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Application of point-to-area propagation prediction models for digital terrestrial television network implementation in Nigeria

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ABSTRACT

The digital terrestrial television (DTT) network propagation models best fit for path-loss prediction in Jos and its environs, Plateau State, Nigeria is presented in this paper. The aim of the research is to establish the finest path-loss broadcast model for DTT network planning and deployment in Jos, Plateau State, Nigeria. The field strength, channel power and received signal strength parameters were measured from the field through a simple field measurement campaign spanning through the wet and dry season. The result obtained implies that Okumura-Hata and COST123 Walfisch-Ikegami models presented the finest performances in Jos and its environs with root mean squared errors (RMSEs) values of 0.4dB, 0.7dB, 0.2dB, 0.3 dB and 0.6dB, 0.5dB, 0.1 dB, 0.4 dB respectively along the measured roots. The Okumura-Hata and COST 123 Walfisch-Ikegami model present high performance level in terms of received signal strength when compared to other propagation models.

Keywords: Path-loss model, signal propagation, radio coverage, received signal strength, field strength.

1. INTRODUCTION

The radio propagation between transmitting stations and receivers in wireless communications are influenced by parameters like diffraction, scattering, and reflection. The radio signal path-loss rises with higher frequency; this defines the radio coverage of any network (Mohammed and Tharek, 2018). The decline in power density of an electromagnetic wave as it propagates over the space is defined as the path-loss of any signal which is an actual critical element in the investigation and planning of a link budget of a broadcast system (Goshwe et al., 2013).

Furthermore, path-loss is a function of the distance, effect of perturbations arising from the terrain and atmospheric conditions (Igbonoba and Obayuwana, 2021). These could be influenced by refraction, reflection, free space loss, diffraction, aperture-medium link loss and absorption. This may also be subject to topography and environmental contours, propagation channel, the space between the transmitter (TX) and the receiver (RX) sites, and the elevation and position of the antennas (Shalangwa and Jerome, 2010); (Green, 2004).

The radio wave propagation as defined by frequency, distance and other characteristics describes the genuine calculated plan of a radio propagation model (Mohammed and Tharek, 2018). The signal propagation from one point to another in-order to predict the path-loss effect in a single frequency network (SFN) or multiple frequency network (MFN) covered domain validate the aim of the signal propagation in a radio frequency (RF) (Mohammed and Tharek, 2018). Generally, higher frequencies affect the coverage areas a DTT system over the distances required with varied terrain characteristics (ITU-R P.452-12, 2007).

The survival of digital terrestrial television broadcasting (DTTB) network transmission in Nigeria is being threatened by the activities of atmospheric and environment perturbations prevalent due to the tropical nature of Nigeria (Igbonoba and Omoifo, 2021). This indicates that professional improvement in the design, planning, management and deployment of digital terrestrial television (DTT) facility should be of paramount importance to the radio Engineers. So to overcome the above problems, this study was initiated with the following objectives:-

1. To evaluate the DVB-T2 propagation path-loss model recommended by ITU for terrestrial point-to-area propagation prediction models for DVB-T2 network design and implementation.
2. Determination of the DVB-T2 best-fit propagation model for broadcast network planning and application in Jos and its environs.

The section 1 describes the introduction, the next Section contains the literature review, section 3 contains details of the materials and method used for the work, Section 4 describes the results and their discussions and, Section 5 gives a detail conclusion reached in actualizing the research objective to establish the finest path-loss broadcast model for DTT network planning and deployment in Jos, Plateau State, Nigeria.

2. LITERATURE REVIEW

(A) An overview signal propagation models

The physical tools of electromagnetic wave propagation are free space propagation, reflection, diffraction, and scattering (Kasampalis, 2018). These tools determine the propagation of electromagnetic signals. However, techniques and models have been established over time for predicting radio wave propagation. This research will focus more on empirical model of predicting radio wave propagation rather than the deterministic- geometrical models. The empirical models are better adapted to a fast, approximate and reliable calculation of coverage area without requiring an extensive knowledge of the terrain. These models use data collected from extensive measurements in different locations and presentation of simple equations with minimal reliance on the cartographic data.

(B) Propagation models

The calculation of DTTB coverage area is done by the application of point-to-area radio-wave propagation models (Igbonoba, 2021). This realized with the accessibility of territory elevation data for the facility region and the propagation paths between the assumed coverage region and the transmitters (ITU-R, 2016). The International Telecommunication Union (ITU) DTTB suggested propagation calculation models are the Okumura-Hata model, Cost 231- Hata and Cost-231 Walfish-Ikegami model (ITU-R P.1546-6, 2019). These deliver terrestrial point-to-area field strength calculation values founded on the numerical investigation of experimental data. This ITU suggested models will be compared with free space propagation path-loss model in order to validate the superiority of the suggested models over others in this research work.

(i) Okumura -Hata model

The combination of Okumura (1968) and Hata (1980) model gave rise to Okumura-Hata model (Imoize and Oseni, 2019). Okumura-Hata model application is suitable for macro cell environs, with empirical field measurements in and the surrounding of Tokyo city and the results obtained are best shown using graphical representation.

The presentation of the measurements carried out by Hata further resulted in a set of equations with additional correction factors for presentation in other terrains. This model can be useful in quasi-smooth environment in a metropolitan area without the extra correction factors. The Considerations for the Okumura-Hata model are as follows: Frequency (f): 150MHz-1500MHz, with likely extension from 1500MHz - 2000MHz, distance between transmitter station (TS) and base station (BS), distance (d): 1-20km, transmitter antenna height hb: 3-200m, receiver antenna height hm : 1-10m.

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Okumuru – Hata model is expressed mathematically as:-

Lp = 69.55 + 26.16logfc – 13.82log hb -a(hm) + 44.9 -6.55log(hb)log (d)+lothers s. 1

and

a(hm) = [1.1 log10 (f) – 0.7] hm - [1.56 log10 (fc) – 0.8] 2

where,

fc is the carrier frequency in MHz,

d is the distance in kilometer (Km),

h_b is the transmitter antenna height in meters (m),

h_m is the antenna height in meters(m).

l_{others} is the additional correction factor

(ii) Cost 231–Hata model

This model is applied for system frequencies up to 2000 MHz. Furthermore, this is realistic where the transmitting antenna is beyond the roofs of neighboring houses which permits lesser portable antenna heights than Okumura-Hata? (ITU-R, 2016). This is equally called enhanced form of the Hata model which extends from frequencies range of 1500 MHz to 2000 MHz with effective transmitter antenna height (h_{te}) from 30 m to 200 m, effective receiver antenna height (h_{re}) ranging from 1 to 10 m and distance d between transmitter and receiver from 1 km to 20 km and was developed by the working Committee for Scientific and Technical Research of European Cooperation in Science and Technology (EURO-COST).

The Path-loss calculation is expressed mathematically as:-

L_{50} (urban) (dB) = 46.33 + 33.9 log10 fc – 13.82 log10 h_{te} – a(h_{re}) +

(44.9 – 6.55 log10 h_{te}) log10 d + Cm 3

Where

a(h_{re}) is defined in Okumura-Hata model

$$Cm = \left\{ \begin{array}{l} o\ dB\ for\ medium\ sized\ city\ and\ suburban\ areas \\ 3\ dB\ for\ metropolitan\ centres \end{array} \right.$$

(iii) Cost-231 Walfish-Ikegami model

This model was designed for city regions where the obstructing structures altitude and street width, and other elements associated to the metropolitan terrain is taken into consideration. This equally regarded as an enhanced Ikegami model. The model's three basic components are:-

- Loss in the free space (L0)
- Loss by diffraction and scattering from rooftop to street (Lrts).
- Multi-screen diffraction losses (Lms) (Yazan, 2013).

To calculate for "street-canyon" propagation more accurately, building height and layout data are necessary for urban cell coverage calculations (ITU-R, 2016). The total attenuation loss for line of sight condition P_{LOS} is expressed mathematically as (Yazan, 2013).

$$P_{LOS} = 42.6 + 26 \log d + 20 \log f \quad 4$$

(iv) Free space path-loss model

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The free space path-loss model adopts a perfect state of a line-of-sight (LOS) between the TX and the RX. The radio wave propagation signal path usually follows Non-Line-of- Sight (NLOS) conditions with obstacles distorting the signal paths (Imoize and Oseni, 2019). In certainty, the free space model has limited application because it is based on ideal situations.

The hitches instigated by perturbations corresponding to free space loss find expedient presentations in the appraisal of path-loss between the portable station and the base station in difficult environments.

However, degradation and attenuation should be taken into consideration due to the changes in the environment caused by perturbations and other physical obstacles with respect to the LOS condition, while log-normal distribution is used to justify the effects of slow fading (Rappaport).

In free space, the power density S at a propagation space d is as shown in equation (5). The effective propagation range of the receiver antenna, which affects the received power, is given in equation (6) and the received power density is given in equation (7). By combining (6) and (7), the power received is given in (8).

$$S = \frac{P_t G_t}{4\pi d^2} \quad 5$$

where;

P_t = Power Transmitted

G_t = Gain of the transmission antenna

$$A = \left(\frac{\lambda^2 G_r}{4\pi}\right) \quad 6$$

where;

λ= Wavelength

G_r = Gain of the receiver antenna

$$S = \frac{P_r}{A} \quad 7$$

$$P_r = P_t G_t G_r \left(\frac{\lambda}{4\pi d}\right)^2 \quad 8$$

Free space path-loss is the ratio of the transmitted power to the received power, which is given in its Simplified form in (9). In logarithmic form, the free space loss is given in (13).

$$L = \left(\frac{4\pi d}{\lambda}\right)^2 \quad 9$$

$$PL\ (dB) = 92.44 + 20 \log10\ f\ (GHz) + 20 \log10\ d\ (Km) \quad 10$$

Alternatively path-loss lower frequency band is given as:

$$Lp\ (dB) = 20 \log10\ (f) + 20 \log10\ (d) - 20 \log10\ (\lambda) \quad 11$$

Then substituting λ (in km) and f (in MHz)) and rationalizing the equation produces the generic free space path-loss formula, which is stated in equation (12):

$$Lp\ (dB) = 32.4 + 20 \log10\ (d) + 20 \log10\ (f) \quad 12$$

$$L = 32.4 + 20\log10 F + 20\log10\ d \quad 13$$

where;

F is the frequency in mega hertz

d is the distance in kilometers

$$\lambda = C / F, \quad 14$$

(C) Path loss measurement and prediction

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Path loss being a function of terrain, frequency of operation and antenna height varies with respect to distance and power of the transmitter. Path-loss is expressed mathematically as (Kasampalis, 2018);-

Path-loss, $L_p = P_t\,(dB) – P_r\,(dB)$ 15

The relationship between P_t and P_r in a free space model, is given as

$$P_r = \frac{P_t \lambda^2}{(4\pi d)^2} \quad 16$$

The wavelength of the carrier is $\lambda = c / f$

$$P_r\,(dBm) = P_t\,(dBm) – 21\text{- }98 + 20\log_{10}(\lambda) – 20\log_{10}(d) \quad 17$$

$$L_p\,(d) = P_t – P_r = 21\text{- }98 – 20\log_{10}(\lambda) + 20\log_{10}(d) \quad 18$$

$$= Lo + 20\log_{10}(d) \quad 19$$

Where,

Lo is the path-loss at the first meter (put d = 1) and 20dB per decade loss in signal strength

P_t is the transmitter power

P_r is the receiver power

λ is the wavelength of the RF carrier

The relationship between P_t and P_r over a distance is given by

$$P_r = Pt\lambda^2 / (4\pi)^2 d^2 \quad 20$$

Where d is in meters, therefore

$$P_r\,(dBm) = P_t\,(dBm) – 21.98 + 20\log_{10}(\lambda) – 20\log_{10}(d) \quad 21$$

$$\text{Path loss} = L_p = P_t – P_r = 21.98 – 20\log_{10}(\lambda) + 20\log_{10}(d) \quad 22$$

$$\text{Path loss } PL_m\,(dB) = EIRP_t - P_r\,(dB) \quad 23$$

Where

$EIRP_t$ is the Effective isotropic radiation power in dBm

P_r is the Mean reference signal power in dBm

The effective isotropic radiated power $EIRP_t$ (dBm) is defined as the sum amount of power density that is transmitted from the base station into the propagation medium (Stroud and Booth, 2013).

$$EIRP_t = P_t + G_t - L_r \quad 24$$

Where;

P_t is the Transmitter power in (dBm)

Gt is the gain of the Transmitter antenna in (dBi)

L_r is the Total transmission losses (dB)

(D) Related works

The urban radio propagation adaptation path-loss model for a DVB-T2 system was evaluated using Quantitative measurement method. Least squares (LS) method of data processing was used to evaluate the measured data. The researchers established that the suggested model was more precise in calculating the quantifiable measurement of propagation data than the predictable Hata path-loss model but failed to identify the obstacles encountered during the measurement campaign (Pitak et al., 2018).

The investigated path-loss and modeling for DTT over Nigeria aimed at ascertaining the accurate prediction path-loss for DTT in guaranteeing quality of service (QoS) with the application of field measurement methodology. The result gotten revealed that path-loss predicted with Okumura-Hata model was the best fit and equally shown that path-loss rises with rise in trans-receiver spaces. Finally, the authors failed to outline how the transmitting power affects the path-loss (Akinbolati and Ajewole, 2020).

The researcher (Akinbolati et al., 2020) investigated the propagation curves and coverage areas of DTTB base stations in the tropical zone in Nigeria with the purpose of developing the propagation curve and classifies the coverage area of DTTB network in

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Nigeria. A drive test methodology was adopted and the result obtained showed that DTT signal do not decline usually with distance as anticipated by the theoretical inverse square law. Rather, it ripples with respect to space owed to environment and tropospheric mechanisms alongside its path of propagation. The researchers failed to establish the perturbation component that has higher influence on signal propagation (Akinbolati et al., 2020).

The investigated propagation models for wireless communication structure intended at giving an overview of the propagation models in wireless communication systems thereby identifying other additional path-loss model that exist between the transmitter and the receiver was achieved using simple field measurement campaign. The result obtained revealed that other additive losses occurred such as losses resulting from walls, floors and doors but no result was offered on how to manage these additive losses during transmission (Zahera et al., 2018).

However, the researcher (Aaron et al., 2020) predicted the radio wave propagation by simulation of free space propagation path-loss aimed at determining how vital path-loss is in the design of communication systems was realized with the aid of MATLAB replication approach. The design and implementation of the radio communications system is dependent on the path-loss parameter as presented by the result obtained from the analysis. The researchers acknowledged how high frequency affects the path-loss but failed to mention the effect of perturbations on signal propagation (Aaron et al., 2020).

3. MATERIALS AND METHOD

(A) Investigated environment

The measurement campaign was carried out in the City of Jos and its environs. The City of Jos is located in the north-central geo-political zone of Nigeria and geographically classified as a Sahel region. The City is semi-urban in nature with few high rise building but associated with hilly or rocks features capable of causing signal obstruction.

The measurement campaign was carried out in the wet and dry season (July - August and October - November, 2019) to establish the effect of terrain and rain on DTT signal in the area investigated. A total of ninety six (96) sample measurements were taken. The locations were divided into two major routes (route A and B) across the investigated area. The two major routes were sub-divided into: A1, A2 and B1, B2 (route A1, A2 are same routes measured in different season - wet and dry season while B1, B2 are same routes but measured in different season - wet and dry season). The Nigerian Television Authority (NTA) signal Distribution Company -Integrated Television services (ITS) signal was used for the measurement campaign. At the time of this measurement campaign ITS was the only DVB-T2 network operator (free-to-air) in Jos, Plateau State. The Figure 1 presents the geographical map of the study area.

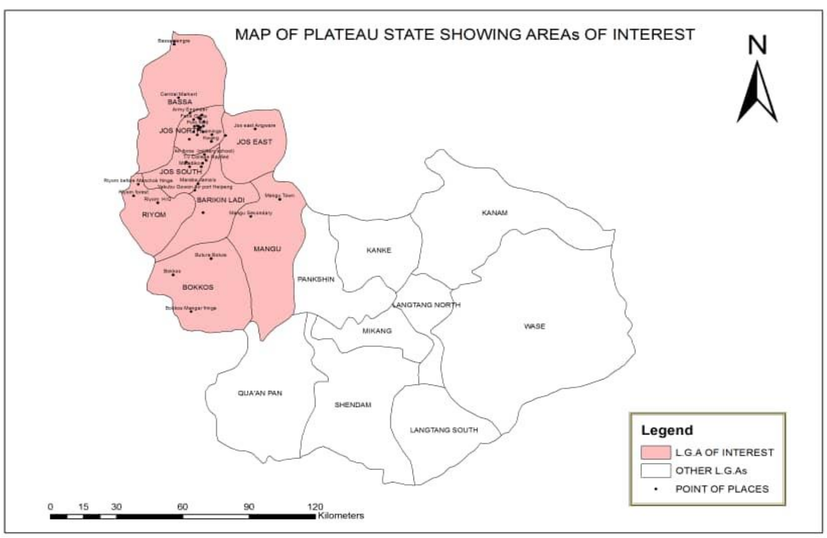

Figure 1: The Study Map (www.researchgate.net)

The map in Figure 1 presents the geographical location of the seventeen (17) Local Government Areas (LGA) of the State with the coverage area. The map was downloaded from www.researchgate.net and modified to suite my purpose using geographical information system software (ArcGIS).

(B) Experimental setup and measurements

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To guarantee high permanence and relative precision using spectrum analyzer in carrying out field measurement in broadcasting, ITU recommendations on field measurement, relevant equipment and settings specified were followed (ITU-R, 2011).

The measurement tool for the field test system comprise of test equipment carried in a Van and driven to test locations within the selected areas. The test equipment used as presented in Figure 2 include;-

A. A Calibrated Logarithmic Antenna
B. Dedicated decoder (Digital Terrestrial Receiver) capable of decoding (DVB-T2) signals
C. A Deviser Spectrum analyzer E8000A series
D. A Television monitor capable of displaying SDTV and HDTV (DVB-T2) signals
E. Global positioning satellite (GPS) enable smart phone
F. 75Ω, 15m RF cable and connectors

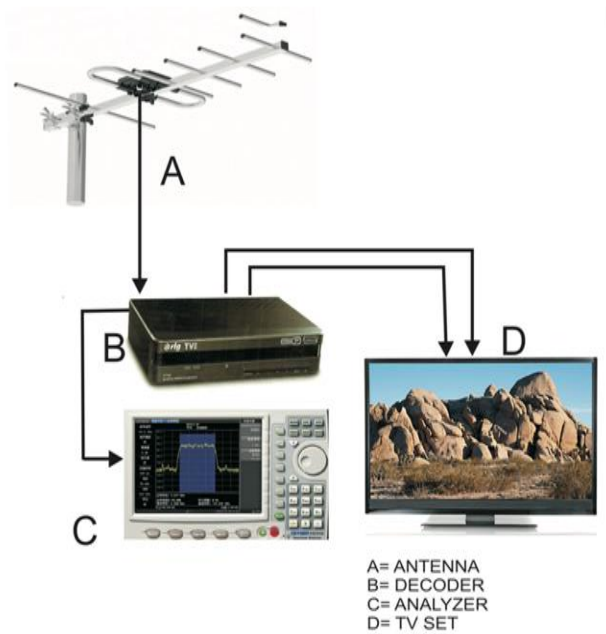

Figure 2: Equipment setup for field measurement

The equipment set-up in Figure 2 was in conformity with the ground and rooftop level measurement procedure in order to achieve acceptable result as laid down by ITU for frequency managers, monitoring services, and broadcasters.

(C) Modeling and measurements parameters

The methodology adopted for the field measurement was simple drive test. During the measurement exercise, eight (8) Local Government Areas were covered (Jos North, Jos East, Jos South, Bassa, Riyom, Barkin Ladi, Bokkos and Mangu**)**. The key parameters measured were: - field strength (FS), channel power (CP) and received signal strength (RSS). The ITS transmitter parameters is summarized and presented in Table 1.

Table 1: ITS Network Parameters

S/N	Parameter	DVB-T2 Value
1	TX frequency	522MHz
2	Effective isotropic radiated power (EIRP)	62.14 dBm
3	Base station location and Geographical Coordinate	Latitude: 9.89°, Longitude: 8.87°
4	Base station transmitted power (Kw)	1.3Kw
5	Base station frequency (MHz)	522MHz
6	Height of the transmitting antenna (m)	107m
7	Height of the mobile antenna (m)	10m
8	Antenna Pattern	Horizontal – Omnidirectional

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4. RESULTS AND DISCUSSION

This section present the results of the Path-loss measured and predicted data. The signal strength for the routes measured at a distance d (km) was used to determine the path-loss measured, PL m (dB) as presented in Table 2 and 3.

Table 2: Table of Signal Analysis of Field data in Route A

Model Parameters	Mean	Standard Deviation	Low Value	High Value
PLm (A_1)	122.84	15.9	103.7	149.2
PLm (A_2)	117.7	14.6	98.5	147.3
PLO-HM	121.07	12.8	95.8	146.8
PLC-HM	128.3	25.6	102.7	153.9
PLCW-IM	120.1	14.2	103.9	136.3
PLFSM	109.9	16.2	93.7	126

Table 3: Table of Signal Analysis of Field data in Route B

Model Parameters	Mean	Standard Deviation	Low Value	High Value
PLm (B_1)	118.23	15.1	104.4	134.5
PLm (B_2)	115.6	12.6	98.6	129.84
PLO-HM	116.5	10.2	107.9	125.1
PLC-HM	124.4	20.4	104	144.8
PLCW-IM	117.7	12.6	104.8	130.5
PLFSM	107.4	15.8	94.5	120.3

(A) Measured and predicted path-loss comparison

The field data of the measured path-loss in the investigated routes were compared with the predicted path-loss models. These models were selected as template for contrast in line with the frequency assortment for which they are effective. Though, there are other practical models that are effective at 1800MHz, the models were selected due to its simplicity of applicability and accessibility of correction factors. The result presentation of the relative presentation of the predicted and measured path-loss for the investigated routes in A and B are presented in Table 2 and 3 respectively. However, the Table 4 and 5 present the difference between the forecast and the measured models.

The empirically predicted results were validated by comparing the output of the results obtained from the path-loss measured. The Okumura-Hata and COST 123Walfisch- Ikegami models presented values very close the path-loss measured. Also the graphical presentations of the path-loss measured and predicted along route A and B are presented in Figure 3 and 4 to show the path-loss predicted with the best fit in Jos, Nigeria.

Table 4: Difference between Measured and Predicted Models with the Percentage Error in Route A

Model Parameters (PLm – PL_r)	Mean Value Difference	Percentage error (%)
PLm (A_1) – PLO-HM	1.77	1.4
PLm (A_2) – PLO-HM	-3.37	-2.9
PLm (A_1) - PLCHM	-5.46	-4.4
PLm (A_2) - PLCHM	-10.6	-9.0
PLm (A_1) -PLCW-IM	2.74	2.2
PLm (A_2) PLCW-IM	-2.4	-2.0
PLm (A_1) - PLFSM	12.94	10.5
PLm (A_2) - PLFSM	7.8	6.6

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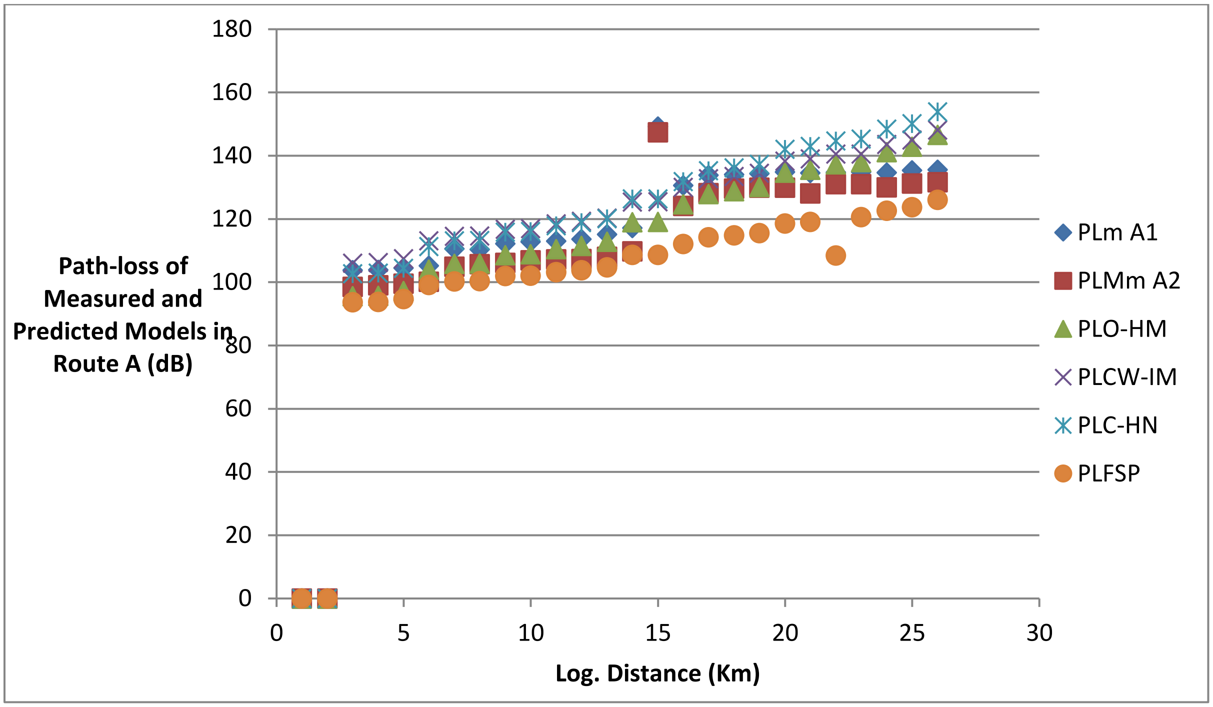

Figure 3: Plot of Path-loss Measured and Predicted Model vs. Log. Distance (Route A)

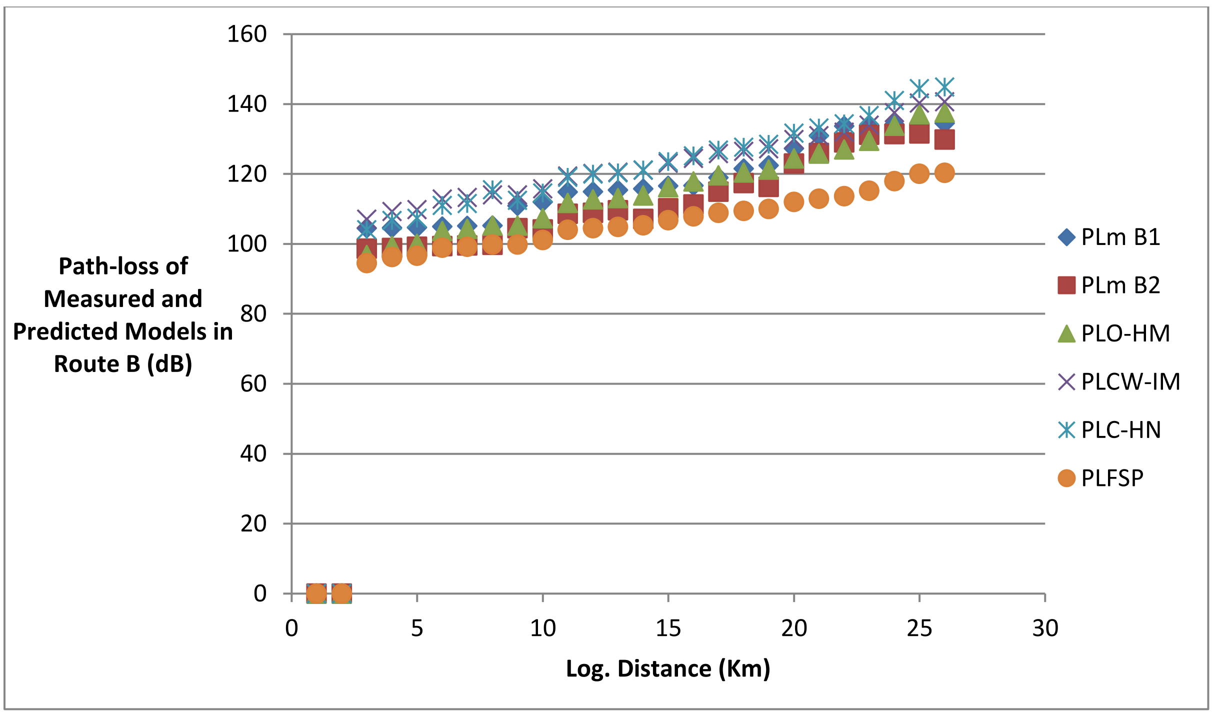

Figure 4: Plot of Path-loss Measured and Predicted Models vs. Log. Distance (Route B)

Table 5: Difference between Measured and Predicted Models with the Percentage Error in Route B

Model Parameters ($PL_m - PL_r$)	Mean Value Difference	Percentage error
PLm (B_1) – PLO-HM	1.73	1.5
PLm (B_2) – PLO-HM	-0.9	-0.8
PLm (B_1) - PLCHM	-6.17	-5.2
PLm (B_2) - PLCHM	-8.8	-7.6
PLm (B_1) -PLCW-IM	0.53	0.4

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PLm (B_2) PLCW-IM	-2.1	-1.8
PLm (B_1) - PLFSM	10.83	9.2
PLm (B_2) - PLFSM	8.2	7.1

(B) Signal propagation model best fit

The validity of Okumura-Hata and COST 123 Walfisch-Ikegami prediction models for DVB-T2 was confirmed with the root mean square error (RMSE) analysis.

The RMSE is expressed mathematically as:-

$$RMSE = \sqrt{\sum_{=1}^{k} \frac{[PL_{m}(d) - PL_{r}(d)]^2}{K}} \quad 25$$

where;

PLm (d) is the measured path-loss (dB)

PLr (d) is the Predicted path-loss (dB)

K = 24 (number of measured locations on each route)

Scenario 1. Okumura – Hata (A and B route)

For route A1 $RMSE = \sqrt{\frac{[122.84-121.07]^2}{24}} = 0.4$

For routeA_2, $RMSE = \sqrt{\frac{[117.7-121.07]^2}{24}} = 0.7$

For route B_1, $RMSE = \sqrt{\frac{[118.23-117.17]^2}{24}} = 0.2$

For route B_2, $RMSE = \sqrt{\frac{[115.61-117.17]^2}{24}} = 0.3$

Scenario 2. COST 123-Hata model (A and B route)

For A_1 route, $RMSE = \sqrt{\frac{[122.84-128.3]^2}{24}} = 1.1$

For A_2 route, $RMSE = \sqrt{\frac{[117.7-128.3)^2}{24}} = 2.2$

For B_1 route, $RMSE = \sqrt{\frac{[118.23-124.4]^2}{24}} = 1.3$

For B_2 route, $RMSE = \sqrt{\frac{[115.61-124.4]^2}{24}} = 1.8$

Scenario 3. COST 123 Walfish–Ikegami model (A and B route)

For A_1 route, $RMSE = \sqrt{\frac{[122.84-120.1]^2}{24}} = 0.6$

For A_2 route, $RMSE = \sqrt{\frac{[117.7-120.1]^2}{24}} = 0.5$

For B_1 route, $RMSE = \sqrt{\frac{[118.23-117.7]^2}{24}} = 0.1$

For B_2 route, $RMSE = \sqrt{\frac{[115.61-117.7]^2}{24}} = 0.4$

For scenario 4, (FSPM A and B route)

For route A_1, $RMSE = \sqrt{\frac{[122.84-109.85]^2}{24}} = 2.7$

For route A_2, $RMSE = \sqrt{\frac{[117.7-109.85]^2}{24}} = 1.6$

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For route B_1, RMSE = $\sqrt{\frac{[118.23-107.4]^2}{24}}$ = 2.2

For route B_2, RMSE = $\sqrt{\frac{[115.61-107.4]^2}{24}}$ = 1.7

The validity of the result presented a performance value of (Okumura-Hata: 0.4 dB, 0.7dB and 0.2dB, 0.3dB) and (COST123 Walfisch-Ikegami: 0.6dB, 0.5dB and 0.1dB, 0.4dB) along route A and B respectively. The RMSEs values closer to zero, show better performance in the signal prediction accuracy of the models (Imoize and Dosunmu, 2018); (Imoize et al., 2019). The summary of the root mean square error(s) are tabulated in Table 6.

Table 6: The RMSE of Predicted Path-loss Model Values

Model	A_1 vs. A route	A_2 vs. A route	B_1 vs. B route	B_2 vs. B route
PLO-HPM (RMSE)	0.4	0.7	0.2	0.3
PLC-HM (RMSE)	1.1	2.2	1.3	1.8
PLCW-IM (RMSE)	0.6	0.5	0.1	0.4
FSPM (RMSE)	2.7	1.6	2.2	1.7

On the strength of the assumption in Table 6 considering the RMSE analysis, the Okumura-Hata and COST 123 Walfisch-Ikegami prediction model falls within the range of agreement and has better correlation compared to the COST 123-Hata and free space propagation model. However, these implies that Okumura-Hata and COST 123 Walfish-Ikegami propagation model are better prediction model to use for DVB-T2 television network planning in Jos Plateau State, Nigeria.

5. CONCLUSION

This study was focused on propagation measurements of DTTB network in Jos, Nigeria. The result obtained from the RMSE analysis as presented in Table 6 implies that Okumura-Hata and COST123 Walfisch-Ikegami models produced the best results compared to the other propagation models tested. The models presented the following values; Okumura-Hata: 0.4 dB, 0.7dB and 0.2dB, 0.3dB) and (COST123 Walfisch-Ikegami: 0.6dB, 0.5dB and 0.1dB, 0.4dB) along route A and B respectively. The RMSEs values closer to zero show better performance in the signal prediction accuracy of the models. The RMSEs value closer to zero demonstrated a great improvement in the prediction exactness of the model. These models could be extremely appreciated for revamping network planning, system design and wireless network deployment in and around Jos.

It is recommended using broadcast Engineers at feasibility stage of planning DTV broadcasting infrastructure in order to achieve quality terrestrial point-to-area propagation prediction models for DVB-T2 network design and implementation.

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Conflict of Interest

The author declares that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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