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ASSESSMENT OF RADIO WAVES PROPAGATION PATTERN FROM RADIO STATIONS IN LOKOJA AND OKENE, KOGI STATE, NIGERIA

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ABSTRACT: *Okene, Lokoja and their environs have been experiencing radio signal distortions and have been of great concern to the citizens due to bad quality signals and signal attenuation increase. This study assesses the patterns of radio wave propagation from five radio stations in Lokoja and Okene, Kogi State, Nigeria. Equipment, a field strength metre was used to measure signal strengths and quality of radio signals. Six locations in both Lokoja, Okene and the environs were selected for each radio station. The approximate distances between the transmitting and receiving antennas were determined. Thirty-five locations were measured inclusive of the five radio stations and the six selected positions. Three locations in Okene and another three locations in Lokoja were used. Thereafter, calculations of the signal wavelengths of each radio station and the free space path-loss of signals were calculated at the positions. Factors such as reflections by buildings, mountains and vegetation cover, refractions by the rivers, streams, rainfall and absorption of the human abdomen were looked into at such areas as likely causes of signal attenuation. Good locations to site FM radio stations were determined from the results. The approximate distances from the stations to establish booster stations in order to receive news adequately were also determined.*

KEYWORDS: Radio waves; attenuation; impedance mismatch; path loss; EM fields; EM Spectrum; propagation pattern

INTRODUCTION

Radio waves are combinations of electric and magnetic fields emanating from the oscillation of electrons in an area. They cover a large range of strengths and are used mainly in communication [1]. Radio waves have the very important property of being refracted by the ionosphere if they are incident on the ionosphere at certain angles. Very high-frequency (VHF) radio waves are not sufficiently refracted by the ionosphere, which has different refractive indices for different frequencies [2, 3]. Radio waves are usually beamed at a particular angle and secondary transmission stations pick up and re-radiate them. Although audio frequencies are much lower than radio frequencies, audio frequency information is carried by radio waves through a process called modulation [4]. In amplitude modulation (AM), the amplitude of the radio wave (wave carrier) is altered to correspond to that of the low-frequency audio wave. For frequency modulation (FM), the frequency of the radio wave is varied. A radio receiver picks up the radio wave and by demodulation obtains the audio frequency information [3, 5]. The energy in electromagnetic radiations is radially emanated, formed by the combined vibration of both the electrical and magnetic fields. This energy can travel in the vacuum of space, unlike sound which needs air for its propagation. The electric and magnetic fields that comprise an electromagnetic wave are perpendicular to each other in the direction of the travelling wave, and it travels at the speed of light until it interacts with substantial objects which may interfere with its propagation, such as concrete or metal [1]. According to Saroj and Smruti [6], Electromagnetic interference is a result obtained when electromagnetic fields interfere with one another, which leads to the distortion of the two fields. This is commonly observed in radios when switching between frequencies and channels experience noise, as well as on over-the-air Television when the picture becomes distorted as a result of distortion in the signal.

A radio frequency field (RF field) is an alternating current that, when put through an antenna, generates an electromagnetic field called a radio frequency field and is propagated through space for wireless broadcasting or communication by sending a current through an antenna. A radio frequency field covers a major portion of the electromagnetic radiation spectrum. Sources such as mobile radio communication transmissions, radio and television broadcasting, radar, and cell phones produce RF fields [7]. This is also called a radio wave. Ellingson [8] described radio propagation as the transmission of radio signals from one point to another within the earth's atmosphere. They are electromagnetic waves, thus, exhibit properties such as reflection, refraction, diffraction, absorption, polarisation and scattering. Radio propagation is never 100% predictable and this is a reason strong probabilistic concepts come into play while transmitting. Many different protocols have been devised over the century for the propagation of radio waves; the distance between the transmitter and the receiver determines the mode to be adopted [9]. Radio signals are strongly influenced by objects in their path and the medium of propagation. This means that the strength of radio signal transmission is important when designing or operating a radio system [10].

The security of lives and properties has been and continues to be given critical consideration while embarking on any form of development by the government, individuals and/ or corporate organisations if such development intends to be sustained [11, 12]. A secure environment gives room for proper planning, establishment and management of both human and material resources needed to establish and manage any business [12]. In recognition of this, the federal government of Nigeria invests heavily in security by allocating a very significant percentage of its annual budget to security. Unfortunately, in Nigeria, insecurity

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has been increasing at alarming rates in the form of armed banditry, kidnapping and terrorism [13]. In many instances, people fall victim due to ineffective communication systems occasioned by the poor reception of radio signals from transmitting stations. This paper assesses the strengths and quality of radio signals from three radio stations in Lokoja and two in Okene, Kogi State, Nigeria with a view to suggesting ways of improving their signals for more effective and efficient communication with the people in remote areas, especially on security matters for sustainable development. The study will help in identifying locations for the sitting of radio stations for better quality and reception in the locality.

MATERIALS AND METHOD

Materials

The materials and their specifications used for the assessment of radio wave propagation patterns from three radio stations in Lokoja and two in Okene Kogi State, Nigeria include hand-held field strength metre, spectral V5 hand-held RF power metre, 8VSB (ATSC) modulator metre, and hand-held GPS.

The Field Strength Metre

Figure 1 presents a typical field-strength metre used in this study. This is a simple passive (unpowered) circuit in which radio frequency energy is intercepted by the antenna, rectified to DC, and then used to directly drive the metre. The maximum sensitivity of this circuit is based primarily on several factors such as:

- The gain of the antenna: How much of the signal is actually intercepted.
- The sensitivity of the metre movement being used.
- The capacity of the battery in the metre.

Fig. 1: High resistance/low conductance field strength metre

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Methods

Area of Study

Lokoja is located on latitude 07.80^0 North of the equator and Longitude 06.73^0 East of the meridian and situated at an elevation of 53 metres above sea level. The town is situated about 165km SouthWest of Abuja and 390km NorthEast of Lagos and is adjoined by Obajana, Okene, Kotokarfi and Ajaokuta. Lokoja, a city in Nigeria, lies at the confluence of the Niger and Benue rivers and is the capital city of Kogi state. While the Bassa Nge, Yoruba, Igala and Ebira are indigenous to the area, other ethnic groups of Nigeria, including the Igbo, Benin/Edo, Tiv and Nupe have recently established themselves there. It operates in the WAT time zone and covers a total area of 3,180km^2 with a population of 195,261 making it the fourth largest city in Kogi State (2006 census). The people in this town run different kinds of businesses such as hotels, filling stations, schools, civil service works, and supermarkets and 75% of others are farmers (fishing and crops farming). Radio stations in Lokoja town include Confluence FM (94.1FM radio), Grace FM (95.5FM) and Prime FM/FRCN (101.5 FM). While Okene is a town strategically located on latitude 7.55^{0}North of the equator and longitude 6.24^0 East of the meridian. The town is based in three local government areas: Adavi, Okehi and Okene. It runs along two highways with an area of 328km^2 and a population of 325,623 which makes it the largest city in Kogi State (2006 census). It is located in South Central Nigeria and lies at the intersection of roads from Lokoja, Kabba, Ikare, Ajaokuta and Auchi. The people in this town run different kinds of businesses such as hotels, filling stations, schools, civil services works, and supermarkets and 80% of others are farmers. Radio stations in Okene town include Kogi Radio (93.5 FM radio) and TAO FM (100.9 FM).

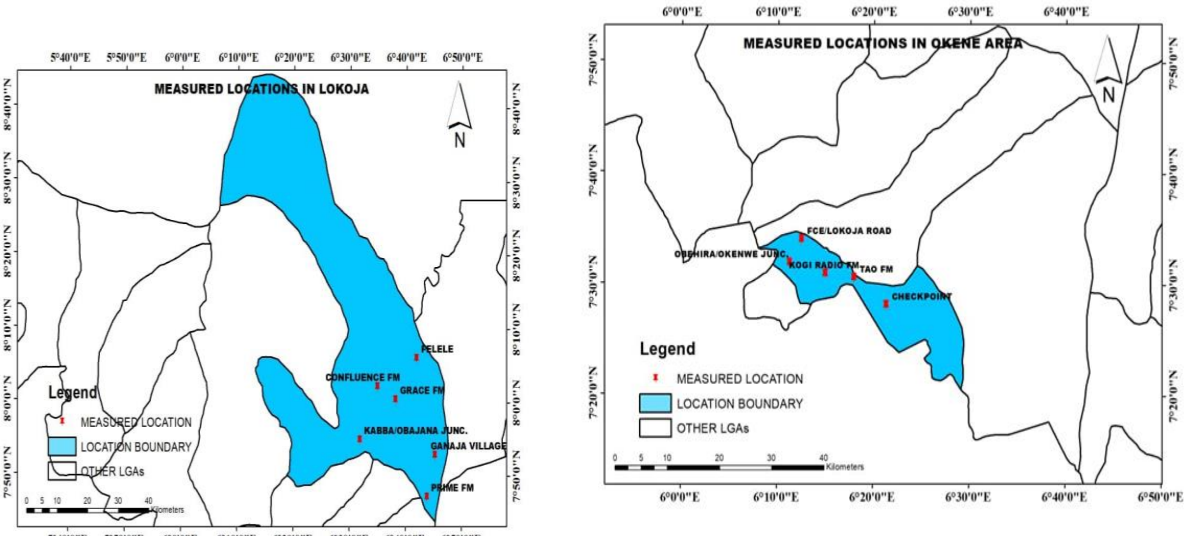

Fig. 2: Map of Lokoja and Okene showing the measured locations

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Method of Determining Signal Strength

The field strength metre was powered on, tuned in to radio frequency mode and FM was selected to capture only frequencies in the FM mode. The antenna was adjusted such that it could capture signals from various directions and allowed to scan the readings for about two minutes while watching and reading the screen continuously. The peak of the reading was taken within this period as the values of the readings fluctuate up and down. The approximate distance of the location (receiving antenna) to the radio channel (transmitting antenna) was also recorded. The reading was taken in an open space, to avoid interference with vegetation cover, trees, buildings and such external features. The readings were taken between 19th August and 3rd September 2019 (Sixteen days). The period fell into the rainy season but the rainy days were avoided because of the sensitivity of the equipment to water. The cloudy days were also exempted for better reception and signal quality. The readings taken at the radio stations are expected to have little or no distances from the transmitters which made the distances approximately zero at the radio stations.

The strengths of the radio signals were measured at six selected locations in Lokoja and Okene as points 02 to 07 which are several kilometres from the transmitting antenna. In addition, the signal strengths of the five radio channels were also measured at each of the radio stations as 01A, 01B, 01C, 01D and 01E which were compared with their strengths at those six locations. The approximate distances away from the radio channels to the selected locations were also recorded. Also, the data on the available transmitters' powers and the powers being transmitted by the radio stations were also obtained from the FM stations. The selected positions were just sampled geographically based on their likely coverage. Northern, Eastern and Western parts were considered in the sampling process. The Global Positioning System (GPS) of each location were taken and codes were assigned to each point as shown in Table 1.

Table 1: Codes for the selected locations and their GPS points

Locations	Codes	GPS Locations
The FM Stations (Kogi Radio)	01A	Lat.N7^{0}33'3.52116" & Long.E6^{0}13'59.38392"
(Confluence FM)	LK1A	Lat.N7^{0}48'32.80068" & Long.E6^{0}43'56.4798"
(Grace FM)	LK1B	Lat.N7^{0}48'33.84" & Long.E6^{0}43'53.15988"
(Prime FM)	LK1C	Lat.N7^{0}41'57.66252" & Long.E6^{0}44'8.7648"
(TAO FM)	01B	Lat.N7^{0}33'7.78788" & Long.E6^{0}14'16.208"
Ganaja Village, Jimgbe, Lokoja	02	Lat.N7^{0}42'52.06428" & Long.E6^{0}44'25.3986"
Felele, Lokoja	03	Lat.N7^{0}50'43.2132" & Long.E6^{0}44'53.007"
Kabba/Obajana Junction, Lokoja	04	Lat.N7^{0}449'32.37852" & Long.E6^{0}34'57.9666"
Check Point, Okene	05	Lat.N7^{0}31'37.32168" & Long.E6^{0}15'18.03816"
Obehira/Okenwe Junction, Okene	06	Lat.N7^{0}32'54.69" & Long.E6^{0}12'13.81788"
FC/Lokoja Road, Okene	07	Lat.N7^{0}36'35.09568" & Long.E6^{0}15'41.24988"

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Method of Calculating Wavelength

Wavelength (λ), which is the linear distance between two successive wave crests or troughs, was calculated using the following relation:

$\lambda = cf$ (1)

Where λ is the signal wavelength, c is the velocity of electromagnetic wave with constant value of $3x10^8 ms^{-1}$ and f is the frequency of the transmission

Method of Calculating Free Space Path Loss

Free space path loss (FSPL) of the signals as it propagates through distances is the attenuation of radio energy between the feed points of two antennas (transmitting antenna at the radio stations and the receiving antennas of the field strength metre). This was also calculated for each of the selected locations using the following equation:

$FSPL = \{ \frac{4\pi d}{\lambda} \}^2$
(2)

Where, d is the distance between the antennas, λ is the calculated wavelength from equation 1, and 4π is a constant.

RESULTS

Signal Strength

Tables 2 to 6 present the results of the signal strengths and approximated distances away from the radio channels as obtained at each of the FM radio stations. Meanwhile, at certain distant locations from the transmitters, there were no signals on the metre due to signals' attenuation. The signals became weak after going through a long distance and thus became attenuated in the process. This was observed largely when reading Okene from the distant area in Lokoja and when reading Lokoja from Okene.

Table 2: Data from Kogi radio at Okene Bar Area, Okene

Positions	Signal Strengths (dBμV)	Approximate distance btw the antennas $x10^3$ (m)	Frequency of the signal (MHz)
01A	100.9	0.0	93.5
02A	74.4	5.0	93.5
03A	59.1	5.5	93.5
04A	45.2	10.0	93.5
05A	30.3	71.0	93.5
06A	37.5	73.0	93.5
07A	Nil	75.0	93.5

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From Table 2, the signal strength from location 01A is very strong with value 100.9dBµV the signal even responded without connecting the equipment antenna to it and the distance between the antennas at this point is approximately 0.0m. Location 07A does not have a signal which may be due to several factors ranging from fading as a result of the distance between the antennas of approximately 75,000m to reflection, refraction, and diffraction of signals by obstacles could be responsible. Location 02A with an approximate distance of 5,000m has a signal strength of 74.4dBµV. It could be summarily inferred from the table that, the distance between the transmitting antenna and the receiving antenna is proportional to the signal strengths.

Table 3: Data from 94.1FM, Confluence FM, at Mount Patti, Lokoja.

Positions	Signal Strengths (dBµV)	Approximate distance btw the antennas x10^3 (m)	Frequency of the signal (MHz)
LK1A	108.2	0.0	94.1
LK2	58.7	4.0	94.1
LK3	79.9	3.0	94.1
LK4	66.7	5.0	94.1
LK5	Nil	75.0	94.1
LK6	38.8	72.0	94.1
LK7	38.9	68.0	94.1

From Table 3, the signal strength from location 01B is very strong with value 108.2dBµV and the distance between the antennas at this point is approximately 0.0m. Location 02 has 58.7dBµV against a distance of approximately 4,000m away from the transmitting antenna. Location 03 whose distance is 3,000m from the transmitter has a strength of 79.9dBµV while location 05 does not have a signal which may be due to a number of factors ranging from fading as a result of the distance between the antennas of approximately 75,000m, reflection, refraction, diffraction of signals by obstacles as it propagates media could also be responsible. Location 06 with an approximate distance of 72,000m has a signal strength of 34.8dBµV. It could be summarily inferred from the table that, the distance between the transmitting antenna and the receiving antenna is proportional to the signal strengths.

Table 4: Data from 95.5FM, Grace FM, at Mount Patti, Lokoja.

Positions	Signal Strengths (dBµV)	Approximate distance btw the antennas x10^3 (m)	Frequency of the signal (MHz)
LK1B	46.9	0.0	95.5
LK2	Nil	4.0	95.5
LK3	34.3	3.0	95.5
LK4	Nil	5.0	95.5
LK5	Nil	75.0	95.5
LK6	Nil	72.0	95.5
LK7	Nil	68.0	95.5

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From Table 4, location 01C is assigned to the radio station which housed the transmitter. The strength of the signal here is not very strong compared to other radio channels. It has a value of 46.9dBµV with the approximate distance between the antennas equal to 0.0m. Position 03 has a signal strength of 34.3dBµV against a distance of approximately 3,000m away from the transmitting antenna. Every other location, 02, 04, 05, 06, and 07 did not have signals though some positions at close range to the transmitting antenna. Impedance mismatch and or faulty transmitter could be responsible for these poor signals.

Table 5: Data from 101.5FM, Prime FM/FRCN, Near Stella Obasanjo's library, Lokoja.

Positions	Signal Strengths (dBµV)	Approximate distance btw the antennas x10^3 (m)	Frequency of the signal (MHz)
LK1C	73.2	0.0	101.5
LK2	68.4	0.2	101.5
LK3	48.6	4.0	101.5
LK4	42.6	6.0	101.5
LK5	Nil	75.0	101.5
LK6	50.0	73.0	101.5
LK7	34.2	65.0	101.5

From Table 5, the radio channel location recorded signal strength of 73.2dBµV with the approximate distance between the antennas of 0.0m. Location 02 has a signal strength of 68.4dBµV against a distance of approximately 200m away from the transmitting antenna. Locations 03, 04 and 05 of distances 4,000m, 6,000m and 75,000m have signal strengths of 48.6dBµV, 42.6dBµV and no signal respectively. The lack of signal recorded in location 05 could be due to fading as the signal propagates a long distance. Reflection, refraction, and diffraction by obstacles could also be responsible for the lack of signal. Meanwhile, position 06 has 50.0dBµV as against an approximate distance of 73,000m which has a higher signal value and longer distance compared to location 07 of 34.2dBµV and a distance of 65,000m. Since it's an electromagnetic wave, it may not have many factors to attenuate the signal along the 73,000m direction.

Table 6: Data from TAO FM, at Kuroko, Okehi

Positions	Signal Strengths (dBµV)	Approximate distance btw the antennas x10^3 (m)	Frequency of the signal (MHz)
01B	102.2	0.0	101.9
02B	64.4	4.0	101.9
03B	42.9	5.0	101.9
04B	46.7	5.0	101.9
05B	36.4	69.0	101.9
06B	Nil	72.0	101.9
07B	Nil	73.0	101.9

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From Table 6, location 01B which is the radio channel location recorded a signal strength of 102.2dBμV with the approximate distance between the antennas of 0.0m. Locations 06B and 07B recorded no signal which might have resulted from fading as the signals travel through different media over distances of 72,000m and 73,000m respectively. Apart from fading, these signal losses could be due to reflection, refraction, and diffraction by obstacles along its propagation paths.

Wavelength

Using Tables 2 to 6, the wavelengths (λ) for each of the FM radio stations were calculated using equation 1 and presented in Table 7. Here, both the frequency of the signal and wavelength is proportional to the velocity of the electromagnetic wave (speed of light) which is essentially a constant and has an approximate value of $3x10^8 ms^{-1}$.

Free Space Path Loss

Using Tables 2 to 7 and equation 2, the free path loss of the signals in each of the selected locations were calculated and presented in Table 8 to 12.

Table 7: Calculated values of the wavelengths

Radio Stations	Frequency (MHz)	Velocity (ms^{-1})	Wavelength (m)
Kogi Radio	93.50	$3.00x10^8$	3.21
Confluence FM	94.10	$3.00x10^8$	3.19
Grace FM	95.50	$3.00x10^8$	3.14
Prime FM/FRCN	101.50	$3.00x10^8$	2.96
TAO FM	109.50	$3.00x10^8$	2.94

From Table 7, since it is evident that higher frequency electromagnetic signal with a smaller wavelength will attenuate faster than a lower frequency signal with larger wavelength, the TAO FM is expected to attenuate faster than Kogi radio as they pass through various physical media such as brick walls and vegetation.

Table 8: Calculated free space path loss for Radio Kogi

Location/ Measured Values	Signal Strengths (dBμV)	Approximate distance btw the antennas $x10^3$ (m)	Wavelength (m)	Free Space Path Loss
01A	100.90	0.00	3.21	0.00
02	74.40	5.00	3.21	$3.84x10^{-4}$
03	59.10	5.50	3.21	$4.64x10^{-4}$
04	45.20	10.00	3.21	$1.53x10^{-3}$
05	30.30	71.00	3.21	0.077
06	37.50	73.00	3.21	0.08
07	Nil	75.00	3.21	0.09

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Table 9: Calculated free space path loss for Confluence FM.

Location/ Measured Values	Signal Strengths (dBμV)	Approximate distance btw the antennas x10^3 (m)	Wavelength (m)	Free Space Path Loss
LK1A	108.20	0.00	3.19	0.00
LK2	58.70	4.00	3.19	$2.49x10^{-4}$
LK3	79.90	3.00	3.19	$1.40x10^{-4}$
LK4	66.70	5.00	3.19	$3.89x10^{-4}$
LK5	Nil	75.00	3.19	0.09
LK6	38.80	72.00	3.19	0.08
LK7	38.90	68.00	3.19	0.07

Table 10: Calculated free space path loss for Grace FM

Location/ Measured Values	Signal Strengths (dBμV)	Approximate distance btw the antennas x10^3 (m)	Wavelength (m)	Free Space Path Loss
LK1B	46.90	0.00	3.14	0.00
LK2	Nil	4.00	3.14	$2.56x10^{-4}$
LK3	34.30	3.00	3.14	$1.44x10^{-4}$
LK4	Nil	5.00	3.14	$4.00x10^{-4}$
LK5	Nil	75.00	3.14	0.09
LK6	Nil	72.00	3.14	0.08
LK7	Nil	68.00	3.14	0.07

Table 11: Calculated free space path loss for Prime FM/FRCN

Location/ Measured Values	Signal Strengths (dBμV)	Approximate distance btw the antennas x10^3 (m)	Wavelength (m)	Free Space Path Loss
LK1C	73.20	0.00	2.96	0.00
LK2	68.40	0.20	2.96	$7.23x10^{-7}$
LK3	48.60	4.00	2.96	$2.89x10^{-4}$
LK4	42.60	6.00	2.96	$6.51x10^{-4}$
LK5	Nil	75.00	2.96	0.10
LK6	50.00	73.00	2.96	0.096
LK7	34.20	65.00	2.96	0.08

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Table 12: Calculated free space path loss for TAO FM

Location/ Measured Values	Signal Strengths (dBµV)	Approximate distance btw the antennas x10^3 (m)	Wavelength (m)	Free Space Path Loss
01B	102.20	0.00	2.94	0.00
02B	64.40	4.00	2.94	$2.92x10^{-4}$
03B	42.90	5.00	2.94	$4.56x10^{-4}$
04B	46.70	5.00	2.94	$4.56x10^{-4}$
05B	36.40	69.00	2.94	0.087
06B	Nil	72.00	2.94	0.095
07B	Nil	73.00	2.94	0.097

From Tables 8 to 12, we can see that in terms of the free space loss, frequency and wavelength properties of RF signal do not cause attenuation. Distance is the main cause of attenuation because as the signal travels through our atmosphere, the signal will attenuate to amplitudes below the received sensitivity threshold of a receiving radio. Therefore, the signal will arrive at the receiver, but it will be too weak to be detected. The relationship between signal strength, distance and free space path loss for radio stations is presented in Figures 3 to 7.

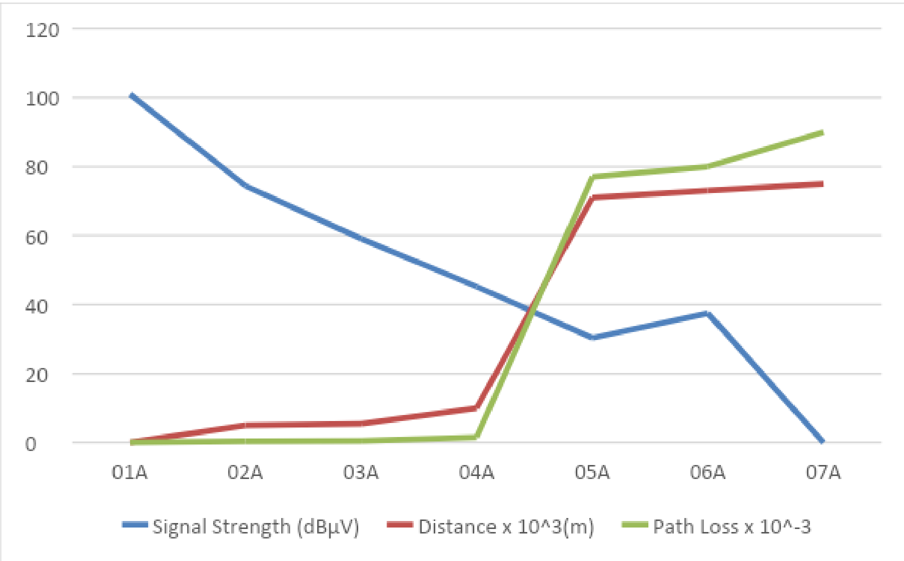

Fig. 3: Relationship between signal strength, distance and path loss for radio Kogi

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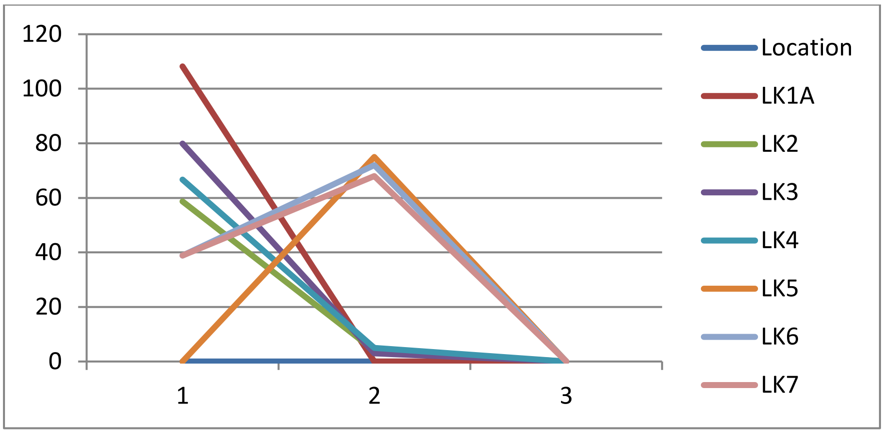

Fig. 3: Relationship between signal strength, distance and path loss for Confluence FM

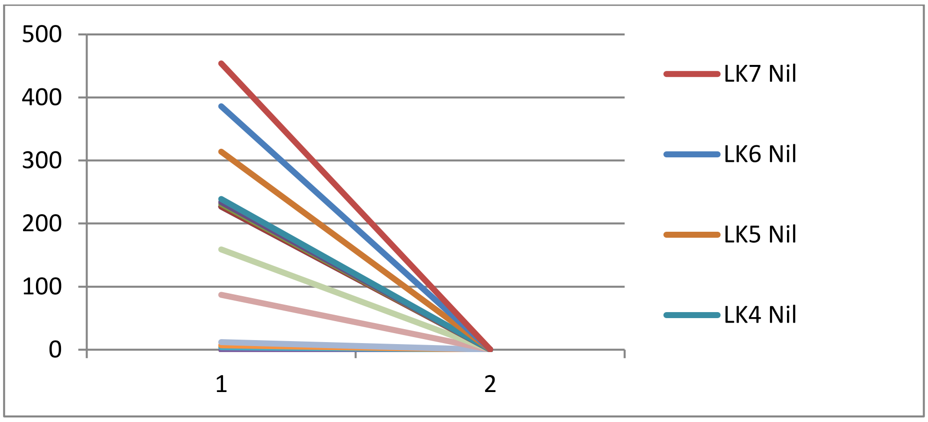

Fig. 4: Relationship between signal strength, distance and path loss for Grace FM

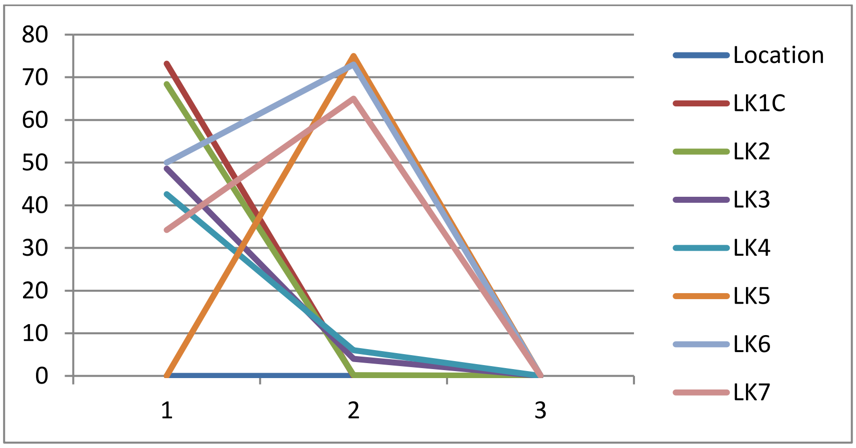

Fig. 5: Relationship between signal strength, distance and path loss for Grace FM

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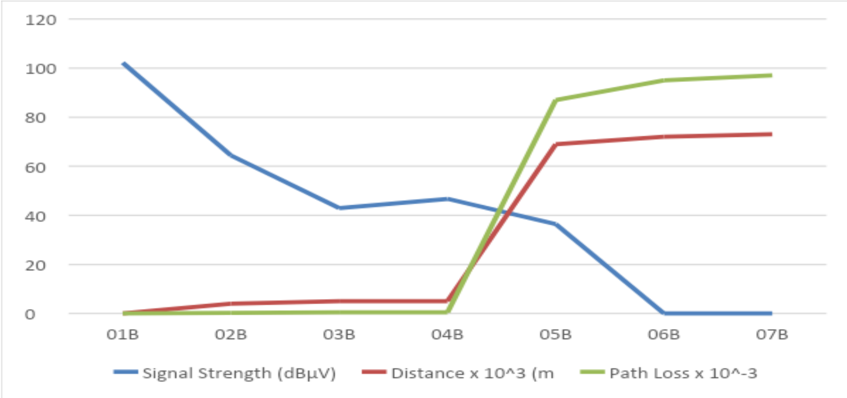

Fig. 4: Relationship between signal strength, distance and path loss for TAO FM

DISCUSSION

It has been shown that the wavelength of the signal is inversely proportional to the frequency. The higher the frequency of the channels, the lower the wavelength. The free space path loss depends on the distances between the two antennas. However, at the radio stations, the free space path loss is very low and almost zeros (0) because the distances between the antennas are very small. The signals at the respective radio stations were very strong due to the nearness to the transmitters. An exception was at the Grace FM where low signal strength was measured. The possible cause might be the power of the transmitter or its efficiency which the station engineers might not notice at the time of measurement. Another possible cause is impedance mismatch where the cable that links the transmitter to the antenna, the antenna itself and the transmitter all must be 75Ω each. Otherwise, impedance mismatch occurs and affects the output of the signal by the reflection of the part of the signals. The weather was not too good at that period, rain was gradually drizzling, which is capable of causing signal diffraction in the process and reducing the signal strength as supported by [18] from an experimental investigation of near sea-surface radio wave propagation.

The distance has a direct proportionality with the path loss and inverse proportionality with the signal strength. The more the distance, the higher the path loss. Radio stations have very strong signals as a result of the closeness to the transmitters. Vegetation covers, hills, mountains, trees, sea, rivers, bushes and buildings between these transmitting and receiving antennas also caused signal losses. Hard surfaces of obstacles like buildings, trees, and mountains along the propagation paths caused a signal loss in the form of refractions, diffractions, and reflections as observed by signals from TAO FM at Ganaja, Jimgbe and Felele while Kogi radio experiences such signals at Ganaja, Jimgbe; This fact, however, was supported by [14] in the analysis of signal loss modelling for near-ground radio wave propagation through forests with tree-canopy reflection effect. Similar research on surface wave propagation along multi-mixed paths with irregular terrain over spherical Earth in two-dimension (2D) by [15] also supported this claim.

Signals were weak in the densely populated areas because human bodies have a lot of influence on transmitted signals in spite of being at close ranges from the transmitting antennas because human bodies have a lot of influence on transmitted signals. This

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phenomenon was observed at Ganaja village, Jimgbe, Lokoja, when the signal from Confluence FM was measured. The signals of Grace FM and Prime FM as read from Felele, and Lokoja also established that there was obstruction of signals by human bodies due to the market scene, Motor Park, Kogi state polytechnic students and travellers. This phenomenon was also observed in the signals from the TAO FM and Kogi radio as measured at FC due to the population of the students and the business activities around the area and travellers linking Lokoja and Abuja. [16] had supported this through research work where analysis of the influence of a human body in dosimetry evaluations was carried out. A simplified human body model, including the dispersive nature of material parameters of internal organs, was implemented and observed that the received power level was lower in the human body when placed between the transmitter and the receiver. It was also shown that the influence of the person facing the transmitter is also considerable and that the received power levels for the measurement of the front part of the human body, specifically the abdomen and the knee had higher values of power than the rear part, back and back knee. This is of course due to the human body penetration losses which are present in the radio-electric path. However, these losses are greater in the abdomen part of the body than in the knee, due to the higher volume of mass as well as to the higher volume of liquid content in the first case. The path loss when compared with the measured signal strength showed an inverse proportionality at most of the locations.

CONCLUSION

In conclusion, all the radio stations transmit 2kW and above from their stations and are majorly located on the hills which in turn add up to the height of the antennas. These available factors are believed would help the radio stations maintain a wide coverage of signals, several other physical factors have limited their coverage from reaching the targeted audiences. Factors such as the availability of forests and vegetation, buildings and hills, human beings and sea or waters (rivers) have all limited the signal coverage. The results obtained have clearly indicated the best areas to receive signals from particular radio stations as a result of the signal strengths measured from such areas. Quality radio signals are therefore best enjoyed as analysed in the results. The results also show that the signal strengths at most of the locations have inverse proportionality with the calculated free space path loss. At reduced signal strengths, the path loss becomes higher. Approximately 70km from the main stations is recommended for booster stations depending on the locations of the targeted audiences. As part of the recommendations also, it is expected to guide the prospective radio stations on where to site future radio stations.

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