BTSs and Masts to Environmental Standards*

125 BTSs and Masts were selected randomly from the seventeen local government areas in Abia State, and were surveyed to generate data on the following six variables: Set-back from road, Set-back from residential properties, Height of Mast in residential Districts, Tower to tower Spacing, Nearness to power line and infrastructure, and Screening wall. Table 7 (see Appendix A) shows the result of the survey. The BTSs and Masts were given code names, example A01, where: A stands for the network provider that owns the BTS (A = AIRTEL, E = ETISALAT, G = GLOBACOM, and M = MTN), and 01 identification number. Dummy variables were used to represent Height of Mast in residential districts, whereby: 0 represents masts that are less than 25meters or built in non-residential districts, and 1 represents Masts that are more than 25meters. Also dummy variables were used to represent tower to tower spacing whereby: 0 represents masts that are located greater than 1km from the nearest mast (adequate spacing), and 1 represents masts located less than 1km apart (inadequate spacing). Likewise dummy variables were used to represent Nearness to Power line (where NO represents masts that are not near to any power line, and YES represents masts that are near to power line); and Screening wall (where BAD represents BTSs that either do not have screening walls [where the walls fall short of specifications] or lack landscaping, and OK represent BTSs that their screening walls comply with specification, and have proper landscaping).

The survey further revealed that the BTSs and Masts failed compliance on four criteria: Set-back from road, Set-back from residential properties, Maximum height in residential districts, and screening wall, whereas they complied with standards on two criteria: Tower to tower spacing, and Nearness to power lines. Table 3 shows that only 21.6% of the BTSs complied with set-back standards from major roads,43.2% complied with set-back standards from residential properties, 32.8% complied with maximum height of masts in residential districts, and only 10.4% complied with screening wall standards. However, 96% and 88% of the masts complied with tower to tower spacing and nearness to power line standards respectively.

Table 3. Level of compliance of BTSs and masts to standards

| S/N | Variable | Standard | No. That met standard | No. That failed standard | Total no. Sampled | % compliance |
|---|---|---|---|---|---|---|
| 1 | Set-Back from major Road | Minimum of 50meters | 27 | 98 | 125 | 21.6 |
| 2 | Set-Back Residential Property | Minimum of 10meters | 54 | 69 | 123 | 43.2 |
| 3 | Height in Residential Dist. | Maximum of 25meters | 41* | 83 | 124 | 32.8 |
| 4 | Tower to Tower Spacing | Towers greater than 55m must be of 1km apart | 120 | 5 | 125 | 96.0 |
| 5 | Nearness to Power Line | Minimum of 120% of Height of mast | 110 | 15 | 125 | 88.0 |
| 6 | Screening Wall | Opaque screen 2.5meters in height , with landscaping | 13 | 110 | 123 | 10.4 |
| | | TOTAL | 365 | 385 | 750 | 48.7 |

*Figure constitute mainly masts located in non residential districts

Source: Authors' Field Survey, 2016

The *t* test for paired samples was performed to prove the hypothesis (Ho): there is no significant difference between the mean value of total number of BTSs/Masts surveyed and the mean value of the number that complied with regulatory standards. The result is displayed on table 4, and it showed $t$ = 3.53, and $P$ value = 0.017 which is statistically significant under 0.05 significant level. Hence we reject Ho, which implies that a significant number of the BTSs/Masts did not comply with environmental standards in Abia State.

Table 4. Paired sample *t* test

| | | Paired Differences | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Base Stations Surveyed / Number that met standard | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | t | df | Sig. (2-tailed) |
| | | | | | Lower | Upper | | | |
| Pair1 | | 63.167 | 43.897 | 17.921 | 17.099 | 109.234 | 3.525 | 5 | .017 |

Source: Computer SPSS Data Analysis by Authors

The study also examined the rate of compliance of the individual mobile telecommunication networks to the environmental regulatory standards, and the result is displayed on table 5. Based on the data, a second hypothesis (Ho); there is no significant difference between the telecommunication networks in their application of the environmental standards was tested using Analysis of Variance (ANOVA).

Table 5. Rate of compliance of mobile networks to standards in different L.G.As

| S/N | Local govt. Area | Number Sampled/L.G.A | No. That Complied With Standard | | | |
|---|---|---|---|---|---|---|
| | | | AITEL | ETISA | GLO | MTN |
| 1 | Aba North | 9 | 1 | 2 | 0 | 2 |
| 2 | Aba South | 9 | 2 | 1 | 1 | 2 |
| 3 | Arochukwu | 6 | 0 | 1 | 2 | 1 |
| 4 | Bende | 7 | 1 | 1 | 1 | 2 |
| 5 | Ikwuano | 8 | 0 | 2 | 1 | 2 |
| 6 | Isiala-Ngwa North | 7 | 1 | 1 | 0 | 2 |
| 7 | Isiala-Ngwa South | 7 | 1 | 1 | 1 | 2 |
| 8 | Isuikwu-ato | 6 | 2 | 0 | 1 | 0 |
| 9 | Obingwa | 8 | 1 | 1 | 1 | 2 |
| 10 | Ohafia | 6 | 1 | 1 | 1 | 1 |
| 11 | Osisioma | 9 | 1 | 2 | 1 | 3 |
| 12 | Ugwunagbo | 6 | 0 | 1 | 0 | 1 |
| 13 | Ukwa East | 6 | 1 | 1 | 1 | 0 |
| 14 | Ukwa West | 7 | 1 | 0 | 2 | 1 |
| 15 | Umuahia North | 9 | 2 | 1 | 1 | 3 |
| 16 | Umuahia South | 9 | 1 | 2 | 2 | 1 |
| 17 | Umunneochi | 6 | 1 | 1 | 1 | 1 |

Source: Authors' Field Survey, 2016

The ANOVA result is shown on table 6, which reveals that there were no significant differences between the telecommunication networks (AITEL, ETISALAT, GLOBACOM, and MTN) in their application of the environmental standards, (F = 2.092; $P$ = 0.151) $P > \alpha$ (0.05) significant level. Hence *Ho* is not rejected. This means that all the four major telecommunication networks are guilty of contravening the environmental standards for the installation of BTSs and Masts in Abia State, and in Nigeria by extension.

Table 6. ANOVA

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.983 | 3 | 1.328 | 2.092 | .151[a] |
| | Residual | 8.252 | 13 | .635 | | |
| | Total | 12.235 | 16 | | | |

Source: Computer SPSS Data Analysis by Authors

## 5. Conclusion

This study assessed the level of compliance of telecommunication masts and base stations to regulatory standards in Abia State, Nigeria. The investigation revealed that there is significant difference between the mean value of total number of BTSs/Masts surveyed and the mean value of the number that complied with regulatory standards, which implied that a significant number of the BTSs/Masts contravened the environmental standards. The study also revealed that all the four major telecommunication networks (AITEL, ETISALAT, GLOBACOM, and MTN) are guilty of contravening the environmental standards for the installation of BTSs and Masts in Nigeria. The study therefore recommends that Federal Government should mandate the Nigerian Communication Commission (NCC) and the National Environmental Standards and Regulations Enforcement Agency (NESREA) to carryout their statutory roles of regulating the installation and management of the BTSs and Masts. Since both are federal government agencies, and lack the manpower and other resources to monitor compliance of the telecom industry across the nation, we recommend that both NCC and NESREA be made to devolve their supervisory responsibilities to Town planning authorities at the local government level. This will ensure effective monitoring of the BTSs and Masts. There is the need to also enforce compliance to co-location guidelines for the BTSs and Masts to reduce their proliferation especially in urban areas. NCC should encourage the telecom operators to adopt stealth &/or camouflage designs of mast and towers to reduce their visual impacts on the environment. As much as possible, alternative power sources that are environmental friendly should be encouraged, standards and permissible levels for generator setback, noise level, vibration, smoke and all forms of pollution must be enforced. We note that due cognisance should be taken of evolving demographics over the 25 year lifespan of a tower or mast. This is because areas that were initially sparsely populated could easily become densely populated over time leading to the violation of requirements such as setback distance and height specifications. This is the more reason why the involvement of local town planning authorities in the regulation of BTSs and Masts is highly recommended.

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## Appendix A

Table 7. BTSs and Masts Surveyed and the Variables measured

| S/N | Code | Location | Setback Road (m) | Setback Res.Ppt (m) | Height Res.Dist (m)* | Tower -Tower Spacing ** | Nearness Power Line | Screening wall |
|---|---|---|---|---|---|---|---|---|
| 1 | A01 | EZIAMA | 15.2 | 4.5 | 1 | 0 | NO | BAD |
| 2 | E02 | INDUSTRIAL L.OUT | 6.4 | 8.5 | 0 | 0 | NO | BAD |
| 3 | M03 | OKIGWE ROAD GRA | 13 | 5.5 | 1 | 0 | NO | BAD |
| 4 | M04 | OSUSU | 8 | 5.6 | 1 | 0 | NO | BAD |
| 5 | M05 | URATTA | 14.2 | 7.7 | 1 | 0 | YES | BAD |
| 6 | G06 | UMUOLA | 26 | 12.9 | 1 | 0 | NO | BAD |
| 7 | M07 | FAULKS ROAD | 13.5 | 3.6 | 1 | 0 | NO | BAD |
| 8 | E08 | OGBORHILL | 12.8 | 6.0 | 1 | 0 | YES | OK |
| 9 | M09 | EZIUKWU | 4.5 | 5.3 | 1 | 1 | NO | BAD |
| 10 | G10 | AKOLI | 56.6 | 5.9 | 1 | 0 | NO | BAD |
| 11 | G11 | IHEORJI | 158 | 10.5 | 1 | 0 | YES | BAD |
| 12 | A12 | OHABIAM | 233 | 33.0 | 1 | 0 | NO | OK |
| 13 | E13 | EKEOHA | 48.1 | 4.4 | 1 | 0 | NO | BAD |
| 14 | G14 | AZIKIWE ROAD | 9.9 | 3.2 | 1 | 0 | NO | BAD |
| 15 | M15 | SCHOOL OF HEALT | 6.2 | 6.2 | 1 | 0 | NO | BAD |
| 16 | E16 | ETCHE ROAD | 5 | 3.6 | 1 | 1 | NO | BAD |
| 17 | A17 | OVUKWU | 26 | 66.1 | 1 | 0 | NO | BAD |
| 18 | M18 | OHAEKE | 312 | 15.5 | 1 | 0 | NO | BAD |
| 19 | G19 | ABAM CET SCH | 43.3 | 9.5 | 1 | 0 | YES | BAD |
| 20 | M20 | OBINKITA | 512 | 6.7 | 0 | 0 | NO | BAD |
| 21 | E21 | IHEOCHIOWA | 41.4 | 4.3 | 1 | 0 | NO | BAD |
| 22 | A22 | UTUTU | 35 | 6.8 | 1 | 0 | NO | BAD |
| 23 | G23 | AMUVI | 32.8 | 15.5 | 0 | 0 | NO | BAD |
| 24 | M24 | AMANKALU | 52.1 | 21.5 | 0 | 0 | YES | OK |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 25 | G25 | BENDE | 16.5 | 17.3 | 1 | 0 | NO | BAD |
| 26 | A26 | UGWUEKE | 35.4 | 15.4 | 1 | 0 | NO | OK |
| 27 | A27 | IGBERE | 31.2 | 15.8 | 0 | 0 | NO | BAD |
| 28 | E28 | AMAOKWE ITEM | 50.6 | 55.6 | 0 | 0 | NO | OK |
| 29 | M29 | OKOKO ITEM | 8.9 | 7.5 | 0 | 0 | NO | BAD |
| 30 | M30 | UZUAKOLI | 43.7 | 8.5 | 1 | 0 | NO | BAD |
| 31 | E31 | OLOKO CENT. SCH | 86 | 4.6 | 1 | 0 | NO | BAD |
| 32 | M32 | NGWUGWO IBERE | 29.4 | 64.3 | 0 | 0 | Y ES | BAD |
| 33 | E33 | AMAWOM OBORO | 74.1 | 33.1 | 1 | 0 | NO | BAD |
| 34 | M34 | UMUDIKE | 12.8 | 3.1 | 1 | 0 | YES | BAD |
| 35 | A35 | OKWE COMM SCH | 17.4 | 6.4 | 1 | 0 | NO | BAD |
| 36 | E36 | ARIAM | 123.4 | 7.9 | 1 | 0 | NO | OK |
| 37 | M37 | USAKA | 16 | 16.3 | 0 | 0 | NO | BAD |
| 38 | G38 | AMASA NSULU | 66.5 | 73.4 | 1 | 0 | NO | BAD |
| 39 | G39 | ISIALA NSULU | 44.1 | 14.6 | 1 | 0 | NO | BAD |
| 40 | G40 | NGWA UKWU | 24.9 | 10.5 | 1 | 0 | NO | BAD |
| 41 | A41 | IHIE | 27.7 | 9.4 | 1 | 0 | NO | BAD |
| 42 | M42 | AMAPUNTIGHA | 42 | 6.8 | 1 | 0 | NO | BAD |
| 43 | E43 | UMUOHA | 21.1 | 7.9 | 0 | 0 | NO | BAD |
| 44 | M44 | NBAWSI | 46.8 | 6.5 | 1 | 0 | YES | BAD |
| 45 | A45 | UMUNNA NSULU | 33.3 | 18.5 | 0 | 0 | YES | BAD |
| 46 | G46 | UMUEKEA | 41.6 | 5.5 | 1 | 0 | NO | BAD |
| 47 | M47 | UMUNTA NGWAOBI | 145.5 | 5.7 | 0 | 0 | NO | OK |
| 48 | E48 | MBUTU UKWU | 280.5 | 93 | 0 | 0 | NO | BAD |
| 49 | E49 | OBUBA | 152 | 44.3 | 0 | 0 | NO | BAD |
| 50 | M50 | OMOBA | 34.5 | 8.5 | 1 | 0 | NO | BAD |
| 51 | G51 | OSOKWA | 36.2 | 16.4 | 1 | 0 | NO | BAD |
| 52 | M52 | UMUAPU OVUNGWU | 11.2 | 5.0 | 0 | 0 | NO | BAD |
| 53 | A54 | OKPORO AHABA | 40.5 | 17.2 | 0 | 0 | NO | BAD |
| 54 | E55 | AHABA IMEYI | 26.9 | 22.1 | 0 | 0 | YES | BAD |

| S/N | Code | Location | Setback Road (m) | Setback Res. Ppt (m) | Height Res. Dist (m) | Tower -Tower Spacing | Nearness Power Line | Screening wall |
|---|---|---|---|---|---|---|---|---|
| 55 | M55 | OVIM EZERE | 66.5 | 66.4 | 0 | 0 | NO | BAD |
| 56 | E56 | ISUIKWUATO | 45.6 | 44.2 | 0 | 0 | NO | BAD |
| 57 | E57 | UMU OKOGBUO | 72.0 | 15.4 | 0 | 0 | NO | BAD |
| 58 | A58 | UMUNNEKWU | 51.5 | 24.1 | 0 | 0 | NO | BAD |
| 59 | M59 | ACHARA | 22.4 | 9.4 | 0 | 0 | NO | BAD |
| 60 | G60 | IKEAGHA | 32.5 | 14.2 | 0 | 0 | NO | BAD |
| 61 | M61 | ABSUUTURU | 35.1 | 14.5 | 0 | 0 | NO | OK |
| 62 | G62 | ABAYI OBEALA | 37.7 | 8.8 | 1 | 0 | NO | BAD |
| 62 | M63 | UMUAFOR | 40.5 | 6.1 | 1 | 0 | YES | BAD |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 64 | E64 | MGBOKO ITUNGWA | 44.2 | 7.5 | 1 | 0 | NO | BAD |
| 65 | A65 | AHIABA | 46.2 | 8.6 | 1 | 0 | NO | BAD |
| 66 | A66 | MGBOKO AMAIRI | 55.3 | 8.4 | 0 | 0 | NO | BAD |
| 67 | M67 | ALAUKWUOHANZE | 12.7 | 9.4 | 0 | 0 | NO | BAD |
| 68 | E68 | OVOM 1 | 26.4 | 12.6 | 1 | 0 | NO | OK |
| 69 | G69 | ONICHANGWA | 24.5 | 19.4 | 0 | 0 | NO | OK |
| 70 | M70 | ISIAMA | 26.2 | 14.3 | 0 | 0 | NO | BAD |
| 71 | M71 | EBEM OHAFIA | 9.4 | 16.2 | 1 | 0 | NO | BAD |
| 72 | G72 | NDI ELU | 80.4 | 4.6 | 1 | 0 | NO | BAD |
| 72 | E73 | NDI ETITI NKPORO | 26.7 | 7.6 | 1 | 0 | NO | BAD |
| 74 | M74 | AMEKE ABIRIBA | 41.3 | 19.4 | 0 | 0 | NO | BAD |
| 75 | E75 | AMAOGUDU ABIRIBA | 42.2 | 27.4 | 1 | 0 | NO | BAD |
| 76 | G76 | TRADE CENTRE ANIA | 45.5 | 4.2 | 1 | 0 | NO | BAD |
| 77 | E77 | MBUTU UMUOJIMA | 44.6 | 8.4 | 1 | 0 | YES | BAD |
| 78 | M78 | OSISIOMAJUNCTION | 26.5 | 9.3 | 1 | 1 | NO | BAD |
| 79 | E79 | UMUOKOROCHA AM | 28.5 | 18.2 | 1 | 0 | NO | OK |
| 80 | A80 | NGWA HIGH SCHOOL | 35.2 | 22.1 | 1 | 0 | NO | BAD |
| 81 | E81 | ARO NGWA | 24.6 | 14.6 | 1 | 0 | NO | BAD |
| 82 | M82 | AMA ASAA | 66.1 | 16.3 | 1 | 0 | NO | BAD |
| 83 | G83 | URATTA | 12.8 | 7.7 | 1 | 0 | NO | BAD |
| 84 | A84 | AMAPUIFE | 22.2 | 8.5 | 1 | 0 | NO | BAD |
| 85 | G85 | OBEGU | 23.6 | 9.8 | 1 | 0 | NO | BAD |
| 86 | G86 | OBEAJA | 34.1 | 9.9 | 0 | 0 | NO | OK |
| 87 | A87 | ABAYINCHOKO | 32.1 | 5.8 | 0 | 0 | NO | BAD |
| 88 | E88 | OWERRI –ABA | 71.2 | 6.5 | 1 | 0 | NO | BAD |
| 89 | G89 | AKANU NGWA | 133.5 | 10.2 | 0 | 0 | NO | BAD |
| 90 | A90 | UMUARUKWU | 70.6 | 17.2 | 0 | 0 | NO | BAD |
| 91 | A91 | ASA UMUNKA | 40.3 | 61.2 | 0 | 0 | NO | BAD |
| 92 | E92 | IKWURIATOR | 24.4 | 14.2 | 0 | 0 | NO | BAD |
| 93 | E93 | AZUMIRI | 30.4 | 14.2 | 1 | 0 | NO | BAD |
| 94 | E94 | AKWETE | 24.5 | 8.5 | 1 | 0 | NO | BAD |
| 95 | A95 | OBOHIA | 13.4 | 5.4 | 1 | 0 | NO | BAD |
| 96 | A96 | OHAMBELE | 11.8 | 8.6 | 1 | 0 | NO | BAD |
| 97 | E97 | NKPOROBE | 40.8 | 8.0 | 1 | 0 | NO | BAD |
| 98 | G98 | OHANKU | 19.6 | 6.0 | 1 | 0 | NO | BAD |
| 99 | G99 | OBOKWE | 16.4 | 9.5 | 1 | 0 | NO | BAD |
| 100 | M100 | OGWE PRIMARY SCH. | 49.5 | 7.9 | 1 | 0 | NO | BAD |
| 101 | A101 | UMUAKA ASA-NORTH | 44.3 | 15.0 | 0 | 0 | NO | BAD |
| 102 | E102 | OBUZOR | 6.5 | 43.5 | 1 | 0 | NO | BAD |
| 103 | G103 | OBEHIE | 40.7 | 5.4 | 1 | 0 | NO | BAD |
| 104 | M104 | UZUAKU | 122.6 | 22.6 | 1 | 0 | NO | BAD |
| 105 | E105 | OZAA UKWU | 259 | 14.5 | 0 | 0 | NO | BAD |
| 106 | M106 | NKATA IBEKU | 40.5 | 32.1 | 1 | 0 | NO | BAD |

| S/N | Code | Location | Setback Road (m) | Setback Res. Ppt (m) | Height Res. Dist (m) | Tower -Tower Spacing | Nearness Power Line | Screening wall |
|---|---|---|---|---|---|---|---|---|
| 107 | A107 | UMUAGU IBEKU | 20.3 | 6.0 | 1 | 0 | NO | BAD |
| 108 | A108 | NDUME | 35.1 | 9.7 | 1 | 0 | NO | OK |
| 109 | G109 | AJATA OKWURU | 33.7 | 9.6 | 1 | 0 | YES | BAD |
| 110 | E110 | SCHOOL ROAD | 42.2 | 8.5 | 1 | 1 | YES | BAD |
| 111 | A111 | ST. STEPHENS | 55.7 | 7.9 | 1 | 1 | NO | BAD |
| 112 | G112 | UGWUNCHARA | 52.5 | 7.0 | 1 | 0 | NO | BAD |
| 113 | G113 | UMUAWA ALAOCHA | 12.9 | 6.3 | 1 | 0 | NO | BAD |
| 114 | A114 | UMUEKWULU | 41.2 | 21.3 | 1 | 0 | NO | BAD |
| 115 | G115 | UMUNWANWA | 25.6 | 14.0 | 0 | 0 | NO | BAD |
| 116 | A116 | OLOKORO | 23.5 | 4.4 | 1 | 0 | NO | OK |
| 117 | A117 | ST SILAS OLD UM | 8.6 | 8.4 | 1 | 0 | NO | BAD |
| 118 | A118 | AMANKAMA | 16.7 | 9.6 | 1 | 0 | NO | BAD |
| 119 | G119 | UBAKALA | 19.5 | 6.6 | 1 | 1 | NO | BAD |
| 120 | G120 | NSIRIMO | 27.5 | 6.9 | 1 | 0 | NO | BAD |
| 121 | A121 | AMIGBO | 36.6 | 7.0 | 1 | 0 | YES | BAD |
| 122 | A122 | ISUOCHI | 33.5 | 16.1 | 1 | 0 | NO | BAD |
| 123 | A123 | UMUAKU | 115 | 14.2 | 0 | 0 | NO | BAD |
| 124 | M124 | EZINGODO | 310.5 | 8.6 | 0 | 0 | NO | BAD |
| 125 | G125 | NDIAWA | 466.4 | 26.5 | 0 | 0 | NO | BAD |

NOTE: * 0 = 25morLESS, orNON RESIDENTIAL DISTRCT;1 = GREATER THAN 25m

**0 = ADEQUATE SPACING (> 1km),1= INADEQUATE SPACING (< 1km)

Source: Field survey by Authors, 2016.