

Locational Effect of GSM Mast on Neighbouring Residential Properties' Rental Values in Akure, Nigeria

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Doi:10.5901/ajis.2013.v2n3p147

Abstract

This paper examined the response of rents from residential properties to the siting of Global System for Mobile (GSM) Communications' masts in various residential zones in Akure town. The study employed survey approach in order to understand the relationship that exists between location of GSM masts and rental values offered on proximate residential properties within a 300 metres radius of GSM masts. The town was divided into high, medium and Low density zone; and three GSM masts were selected from each of the zones for the study. In all, a total of 180 questionnaires were administered on residents within the radius and 139 (77.22%) were retrieved and good for analysis. Regression analysis was employed to determine the causal effect of GSM mast on the rental values of neighbouring residential properties in the study area. The findings revealed that the location of GSM mast has no significant effect on rental values of residential properties in the high and medium density residential zones of Akure. This is attributable to the fact that demand for residential properties in town is generally very high, and the residents are left without much choice due to attendant high rent charged on existing residential properties. However, there exists a positive effect on rental values of properties in the low density zone. There is need for the Nigerian Communications Commission (NCC) to follow the global trends on new findings about health implication of siting of GSM base stations around residential neighbourhood and ensure that international standard of safety is strictly adhered to by the operators in Nigeria.

Keywords: Akure, Residential properties, GSM Mast, Rent, Rental Value.

1. Introduction

The increasing need for functional telecommunication networks to service the desires and need of the teeming users for effective communication and the use of mobile phones has increased dramatically over the last decade. The launch of Global System for Mobile (GSM) Communications in Nigeria in 2001 heralded a dawn of relieve to teeming Nigerians. Today services like mobile TV, electronic payments, mobile tracking services, cheaper international calls, internet banking, and mobile banking etc. occasioned by mobile telecommunication are commonplace in the country. GSM has become a vital and an indispensable tool of transmitting or exchanging information for a modern man (Bello, 2010). Wireless digital telecommunications, the internet and information communication technology have revolutionized the world and the impact of information technology (IT) has been felt in all economic and social activities in every conceivable manner. The convergence of all forms of communications on the digital playfield is opening up immense new possibilities of achieving speed, versatility and space-time independence. The use and deployment of cellular phones and other wireless communication facilities around the world is phenomena, it has not only reduced the world into a global village but more importantly into a global household. What was once solely a business tool; wireless phones are now a mass market consumer device contributing positively, to the Gross Domestic Products (GDP) of various countries and providing

job opportunities to millions of youths, professionals and even petty traders (Otubu, 2012).

GSM base stations and cellular telephone masts form part of the infrastructure required for an effective communication system. In order to have optimal network coverage, most base stations locate in close proximity to the target users; the reason telecom operators also site their masts in residential neighborhoods. 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 used for the data transfer between mobile telephones and base stations and the possible negative effect on health has been a thing of concern to many people including researchers. Many studies have linked certain health condition to hazard of exposure to electromagnetic fields. Although studying effects of electromagnetic field on health have been discouraged by authoritative bodies like WHO (2006) International EMF Project and COST 281 (Kundi and Hutter, 2009), available literature have not totally allayed the fear attributed to the perceived danger associated with living close to the station. The choice of where to reside as tenant is premised on many criteria which could be internal or external to the rented apartment. The importance attached to the choice eventually made determine what they will be willing to pay as rent.

Akure is currently experiencing a high pace of urbanisation compared to other emerging cities in Nigeria (Tofowomo, 2008) and there is increasing need to service the populace with tele-communication infrastructure. This has led to proliferation of many GSM base stations around the city. In spite of many perceived health-related problems claimed to be associated with electromagnetic emissions from GSM base stations, the proximity of the stations do not appear to influence decision of many individuals on where to reside. The rent offered to pay on an apartment is reflection of the value attached to the location by the prospective tenant. However, some residential properties in the neighbourhood of GSM masts command rents as high as those properties that are not in close proximity. People who live close to GSM masts perceive the sites less negatively than those who live further away (Bond, Mun, Sakornvanasak and McMahon, 2003; Bond and Wang, 2005). Some investors do not see any evil in developing residential properties close to existing masts, while some land-owners lease part of their undeveloped lands to companies in order to site GSM base station. The questions therefore are what is the rate of demand for properties in close proximity to GSM masts; what factors prompt tenants to take up accommodations in close proximity to GSM masts and how does this proximity reflect in the various properties' rental value? This study therefore, looks into the effect of GSM mast on residential properties' rental values in Akure.

2. Literature Review

2.1 GSM Base Stations and Health Hazards

Man as a social being must interact and this is achieved by exploring every avenue that provides a cheap mean among alternatives. Cell phones serve as tool for social connection and managing social relationships among people (Banjo, Hu and Sundar, 2008). However, there is currently considerable confusion over the health and safety issues relating to non-ionizing radiation emitted by GSM telephony base stations and handsets. There is obviously conflicting information from the various scientific sources and environmental groups with respect to health hazards associated with GSM telephony (Yusuf, 2009).

A growing number of studies have linked electromagnetic field associated with the operation of mobile telephony with health hazards ranging from changes in cognitive performance and sleep disturbances to serious illness and disablement, with even higher cancer rates (Abdel-Rassoul, Abou El-Fateh, Abou Salem, Michael, Farahat, El-Batanouny, and Salem (2006).; Bortkiewicz et al., 2004; Cherry, 2000; Eger, Hagen, Lucas, Vogel and Voit, (2004).; Hutter et al., 2006; Navarro, Segura, Portolés, Gómez-Perretta, 2003; Santini, Santini, Danze, Le Ruz, Seigne, 2002.; Wolf and Wolf, 2004). Hamblin and Wood (2002) claimed that exposures to electromagnetic radiation can affect the natural rhythms of the brain's electrical activity, as measured by Electroencephalogram. Fernie and Reynolds (2005) iterated that studies of the effects of exposure to electromagnetic fields on populations of wild birds can provide further insights into the potential impacts on animal and human health. According to Cherry (2000), cell sites are risk factors for cancer, specifically brain tumours and leukemia; 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.

Contrariwise, some research works opposed the assertion that erection of GSM mast within residential neighbourhoods has negative effect on people's health. For instance, Chagnaud et al. (1999) and Heikkinen et al. (2001)

looked at the short time effects of pulse microwave radiation on rodents and the result produced negative evidence of the effect of mast on these animals. This further alleviated the fears of people who live in close proximity to these masts. In September 1999, the Health Council of the Netherlands received a request from the Minister of Housing, Spatial Planning and the Environment; Minister of Health, Welfare and Sport; the State Secretary of Social Affairs and Employment and the State Secretary of Transport, Public Works and Water Management to advise on whether exposure to electromagnetic fields used for the data transfer between mobile telephones and base stations may result in negative health consequences. The Committee based its report on several reviewed articles and reports which have been published in recent years. Both thermal and non-thermal effects of GSM base stations on health were examined. It could not be established if exposure to electromagnetic field could cause changes to the functioning of the cell membrane. Damage to the DNA, the genetic material, which can form a step in the development of cancer, could not also be established. The effects on brain function were investigated and on the basis of the available data, the Committee concluded that the occurrence of health problems at exposure levels associated with the use of mobile phones is unlikely. It is considered virtually impossible that the low field strengths in the vicinity of base stations give rise to changes in cognitive functions (Health Council of Netherland, 2000)

Norwegian Institute of Public Health was commissioned by the Ministry of Health and Care Services and the Ministry of Transport and Communication in 2009 to summarise the knowledge regarding exposure to weak high-frequency fields and present a report of the current management practices in Norway and in comparable countries. The purpose is to investigate the management and regulations concerning electromagnetic radiation, including the placement of mobile masts, base stations and wireless networks. The Expert Committee reviewed previous scientific reports from independent expert panels worldwide, as well as recently published studies on the possible effects on health following exposure to weak RF fields and presented specific report on the link between use of mobile phones and base stations and cancer, reproductive health, heart, blood pressure and circulation, the immune system, hormonal effects, effects on the nervous system, changes in gene expression, and electromagnetic hypersensitivity. A large number of scientific studies agree that it is probable that the physical characteristics of electromagnetic fields are not the direct or contributory cause of health problems attributed to electromagnetic fields (electromagnetic hypersensitivity). The Committee believes that there is no need to revise radiation protection legislation for individuals who attribute their health problems to electromagnetic field exposure (Norwegian Institute of Public Health, 2012). It is scientifically improbable that the reduction of exposure to electromagnetic fields is significant for health problems attributed to electromagnetic fields. The Committee therefore believes that there is no basis to recommend measures aiming to reduce exposure to electromagnetic fields for individuals with health problems attributed to electromagnetic fields. The health service and other parties should instead encourage the reduction of avoidance behaviour and discourage implementation of measures for which there is no scientific basis. However, it recommended that it is always important to respect individuals and their choices.

2.2 GSM base Station and Property Values

Understanding the effects of cell phone base stations on property values is important to telecommunications companies in planning the siting, and handling likely opposition from property owners. Similarly, property valuers need to understand the valuation implications of this when valuing properties which are in close proximity to cell phone base stations (Bond *et al* 2003). Considerable growth in the use of mobile phones has led to increasing demand for land to site telecommunication base stations and associated infrastructures (Biebuma and Esekhaigbe, 2011). The literature on the impact of GSM base station on property values is still very scanty especially in developing countries. Bello (2010) examined the variation in the satisfaction of people living around GSM base stations with samples drawn from Akure, Nigeria. Using Crosstabs' nominal-by-nominal measures, 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. However, the result of the study did not show how property values respond to base station situation whether it increases or reduces rent passing on these properties.

Bond *et al* (2003), studied residents' perceptions toward living near Cell Phone Base Stations (CPBS) and how they evaluate the impacts of these structures. Two case study areas in the city of Auckland, New Zealand were selected in order to understand how residents' perceptions impact on property values. The study revealed mixed responses from residents ranging from being prepared to pay the same to being prepared to pay more than twenty percent less for a property located near a CPBS. Bond and Beamish (2005) assessed the perceived impact of cellular phone towers on

residents and property values in Christchurch, New Zealand. The study revealed that people who live close to a CPBS perceive the sites less negatively than those who live further away. However, overall, respondents would pay from 10-19% less to over 20% less for a property if it were in close proximity to a CPBS.

Brandt and Maennig (2012) examined the impact of cell phone base stations on prices of condominiums in Hamburg, Germany. The study distinguished between individual masts and groups of masts and it was found that only immediate proximity to groups of antenna masts is perceived as harmful by residents of nearby condominiums. For individual masts no effect on residential property prices in the surrounding areas was observed. It was recommended that cell phone service providers should prevent installation of groups of masts in a single location.

3. Methodology

The data for this study was gotten from 3 residential neighbourhoods in Akure South Local Government Area of Ondo State. Akure was divided into three residential strata according to the density zones namely the high, medium and low density zones. In each zone, residential properties within 300 metres radius of three different GSM masts were conveniently sampled for questionnaire administration. A total of 180 structured questionnaires were administered on the occupiers of these residential properties out of which 139 (77.22%) were retrieved for analysis.

The questionnaire for the occupiers of the residential properties were structured to get information on their level of satisfaction with living in close proximity to GSM mast, the effect of the GSM mast on the rent paid on the residential property, factors that motivated tenants to locate near a GSM mast, and rent paid on their accommodation over a period of time among others.

The data collected were analyzed using descriptive statistics (Mean Score) and inferential statistics in form of Linear Regression Model.

The Regression Model used is of the form;

$$RENTV = b_0 + b_1DISTM + e$$

Where;

RENTV = the rental value of the properties

DISTM = the distance of the properties from GSM mast

b_0 = Regression coefficient for variable DISTM

e = error term.

Table 1: Operationalization of Variables

Variables	Definition of Variables	Measurement
RENTV	Rental Value	Naira (N)
DISTM	Distance from GSM Mast	Metres

Source: Compiled by the Author

4. Data Analysis and Discussion of Findings

The level of awareness of the effect of the radioactive emission from GSM mast by the respondents on human health was relevant in this section as this determines their willingness to live in close proximity to these masts. Table 1 below revealed their responses in this regard.

Table 2: Respondents' Awareness of the Effect of GSM Mast on Health

Response	Frequency	Percent
Yes	75	54.0
No	64	46.0
Total	139	100.0

Source: Field Survey, 2012

From the table, 54% of the respondents show awareness of the negative effect of GSM mast on human health while 46%

do not. There is little difference in the level of awareness of respondents indicating that many residents do not take cognizance of the location of GSM Mast in their neighbourhoods before locating there. Some property owners even permit the erection of masts within their premises.

Based on the awareness of the respondents on the effect of GSM mast on health, their feelings about having a mast located within their neighbourhoods were sampled and the result is as shown in the Table 3 below.

Table 3: Feelings of Respondents about Erecting GSM Mast in their Neighbourhood

Feelings about Mast Erection in the Area	Frequency	Percent
Positive feeling	21	15.1
Negative feeling	20	14.4
No feeling	98	70.5
Total	139	100.0

Source: Field Survey, 2012

From table 3 above, majority of the respondents (70.5%) indicates no feeling about the presence of GSM mast in their neighbourhood. 21(15.1%) are happy about the location of Mast in their neighbourhood, while only 20 respondents representing 14.4% have negative feeling concerning it. This result reveals the reason behind respondents living even in compounds where there is GSM mast.

The opinions of the respondents were also sought on the factors that actually motivated them into residing within their neighbourhoods. This was done in order to confirm if the presence on GSM Mast in the neighbourhood was a major factor or not. The result is shown in table 4 and 5 below.

Table 4: Factors that Motivate tenants' choice of Residential Location

Variables	Low Density		Medium Density		High Density	
	Mean	Rank	Mean	Rank	Mean	Rank
Constant Electricity Supply	3.08*	5	3.14*	1	2.64	7
Affordable Rent	3.06*	7	2.88	2	3.17*	3
Availability of pipe borne Water	3.08*	5	2.86	3	2.17	9
Good GSM Network	3.43*	2	2.62	4	3.46*	1
Security	3.91*	1	2.62	5	2.81	6
Nearness to Work Place	3.11*	4	2.45	6	2.88	5
Good Access Road	3.02*	8	2.36	7	2.63	8
Nearness to Children's School	3.34*	3	1.95	8	2.93	4
Nearness to Main Market	2.70	9	1.57	9	3.32*	2

Source: Field Survey, 2012

Table 5: General Response on factors that motivates tenants' choice of residential location

Variables	Mean	Rank
Good GSM Network	3.24*	1
Affordable Rent	3.06*	2
Constant Electricity Supply	2.90	3
Security	2.88	4
Nearness to Work Place	2.84	5
Nearness to Children's School	2.81	6
Good Access Road	2.68	7
Nearness to Main Market	2.68	8
Availability of pipe borne Water	2.63	9

* indicates major factors.

Source: Field Survey, 2012

From table 4, all the factors listed are considered by the respondents in the Low Density area of Akure before residing within their neighbourhoods except Nearness to Main Market with mean response of 2.70. Security of the neighbourhood, availability of good GSM network and nearness to children's school are the most relevant of these factors with mean response of 3.91, 3.43 and 3.34 respectively. In the High density area, Good GSM network, Affordable rent and Nearness to main market are the major factors put into consideration. However, in the Medium density area, only constant electricity supply is being considered by the tenants. This is evidenced with a mean response of 3.14. From the table, there is evidence that tenants want to locate where there will be good communication network; hence, they do not feel bad about residing near GSM Mast.

From Table 5 above, the overall response from respondents in Akure shows that Good GSM network and Affordable rent passing on the property with mean responses of 3.24 and 3.06 respectively are the major factors that motivate their choice of residential location.

Tenants' haven found themselves in a neighbourhood where there is/are GSM masts, it becomes important to analyse the level of satisfaction of the respondents with the presence of the mast within a few meters of their houses. This is shown in table 6.

Table 6: Residents' Satisfaction with Mast's erection in the Area

Satisfaction with Mast erection in the Area	Frequency	Percent	Mean
Not Satisfied	24	17.3	2.40
Does Not Matter	66	47.5	
Satisfied	19	13.7	
Highly Satisfied	30	21.6	
Total	139	100.0	

Source: Field Survey, 2012

Table 6 shows that most of the respondents (47.5%) do not see anything wrong in having Mast around them 21.6% and 13.7% of the respondents are highly satisfied and satisfied respectively, while only 17.3% are not satisfied with GSM Mast being located within their neighbourhood. This is an indication that most residents do not perceive any danger or problem inherent in having mast near their residence. This however contradicts the findings of Bello (2010) which reveals that residents within a close proximity of GSM mast are not satisfied with the location of the mast in their neighbourhood. The perception of the respondents to the effect of mast on health has changed over the years as people no longer consider mast a threat to their health. The level of satisfaction of the respondents further reveals that Mast location is not a criterion for choice of accommodation by tenants within a neighbourhood.

Table 7: Respondent's Perception on the Effect of Mast on Residential Property

Effect of Mast on Residential Property	Mean	Rank
Loss of Aesthetic Value of Neighbouring Properties	3.52	1
Increase Demand	1.98	2
Reduce Demand	1.76	3
Reduce Rent for Houses	1.75	4
Increase Rent for Houses	1.75	4

Source: Field Survey, 2012

From table 7 above, Loss of aesthetic value of the neighbourhood was the only major effect that mast has on properties in the neighbourhood. This is evidenced by the mean score of 3.52. However, it does not have effect on the economic values of properties in the area and neither does it increase nor reduce the demand for and rent of residential properties in the area. This shows that landlord do not consider this when fixing the rents on their properties. The only major effect which a Mast has on neighbouring properties is that of loss of aesthetic values of the property. This supports the findings of Picard (1996) and Bond et al. (2003) that GSM mast or base station hampers the aesthetic view of neighbouring residential properties. This is in form of blockage of views of the properties. However, it neither increases nor decreases the demand or rent passing on properties.

4.1 Regression Analysis of the effect of GSM Mast Location on Neighbouring Residential Properties' Rental Values

From each of the zones, a dominant type of rented residential property was selected and the rental value regressed against the distance of the property from GSM Mast. The results of the regression analyses are presented in tables 8 - 16 below.

Table 8: Summary of Model of 4 Bedroom bungalows (Low Density)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.889(a)	.791	.765	49805.522

R is 0.889, R – Square is 0.791, Adjusted R – Square is 0.765

Source: Field Survey, 2012

Table 8 reveals the Adjusted R² statistic as 0.765. This shows that 76.5% of the sample variation in the rental values of 4 Bedroom Bungalows in the Low density area of Akure is attributed to the independent variables (distance from GSM Mast). The computed F statistics (F = 30.297) in Table 9 falls in the rejection region. The data provides strong evidence that the model coefficient is non-zero and hence the model will be useful in predicting rental value of 4 Bedroom Bungalow in the low density area.

Table 9: Analysis of Variance (4 Bedroom Bungalows)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	75155279503.106	1	75155279503.106	30.297	.001(a)
Residual	19844720496.894	8	2480590062.112		
Total	95000000000.000	9			

Source: Field Survey, 2012

Table 10: Summary of Model of 3 Bedroom flats (Medium Density)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
2	.595(a)	.354	.246	35906.090

R is 0.595, R – Square is 0.354, Adjusted R – Square is 0.246

Source: Field Survey, 2012

Table 10 reveals the Adjusted R² statistic as 0.246. This shows that 24.6% of the sample variation in the rental values of 3 Bedroom flats in the medium density area of Akure is attributed to the independent variables (distance from GSM mast). The computed F statistics (F = 3.286) in Table 11 falls in the rejection region. The data provides evidence that the model coefficient is non-zero and hence the model will be useful in predicting rental value of 3 Bedroom flat in the medium density area.

Table 11: Analysis of Variance (3 Bedroom flats)

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	4236391129.032	1	4236391129.032	3.286	.120(a)
Residual	7735483870.968	6	1289247311.828		
Total	11971875000.000	7			

Source: Field Survey, 2012

Table 12: Summary of Model of Tenement Buildings (High density)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
3	.167(a)	.028	.007	4254.255

R is 0.167, R – Square is 0.028, Adjusted R – Square is 0.007

Source: Field Survey, 2012

Table 12 reveals the Adjusted R² statistic as 0.007. This shows that 0.7% of the sample variation in the rental values of Tenement Buildings in the High density area of Akure is attributed to the independent variables (distance from GSM Mast). The computed F statistics (F = 1.313) in Table 13 falls in the rejection region. The data provides weak evidence that the model coefficient is non-zero and hence the model will not be useful in predicting rental value of Tenement Building in the high density area.

Table 13: Analysis of Variance (Tenement Buildings)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	23767090.953	1	23767090.953	1.313	.258(a)
Residual	832539575.713	46	18098686.429		
Total	856306666.667	47			

Source: Field Survey, 2012

Table 14: Regression Coefficient of the distance of 4 Bedroom Bungalows from Mast

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	534472.050	37030.499		14.433	.000
Distance from GSM Mast	-68322.981	12412.651	-.889	-5.504	.001

Source: Field Survey, 2012

Table 15: Regression Coefficient of the distance of 3 Bedroom flat from Mast

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	90645.161	32244.621		2.811	.031
Distance from GSM Mast	33064.516	18240.312	.595	1.813	.120

Source: Field Survey, 2012

Table 16: Regression Coefficient of the distance of Tenement Buildings from Masts

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	18994.001	1359.022		13.976	.000
Distance from GSM Mast	456.767	398.593	.167	1.146	.258

Source: Field Survey, 2012

Tables 14, 15 and 16 above show the regression coefficients of the distance of 4-Bedroom Bungalow in the Low density, 3-Bedroom flat in the medium density and Tenement Buildings in the high density areas of Akure from GSM masts respectively. From Table 14, the Rental value of 4-Bedroom Bungalows in the low density area is strongly and negatively influenced by the distance from GSM mast. This is evidenced by the correlation matrix of -0.889 and this is significant at 0.001 significant levels. On the other hand, Tables 15 and 16 show weak positive correlation and influence of distance of

GSM mast on neighbouring 3-Bedroom flats and Tenement Buildings respectively. However, these influences are not statistically significant at 0.05 significant levels. Therefore, it can be said that the rental values of properties in the medium and high density areas of Akure are not affected by their distance from GSM Mast while that of 4-Bedroom Bungalows in the low density area are affected by their location near GSM Masts.

5. Conclusion and Recommendation

The result of the findings from this paper revealed that the percentage number of the respondents who perceive the electromagnetic emission from GSM mast as dangerous to their health is not different from those who do not hold such opinion. This was reflected in the way the respondents feel about the presence of the masts in their neighbourhood. This consequently has a bearing on their willingness to pay for their present accommodation without consideration for GSM masts' location. Therefore, an investor in residential property within any zone in Akure should work more at improving the quality of facilities provided in the building in order to enhance the value of such. It is also recommended that the Nigerian Communications Commission (NCC) should follow the global trends on new findings about health implication of siting of GSM base stations around residential neighbourhood and ensure that international standard of safety is strictly adhered to by the GSM operators in Nigeria.

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