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Original Research Article

Impact of Telecommunication Masts on Environmental Planning in Enugu Urban Area of Enugu State

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ABSTRACT

This research assesses the impact of telecommunication masts on environmental planning in Enugu Urban Area of Enugu State. Eighteen (18) layouts in the three local government area of Enugu Urban (Enugu North, Enugu South and Enugu East) were randomly selected for purpose of data collection. The study areas in the selected local government areas were stratified into three (3) homogenous residential densities namely, Low, Medium and High. Three hundred and eighty (380) questionnaires were randomly administered out of which 297 response rate representing 78.5% were returned, examined and analyzed. The research identified means of the spatial distribution of masts location by measurement of the distance between each masts, its attributes such as; nature of land for masts erection, nature of adjacent land uses to masts location as well as the plot sizes and height of each masts and also the impact of masts on environmental planning which include; impact on urban scene, aviation, aesthetics and visual intrusion, public utilities, diversion in roads, buildings and general well being of man. One way analysis of variance (ANOVA) and Chi- square were employed in testing the hypotheses. The result revealed that the prime targets were dissatisfied with the location of masts. There was significant variance in the spatial distribution of masts in layouts plan. But there was no significant difference in the negative impact of telecommunication masts on environmental planning. It also identified four hundred and sixty one (461) base stations randomly distributed within the eighteen layouts. In the high density layouts, the observed mean distance between masts located is less than 1km. Thus the spatial distribution is neither clustered nor dispersed but random in nature while the mean distance for medium ranges from 0.7km to 1km and low density layout is above 1km. This also confirms random distribution of masts location. The study recommends that telecommunication operators should prepare and submit their program on network expansion for integration into the land use plan of the study area and for the city in general. The study concludes that future location of telecommunication masts in the study area should be based on conscious planning decisions and telecommunication operators should adopt the means of co-location.

Keywords: Enugu, Telecommunication, Residential Areas, Town Planning and environment.

INTRODUCTION

Our urban centers have witnessed unprecedented erection of masts to accommodate phone users with little regards to standards, health, safety and general well being of the teeming population. There is a general consensus that migration and remittances reduce rural poverty and contribute to the improvement of household living standards (Moses., *et al*. 2015). Migration into Enugu metropolis have lead to increase in number of mobile phone users this has resulted in telecommunication

companies increasing the number of telecommunication masts so as to render quality service for its users. This has become an eye sore to urban planners and a threat to the general well being of inhabitants of where these masts are located (Ubani, 2011). Today Nigeria has over 25,000 erected masts from GSM operators alone (MTN, ETISALAT, AIRTEL, and GLOBACOM) (Olukolajo, Ezeokoli and Ogungbenro 2013). In Enugu urban, there are high proliferations of telecommunication masts close to residential buildings. Residential land use in Enugu urban accounts for the highest land use area and comprises about 54.3% of the total urban area in Enugu (Ubani, 2011). The use of telecommunication masts have compounded challenges in the city and has impact on the environmental planning of the area. All these are issues of concern and focus in this research. Awe (2012) stated that in Nigeria telecommunication infrastructure remains one of the major issues affecting the environment. The provision and sitting of these masts within the country are necessary for the availability of telecommunication and internet services for fast-tracking businesses and government social services, which seems to be an issues and concerns from wide range quarters. Chinedu, (2005) however stated that although telecommunication market has created numerous opportunities for investors to address the increase in demand for telecommunication services, this has led to the spatial distribution of telecommunication masts in residential and commercial area of the of Enugu state. The study is limited to telecommunication masts and their implication on environmental planning in Enugu urban. The various hierarchies of masts which ranges from high, medium to low density area, its distribution and location close to buildings (residential and commercial), roads and drainage and how it affects environmental planning in different layouts in Enugu urban such as Achara layout, Abakpa Nike community layout, Uwani Southern Portion layout, New Abakiliki layout Emene, Paradise city layout, New Era layout, New Haven East layout, New Haven West layout, Trans- Ekulu community layout, Aria Road layout, Golf Estate layout, Thinker's corner layout, Trans- Ekulu Pocket layout, Independence layout phase 1&2, Old GRA layout , New GRA layout, Gateway layout Ibagwa Enugu and Market Garden layout are considered as shown in (Fig.1). Despite the huge benefits of Global System of Mobile Communication (GSM) the new technology has come with its challenges, as telecommunication masts has strong effect on the urban scene (Pitchard, 2006). Pitchard further stated that some of the existing base stations (Masts) have caused much dissent and the fact that more are needed has adversely affected environmental planning. These Masts /Base stations of some of the key players in the GSM business are not only properly located and their proximity to roads, buildings public utilities, playgrounds, conservation areas, airports etc are a major problems to town planners and the environmental managers (Donati and Marino, 2003). The height of these masts poses serious threats to aviation business. It is imperative that telecommunication operators should observe strictly, the maximum height limit of 100m from the ground level for their various masts with warning lights to avoid air craft collision and resultant accidents. As the topography of Enugu underscores the need to ensure extreme care and caution in this regards (Chinedu, 2005).

Statement of the Problem

At present time, the problem of the telecommunication masts in Enugu urban is that planning policy guidelines are not put into place while mounting these mast and these have had great impact on environmental planning in the area. Preliminary studies in Enugu Urban indicates that telecommunication masts are located poorly and in this affect the environmental planning of the area, safety and general well being of inhabitants is being compromised. The erection of these

masts is erratic and has a problem to urban managers. Enugu urban has a population of 722,664 (Nigeria Population Commission, 2006) therefore the demand for base stations (masts) is high because of its population and increasing number of phone users. By implication more masts need to be provided for effective network coverage and optimum service delivery without regards to laid down procedures and guidelines.

Research Questions

Based on the formulated aims and objectives, the following research questions were asked.

i. What is the spatial distribution of telecommunication masts in selected layouts of Enugu Urban?
ii. What are the attributes of the masts locations?
iii. What is the place of the attributes of masts in Enugu urban?
iv. How have the existing masts affected environmental planning in Enugu Urban?

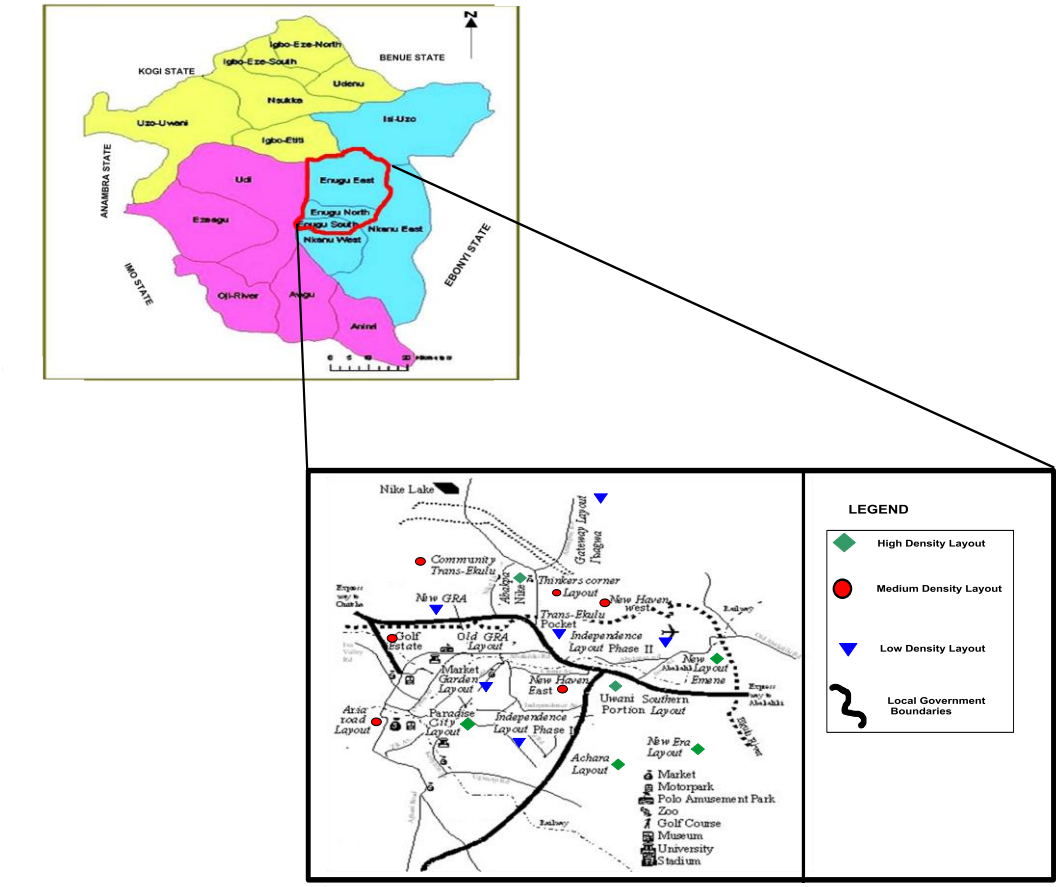

Fig. 1: Map of Enugu Urban (Source: Enugu State Survey Department).

Aims and Objectives

The aim of this research is to assess how the telecommunication masts affect environmental planning in Enugu Urban Area of Enugu State with a view to suggesting ways of efficiency. The following objectives were set to pursue the aim.

i. To determine the spatial distribution of telecommunication masts in selected layouts of Enugu Urban
ii. To examine the general attributes (Heights, sizes, land uses, plot sizes etc.) of base stations (masts) and the extent of application of these in the study area.

iii. To assess how the existing masts have affected environmental planning in Enugu Urban.
iv. To recommend precautionary approach to the deployment of telecommunication infrastructure in Enugu Urban.

Statement of Hypotheses

The following hypotheses were formulated and tested in the course of the research study:

Hypothesis One: H_o - There is no significant variation between telecommunication masts as measured by their spatial distribution in selected layouts plan in Enugu Urban.

Hypothesis Two: H_o - There is no significant variation in the attributes of location as measured by their land uses in the selected layouts.

Hypothesis Three: H_o - There is no significant difference in responses of respondents on the negative impact of telecommunication masts on environmental planning of the area.

MATERIALS AND METHODS

The research design for this study employed survey research design. It defines the study population and data acquisition techniques. The choice of this design is based on assertion by (Akinbode, 2012) that the general purpose of survey is to reveal current conditions, to point out acceptability of previous state and show the need for changes. A total of 360 questionnaires were distributed to the selected layouts under the three local Government Area of Enugu Urban such as Achara layouts, Abakpa Nike community layout, Uwani Southern portion layout, New Abakaliki layout Emene, Paradise city layout New Era layout, New Haven East layout, New Haven West layout, Community Layout Trans-Ekulu, Aria Road layout, Golf Estate layout, Thinker's corner layout, Trans- Ekulu pocket layout, independence layout phase 1&2, Old GRA layout, New GRA layout, Gateway layout Ibagwa and Market Garden layout (Table.1). Twenty questionnaires were distributed to each of these layouts. The descriptive statistical techniques was used, where three hundred and eighty well structured questionnaires were distributed among the target groups as regards the study namely; the resident population, telecommunication service providers and the town planning officials. Statistical tool such as frequency, percentages, averages, charts, histograph and multiple histograph were used for the descriptive data.

Table 1:Population of the Study.

S/N	Item	Size	Remarks
1	Residents Population	360	18 layouts
2	Service Providers	5	5 service providers
3	Town planning Authority	15	15 town planning officials
Total		**380**	

Source: *Researcher's Field Survey, 2015.*

Test of Hypotheses

In testing of hypotheses, one way analyses of variance and Chi-square were used through statistical packages for the social sciences (SPSS).

Hypothesis One and Two:

One way analysis of variance (ANOVA) without interaction was used to test hypotheses one and two in the research. Analysis of variance was discovered by Sir Ronald Fisher in 1923. It is a statistical method that tests the equality of three or more means with the aim of determining their variance. It was used to test the variations between telecommunication masts locations as measured by their spatial distribution in selected layout plan. It was also used to test the variation between the attributes of masts locations as measured by their land uses. It separates the total variation displayed by a set of observation as measured by the sums of squares of the deviations from the mean, into components associated with defined sources of variation used as criteria of classification for the observations. These components are then analyzed in order to test certain hypothesis (Eze, 2012). ANOVA is preferred in this test than any other tests that can be used to compare means because it allows for the computation of three or more means simultaneously.

In a One – way ANOVA, one factor is involved. The model is given by

Model $X_{ij} = \mu + \acute{a}i + eij$ …… (1)

$i = 1, 2, \ldots p$

$j = 1, 2, \ldots q$

Where Xij is the jth observation in the ith treatment, μ is a constant, άi is the mean effect of the ith treatment and eij is the error associated with the observation X

$$F\text{–ratio} = \frac{\text{Ms between}}{\text{Ms within}}$$

Hypothesis Three

The chi-square statistical tool was used in analysis of data of the experiment test as obtained from the study area. Chi square is symbolically written as X^2, is a statistical measure used in the context of sampling analysis for comparing a variance to a theoretical variance. As a non-parametric test, it is used to determine if categorically data shows dependency or the two classifications are independent. It is also used to make comparisons between theoretical population and actual data when categories are used. It is applicable in large number of problems. These distinguish Chi-square and make it adoptable for use to test the difference in the determining the impact of telecommunication masts on environmental planning.

The model is given by:

$$\text{Module } X^2 = \sum_{n-1}^{k} \frac{O_i - E_i}{E_i}$$

Where:

Oi = observed values, Ei = Expected values, Σ_i = Summation of all values to I term.

(n - 1) =Degree of freedom and n = Number of items in the sample.

RESULT AND DICUSSION

Three hundred and eighty questionnaires were randomly administered; two hundred and seventy-seven to respondent population, five to telecommunication service providers and fifteen to town planning officials. And as the time of compiling this result a total of two hundred and ninety seven responses were received, representing 78.5% effective responses rate.

Table 2: Respondents' Response Rates.

	No Distributed	No Received	Response rate of received against distributed questionnaire
Resident population	360	277	76.9%
Telecom Service Providers	5	5	100%
Town planning officials	15	15	100%
	380	297	78.5%

In Table 2, above it is obvious; that questionnaires distributed for resident's population were returned with 76.9%. Responses for telecommunication service providers and town planning officials are encouraging for this research with 100% respectively. This revealed that telecommunication service providers are in the zeal to embrace the need to improve the quality of the environment as regards the haphazard nature of sitting of telecommunication masts.

Sub Group of Respondents'

The demographic profile of the respondents in Table 3 shows that 93.3% respondents were in the resident population category, 1.7% is in the telecommunication service providers' category and 5% are in the town planning authority. This resident population, service providers and town planning authority were mainly the target group for this study who are believed to be concerned and responsible for effective environmental planning. This kind of mix in responses put away the fear of having one-sided opinion.

Table 3: Sub- Group or Respondents'.

	Total	Percent	Cumulative Percent
Resident Population	277	93.3	93.3
Telecommunication Service providers	5	1.7	95
Town Planning Officials	15	5	100
	297	100	

Respondents' Educational Qualification

Efforts were made to ascertain the educational qualification of the respondents; this is because less informed staff may not contribute to the positive success of this research work.

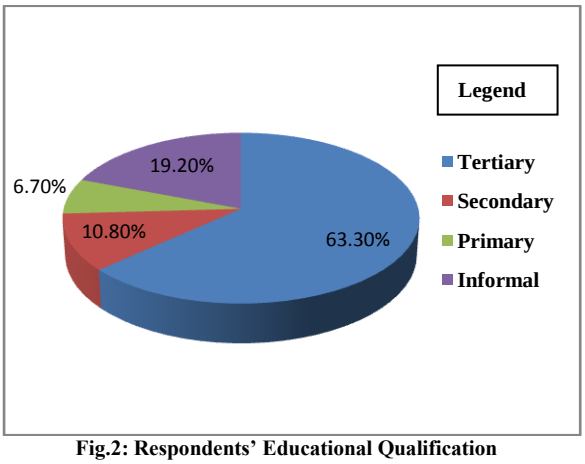

Fig.2: Respondents' Educational Qualification

One hundred and eighty eight of the respondents representing 63.30% had tertiary as their highest educational qualification. This was followed by those with informal having 57 respondents representing 19.20%. However, 32 respondents representing 10.80% had secondary. Those with primary education are 20 respondents representing 6.70% respectively (Fig.2). This indicated that majority of the respondents were educated and require less explanation to understand the issues raised in the questionnaire. Moreover, they were eager to see that the standard and criterion required for mounting of telecommunication masts are adhered to by the telecom operators and proper planning policy guidelines are maintained.

RESIDENT POPULATION

Line used by Respondents

Mobile phones are reliable tools for the coordination of day to day activities in telecommunication industry; hence the researcher wants to know the line used by respondents in different layouts, the availability of this will help identify the masts that are most dominant as regard the number of line used by the respondents. The respondents were asked to choose from the variables: MTN, GLO, ETISALAT and AIRTEL.

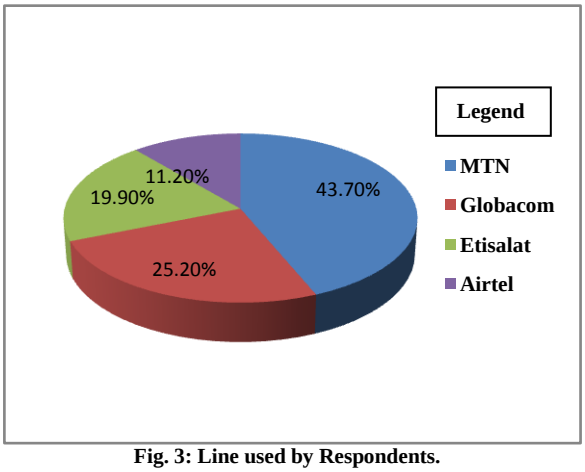

Fig. 3: Line used by Respondents.

121 of the respondent representing (43.70%) in high, medium and low density used MTN line. This was followed by Glo with 70 (25.20%) and 55 of the respondents representing (19.90%) which used Etisalat and Airtel with 31 (11.20%) respectively (Fig.3). The researcher wants to identify the line used by the respondents and the line which is most dominant among the respondent. The researcher from her field observations agreed that MTN has majority of mast erected in the study area.

General Awareness of Telecommunication Masts

Knowledge of telecommunication masts by respondents

The researcher wanted to know if respondents have a general knowledge of telecommunication masts. This was elicited to determine the level of awareness of the respondents on what the research work is all about.

Table 4: Knowledge of Telecommunication Masts by Respondents.

S/N	Layouts	Yes	% Yes	No	% No
1	High Density	59	24.6	22	59.5
2	Medium Density	80	33.3	14	37.8
3	Low Density	101	42.1	1	2.7
	Total	240	100	37	100

Source: *Researcher's Field Survey, 2015.*

In Table 4 it shows that 59 of the resident's population representing 24.6% in the high density layouts have knowledge of

telecommunication masts, while 22 (59.5%) have no knowledge. This was followed by respondents in the medium density layouts 80 representing 33.3% of the resident population indicated they have a knowledge of telecommunication masts, while 14 (37.8%) had no opinion. However, 101 representing 42.1% of the resident's population in the low density layouts indicated that they know what telecommunication is, while 1 (2.7%) indicated No. This means that some of the respondents in high density layouts had no knowledge of telecommunication masts; this is due to their low level of educational background. However, in medium and low density majority of the respondents had knowledge of what telecommunication masts is and this serve as a greater advantage to the researcher and contributed to the success of the study.

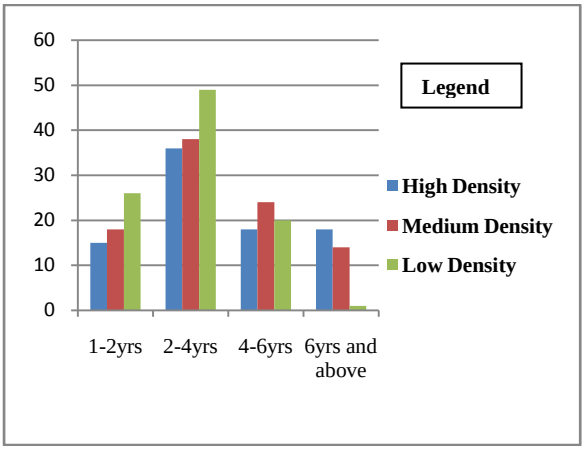

Fig.4: Response on how long the masts have being erected.

Response on how long the masts have been erected.

Response on how long the masts have being erected.This is a pre requisite for determining how long the erection of masts has affected the planning of the area.

In a total of 277 respondents, 59 respondents representing 21.3% stated the masts had being erected form one to two years. This is followed by those erected between two to four years having123 respondents representing 44.4%. Those erected within four to six were 62 (22.4%). While those erected above six were 33 (11.9%). Fig.4 showed that most of the masts erected ranges from two to six representing 66.8%. However, those in two to four years category are more. These periods and percentage representations are good enough to provide a reliable data.

Table 5: Response on whether they were contacted before the masts was erected.

S/N	Layouts	Yes	No	Frequency
1	High Density	28	53	81
2	Medium Density	17	77	94
3	Low Density	17	85	102
4	Total	62	215	277
5	Percent	22.4%	77.6%	100%

Source: *Researcher's Field Survey, 2015.*

Majority of the respondents representing 215 (77.6%) of the respondent's population indicated that they were not contacted before the masts were erected. While 62 (22.4%) of the respondents stated they were contacted. Hence, this indicated that service providers do not consider the resident population and planning of the area before sitting of their masts (Table.5). The researcher from her field observations agreed that most masts erected do not meet the standard given by NCC and regulatory authority and go against the orderly layout plan of the area.

TELECOMMUNICATION SERVICE PROVIDERS

Designation of Service Providers

The researcher wanted to know the designation of his respondents because identifying this, will help to obtain information from the right person as regards masts erection and not doing this may not contribute positively to the success of this study.

Table 6 indicated that the respondent for Globacom was Base Station Transmission Engineer 1 representing 20%. This was followed by 1 Capital Project Manager in MTN representing 20%while Airtel were 2 respondents Radio Access and Facility Managers as information needed was to be obtained from them representing 40% respectively and Maintenance Engineer for Etisalat was 1 respondent representing 20%.

Table 6: Designation of service providers

S/N	Designation of Respondent	Telecommunication Service Providers	Frequency	Percent
1	Base Station Engineer	Globacom	1	20%
2	Capital Project	MTN	1	20%
3	Radio Access Manager and Facility Manager	Airtel	2	40%
4	Maintenance Engineer	Etisalat	1	20%
	Total		5	100%

Source: *Researcher's Field Survey, 2015.*

Spatial Distribution of Telecommunication Masts in Enugu Urban.

Distribution of Masts in Selected Layouts.

Efforts were made to find out the spatial distribution of telecommunication masts. This was elicited to determine the distribution of masts in the study area and this can only be achieved by knowing the number of masts in each of the selected layouts.

Table 7: Distribution of Masts in Selected Layouts.

S/N	Variables	High Density	Medium Density	Low Density	Total	Percent
1	MTN	90	57	39	186	40.3%
2	Globacom	63	43	24	130	28.2%
3	Airtel	49	34	13	96	21%
4	Etisalat	24	16	9	49	10.5%
	Frequency	226	150	85	461	100%

Source: *Researcher's Field Survey, 2015.*

In totality the total number of masts according to the different service providers in the selected layouts of Enugu Urban is 461 (100%), with MTN having the highest number of masts at 186 representing 40.3%. This was followed by Globacom 130 (28.2%). Those with 96 (21%) represent Etisalat, while Airtel 49 (10.5%) respectively (Table.7). This proportion therefore is relied upon to elicit data in determining the spatial distribution of masts in the selected layouts of Enugu Urban.

Table.8: Measurement of Distances between Telecommunication Masts in Selected Layouts.

S/N	Variables	High Density	Medium Density	Low Density
1	Mtn –Airtel	1.58	4.2	8.3
2	Glo – Mtn	1.55	5.54	7.69
3	Etisalat – Glo	0.96	5.03	8.09
4	Mtn – Etisalat	1.37	5.37	9.11
5	Etisalat – Mtn	1.3	5.47	8.72
6	Airtel – Etisalat	1.85	4.95	7.94
7	Mtn – Mtn	2.84	6.53	9.39
8	Glo – Glo	2.5	6.7	9.48
9	Etisalat – Etisalat	2.98	8.57	10.31
10	Airtel – Airtel	2.77	6.78	8.96
	Total	19.7	59.14	87.66

Source: *Researchers Field Survey, 2015.*

Table 8 shows the measurement of the distance between one telecommunication masts and another. From the field measurement it shows that the spatial distribution observed is neither dispersed but random in nature. The mean distance of masts in high density layouts was found to be less than 1km. This also confirms random pattern of masts distribution. Also, it was obvious from this study that the mean distance of masts in medium density layouts was between 0.7km to 1km and higher than 1km in high density layouts. These results further confirm the earlier low ranking of proximity of masts as a factor of the distribution of masts by operators. The random pattern observed further confirms the absence of a definite spatial planning and technical threshold standard to guide masts distribution.

Table 9: Categories of permit obtained by Service providers.

S/N	Regulatory Authority where permit is obtained	Type of permit obtained	Service Provider
1	ESMULD	Development Permit	MTN, Airtel, Glo &Etisalat
2	National Civil Aviation Authority	Aviation Clearance	MTN, Airtel, Glo &Etisalat
3	Ministry of Environment	EIA Clearance	MTN, Airtel, Glo &Etisalat

Source: *Researcher's Field Survey, 2015.*

Table 9 indicated that, the service providers obtain permit from ESMLUD, NCAA and Ministry of Environment and the type of permits are development permit, aviation clearance and EIA certificate respectively. The researcher went further to deduce on friendly approach; why? Some telecommunication operators do not abide by the permit from the regulatory authorities. Some revealed that certain factor influences them in sitting of the masts, the important factor being the population while the dominant is that of availability of land.

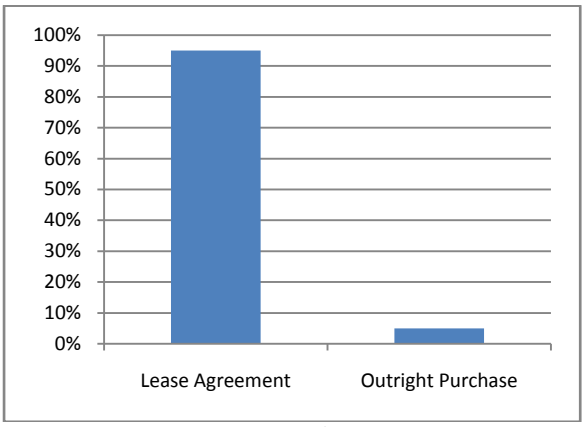

Fig. 5: How Respondents get Land for Masts Erection.

How Respondents get land for Mast Erection.

Response on how respondents get land for mast erection was elicited to determine whether most masts erected were obtained through lease agreement or outright purchase from the land owners. The reason being that majority of the masts cited do not meet the criterion for the approval of masts by the regulatory authority

Fig.5 reveals that 95% of the Service Providers obtain land for the erection of telecommunication masts through lease agreement while 5% is outright purchase. Most of the operators prefer to approach residential land owners to lease part of their properties to them for the purpose of locating their base stations. This explains why majority of the masts are on shared plots of land. However, these shared properties hardly conform to the town planning and NCC regulations.

Attributes of Masts Location and extent of its Application in Enugu Urban.

Response on the Nature of Masts Location.

Response on the nature of masts location. There is need to ascertain the nature of land for masts erection, and how this has negatively affected the planning of the area.

Table 10: Response on Nature of Masts Location

S/N	Variables	High Density	Medium Density	Low Density	Total	Percent
1	Shared or Subdivided Plots	114	89	71	274	59.4%
2	Dedicated Plots	19	17	10	46	10%
3	Roof tops	-	-	-	-	-
4	Organized open space	47	9	9	83	18%
5	Incidental open space	31	16	11	58	12.6%
	Frequency	211	131	101	461	100%

Source: *Researcher's Field Survey, 2015.*

Assessment on the Plot Size and Height of each Mast.

Table 11: Assessment on the Plot Size and Height of each Mast.

S/N	Plot sizes	Height of mast	Service Providers
1.	15m X 15m and 20m X 20m	35m, 50m, 70m &100m	MTN
2.	12m X 12m 15m X 15m and 20m X 20m	30m, 50m and 70m	Globacom
3.	15m X 15m and 20m X 20m	50m, 75m and 100m	Etisalat
4.	12m X 12m and 15m X 15m	35m, 50m and 75m	Airtel

Source: *MTN, Globacom, Etisalat, Airtel, 2015.*

Respondent's opinion on the nature of masts location reveals five possible locations which are further classified as dedicated and non-dedicated. Majority (59.4%) are located on shared or subdivided plots, (10%) on dedicated plots of land, (0%) on roof tops, (18%) on organized open spaces and (12.6%) on incidental open spaces (Table.10). Hence, majority of the masts are located on non dedicated plots. This suggests lack of conscious planning in the distribution and location of masts in the study area. Consequently future expansion of masts in study areas may continue to invade and succeed the residential, commercial and other land uses rather than co-locate with other base stations.

Table 11 indicated respondents' opinion on the standards and criterion for masts erection with respect to plot sizes are15m x15m & 20m x 20m and height of mast are 35m, 50m, 70m and 100m for MTN, 12m x 12m, 15m x 15m and 20m x 20m for plot sizes for Globacom while the height of masts are 30, 50m, 70m respectively, 15m x 15m & 20m x 20m for plot sizes for Etisalat and 50m, 75m and 100m for height of mast. And 12m x 12m & 15m x 15m in terms of plot sizes for Airtel while the height of mast standards are 35m, 50m, and 75m respectively. The researcher made a general assessment of this, and from the field observations it was deduced that not all masts meet the criterion and standards and there should be need for effective monitoring by the NCC to meet the standards.

Table 12: Nature of Adjacent Land Uses of Masts Location

S/N	Layouts	Masts located on residential land use	Masts located on commercial land use	Masts located on other type of land use public, recreation & industries	Masts located adjacent to access road to residential	Masts located adjacent to express	Masts located along distributor roads	Masts located along streets	Frequency
1	High Density	37	44	24	61	10	25	19	220
2	Medium Density	36	31	20	34	3	13	11	148
3	Low Density	8	15	22	6	14	14	6	93
	Total	81	90	66	101	27	27	36	461
	Percent	17.6%	19.5%	14.3%	21.9%	5.8%	5.8%	78.6%	100%

Source: *Researcher's Field Survey, 2015.*

The nature of adjacent land uses to the masts location shows that 17.6% have residential uses as their adjacent land use, 19.5% have commercial and 14.3% have other types of land uses (public, recreation and industrial) as their adjacent land uses. This reveals that location of masts in the study area lacks coordination in term of land use planning. A consideration of the type of roads adjacent to the masts shows that majority 21.9% are located adjacent to access roads within the residential areas, 5.8% are located adjacent to arterial or expressways, 13.0% along distributor roads and 7.8% along collector roads (Table.12). This suggests that telecom operators prefer to site most of their masts adjacent to higher hierarchy of roads in and around residential and commercial areas. Accessibility is considered as the major factor for this pattern since the base stations (masts) need to be serviced on regular basis especially for the supply of fuel for the electricity generating sets that power the base stations.

Table 13: Factors that influences Masts Location.

S/N	Variables	Service providers
1	Population	All Service Providers
2	Topography	
3	Technical specification	
4	Land use	
5	Security of Land location	
6	Accessibility of Location	
7	Availability of Power and Electricity	
8	Size of Land of the Area	
9	Regulatory Standards	
10	Proximity of Base Stations	

Source: *Researcher's Field Survey, 2015.*

Table 13 revealed the factors influencing the location of masts in the study area. The result shows that there are 10 key factors and these include: accessibility, land value, size of land area, population, and availability of power/electricity, security, and proximity to other base stations, topography, regulatory standards and technical specifications. These factors were ranked based on their importance. Population was ranked first, followed by topography, technical specifications, land value, security level of the location, N accessibility to the location, availability of power, size of the land, regulatory standard (Planning/NCC) and lastly proximity to other base stations. While there is an agreement among telecommunication operators about the most important factor being population of the area, there is no common template used as guide in the choice of location. Hence availability of land becomes a dominant factor of location and the implication of this is that most of the locations are unplanned and thus the spatial distribution is likely to be haphazard.

REGULATORY AUTHORITY

Respondents Years of Working Experience.

The researcher wanted to know the number of years each respondent have been working. This will help determine how certain the data generated by them, as experience the say is the best teacher.

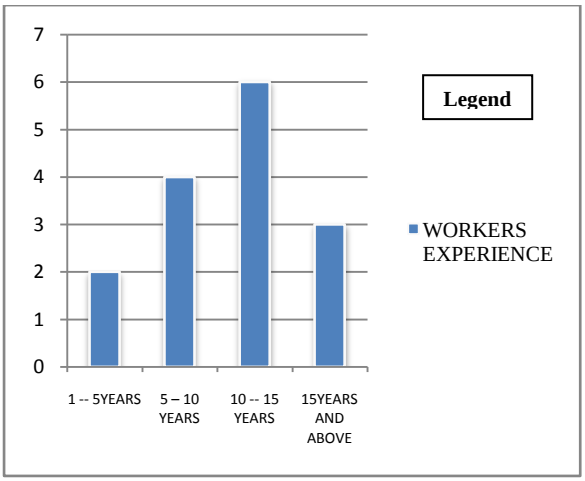

Fig. 6: Respondents Years of Experience

In a total of fifteen respondents, 2 respondents representing 13.3% had one to five years experience. This was followed by those with five to ten years working experience, having 4 respondents representing 26.7 %. Those with ten to fifteen years of experience were 6 representing 40% while those with 15 years and above was 3 representing 20% respectively (Fig. 6). It showed that majority of the respondent's posses a working experience ranging from five to fifteen years and above representing 66.7% (Fig.5). These period and percentage representations are relatively good enough to provide a reliable data.

Table 14: Response on the Criterion for Masts Approval

S/N	Criteria
1.	Location away from schools and flight path etc.
2.	EIA Certificate from Ministry Of Environment
3.	EIA Produced report
4.	Evidence of Site Acquisition and Lease Agreement
5.	Payment of relevant fees
6.	Site visitation by Development Control and Town Planners

Source: *Enugu State Ministry of Land & Urban Development (ESMLUD), 2015.*

Table 14 indicated that the criterion for approval of masts are, location away from schools and flight path, EIA Certificate from Ministry of Environment, EIA produced Report, Evidence of Site Acquisition, Payment of relevant fees and site visitation. The researcher from her field observation observed that majority of the masts erected do not follow the criterion given by the regulatory authorities, thus has affected the environmental planning of the area.

Table 15: Mechanism in Monitoring the Erection of Telecommunication Masts to ensure Compliance.

S/N	Monitoring Mechanism
1.	Through Development Control and Town Planners Site Visitations

Source*: Enugu State Ministry of Land & Urban Development (ESMULD), 2015.*

Table 15 indicated that regulatory authority monitors the erection of telecommunication masts to ensure compliance through site visitations by development control and town planners under town planning department. The

researcher did ask why? They responded that monitoring the erection of telecommunication masts will help reduce its negative effect on the environmental planning as well as the haphazard nature of masts erection by telecommunication operators. The researcher from her field observation observed that despite the monitoring most masts are sited contrary to the planning policy guidelines. This means that compliance by regulatory authority was not strictly monitored for proper sitting of telecommunication masts by telecommunication operators.

GENERAL ASSESSEMENT

Impact of Telecommunication Masts on Environmental Planning in Enugu Urban.

Table 16 : Response on how respondents rate the effect of Telecommunication Masts on Environmental Planning.

S/N	Variables	Resident Population	Service providers	Regulatory Authority	Total	Percent
1	Very Satisfactory	-	-	-	-	
2	Not Satisfactory	104	2	9	115	38.7
3	Fair	44	2	1	47	15.8
4	Poor	129	1	5	135	45.5
	Total	277	5	15	297	100

Source: *Researcher's Field Survey, 2015.*

Table16 indicated that 38.7% of the respondents rate the effect of telecommunication masts on environmental planning as not satisfactory; while 45.5% rates it poor, this is followed by 15.8% of the respondents rated it poor. Further interrogations on the field survey equally disclosed that out of the 15.8% that rated it fair were those respondents that benefitted electricity, employment and those compensated from the masts erected. This also means that majority agreed that the effect of telecommunication masts on environmental planning is not satisfactory.

Table 17 : Response on whether Telecommunication Masts affects the Environmental planning of the Area.

S/N	Variables	Resident population	Service Providers	Regulatory Authority	Total	Percent
1	Yes	206	2	15	223	75.1
2	No	34	2	-	36	12.1
3	Undecided	37	1	-	38	12.8
	Total	277	5	15	297	100

Source: *Researcher's Field Survey, 2015.*

Table 17 revealed that 75.1% of the respondents agreed that telecommunication masts have effect on environmental planning. While 12.1% of the respondents said no. This agreed with the previous responses and goes further to buttress that some of the respondents benefitted from the sitting of the mast.

Validation of Hypotheses

Hypothesis One: H_o – There is no significant variation between telecommunication masts locations as measured by their spatial distribution in selected layouts plan of Enugu Urban.

The intent of the hypothesis is to see whether there is a significant variance between telecommunication masts locations as measured by their spatial distribution in selected layouts plan of Enugu Urban.

Data Used:

1. Respondents opinion on line used; Fig. 2
2. Distribution of telecommunication masts in selected layouts; Table 5.6
3. Measurement of distances between telecommunication masts in selected layouts of Enugu Urban; Table 5.7

Statistical Instrument used: one way analysis of variance

Model $Xij = \mu+\acute{\alpha}i + eij$ …… (1)

$I = 1, 2,….p$

$J = 1, 2,....q$

Where: Xij is the jth observation in the ith treatment, μ is a constant, άi is the mean

effect of the ith treatment and eij is the error associated with the observation Xij

F –ratio = Ms between / Ms within

Table 18 : Summary of statistical analyses between telecommunication masts location and their spatial distribution in selected layouts plan. (See appendix 2a detailed calculations).

Source of Variation	Telecommunication Masts and their Spatial Distribution				
	Sum of Squares	Degree of freedom	Mean sum of Squares	F	Decision
Between Groups	234.32	2	117.16	108.48	Rejected Hypothesis
Within Groups	29.27	27	1.08		
Total	263.59				

Source: *Researcher's Field Survey, 2015.*

NSV – No Significance Variance

In testing hypothesis 1 which states that there is no significant variation between telecommunication masts location as measured by their spatial distribution in the study area at 5% level ANOVA test used. The result of the one way ANOVA test F calculated of 108.48 > F critical of 3.35 (in the selected layouts) as in table 5.14, at 27 degree of freedom, this follows that H_o: 1is rejected. This implies that the spatial distribution of telecommunication masts differs significantly in terms of their location in layouts plan.

Table 5.14 showed the summary of statistical analyses of telecommunication masts as measured by their spatial distribution in layouts plan of Enugu Urban. The table indicated that there is a significant variation between telecommunication masts location as measured by their spatial distribution in layouts plan.

Implications of one way analysis of variance results

One way analysis of variance statistical tool was used to test whether there was no significant variance between telecommunication masts location as measured by their spatial distribution. The analyses revealed that there is significant variance in telecommunication masts location as measured by their spatial distribution. Field observation also supported the fact that majority of these masts do not follow a conscious planning pattern in the selected layouts of Enugu Urban. The general implication is that telecommunication masts location differs significantly in terms of their location and spatial distribution.

Hypothesis Two: H_o – There is no significant variation in the attributes of masts location as measured by their land uses in selected layouts.

The intent of the hypothesis is to test whether there is a significant variation in the attributes of masts location as measured by their land uses in Enugu Urban.

Data Used:

1. Response on the nature of masts location; Table 5.9
2. Assessment of plot size and height of masts; Table 5.10
3. Nature of adjacent land uses of masts locations; Table 5.11

Statistical Instrument used; one way analysis of variance

Model $Xij = \mu+\acute{\alpha}i + eij$ …… (1)

I = 1, 2,….p

J = 1, 2,....q

Where: Xij is the jth observation in the ith treatment, μ is a constant, άi is the mean effect of the ith treatment and eij is error associated with the observation Xij

F –ratio = Ms between / Ms within

Table 19: Summary of statistical analyses on the attributes of masts location in their various land uses.

Source of Variation	**Attributes of Masts Location and their Land Uses**				
	Sum of Squares	Degree of Freedom	Mean sum of Squares		
Between Group	1161.73	2	580.87		
Within Group	3045.47	18	169.19	3.43	Accepted Hypothesis
Total	4207.15				

Source: *Researcher's Field Survey, 2015.*

NSV – No Significance Variance

Implications of one way analysis of variance results

One way analysis of variance statistical tool carried out was used to test whether; there is a significant variance in the attributes of masts location as measured by their land uses in selected layouts of Enugu Urban at 5% level ANOVA test used. The statistical analyses presented F cal. of 3.43 < F critical of 3.55 at 18 degree of freedom hence hypothesis 2 is accepted (Table.19). The analysis revealed that there is no significant variation in the attributes of masts location as measured by their land uses. Field observation also supported that the location of telecommunication masts in the study area lack co-ordination in terms of land use planning. The general implication was that there is no significant variance in attributes of masts location as measured by their land uses.

Hypothesis Three: H_o – There is no significant difference in responses of the respondents on the negative impact of telecommunication masts on environmental planning in the study area.

The intent of the hypothesis is to test whether telecommunication masts has impact on environmental planning in study area.

Data used.

1. Response on how they rate the effect of telecommunication masts on environmental planning of the area; Table 19
2. Response on whether telecommunication masts affect the environmental planning of the area; Table 5.16

Statistical Instrument Used: Chi-square tests

$$\text{Module } X^2 = \sum_{n-1}^{k} \frac{O_i - E_i}{E_i}$$

Where Oi = Observed values, Ei = Expected values, Σ = Summation of all values to I term and (n-1) = Degrees of freedom

Table 20: Summary of Chi-square results on the impact of telecommunication masts on environmental planning of the area. (See details in appendix 2c).

Variables	Calculated value	Critical value	Degree of freedom	Decision
Determining telecommunication masts and its effect environmental planning	9.35	9.49	4	Accepted Hypothesis

Source: *Researcher's Field Survey, 2015.*

NSD – No Significant Difference

Chi- square statistical analysis was used in hypothesis 3, to test whether there is no significant difference in responses of the respondents on the negative impact of telecommunication masts on environmental planning at 5% significant level. The results revealed that Fcal. 9.35 < F critical of 9.49 at 4 degree of freedom; hence Ho is accepted and Ha is rejected (Table. 20).

DISCUSSION

The activities of telecommunication operators in the context of environmental planning cannot be over emphasized. These include; violation of land use regulation resulting in aesthetics nuisance, city beautification, disruption of urban scene, diversion of building plans, roads and drainages, falling masts on houses causes destruction to properties thereby affecting man and the environment. All these have impact on the environment and general layouts plan in the selected layouts of Enugu Urban; this presents a glimpse of greater challenges to the telecommunication operators and regulatory agencies more than ever before. If left unchecked the indiscriminate erection of multiple single user telecommunication sites within the study area will turn to eye sore and a major problem to urban managers. The impact of telecommunication masts in Enugu Urban was assessed on the basis of its spatial distribution and layouts plans. Also assessed were its attributes in relation to their land

use and its impact on environmental planning. The findings showed that the distribution of telecommunication masts in Enugu Urban is random. This support the fact that telecom operators do not follow the conscious planning pattern (i.e. do not adhere to the criterion, standards and guidelines for sitting of masts by NCC and regulatory authorities) hence, environmental planning is affected. Field observation showed that the spatial distribution of masts is neither clustered nor dispersed but random in nature. Also it was observed that the distance between masts locations in high density layouts is less than 1km, while the one for medium density ranges from 0.7km to 1.4km and higher than 1km in high density areas. This result confirms the earlier low ranking of proximity of masts as a factor of masts location by telecommunication operators. The random pattern observed further confirms the absence of a definite spatial planning and technical threshold standard to guide masts locations. However, the result of ANOVA test revealed that the distribution of telecommunication masts differs significantly in terms of their locations and spatial distribution. This research identified that the prime actors agreed that telecommunication masts has impact on environmental planning in Enugu urban. In their opinions they were not satisfied with the environmental planning and are making clarion calls for stringent policies to be made for sitting of telecommunication masts, for example the use of "Co-location of Telecommunication Infrastructures i.e. the use of single cell site by multiple telecommunication operators. This will reduce the erection of multiple single cell sites; curtail multiple environmental problems spread across by each operator. Hence, this research proffers the need to enhance proper environmental planning to boost environmental quality in Enugu urban, as a recent assessment among telecommunication operators and the environment planning.

CONCLUSION

This research assessed the Impact of Telecommunication Masts on Environmental Planning. The study was carried out in Enugu Urban Area of Enugu State Nigeria. Hence this study has investigated the spatial distribution of masts, attributes of telecommunication masts and their land uses and its impact on environmental planning. The study concludes that the spatial distribution of masts locations is random and this is due to the absence of definite spatial planning efforts to guide the telecommunication operators in the location of their infrastructure. This situation will surely have effect on environmental planning which are not yet determined. It concludes further that future expansion will be difficult in the face scarcity of ideal property and stringent physical planning regulations. In the future, more residential, commercial and industrial land uses will have to give way to telecommunication masts especially in high density residential areas either through lease or outright purchase of such properties by telecommunication operators. The study also concludes that population and availability of land rather than standards and government regulations influence location of base stations in Enugu urban. In addition there should be adoption of new global trend in telecommunication management which is suitable to both service providers and residents population. The use of "Co-location of telecommunication infrastructures. Co-location is the use of single cell site by multiple telecommunication operators will reduces the erection of multiple single cell sites, Such Co-location infrastructures should also be environmental friendly and should enhance effective environmental planning. Co-location is at the moment in practice in USA, Europe, Asia some part of Africa such as Kenya, Mauritius etc.

Recommendations

This research recommends the precautionary approach for the deployment

of telecommunication infrastructure in Enugu Urban Area of Enugu State Nigeria. From the data collected from various respondents and in line with current global trend in telecommunication management, the following measures could be adopted in the deployment and management of the future location, distribution of telecommunication masts with the following recommendation as deduced from this study;

1. Government should make it mandatory for telecommunication service providers through proper legislative backing to erect environmental friendly GSM masts, with landscaped perimeter fencing and encourage the use of stringent policies to reduce its impact on environmental planning. The legislative backing to be passed by the State House of Assembly should include current acceptable environmental practice a standard for each mast to be erected failure to comply would attract stiff penalty and subsequent violations to attract heavier fines.
2. Government should take inventory of existing telecommunication masts with a view to exploring the use of collocation infrastructures by the telecommunication service providers themselves. The use of Co-location will reduce the use of multiple single user telecommunication infrastructures. Co-location is the use of single cell site by multiple telecommunication operators. This will reduce the erection of multiple single cell sites, reduce violation of land use which poses aesthetic nuisance, visual intrusion which is at conflict with city beautification and curtail multiple environmental problems spread across by each telecommunication operators. Such Co-location infrastructures should also be environmental friendly and should enhance effective environmental planning.
3. Government should in conjunction with a Technical Telecommunication Infrastructure Provider together with legislative backing set up a Co-location Telecommunication Infrastructure for all Service Providers to subscribe to. This involves passing into law by the State House of Assembly the use of An Independent Co-location Infrastructure Provider as a permanent solution to erratic mast erections, appropriate parcels of land of average 20m X 20m to accommodate a maximum of six (6) operators per location and liaising with technical partners to provide Co-location Infrastructure that will be subscribe by the service providers. This will act as income generating opportunity for the state, employment opportunity and in general sound environmental practice.
4. The study also recommends that Government agency in charge of planning of telecommunication masts should be alive to its responsibilities given the unplanned nature of masts locations. It recommends further that the telecommunication operators should put in place their infrastructural expansion plan which should be integrated with the existing land use plan of the residential areas.
5. It is also recommend that all the prime actors should take responsibility of abiding by the policies, standards and criterion guiding the erection of telecommunication masts to reduce its impact on environmental planning.
6. In addition, it is recommended for further research: factors mitigating the impact of telecommunication masts on environmental planning a global challenge.

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