IPJ Ibadan Planning Journal
November 2018,
Vol. 7, No. 2, 42-50

Ibadan Planning Journal
journal homepage: http://journals.ui.edu.ng/index.php/ipj/issue/view/7

Perceived Environmental Effects of Base Transceiver Stations on Residents in Osogbo, Nigeria

*S. A. Adeyinka[1], R. B. Adetoso[1], O. B. Olugbamila[1], A. O. Ojo[1] and H. I. Agbabiaka[1]

Abstract

*The enormous increase in the usage of mobile phone telecommunication has led to the growing number of telecommunication Base Transceiver stations (BTS) commonly located within residential areas, thereby exposing residents to their possible negative effects. These effects, especially on residents in Osogbo, Nigeria, have not been given adequate attention in the literature. Hence, the study set out to investigate perceived environmental effects of BTS on the residents in Osogbo, Nigeria. Both stratified and convenience sampling techniques were used in collecting data for the study. The study adopted the statutory stratification of the study area into three zones, such as the core, intermediate/transition zones and the periphery. Six neighbourhoods having TBS, comprising two from each zone, were purposively selected: Oja Oba and Gbemu in the Core, Kelebe and Uniosun area in the intermediate and GRA and Oroki Estate in the periphery. One BTS was purposively selected from each of the six selected communities. All buildings within 300 metre radius of the existing 34 telecommunication base transceiver stations in Osogbo were identified to be 1900. However, there were 355 residential buildings within 300m radius of the BTS in the selected communities. Therefore 150 residential buildings representing 42.3% were selected through systematic random sampling technique, from where household heads were purposively selected and sampled with the aid of a set of pre-tested questionnaire. Data collected were analyzed using descriptive and inferential statistics such as frequency count, percentages, cross tabulation, Relative Impact Index (RII) and correlation. Findings revealed that t residents considered Noise emanating from the BTS generating plant (RII = 3.75 and MD = 1.00) and Vibration (RII = 3.61 and MD = 0.86) as the major environmental effect of BTS. The study also revealed a statistically significant correlation between BTS location and headache (r = 0.168** at p = 0.000 levels, and BTS location and sleeplessness (r = 0.063** and p = 0.000) indicate that the more the residents are closer to the BTS the higher the level of occurrence of headache and sleeplessness. The study concluded that BTS should not be located in areas less than 300 meters to residential buildings.*

Keywords
Base transceiver station, electromagnetic field, locational impact, regulatory standard, Oshogbo

Article History
Received 16 June 2018
Accepted 6 July 2019
Published online February 15, 2020

* Corresponding author

Contact
S. A. Adeyinka
adeyinkasa@yahoo.co.uk

Declaration of Conflicting Interests
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

1. Introduction

Globalization, Urbanization and Digitization are sharing global economic growth. This growth is creating huge demand for private and public sector infrastructural development. With urbanization being the key driver, infrastructure is set to keep increasing substantially. Every society is linked by three different types of infrastructure: transportation, energy and communications (Alade, Bishi and Olajide, 2011). Contemporary urbanization is often distinguished by the level of infrastructure present in a place while the level and availability of telecommunications infrastructure in particular determines the status of cites today (Alade *et al.* 2011). Bell (1979) noted that revolution in communications makes it likely that there will be a major shift in the relative importance of one of the

[1]*Department of Urban and Regional Planning, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria*

infrastructure with communications being the central infrastructure tying the society together.

Information and communication form the basis of human existence. The dawn of effective information dissemination and communication in Nigeria became a reality when the Global System of Mobile Communication (GSM) was approved in Nigeria on the 27th of August in the year 2000, and was launched in 2001, marking the dawn of effective information dissemination and communication in Nigeria. GSM is a vital economic infrastructure that stimulates modern growth and development, such as poverty alleviation, improved welfare and environmental sustainability as it provides effective services such as mobile TV, electronic payments, mobile tracking services, cheaper international calls, internet and mobile banking among others (Bello, 2010). The enormous increase in the use of GSM in Nigeria cannot be underestimated. For instance, the total number of subscribers has increased rapidly over the past decade: at the end of 2005 there were 19,519,154 subscribers, but by the end of 2015 there were 151,017,244, which is equivalent to an increase of 13,149,809 every year. However, in March 2016, there were 148,745,464 subscribers (Nigerian Telecommunications Services Sector Report, 2016). GSM base stations and cellular telephone masts form part of the infrastructure required for an effective communication system. The enormous increase in the usage of mobile phone telecommunication has led to the growing number of telecommunication Base Transceiver Station (BTS) located commonly near homes, hospitals, places of worship, shops and schools among others (Khurana et al., 2009; Olukolajo, Ezeokoli, and Ogungbenro, 2013; and Nigeria Communication Commission [NCC], 2014). The base stations transfer signals between mobile telephones and a network for mobile or normal telephony by means of radio frequency electromagnetic fields.

The increasing number of people being exposed to the electromagnetic fields as a result of the location of base transceiver stations and the possible negative effect on health of residents has been a thing of concern to many people including researchers (Victor, Norbert, Silas, Abraham, and Patrick. 2012). Sensations of burning or warmth around the ear, headache, disturbance of sleep, memory loss, immune functions, stimulating hormones, mammalian brain, sperm motility and morphology, cancer development and neurological pathology syndromes are some of the effects being reported as resulting from living in the vicinity of Base Transceiver Station (BTS) (Santini, Santini, Le Ruz, Danze, and Seigne. (2003), and Shahbazi-Gahrouei, Karbalae, Moradi, Baradaran-Ghahfarokhi (2014)). In consequence therefore, the need for citing telecommunication base transceiver station at appropriate distance according to the accepted standard for the control of electromagnetic radiation as developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) (Akintonwa, Busari, Awodele, and Olayemi, 2009; and Akinyemi, *et., al.,* 2014) is important.

2. The Study Area

Osogbo is the state capital city of Osun State and also doubles as the seat of the Headquarters of both Osogbo Local Government Area situated at Oke Baale Area and Olorunda Local Government Area situated at Igbonna Area. Osogbo is some 88 kilometres by road Northeast of Ibadan, 100 kilometres South of Ilorin and 115 kilometres Northwest of Akure. Osogbo shares boundary with Ikirun, Ilesa, Ede, Ilobu and Iragbiji and is easily accessible from any part of the state because of its centrality. It is about 48 km from Ife, 32 km from Ilesa, 46 km from Iwo, 48 km from Ikire and 46 km from Ila-Orangun. There are 34 telecommunication base transceiver stations located within close proximity to residences in Osogbo with 12 serving 1720.8ha of land in the core area, 11 serving 2909.4ha of land in the intermediate zone and 11 serving the periphery.

In light of the foregoing, the study examined the perceived environmental effects of these base transceiver stations on the residents of Osogbo by examining the proximity of the base stations to each other; to the nearest residential building; and to the adjoining roads in the different residential zones and also by analysing their locational characteristics, economic, social, health and residents' perceived environmental effects in Osogbo.

3. Literature Review

The issue of telecommunication mast location within residential areas calls for attention as researchers have established that sitting of these masts in residential area had effect on the health of the people (Onifade et al., 2011, Sewo, 2006). Findings on the radiation of the BTS was measured using gauss meter and power density of electromagnetic radiation on buildings around BTS were calculated. The result shows that the radiation emitted exceeds the safety limit set by ICNRIP (Adekunle, Ibe, Kpanaki, Umanah, Nwafor, and Essang, 2015)). For instance, study by Abdel et al (2007) revealed that residents living within 1-5km service radius suffers cancers of the prostate, breast, lungs and leukaemia often resulting to untimely death, fever, and headache. The study also revealed that vibration and pollution of environment due to various activities of generators and mast installation are experienced by the residents. Oni, Amuda, Gilbert, Aseweje and Akinola (2011), assert that blood parameters are affected by exposure to RF radiation. Akinyemi, Makanjuola, Shoewu, and Edeko (2014) also established that most symptoms such as nausea, headache, dizziness, irritability, discomfort, nervousness, depressor, sleep disturbance, memory loss and lowering of libido were common among the inhabitants living within 300m radius to the BTS antennae compared with those living above 300m from the BTS antennae. They suggested that cellular phone BTS antenna should not be closer than 300m to residences in order to minimize exposure of neighbours to radiation.

Oluwajobi, Falusi, and Oyedun (2014) had a contrary assertion that the electric field strength experienced around base stations is within the ICNIRP safety limits, regardless of the position of the exposed person. It was also argued by Ayinmode, and Farai (2014) that people living close to BTS were not affected with any health related issues like depression, sleeping disturbances, headache, memory loss, cancer, blood pressure. However, Felix, Gabriel and Emmanuel (2014) used a cellular mobile network analyzer to measure the received power density from BTS transmitter at residential and commercial areas and the power absorbed was calculated to be 348nW/cm2 at 210m distance from transmitter and become higher as one moved closer to the transmitter from BS. The study concluded that the power density measured within 300m distance from BS transmitter is of higher negative health concern and suggested that BTS transmitter should be located between 300m to 500m distance from human residences. Based on the above results, there is no cogent evidence to conclude that RF radiations from base station are harmful or not harmful to human health. It depends on the location, the system and the service provider's compliance with regulatory bodies and ICNIRP standards. Bello (2010) examined the variation in the satisfaction level of people living around GSM base stations. The study found that residents' satisfaction increases with distance away from the base station. When the effect of fear of health problems exhibited by the residents was introduced, the study found that the variation in the satisfaction level with distance was due to those who harboured fear of health problems.

Considering the potential environmental risks and health impacts associated with the location of BTSs, National Communications Commission (NCC) and National Environmental Standards and Regulations Enforcement Agency (NESREA) have established both technical specifications and environmental guidelines for telecommunications and broadcasting facilities in Nigeria in 2009 and 2011 respectively. The environmental guidelines provided for space requirements, height requirement, set-back to residential buildings, screening, tower to tower spacing, and nearness to power lines as follows:

(a) **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 set back the telecommunication tower in excess of 150 meters height shall be set back at a minimum of 50 meters from the right of way of all controlled access, federal and state roads, to provide unobstructed flight paths for helicopters.

(b) **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 space and drive ways shall not be required for those portions of the site lying more than 50 meters from the paved road.

(c) **Residential areas:** Telecommunication towers above 25 meters in height are not permitted within district delineated as residential areas. Where there are exceptions to allow it, it must be placed at a minimum ratio of 3 to 1 distance to the height, to the nearest building.

(d) **Height of Structure:** free standing mast should not exceed 150 meters in height. Structures above 30 meters in height may only be installed with a clearance certificate issued by the Nigerian Airspace Management Authority (NAMA).

(e) **Tower to tower spacing:** any new telecommunication tower in excess of 55 meters in height must be located at a minimum of 1 km from any other existing tower in excess of 55 meters in height.

(f) **Screening:** An opaque screen at least 2.5 meters 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.

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

(h) **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.

However, 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).

4. Materials and Methods

Primary data were derived through the administration of a set of questionnaire on the residents of the host communities where the BTS are located. Buildings within close proximity, that is, less than 300m, of the selected BTS were surveyed. This range was adopted because it is believed that residents within this radius will feel the impacts of BTS more than residents beyond this distance. Information obtained through the use of questionnaire administration includes: information on indicators for environmental, health, economic and social effects of BTS on the host communities.

Both stratified and systematic sampling techniques were used in collecting data for the study. The study area was stratified into three zones; the core, intermediate/ transition and the periphery (Ministry of Lands, Physical Planning and Urban Development, 2011). Pilot survey revealed that there are 1900 residential buildings within 300m radius to the selected 34 telecommunication base transceiver stations in Osogbo and that 12, 11 and 11 BTS serve the core, intermediate and periphery respectively. However, two BTS were selected from each residential zones of Oja Oba and Gbemu in the core, Kelebe and Uniosun area in the intermediate and GRA and Oroki Estate in the periphery. 150 residential buildings were systematically selected across the three zones in Oshogbo. In each building, a household head was surveyed. In all, a total of 6 BTS and 150 household heads form the sample size for this study.

Data collected were analysed using descriptive and inferential statistics such as frequency count, percentages, cross tabulation, Relative Effect Index (REI) and correlation. The instrument was structured using two different 5 point Likert scale rating. *Very high – 5, High – 4, Medium – 3, Low– 2 and Very low – 1* for environmental impact and *Very often – 5, Often – 4, Rarely – 3, Occasionally – 2 and Never – 1* for health impact where *"Medium and Rarely"* are the midpoint of the respondents' responses which could also be termed as "Indifferent" (Agbabiaka, 2016).

4.1 Computation of REI values for the Environmental Effects Associated with the Location of BTS in the study area

Column 1: Environmental effects indicators

Column 2: Number of individual respondents rating each of the indicators with 5 (Very High)

Column 3: Number of individual respondents rating each of the indicators with 4 (High)

Column 4:Number of individual respondents rating each of the indicators with 3 (Medium)

Column 5: Number of individual respondents rating each of the indicators with 2 (Low)

Column 6: Number of individual respondents rating each of the indicators with 1 (Very Low)

Column 7: Addition of product of individual respondents rating a particular indicator and their respective weight values. For instance, SWV for "Noise" = (14×5) + (87×4) + (47×3) + (2x2) + (0x1) = 563.

Column 8: Residents Knowledge Index equals summation of weight value (SWV) divided by additional of individual respondents rating each indicator. For instance, RII for "Noise" = 563/(14+87+47+2+0) $= \frac{563}{150} = 3.75$

Column 9: The deviation equals to mean of RII for all the 5 identified indicators subtracted from RII value for each indicator. Thus $\frac{13.76}{5} = 2.75$, Deviation (RII $-\overline{RII}$) = (3.75 – 2.75) = 1.00

5. Result and Discussion

This section discusses the result and discussion of the findings. The result centres on the measurement of the proximity of the BTS in different residential zones, BTS to the nearest residential building, BTS to the road, locational characteristic of BTS, socioeconomic, environmental and health effects of the BTS locations in the study area.

5.1 Proximity of Base Stations to Each Other in Different Residential Zones

The study revealed that base stations in the core area of Osogbo are located closer to each other than at the intermediate zone and farther to each other at the periphery. The closest two base stations at the core are at 19 meters to each other. The two closest base stations in the intermediate zone are at 1,043 meters to each other and the closest two base stations in the periphery are at 169 meters to each other. From the analysis, 12 telecommunication base stations serve 1,720.8ha of land in the core area. Eleven telecommunication base stations serve 2.909.4ha of land in the intermediate zone and 11 base stations serve the periphery (Table 1).

Table 1: Proximity of Base Stations to Each Other in Different Residential Zones

Zones	No. of BTS	Land area (Ha)	Minimum distance in meters between BTS
Core	12	1,720.2	19
Intermediate	11	2,909.4	1,043
Periphery	11	Inestimable	169

Source: Field Survey 2016

5.2 Proximity of Base Stations to the Nearest Residential Building

The study revealed that 76.5% of the base stations are located within l0 meters to the nearest residential building in the study area. In the core area 10 base stations are located within 10 meters to the nearest residential building, 2 base stations are located between 11 and 20 meters of the nearest building. In the intermediate zone 7 base stations are located within 10 meters of the nearest building, 3 base stations are situated within l1 and 20 meters of the nearest building and 1 base station is located between 21 and 30 meters of the nearest building. In the periphery, 9 base stations are located within 10 meters to the nearest building (Table 2).

Table 2: Proximity of Base Stations to the Nearest Residential Building

Zones	Within 10 meters		11-20 Meters		21-30 Meters		Total	
	F	%	F	%	F	%	F	%
Core	10	29.4	2	5.9	0	0	12	35.3
Intermediate	7	20.6	3	8.8	1	2.9	11	32.4
Periphery	9	26.5	2	5.9	0	0	11	32.4
Total	26	76.5	7	20.6	1	2.9	34	100.0

Source: Field Survey, 2016

5.3 Proximity of Telecommunication Base Stations to Road

The result of the analysis revealed that 25% of the base stations in the core are located within l0 meters of the nearest road, 54.6% in the intermediate zone, and 45.5% in the periphery respectfully. 41.7% of the base stations in the core area are located between 21 and 30 meters to the nearest road network and 9.0% each of the base stations were located between 21 and 30 meters to the road in the intermediate and periphery. The study further revealed that 41.7% of the base stations in the core area were located between 11 and 20 meters to the nearest road network while 12.2% of the BTS were in the intermediate and 27.3% in the periphery. Also findings established that core, intermediate and periphery accounted for 16.6, 18.2 and 18.2% each of base station located above 30 meters to the nearest road (Table 3).

Table 3: Proximity of Telecommunication Base Stations to Road

Zones	Within 10 m		11-20m		21-30m		Above 30m		Total	
	F	%	F	%	F	%	F	%	F	%
Core	3	25.0	5	41.7	2	16.7	2	16.6	12	100.0
Intermediate	6	54.6	2	18.2	1	9.0	2	18.2	11	100.0
Periphery	5	45.5	3	27.3	1	9	2	18.2	11	100.0
Total	14	41.9	10	29.3	4	11.7	6	17.1	34	100.0

Source: Field Survey, 2016

5.4 Location Characteristics of Base Stations in the Study Area

The research revealed that although network providers complied with most of the guidelines given by the NCC, they did not comply strictly with few other guidelines like the provision of parking facilities and maintenance culture. Analysis from the study revealed that more than 70% of the base stations in the core area, 58%, respectively, in the intermediate and peripheral areas of the city, have no parking facilities, contrary to the standards expected to be observed in the base stations.

5.5 Perceived Socioeconomic Effects

The result of the study revealed that the situation of telecommunication base stations in all the residential zones affects the sales of telecommunication materials like recharge card. For instance, the number of recharge card sellers in all residential zones has increased. General consensus from the residents is that land rent and cost have been affected by the situation of base station in their neighbourhoods. The effect is perceived to be highest in the periphery, moderate in the intermediate zones, and none-existence in the core area of Osogbo. Residents generally affirmed that location of base stations have brought about significant increase in property and rental values in the periphery and intermediate zones of the city. In addition to economic benefits other perceived benefits of location of the base station include better communication network, better access to the internet and the masts themselves forming important landmarks for the various neighbourhoods in the city.

Table 4: Perceived Socioeconomic Effects of Location of BTS in the Study Area

	Core		Intermediate		Periphery		Total	
Zones	F	%	F	%	F	%	F	%
SME (sales of call card)	75	50.0	50	33.3	25	16.7	150	100
Land rent and cost	35	23.3	52	34.7	63	42.0	150	100
Better communica-tion network	71	47.3	32	21.3	47	31.3	150	100
Improved access to internet	69	46.0	22	14.7	59	39.3	150	100
Land mark	33	22.0	45	30.0	72	48.0	150	100
Total	283	37.7	201	26.8	266	35.47	750	100

Source: Field Survey, 2016

5.6 Perceived Environmental Effects Associated with the Location of BTS

The residents' awareness on the environmental impacts associated with the location of BTS were also examined using a five point Likert's scale rating to determine the Relative Effects Index (REI) in identifying the level of importance attached to the identified indicators. A total of 5 indicators were identified. To calculate the RII, the respondents were instructed to rate each environmental impact indicators using one of the five ratings: *Very high – 5, High – 4, Medium – 3, Low– 2 and Very low – 1*. The summations of the weight value (SWV) for each of the indicators were obtained through the addition of the product of the response for each rating of the variable and their respective weight values. Mathematically, this is expressed thus:

$$SWV = \sum_{I=1}^{5} X_i Y_i \qquad \text{…………………eqn. (1)}$$

Where: SWV is the summation of weight value,
X_i is the respondents rating of particular indicator
Y_i is the weight value assigned to each indicator
The Relative Effects Index (REI) for each indicator is arrived at by dividing the summation of weight value by the addition of the number of respondents to each of the five ratings. This is expressed mathematically as:

$$REI = \frac{SWV}{\sum_{i=1}^{5} P_i} \qquad \text{…………...…… equ. (2)}$$

Where REI is the relative effects index, SWV and *Pi* are defined previously. The closer the REI of a particular indicator to 5 the higher is the level of importance attached to such indicator (Agbabiaka, 2016). The result is as presented in Table 5.

Table 5: Perceived Environmental Effects Associated with Base Transceiver Station in Osogbo

	Rating & weight value							MD	
	VH	H	M	L	VL			(RII-	
Indicators	(5)	(4)	(3)	(2)	(1)	SWV	RII	$\overline{RII}$)	Rank
Noise pollution	70	348	141	4	-	563	3.75	1.00	1st
Vibrations	60	304	162	16	-	542	3.61	0.86	2nd
Radiation pollution	31	64	222	80	14	410	2.73	-0.02	3rd
Air pollution	40	96	102	82	43	363	2.42	-0.33	4rd
Disruption of property	10	8	6	36	126	186	1.24	-1 .5 1	5th
Total	211	820	633	218	183	2064	13.75	$\overline{RII} = 2.75$	

Source: Field Survey, 2016

Findings in Table 5 established that the respondents express their dissatisfaction towards 2 out of the 5 environmental effects indicators considered as negative effects associated to the location of BTS within residential areas. The first indicator considered as negative effect was Noise emanating from the BTS generating plant with (RII = 3.75 and MD= 1.00), followed by Vibration with (RII= 3.61 and MD= 0.86). Residents did not consider radiation pollution, air pollution, and disruption of local activities as effects emanating from the location of the BTS in their areas. This could be associated to the fact that residents believe that the location of the BTS closer to them gives them a wider coverage and access to the network for calls and internet services, but rather have not really carried out thorough research on the air quality and extent of radiation of electromagnetic field within their area that could have resulted from the location of BTS. Findings from this study which revealed that vibration and noise pollution are the most perceived environmental effect associated with BTS location, corroborated earlier study of Abdel et al (2007) in which he inferred that vibration and pollution of environment due to various activities of generators and mast installations are felt by the residents living within 1 to 5km of the BTS locations. The study also revealed that the mean RII for all the 5 identified environmental impacts (indicators) denoted by $\overline{RII}$ was 2.75, while the variance in RII was 0.8282, with a standard deviation of 0.9101 and the coefficient of variation in the RII was 35.41% which connotes a spread of respondents opinion about the mean on the negative impact associated with the location of BTS.

$$\text{Average (Mean)} = \overline{RII} = \frac{\Sigma \text{RKI}}{N} = \frac{13.75}{5} = 2.75;$$

$$\text{Variance} = \frac{\sum(\text{RII} - \overline{RII})\,2}{N} = \frac{4.141}{5} = 0.8282$$

$$\text{Standard deviation} = \sqrt{\frac{\sum(\text{RII} - \overline{RII})\,2}{N}}$$

$$= \sqrt{0.972} = 0.9101$$

$$\text{Coefficient of variation} = \left(\frac{0.9101}{\overline{RII}} \times 100\right)\%$$

$$= \left(\frac{0.9101}{2.57} \times 100\right)\% = 35.41\%$$

5.7 Perceived Health Effects of BTS in Osogbo

Residents' awareness on the health effects of the location of BTS in the study area were examined using a five point Likert's scale rating to determine the Relative Effects Index (REI) in identifying the level of importance attached to the identified indicators. For this study, a total of 6 ailments were identified. To calculate the RII, the respondents were instructed to rate the occurrence of each ailment to them using one of the five ratings: *Very often – 5, Often – 4, Rarely – 3, Occasionally – 2 and Never – 1*. The summations of the weight value (SWV) for each of the indicators were obtained through the addition of the product of the response for each rating of the variable and their respective weight values. The result is presented in Table 6.

The result in Table 6 established that the respondents' identified occurrence of two out of the six ailments as being predominant in the vicinity where the BTS are located. The first ailment considered to be most frequent was Headache with RII value of 3.28 and MD of 1.48, followed by Sleeplessness with RII= 2.15 and MD= 0.71 which indicates that headache and sleeplessness are the common ailments in areas where BTS were located which might be as a result of the exposure of the residents to electromagnetic field emanating from the transmission process of the BTS. However, residents did not consider dizziness, leukaemia, memory loss and lung diseases as predominant ailments in their area.

Findings as presented in Table 6 also revealed statistical correlation between proximity to the BTS and headache (R= 0.168** and p= 0.000), indicating that the more the residents are closer to the BTS the higher the level of headache and the farther they are from the BTS the lower the level of headache caused. Findings further established a statistical correlation between proximity to BTS and the causes sleeplessness (R= 0.063** and p= 0.000), indicating that the distance kept away from the BTS reduces the risk of having sleeplessness. The implication of the findings is that BTS should not be located in close proximity to residential buildings as it is majorly associated with headache and sleeplessness among the residents in the three residential zones in the study area. The remaining ailments and proximity to BTS does not show statistical correlation.

Therefore, the predominant ailment due to proximity to the BTS are headache and sleeplessness. This finding is corroborated by Akinyemi *et al.* (2014) whose study established that most of the symptoms such as nausea, headache, dizziness, irritability discomfort, nervousness, depressor, sleep disturbance memory loss and lowering of libido were statically significant in the inhabitants living near the BTS antennae, that is, less than 300 meter radius.

Table 6: Relative Effects Index of Ailment Associated with Location of Base Station

	Rating and weight value							MD		Distance	
Indicators	VO(5)	OF(4)	R(3)	O(2)	N(1)	SWV	RII	(RII-$\overline{RII}$)	Rank	Correlation	P
Headache	60	204	180	42	6	492	3.28	1.48	1st	0.168**	0.000
Sleeplessness	60	20	165	106	25	376	2.51	0.71	2nd	0.063**	0.000
Dizziness	-	12	87	72	80	251	1.70	-0.1	3rd	-0.015	0.859
Leukemia	-	4	18	14	136	172	1.15	-0.65	4rd	0.054	0.510
Memory loss	-	8	-	32	132	172	1.15	-0.65	4rd	-0.259	0.001
Lung Diseases	-	-	-	6	147	153	1.02	-0.78	5th	0.099	0.229
Total	120	248	450	272	526	1616	10.81	$\overline{RII} = 1.80$		**Sig. at 0.01	

Source: Field Survey, 2016

6. Conclusion and Recommendations

6.1 Conclusion

The impacts of BTS on residents living within 300 meters radius was analysed in this study. The study showed the spatial distribution and location characteristics of BTS across the three residential zones in Osogbo. The study also examined the socioeconomic, health and environmental impacts associated with the location of BTS. The study established that telecommunication has both positive and negative impacts on both the environment and the residents. Although the negative impacts affect the health of the residents in terms of causing headache and sleep disorder, while the positive impacts have social and economic benefits to the residents in terms of access to uninterrupted calls and data network as well as increase in land value. Hence the need to put in place the mitigation measures for the negative effects of the BTS on residents in the study area should be emphasized.

6.2 Recommendations

(a) To reduce the environmental impact of base station on the environment, mast collocation should be encouraged by network providers. The multi-network Base Stations that will be jointly owned by three to four telecommunication network providers should be constructed so as to reduce the number of base stations and negative effects on residents.

(b) The use of better equipment and material in the construction of telecommunication base stations such as sound proof materials and radiation blockage devices should be encouraged. This will help in mitigating the adverse environmental impact.

(c) Better maintenance culture should be adopted to reduce the rate at which these base stations deteriorate and go into obsolescence. Stricter policy and guidelines should also be enforced on the network providers to enable them adhere strictly to the laid down standards and guidelines.

(d) Telecommunication planning should be incorporated into development plans in all planning agencies to serve as guide for the erection of telecommunication equipment.

(e) The physical development control agencies in Osun State should be adequately funded, staffed and equipped to face the challenges associated with all illegal mast construction so as to promote a virile sustainable urban environment.

(f) Above all, there should be vigorous public awareness campaign to sensitize the citizenry on the negative effects of residing near the base transmission stations.

References

Abdel- Rassoul, G; Abou El- Batanouny, M; Salem, E. (2007). Neuro Behavioural Effects among Inhabitants around Mobile Phone Base Stations.*Neurotoxicology*. DOI: 10.1016/j.neuro.2006.07. 012.

Adekunle A., Ibe K.E., Kpanaki M.E., Umanah I.I., Nwafor C.O., Essang N., (2015). Evaluating the Effect of Radiation from Cell Towers and High Tension Power Lines Inhabitants of Building in Ota, Ogun state, *Journal of Communication and Applied Science*, 3(1): 1-21

Agbabiaka, H. I. (2016). Physical Planning Implication of Eyo Festival in Lagos Island, Nigeria. *Cogent Social Sciences* (Taylor & Francis), *2*(1):1257461. https://doi.org/10.1080/23311886.2016.1257461

Akindele, O., and Adeniji, M. (2014). Location Adequacy of Telecommunication Masts and Residents Liveability in Osogbo, Nigeria. *International Journal of Research in Applied, Natural and Social Sciences, 2*(11): 7-16. Retrieved January 10, 2016, from www.impact journals.us

Akintonwa, A., Busari, A. A., Awodele, O., & Olayemi, S. O. (2009). The Hazards of Non-Ionizing Radiation of Telecommunication Mast in an Urban Area of Lagos, Nigeria. *African Journal of Biomedical Research*, *12*(1), 31-35.

Akinyemi L.A., Makanjuola N.T., Shoewu O., Edeko F.O. (2014). Comparative Analysis of BTS and Power Transmission Lines Effect on the Human Body in the Lagos Environ, *African Journal of Computing and ICT*, 7(2): 33-42

Alade, W., Bishi, H., & Olajide, O. (2011). Locational Analysis of Telecommunications

Infrastructure in Residential Neigbourhoods of Lagos Metropolis, in Schrenk, M., Popovich, V. V. and Zeile, P. (eds) *Change for Stability: Lifecycles of Cities and Regions,* Proceedings of Real Corp 2011 Tagungsband, pp 543 - 550

Ayinmode, B. O., & Farai, I. P. (2014). Evaluation of GSM Radiation Power Density in Three Major Cities in Nigeria. *World Academy of Science, Engineering and Technology, International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering*, *8*(10), 740-743.

Bell, D., (1979). *The social framework of the information society*, in *the computer age: A 20-year view*, Dertoozos, M. L. and Moses, J., Eds. MIT Press, Cambridge, pp. 500–549.

Bello, M. O. (2010). Effects of the Location of GSM Base Stations on Satisfaction of Occupiers and Rental Value of Proximate Residential Property in Akure, Nigeria. *Journal of Computer and Information Science,* 3(4): 159-170

Khurana, V. G., Teo, C., Kundi, M., et al. (2009). Cell Phones and Brain Tumors: A Review Including the Long-term Epidemiologic Data. Surg. Neurol. 72: 205-214.

Nigeria Cmmunication Commission [NCC]. (2014). *Industry information*. Retrieved from http://www.ncc.gov.ng/index.php?option=com_content&view=category&id=65&Itemid=67

Nigerian Telecommunications (Services) Sector Report (2016). National Bureau of Statistic www.nagerianstat.gov.ng

Oni, O. M., Amuda, D. B., Gilbert, C. E., Aseweje, I. F., & Akinola, F. A. A. (2011). “A Pilot Study of the Effect of GSM Radiofrequency Radiation on Blood Parameters”, *IJRRAS*, .9 (3): 464 - 466

Olukolajo Michael Ayodele, Ezeokoli Nnaemeka Bethel and Ogungbenro Matthew Taiwo (2013). Locational Effect of GSM Mast on Neighbouring Residential Properties' Rental Values in Akure, Nigeria. *Academic Journal of Interdisciplinary Studies*, *2*(3), 147 - 155.

Oluwajobi, A. O., Falusi, O. A., and Oyedum, O. D., (2014). Estimation of the number of 900MHz GSM Antennae and the Field Intensities of their Ray Emissions in Minna Metropolis, Nigeria. *International Journal of Applied Biological Research*, 6(2):56 - 62

Onifade, A.O., Ikotun, S. A., Opejin A.O., and Ibraheem, B. A. (2011). Health Implication of Mast Location in Urban Area. A Case Study of Egbeda L.G.A. of Oyo State: A Planning Seminar Submitted to Department of Urban and Regional Planning, Obafemi Awolowo University Ile-Ife, Osun State

Felix, O. K., Gabriel, A. U., & Emmanuel, A. C. (2014). Investigation and Analysis on

Electromagnetic Radiation from Cellular Base Station Transmitters and the Implications to Human Body. *Journal of Environment and Ecology*, *5*(1), 46-60.

Santini, R., P. Santini, P. Le Ruz, J.M. Danze, and M. Seigne. (2003). Study of the Health of People Living in the Vicinity of Mobile Phone Base Stations: Influences of Distance and Sex. *Pathol. Biol*. 50:369-373.

Sewo, A.O. (2006). “Appraisal of the Application of Geographical Information System (GIS) in the Location of Telecommunication Mast in Ibadan Oyo State. *An Unpublished M.Sc. Urban and Regional Planning (URP) Dissertation,* Department of Urban and Regional Planning, University of Ibadan, Ibadan.

Shahbazi-Gahrouei, Karbalae, Moradi, Baradaran-Ghahfarokhi (2014). “Health Effects of Living Near Mobile Phone Base Transceiver Station (BTS) Antennae: A Report from Isfahan, Iran” *Electromagn Biol Med*. 33(3): 206-210. doi:10.3109/15368378.2013.801352.

Victor, U.J., Norbert, N., Silas S., Abraham, A., and Patrick U. (2012). “Assessment of Radio-Frequency Radiation Exposure Level from Selected Mobile Base Stations (MBS) in Lokoja, Kogi State, Nigeria.