

Analysis of Long-Term Evolution (LTE) Propagation Pathloss Calculation and Pathloss Simulation in Lubuk Minturun Urban Village, Koto Tengah Sub-District, Padang

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Abstract— Good signal quality is characterized by the small amount of propagation path loss or path loss that occurs. These propagation path losses can be caused by the distance between the site and the receiver (mobile station), transmitter frequency, natural conditions, and weather conditions. The farther between the site and the receiver (mobile station), the greater the propagation path loss. The use of propagation models in planning a site development in an area can predict or consider the value of propagation path losses, such as the Okumura-Hatta and COST-231 propagation models. Measurement of signal quality received by the receiver (mobile station) in the making of this final project using the drive test method. Determination of site coordinates in the measurement makes it easier to calculate the distance between the site and the mobile station. The calculation of the Okumura-Hatta propagation model and the COST-231 propagation model will produce a better-received power level value compared to the received power level value in the measurement. This is because the calculation only considers the distance between the site and the receiver (mobile station) without any obstacles or barriers, while the value generated during measurement will be influenced by distance, obstacles or barriers, earth contours, and weather conditions. One of them is Lubuk Minturun Village where the measurement of propagation path loss (Pathloss) is carried out due to the poor quality of the 4G Long Term Evolution (LTE) network.

Keywords— Propagation, Pathloss; Drive Test; Okumura-Hatta Model; COST-231 Model.

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I. INTRODUCTION

Lubuk Minturun is a village in Koto Tengah Sub-district, Padang City, West Sumatra Province. According to (BPS, 2018) Lubuk Minturun Village has an area of ± 23.29 km² (square) with a total population of ± 9286 people recorded with male gender totaling ± 4679 people and women totaling ± 4607 people.

According to (Mardiah Afifah, 2016) the Lubuk Minturun area located in Koto Tengah District, Padang City is one of the areas that have the potential to become a tourist visit area, especially since this area now has Agrotourism and is supported by the Lubuk Minturun water stem which is a bathing place. Also, this area has a Hajj Manasik place for

West Sumatra pilgrims. The Lubuk Minturun area, which is still natural and unpolluted, has the potential to attract tourists to this area, and this area is far from the hustle and bustle of the city, surrounded by rivers and hills. This will be an added value for this area as a tourist attraction.

If we see how rapid development is happening in Lubuk Minturun Village at this time, in the next few years there will certainly be new buildings that will be erected, be it buildings related to schools, government buildings, housing that is being designed, or buildings that will be directly related to agro-tourism later.

buildings that are being designed and buildings that will be directly related to agro-tourism later. This will be one of the causes of the weak signal in Lubuk Minturun Village.

The conditions around Lubuk Minturun can be categorized into sub-urban areas, where the area will begin to be crowded because the development process will be carried out such as the construction of cluster housing and others, which makes the area have problems in radio communication.

Radio (microwave) communication utilizes free air as a transmission medium to carry information signals. Radio waves go through various paths with several basic propagation mechanisms, namely Line of Sight (LOS), which is the trajectory of radio waves and follows the line of sight, which means between the transmitting antenna and the transmitting antenna.

In the Lubuk Minturun Village area, weather problems, natural factors, and conditions in the surrounding environment will cause cellular communication propagation problems, then data collection is carried out as a reference. After several data collection of 4G signal conditions Long Term Evolution (LTE) technology in the Lubuk Minturun area using the TEMS Pocket application can be seen in Table 1 and Table 2.

TEMS Pocket is an android software that has GPS features, records the results of signal measurements in the form of log files, and records data in the form of RSRP (Reference Signal Receive Power), RSRQ (Reference Signal Receive Quality), and SINR (Signal to Noise Ratio), where the data from TEMS pocket is carried out by the Drive test method. According to (Saputra et al., 2019), a Drive test is a method for measuring the Quality of Service (QOS) and basic parameters of actual signal quality emitted by BTS (Base Transceiver Station).

Table 1 Measurements of 4G 900 MHz Signal Quality

No	Time (WIB)	Latitude	Longitude	Signal Level (dBm)
1	08.38	0°51'37.72"S	100°23'59.04"E	-97.6
2	08.41	0°51'13.90"S	100°23'36.92"E	-104.2
3	08.42	0°50'58.87"S	100°23'22.43"E	-100.5
4	08.44	0°50'47.57"S	100°23'11.21"E	-101.9
5	08.45	0°50'36.39"S	100°23'0.49"E	-98
6	08.46	0°50'28.53"S	100°22'37.14"E	-98.4
7	08.47	0°50'28.44"S	100°22'29.31"E	-86.4

Table 2 Measurements of 4G 900 MHz Signal Quality

No	Time (WIB)	Latitude	Longitude	Signal Level (dBm)
1	13.37	0°51'37.72"S	100°23'59.04"E	-101.9
2	13.39	0°51'13.90"S	100°23'36.92"E	-93.5
3	13.41	0°50'58.87"S	100°23'22.43"E	103.7
4	14.42	0°50'47.57"S	100°23'11.21"E	-99.7
5	13.44	0°50'36.39"S	100°23'0.49"E	-85.1
6	13.46	0°50'28.53"S	100°22'37.14"E	-81.2
7	13.47	0°50'28.44"S	100°22'29.31"E	-80.2

Based on the survey table of 4G Long Term Evolution (LTE) signal conditions, the signal quality was obtained in Lubuk Minturun urban village area. Judging from Table 1 and Table 2 if the average Reference Signal Receive Power (RSRP) value in Table 1 is -98 dBm and in Table 2 is -92.2 dBm, it can be concluded that the signal quality in Lubuk Minturun village is included in the weak category.

-92.2 dBm, it can be concluded that the signal quality in Lubuk Minturun village is in the weak category. This can be

caused by the occurrence of some reflection, diffraction, and scattering.

Caused by several events of the wave propagation mechanism, which causes problems along the channel traversed by the signal and will cause attenuation or power loss along the channel better known as Pathloss. The attenuation will affect the quality of the received signal and will also shorten the signal coverage distance.

According to (Sindak Hutauruk, 2011) radio wave propagation in mobile communication plays a very important role because the signal is channeled through air transmission media. The quality of the signal that arrives at the receiver is influenced by noise, interference, fading, contours of the earth traveled, reflection media or obstacles, distance, and others. Some factors that must be taken into account in planning a cell are the height of the Transmitter (Tx), Receiver (Rx) antennas, the data being transmitted, and the cell radius area (urban, suburban, or rural), all of which are greatly influenced by the amount of attenuation that occurs along the channel (Pathloss).

The planning of a cell in urban, suburban, or rural areas is different because the signal that is reflected in the three areas is different, this is due to the different density of houses or buildings. The number of reflections along the channel traveled by the signal will cause attenuation or power loss along the channel better known as Pathloss. This attenuation will affect signal quality and will also shorten the signal coverage distance. Therefore, Pathloss calculation is very important in planning a cell.

In this final project, the author will measure the propagation path loss (Pathloss) of the receiver's receiving power at different frequencies, namely 900 MHz and 1800 MHz in Lubuk Minturun Village using the TEMS application as a measurement and Pathloss 5.0 and Google Earth as a simulation, the reason for taking Lubuk Minturun Village as a place to measure the propagation path loss (Pathloss) is because the quality of the 4G Long Term Evolution (LTE) network is not good and this village is still surrounded by many tall trees and has many houses that are quite close together, and many new building construction processes are underway, making the received signal not as good as in other areas that do not have many trees that will block the signal, this will cause reflection (reflection), diffraction (diffraction), and signal obstacles.

Many new building construction processes are underway, making the received signal not as good as in other areas that do not have many trees that will block (obstacle) the signal, will cause the occurrence of reflection, diffraction, and scattering events.

Based on the measurement and analysis of the calculation of propagation path losses (path loss) is expected to prove the results of the measurement with the calculation of the Okumura-Hata and COST-231 propagation models and can find out the cause of the weak signal received by the receiver.

II. MATERIALS AND METHOD

In making this final project, accuracy is needed to obtain data that will later be analyzed in the calculation. The design diagram is made to find out the stages of implementing the

final project design. The following can be seen in the design diagram in Figure 1.

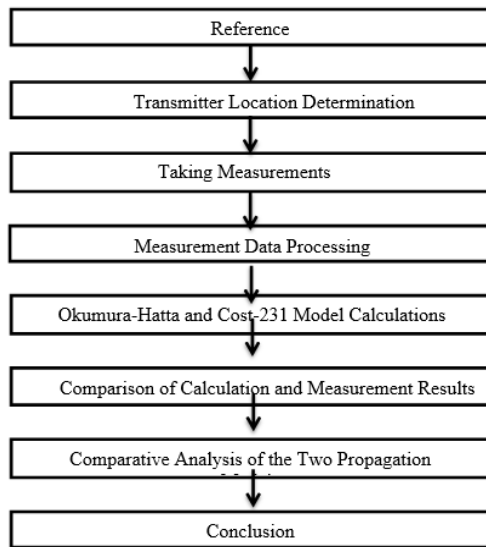


Fig. 1 Diagram of Design

A. Transmitter Location Determination

Before simulating using the Pathloss 5.0 application, the author first determines the coordinate points on the transmitter using the open signal android application and then anticipates that the hope of the received signal leads to Lubuk Minturun District, by selecting a transmitter (BTS tower) whose sectoral antenna leads to the Lubuk Minturun District area.

For site coordinate data that will be used, it can be seen in Table 3 below which contains the longitude and latitude of the site.

Table 3 Site Name

No	Site Name	Latitude	Longitude
1	Lubuk Minturun	0°50'30.08"S	100°22'42.10"E

B. Microwave Communication (Microwave)

Radio waves (microwave) are electromagnetic waves that have a very high frequency where these waves utilize free air as a transmission medium to carry information signals to two relay stations that are visible to each other or the absence of barriers to each other so that the information conveyed is clear or uninterrupted. [2]

A microwave communication system consists of two main parts, the transmitter and the receiver. In its journey from the transmitting antenna to the receiving antenna, radio waves travel through various paths with some basic propagation mechanisms. The basic propagation mechanism is Line of Sight (LOS). Microwave communication defines the microwave LOS system by meeting the ideal criteria that the signal follows a straight line or LOS. [17]

C. Propagation of Radio Waves

Propagation is a method of radio wave propagation process from the transmitter (Tx) to receiver (Rx) and the signal transmission media used is with non-wire media (unguided) and requires an antenna to radiate the signal into free air and the form of the signal emitted by the transmitter is in the form of electromagnetic signal waves. [13]

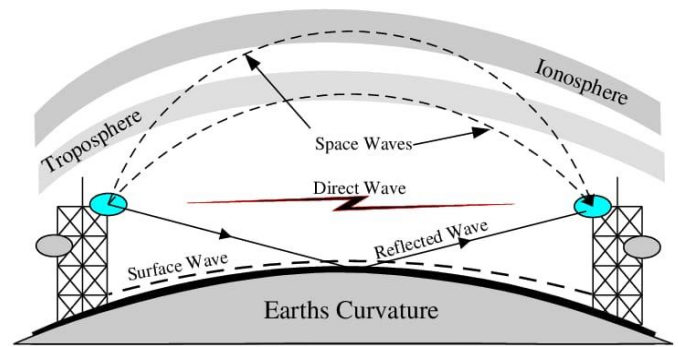


Fig. 2 Radio Wave Propagation

D. Line-of-Sight Propagation

Line-of-sight propagation is also known as direct wave propagation because the waves emitted from the transmitting antenna propagate directly to the receiving antenna and do not propagate over the ground. Therefore, the surface of the earth or soil does not absorb it. In addition, this wave is also called space wave, because it can make up for the ionospheric layer and propagate in space. [2]



Fig. 3 Illustration of LOS (Alia Sherrin Yuchintya et al, 2014)

E. Wave Propagation Mechanism

There are three propagation mechanisms in wireless communication systems, namely reflection, diffraction, and scattering as shown in Figure 4 below. [8]

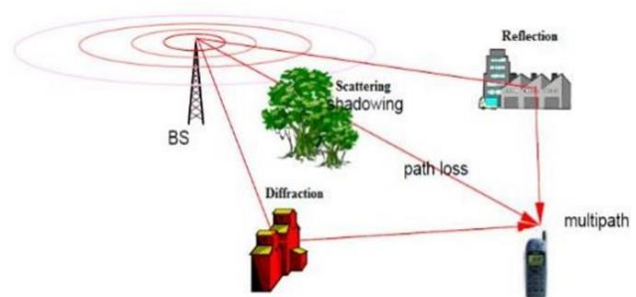


Fig. 4 Wave Propagation Mechanism

1) Reflection

Radio waves will also be reflected if they come into contact with objects or materials that make waves and experience reflection. For radio waves, the main sources that make them bounce are metals and water surfaces. The rule for this reflection event is quite simple, the angle at which the wave enters the surface will be the same as the angle of the reflected wave.

2) Diffraction

Diffraction occurs when the trajectory of a wave is blocked by irregular (sharp and small) surfaces. Diffraction allows radio waves to travel along the Earth's surface at different heights. Diffraction can allow radio waves to propagate through the curvature of the earth. Diffraction looks like the bending of a wave when it hits an object, which is an effect of the nature of the wave itself.

3) Scattering

Scattering occurs when electromagnetic wave propagation is obstructed by media that has smaller dimensions when compared to the wavelength sent from the transmitter, causing reflection in all directions.

F. Propagation Distance (Path Length)

The distance between a site location and another site can be calculated by determining the nominal position between sites on the earth line and calculating the distance between them. The nominal location of a point is usually expressed in latitude and longitude. Each latitude and longitude is expressed in degrees, minutes, and points. Of course, the degree value is converted into kilometers. [4]

To determine the propagation distance between sites, we can use equations (1), (2), and (3) as follows: [10]

$$\text{Latitude Distance: } |\text{Latitude A} - \text{Latitude B}| \times 110.33 \text{ km} \quad (1)$$

$$\text{Longitude Distance: } |\text{Longitude A} - \text{Longitude B}| \times 111.32 \text{ km} \quad (2)$$

Therefore:

$$\text{Distance A and B: } \sqrt{\text{longitude Distance}^2 + \text{latitude Distance}^2} \quad (3)$$

G. Propagation Models

In general, propagation models aim to predict the received signal strength in the form of an average value at a given distance from the transmitter, as well as changes in that signal strength. There are several propagation models to predict the attenuation of a path over an area with irregular surfaces. Propagation models are based on the interpretation and measurement of data in an operator's territory. Here are the propagation models used in general.

1) Okumura-Hatta Model

Okumura and M. Hatta based on measurements in urban and suburban areas. The validity range of the model is frequency f_c between 150 MHz and 1500 MHz, transmitter height between 3 m and 200 m, receiver height between 1 m and 10 m, and distance between sender and receiver between 1 m and 10 km. The following is the Okumura-Hatta propagation formula consisting of types:

$$L_u \text{ (dB)} = 69.55 + 26.16 \log f_c - 13.82 \log h_{te} - a(h_{re}) + (44.9 - 6.55 \log h_{re}) \log d \quad (4)$$

2) COST-231 Model

COST 231 is a propagation model developed from the Okumura-Hatta propagation model. This propagation model will be valid if used for the frequency range between 1500-2000 MHz. Coverage of the COST 231 model is:

1. Frequency is 1500-2000 MHz

2. The effective height of the transmitter antenna is h_{te} : 30-200 m
3. The effective height of the receiver antenna is h_{re} : 1-10 m
4. Link distance (d): 1-20 km

The Pathloss formula in this COST-231 propagation model is as follows:

$$L_p \text{ (dB)} = 46.33 + 33.9 (\log f_c) + 13.82 \log (h_{te}) - a(h_{re}) + (44.9 - 6.55 \log h_{re}) \log d + cm \quad (5)$$

H. Long Term Evolution (LTE)

According to (Lingga Wardhana, 2014) Long Term Evolution (LTE) is a new name for services that have high capabilities in mobile communication systems.

1) Long Term Evolution Architecture (LTE)

Long Term Evolution (LTE) architecture is known as System Architecture Evolution (SAE) which describes an evolution of architecture compared to previous technologies. Overall LTE adopts Evolved Packet System (EPS) technology. Inside there are three important components namely User Equipment (UE), Evolved UMTS Terrestrial Radio Access Network (E-UTRAN), and Evolved Packet Core (EPC).

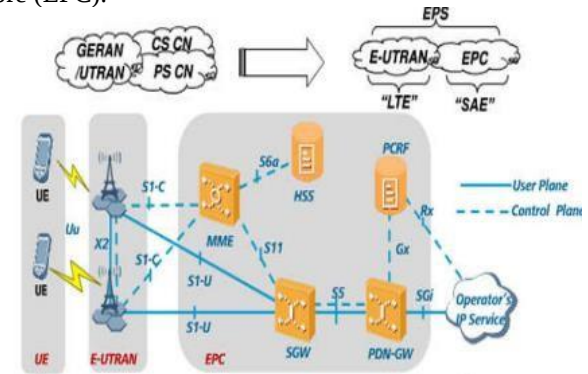


Fig. 5 Long-Term Evolution Architecture

I. Parameter 4G Long-Term Evolution (LTE)

1) Reference Signal Received Power(RSRP)

Reference Signal Received Power (RSRP) is a measure of the signal strength received in units of dBm. Long Term Evolution (LTE) signal power received by the user in a

NO	RX Name	LATITUDE	LONGITUDE
1.	Receiver 1	-0.8604779°	100.3997339°
2.	Receiver 2	-0.8538598°	100.3935891°
3.	Receiver 3	-0.8496865°	100.3895637°
4.	Receiver 4	-0.8465479°	100.386446°
5.	Receiver 5	-0.8434403°	100.3834683°
6.	Receiver 6	-0.8412585°	100.3769842°
7.	Receiver 7	-0.841232°	100.3748073°

particular frequency, the further the distance between the site and the user, the smaller the Signal Received Power (RSRP) received by the user. RS is the Reference Signal or RSRP at each point of coverage. Users who are out of range will not get Long Term Evolution (LTE) service.

2) Reference Signal Received Quality (RSRQ)

Reference Signal Received Quality (RSRQ) is the signal quality that helps RSRP parameters during handover. In addition, the Reference RSRQ parameter is defined as the ratio between the number of resource blocks to the average linear power received by the user including power from the serving cell, noise, and interference.

3) SINR

Signal Interference to Noise Ratio (SINR) is the ratio between the average received power and the average interference and noise. Signal Interference to Noise Ratio (SINR) is the signal quality obtained by users when using LTE cell networks.

III. RESULT AND DISCUSSION

A. Calculation

The calculation is where the measurement data that has been obtained is then calculated by the propagation model formula that has been determined by the parameters that have been determined or known. In the calculation process, measurements have been made on the site (BTS) against the receiver (mobile station) at several coordinate points. The position of the transmitter and receiver in Lubuk Minturun Village is shown in Figure 6.

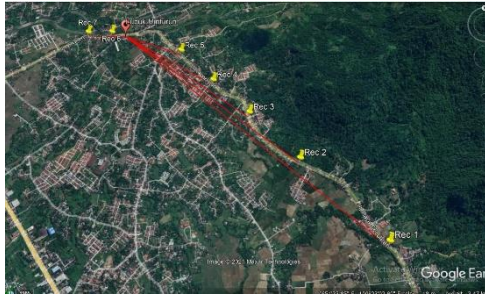


Fig. 6 Transmitter and Receiver locations (Source: Google Earth Pro)

1) Propagation Distance

Table 4 site coordinates and Table 5 receiver coordinates. Table 3 Site Name

Table 4 Site Coordinates

No	Site Name	Latitude	Longitude
1	Lubuk Minturun	-0.841688°	100.378361°

Table 5 Receiver Coordinates

So that the propagation distance between each Lubuk Minturun site and each receiver can be calculated using equations 1, 2, and 3. The results of the calculation can be seen in the table 6 below.

Table 6 Propagasi Distance

Site – MS	Distances (km)
Lubuk Minturun – Receiver 1	3.16
Lubuk Minturun – Receiver 2	2.18
Lubuk Minturun – Receiver 3	1.53
Lubuk Minturun – Receiver 4	1.06
Lubuk Minturun – Receiver 5	1.531
Lubuk Minturun – Receiver 6	0.61
Lubuk Minturun – Receiver 7	0.40

The results of the manual calculation are slightly different from the Pathloss 5.0 software calculation due to the rounding of the results that have not been maximized.

2) Okumura-Hatta Model Calculation

The calculation of the Okumura-Hatta model is carried out to compare measurements with calculations that are closer to measurements. In the calculation of the Okumura-Hatta model in Lubuk Minturun Village, the formulation is used in urban areas.

$$Lu(\text{dB}) = 69.55 + 26.16 \log fc - 13.82 \log hte - a(hre) + (44.9 - 6.55 \log hte) \log d$$

Unknown:

$fc = 900 \text{ MHz}$

$hte = 25 \text{ m}$

$hre = 1 \text{ m}$

$d = 3.16$

• For a small city

$$a(hre) = (1.1 \log(fc) - 0.7) hre - (1.56 \log(fc) - 0.8)$$

$$a(hre) = (1.1 \log(900) - 0.7) 1 - (1.56 \log(900) - 0.8) = -1.26$$

(6)

1) Lubuk Minturun Site with Rec 1

a) Urban

$$Lu(\text{dB}) = 69.55 + 26.16 \log fc - 13.82 \log hte - a(hre) + (44.9 - 6.55 \log hte) \log d$$

$$\begin{aligned} Lu(\text{dB}) &= 69.55 + 26.16 \log 900 - 13.82 \log 25 - (-1.26) + (44.9 - 6.55 \log 25) \log 3.16 \\ &= 69.55 + 77.282 - (-1.26) + (44.9 - 9.156) \log 3.16 \\ &= 69.55 + 77.282 + 1.26 + 35.7 (0.5) \\ &= 128.8 + 17.85 \\ &= 146.7 \text{ dB} \end{aligned}$$

(7)

$$PRX = PTX - Lu + GTX + GRX$$

$$\begin{aligned} &= 47.78 - 146.7 + 17.78 + 0 \\ &= -81.14 \text{ dBm} \end{aligned}$$

(8)

b) Sub-Urban

$$Lsu(\text{dB}) = Lu - 2 \{ \log() \}^2 - 5.4$$

$$= 146.7 - 2 \{ \log() \}^2 - 5.4$$

$$= 146.7 - 2 (1.50708)^2 - 5.4$$

$$= 146.7 - 4.54 - 5.4$$

$$= 136.8 \text{ dB}$$

(9)

$$PRX = PTX - Lu + GTX + GRX$$

$$\begin{aligned} &= 47.78 - 136.8 + 17.78 + 0 \\ &= -71.24 \text{ dBm} \end{aligned}$$

(10)

c) Rural

$$Lr(\text{dB}) = Lu - 4.78 (\log fc)^2 + 18.33 \log fc - 40.94 = 146.7 -$$

$$4.78 (\log 900)^2 + 18.33 \log 900 - 40.94$$

$$= 146.7 - 41.71 + 54.15 - 40.94$$

$$= 118.2 \text{ dB}$$

(11)

$$PRX = PTX - Lu + GTX + GRX$$

$$\begin{aligned} &= 47.78 - 118.2 + 17.78 + 0 \\ &= -52.64 \text{ dBm} \end{aligned}$$

(12)

In the next calculation for Lubuk Minturun site receiver 2 and so on with a working frequency of 900 MHz and a classification of urban and suburban areas. onwards with a working frequency of 900 MHz and the classification of urban and suburban areas can be seen in Table 7 below.

Table 7 Okumura-Hatta Calculation Results

Site – MS	Receiving Power Receiver	
	Urban	Sub-urban
Lubuk Minturun – Receiver 1	-81.14	-71.24
Lubuk Minturun – Receiver 2	-75.68	-65.44
Lubuk Minturun – Receiver 3	-70	-60.14
Lubuk Minturun – Receiver 4	-64.34	-54.44
Lubuk Minturun – Receiver 5	-55.04	-45.04
Lubuk Minturun – Receiver 6	-34.74	-24.84
Lubuk Minturun – Receiver 7	-48.94	-39.04

3) COST-231 Model Calculation

In COST-231 calculations were carried out at the transmitter-to-receiver site(mobile Station) with coordinate points that have been determined in the Lubuk Minturun area. The following is the calculation of COST-231:

$$Lp(dB) = 46.33 + 33.9 (\log fc) + 13.82 \log(hte) - a(hre) + (44.9 - 6.55 \log hte) \log d + cm \quad (13)$$

unknown:

fc = 1800 MHz

hte = 25 m

hre = 1 m

d = 3.16 km

1) Site Lubuk Minturun-Rec 1

a) Urban

$$a(hre) = 3.2(\log 11.75 (hre))^2 - 4.97 a(hre) = 3.2(\log 11.75 (1))^2 - 4.97 = -1.306$$

$$Lp(dB) = 46.33 + 33.9 (\log fc) + 13.82 \log(hte) - a(hre) + (44.9 - 6.55 \log hte) \log d + cm$$

$$Lp(dB) = 46.33 + 33.9 (\log 1800) + 13.82 \log(25) - (-1.306) + (44.9 - 6.55 \log 25) \log 3.16 + 3$$

$$Lp(dB) = 46.33 + 33.9 (\log 1800) + 13.82 \log(25) - (-1.306) + (44.9 - 6.55 \log 25) \log 3.16 + 3 = 46.33 + 110.35 + 19.32 - (-1.306) + (35.7) (0.5) + 3 = 177.4 + (17.9) + 3 = 198.3 \text{ dB} \quad (14)$$

$$PRX = PTX - Lu + GTX + GRX$$

$$= 47.78 - 198.3 + 17.78 + 0$$

$$= -132.7 \text{ dBm} \quad (15)$$

b) Sub Urban / Rural

$$a(hre) = (1.1 \log f - 0.7) hre - (1.56 \log f - 0.8)$$

$$a(hre) = (1.1 \log 1800 - 0.7) 1 - (1.56 \log 1800 - 0.8) = -1.4$$

$$Lp(dB) = 46.33 + 33.9 (\log 1800) + 13.82 \log(25) - (-1.4) + (44.9 - 6.55 \log 25) \log$$

$$= 46.33 + 110.35 + 19.32 - (-1.4) + (35.7) (0.5) + 0 = 177.4 + (17.9) = 195.3 \text{ dB} \quad (16)$$

$$PRX = PTX - Lu + GTX + GRX$$

$$= 47.78 - 195.3 + 17.78 + 0$$

$$= -129.7 \text{ dBm} \quad (17)$$

In the next calculation for Lubuk Minturun site - receiver 2 and so on with a working frequency of 1800 MHz and classification of urban and sub-urban areas can be seen in Table 8 below.

Table 8 COST-231 Calculation Results.

Site – MS	Receiving Power Receiver	
	Urban	Sub-urban
Lubuk Minturun – Receiver 1	-132.7	-129.7
Lubuk Minturun – Receiver 2	-127	-124.3
Lubuk Minturun – Receiver 3	-121.7	-118.6
Lubuk Minturun – Receiver 4	-116	-116
Lubuk Minturun – Receiver 5	-106.7	-106.7
Lubuk Minturun – Receiver 6	-86.3	-86.3
Lubuk Minturun – Receiver 7	-100.5	-100.5

B. Comparative Analysis of Okumura-Hatta and COST-231 Models

The measurement data and the results of the Okumura-Hatta and COST-231 model calculations at each mobile station coordinate point have different receiving power. Measurements in the field, for the results of the data obtained, the propagation mechanism process occurs, namely reflection, diffraction, and scattering. Compared to the calculation results, the known information of the transmitter site frequency, site height, ms height, and the distance between the site and the mobile station does not include obstacles such as houses, trees, and weather conditions at the time of data collection.

1) Okumura-Hatta Model

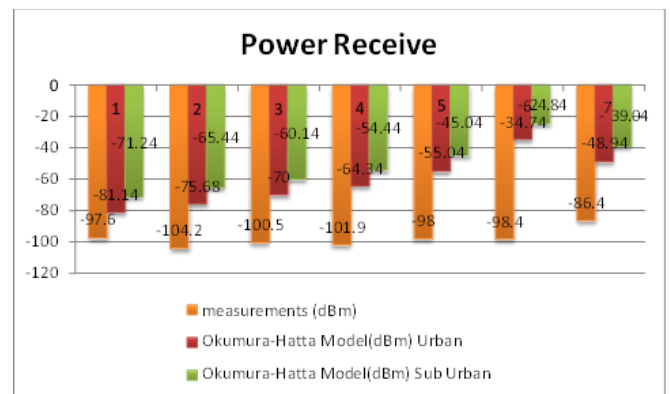


Fig. 7 Measurement and Calculation Graph of Okumura-Hatta Model Frequency 900 MHz

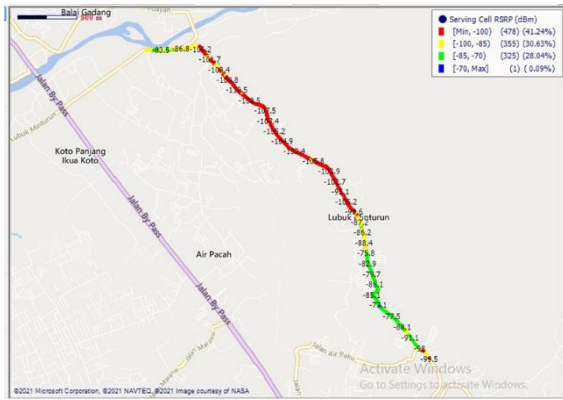


Fig. 8 Measurement Results of 900 MHz Frequency

Seen from figure 7 shows that the value of the calculation is much better than the measurement value. This can be caused because when doing the calculations that are needed and considered only the distance, without having to be related to the obstacle or barrier, while the value obtained from the measurement is included in the weak value, where during the measurement there is a barrier or obstacle that causes the value obtained in the measurement to have a weak value.

In the measurement of the Lubuk Minturun site to receiver 1 with a distance of 3.16 km, the result is -97.6 dB, while in the calculation of the Okumura-Hatta model with an urban classification, -81.14 dBm is obtained and a sub-urban classification is obtained -71.24 dBm with known data including site height, mobile station height, distance between site and mobile station, and transmitter frequency of 900 MHz. From the calculation results with the Okumura-Hatta model, the receiver's received power value has a slightly different difference, both based on the classification of urban and suburban areas. The closest value is the urban classification calculation. For the location in the field between the Lubuk Minturun site and receiver 1, there is a considerable distance so there are obstacles or barriers such as hills in the height difference of the land contour that leads to the Lubuk Minturun site. A simulation of the ground contour conditions between the Lubuk Minturun site and receiver 1 can be seen in Figure 9.

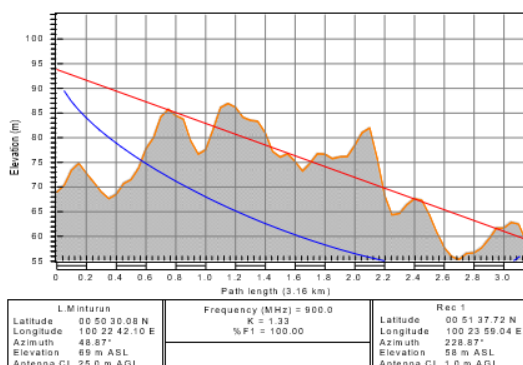


Fig. 9 Simulation of Lubuk Minturun Site Pathloss to Receiver 1 (Source: Pathloss 5.0)

In calculations using the Okumura-Hatta model, natural conditions and the process of propagation mechanisms do not affect, what will affect the results of the calculation is the distance from the site to the mobile station. The greater the

distance between the mobile station and the site, the greater the value that will be obtained.

In the measurement of the Lubuk Minturun site to receiver 2 with a distance of 2.16 km, the measurement result is -104.2 dBm which is one of the red zone value ranges with a range of < -100 indicating that the signal quality is very weak, while in the calculation of the Okumura-Hatta model with the classification of urban areas obtained -75.68 dBm and the classification of sub-urban areas obtained -65.44 dBm with known data including site height, mobile station height, distance between site and mobile station, and frequency 900 MHz. From the calculation results with the Okumura-Hatta model, the receiver's receiving power value has a considerable difference, both based on the classification of urban and suburban areas. The closest calculation result is the calculation result based on the urban area classification. The difference obtained from the Lubuk Minturun site to receiver 2 is due to obstacles or obstacles and differences in the height of the land contour leading to receiver 2. A simulation of the contour conditions between the Lubuk Minturun site and receiver 2 can be seen in Figure 10 below.

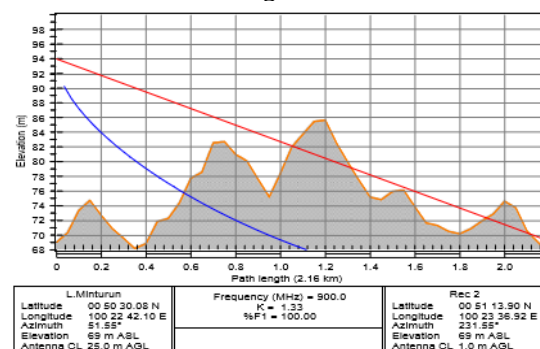


Fig. 10 Simulation of Lubuk Minturun Site Pathloss to Receiver 2 (Source: Pathloss 5.0)

In the calculation using Okumura-Hatta, natural conditions and the propagation mechanism process do not affect the value, which will affect the receiver power value from the calculation depending on the distance between the mobile station to the site.

Measurement of Lubuk Minturun site to receiver 3 with a distance of 1.53 km obtained a measurement result of -100.5 dBm which is included in the yellow zone signal category which has a value range < -100 which indicates that the signal quality is weak, while in the calculation results of the Okumura-Hatta model with a classification in urban areas obtained a value of -70 dBm and sub urban classification obtained a result of -60.15 dBm with known data including site height, mobile station height, distance between site and mobile station and transmitter frequency 900 MHz. The results of the calculation with the Okumura-Hatta model, the receiver received power value has a considerable difference, both in the classification of urban areas and suburban areas. For the location in the field between the Lubuk Minturun site and site 3, there are obstacles because the distance between the site and the mobile station is quite far. A simulation of the ground contour between the Lubuk Minturun site and receiver 3 can be seen in Figure 11 below.

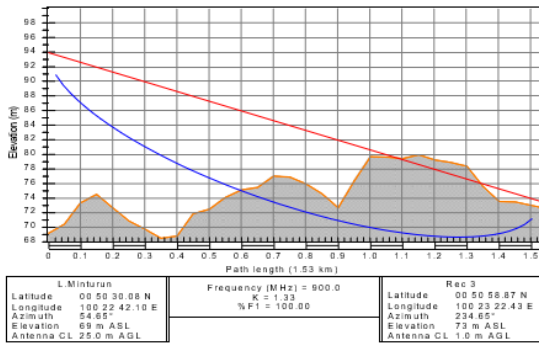


Fig. 11 Simulation of Lubuk Minturun Site Pathloss to Receiver 3 (Source: Pathloss 5.0)

In the calculation using Okumura-Hatta, natural conditions and the propagation mechanism process do not affect the value, which will affect the receiver power value from the calculation depending on the distance between the mobile station to the site.

Measurement of Lubuk Minuturun site to the receiver 4 with a distance of 1.53 km obtained measurement results -101.9 dBm, where the value obtained in this measurement states a very weak signal quality is based on the KPI which value is in the range < -100 . In the calculation of the Okumura-Hatta model, the results obtained are -64.34 dBm, and the suburban classification data is -54.44 dBm with known data including site height, mobile station height, the distance between the site and mobile station and 900 MHz frequency. From the calculation results with the Okumura-Hatta model, the receiver's receiving power value has a considerable difference, both in the classification of urban and suburban areas. For the location in the field between the Lubuk Minturun site and receiver 4, there are no obstacles because the distance between the site and the mobile station is quite close. A simulation of the ground contour between the Lubuk Minturun site and receiver 4 can be seen in Figure 12 below.

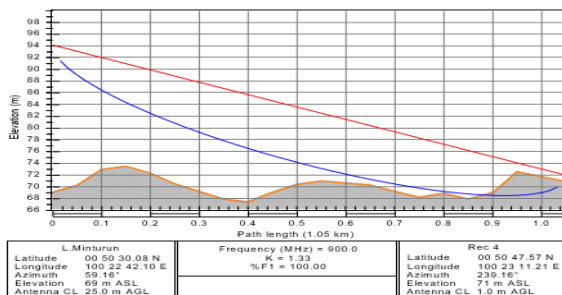


Fig. 12 Simulation of Lubuk Minturun Site Pathloss to Receiver 4 (Source: Pathloss 5.0)

In the calculation using Okumura-Hatta, natural conditions and the propagation mechanism process do not affect the value, which will affect the receiver power value from the calculation depending on the distance between the mobile station to the site.

Measurement of Lubuk Minuturun site to the receiver 5 with a distance of 0.60 km obtained measurement results -98 dBm, where the value obtained in this measurement states the quality of the signal is weak if based on the KPI which value is in the range ≥ -100 to < -85 , while in the calculation of the Okumura-Hatta model, the results obtained are -55.04 dBm,

and suburban classification data is -45.44 dBm with known data including site height, mobile station height, the distance between the site and mobile station and frequency 900 MHz. 900 MHz frequency. The results of the calculation with the Okumura-Hatta model, the receiver receiving power value has a considerable difference, both in the classification of urban and suburban areas. For the location in the field between the Lubuk Minturun site and receiver 5, there are no obstacles because the distance between the site and the mobile station is quite close. A simulation of the ground contour between the Lubuk Minturun site and receiver 5 can be seen in Figure 13 below.

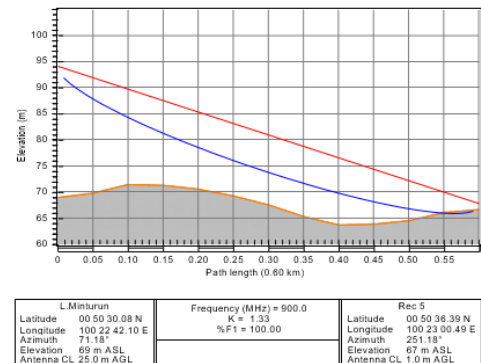


Fig. 13 Simulation of Lubuk Minturun Site Pathloss to Receiver 5 (Source: Pathloss 5.0)

In the calculation using Okumura-Hatta, natural conditions and the propagation mechanism process do not affect the value, which will affect the receiver power value from the calculation depending on the distance between the mobile station to the site.

Measurement of Lubuk Minuturun site to receiver 6 with a distance of 0.16 km obtained measurement results -98.4 dBm, where the value obtained in this measurement states a very weak signal quality is based on the KPI which value is in the range ≥ -100 to < -85 , while in the calculation of the Okumura-Hatta model, the results obtained are -34.74 dBm, and suburban classification data is -24.84 dBm with known data including site height, mobile station height, the distance between the site and mobile station and 900 MHz frequency. From the calculation results with the Okumura-Hatta model, the receiver received power value has the most difference, both in the classification of urban and suburban areas. The location in the field between the Lubuk Minturun site to receiver 6 is quite close so there are no obstacles or obstacles that lead to the Lubuk Minturun site. A simulation of the ground contour between the Lubuk Minturun site and receiver 6 can be seen in Figure 14 below.

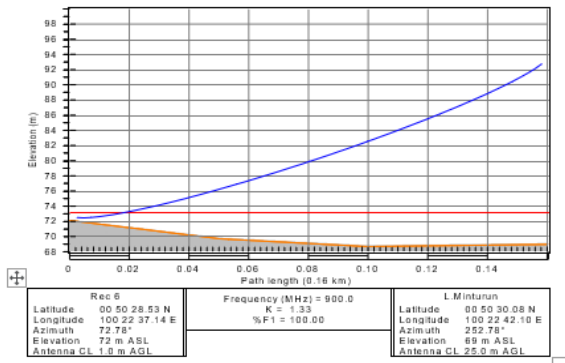


Fig. 14 Simulation of Lubuk Minturun Site Pathloss to Receiver 6 (Source: Pathloss 5.0)

In the calculation using Okumura-Hatta, natural conditions and the propagation mechanism process do not affect the value, which will affect the receiver power value from the calculation depending on the distance between the mobile station to the site.

Measurement of Lubuk Minturun site to receiver 7 with a distance of 0.40 km obtained a measurement result of -86.4 dBm, where the value obtained in this measurement states a very weak signal quality is based on the KPI which value is in the range ≥ -100 to < -85 , while in the calculation of the Okumura-Hatta model the results obtained are -48.94 dBm, and suburban classification data is -39.04 dBm with known data including site height, mobile station height, distance between site and mobile station and 900 MHz frequency. The results of the calculation with the Okumura-Hatta model, the receiver received power value has the most difference, both in the classification of urban and suburban areas. The location in the field between the Lubuk Minturun site and receiver 7 is close enough that no obstructions or obstacles lead to the Lubuk Minturun site. Simulated contour conditions between the Lubuk Minturun site and receiver 7 can be seen in Figure 15 below.

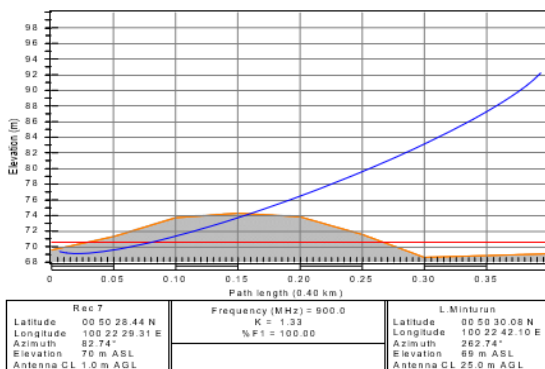


Fig. 15 Simulation of Lubuk Minturun Site Pathloss to Receiver 7 (Source: Pathloss 5.0)

2) COST-231 Model

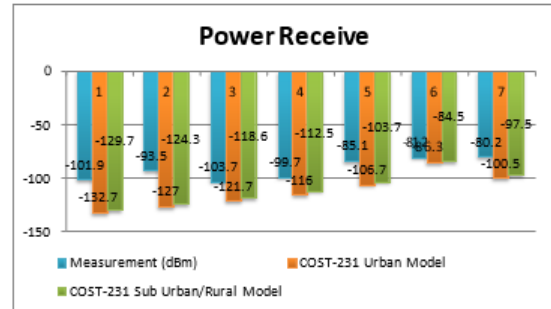


Fig. 16 Graphic of Measurement and Calculation of COST-231 Model 1800 MHz Frequency



Fig. 17 Measurement Results 1800 MHz Frequency

Figure 16 above is a summary of the results of measurements and calculations at the Lubuk Minurun site to receiver 1, receiver 2, receiver 3, receiver 4, receiver 5, receiver 6, and receiver 7 conducted during the day. if observed from graph 4.2 that the value obtained when calculating is much worse than the value at the time of measurement, this is due to the presence of other BTS covering the area, so that at 1800 MHz frequency the calculation value is much worse than the value in the measurement. The COST-231 model formulation can work at a maximum frequency of 2 GHz so that the 1800 MHz site can use COST-231.

In the measurement of Lubuk Minturun site to receiver 1 with a distance of 3.16 km, the measurement value is -101.9 dBm. In the calculation of COST-231, a comparison is made using the classification formula for urban and suburban areas. In urban areas, a value of -132.7 dBm is obtained, while for sub-urban areas a value of -129.7 dBm is obtained. Comparison between measurements at the Lubuk Minturun site and receiver 1 for the calculation results that are closest to the COST-231 model with the classification of suburban and rural areas. For the location in the field between the Lubuk Minturun site and the receiver, 1 has obstacles or obstacles such as hills because between the site and the mobile station is a considerable distance. A simulation of ground contour conditions between the Lubuk Minturun site and receiver 1 can be seen in Figure 18 below.

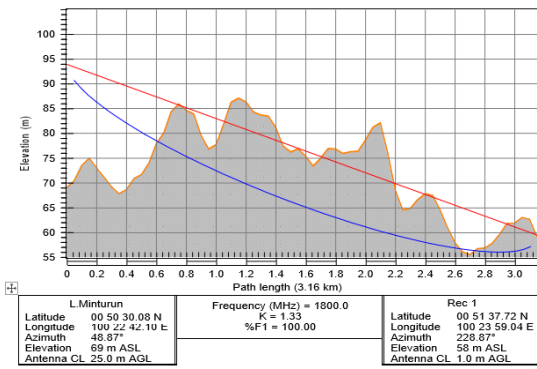


Fig. 18 Simulation of Pathloss Site Lubuk Minturun Frequency 1800 MHz to Receiver 1 (Source: Pathloss 5.0)

Measurement of Lubuk Minturun site to receiver 2 with a distance of 2.16 km obtained a result of -93.5 dBm where the signal quality at the time of measurement includes signal quality in the yellow zone (KPI) with a range of ≥ -100 to < -85 is a weak signal quality, while in the calculation results of the COST-231 model by comparing using the regional classification formula, the urban area obtained a value of 127 dBm while the sub-urban/rural area obtained a value of -124.3 dBm, with data that includes site height, mobile station height, distance between sites with mobile stations, and 1800 MHz transmitter frequency.

At the Lubuk Minturun site to receiver 2, it can be seen that the receiver power value for calculations that is closer to the measurement results is in the classification for sub-urban/rural areas with a difference in the value of -30.8 dBm compared to the difference in value in the classification of urban areas which is -33.5 dBm, this is due to obstacles or natural factors so that the measured power has poor quality, while in the calculation of weather conditions and propagation mechanisms are not included in the formula. The calculation is closest to the COST-231 model with the classification of suburban and rural areas. For the location in the field between the Lubuk Minturun site and receiver 1, there are obstacles such as hills, because the site and mobile station have a considerable distance. A simulation of the ground contour between the Lubuk Minturun site and receiver 2 can be seen in Figure 19 below

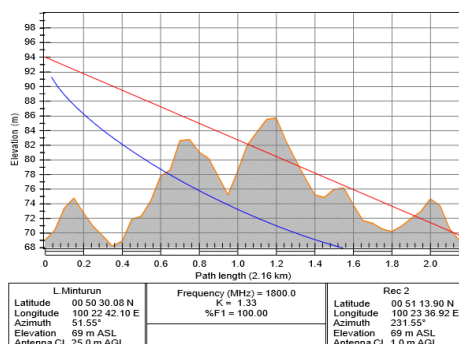


Fig. 19 Simulation of Pathloss Site Lubuk Minturun Frequency 1800 MHz to Receiver 2 (Source: Pathloss 5.0)

Measurement of Lubuk Minturun site to receiver 3 with a distance of 1.53 km obtained a result of -103.7 dBm where the signal quality at the time of measurement includes signal

quality in the red zone (KPI) with a range of < -100 is a very weak signal quality, while in the calculation of the COST-231 model by comparing using the regional classification formula, the urban area obtained a value of -121.7 dBm while the suburban/rural area obtained a value of -118.6 dBm, with data that includes site height, mobile station height, distance between sites with mobile stations, and 1800 MHz transmitter frequency. At the Lubuk Minturun site to the receiver 3, it can be seen that the receiver power value for calculations that is closer to the measurement results is in the classification for sub-urban/rural areas with a difference in the value of -14.9 dBm compared to the difference in value in the classification of urban areas which is -18 dBm, this is due to obstacles or natural factors so that the measured power has poor quality, while in the calculation of weather conditions and propagation mechanisms are not included in the formula that is closest to the COST-231 model with the classification of suburban and rural areas. For the location in the field between the Lubuk Minturun site and receiver 1, there are obstacles or obstructions such as hills, because the site and mobile station have a considerable distance. A simulation of ground contour conditions between the Lubuk Minturun site and receiver 3 can be seen in Figure 20 below.

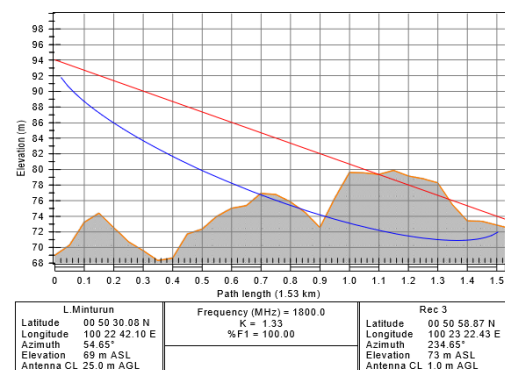


Fig. 20 Simulation of Pathloss Site Lubuk Minturun Frequency 1800 MHz to Receiver 3 (Source: Pathloss 5.0)

Measurement of Lubuk Minturun site to the receiver 4 with a distance of 1.06 km obtained a result of -99.7 dBm where the signal quality at the time of measurement includes signal quality in the yellow zone (KPI) with a range of > -100 to < -85 is a weak signal quality, while in the calculation results of the COST-231 model by comparing using the regional classification formula, the urban area obtained a value of -116 dBm while the suburban/rural area obtained a value of -112.5 dBm, with data that includes site height, mobile station height, the distance between sites with mobile stations, and 1800 MHz transmitter frequency. At the Lubuk Minturun site to a receiver 4, it can be seen that the receiver power value for calculations that is closer to the measurement results is in the classification for suburban/rural areas with a difference in the value of -12.8 dBm compared to the difference in value in the classification of urban areas which is -16.3 dBm, this is due to obstacles or natural factors so that the measured power has poor quality. In contrast, in the calculation of weather conditions and propagation mechanisms are not included in the formula, which is closest to the COST-231 model with the classification of suburban

and rural areas. For the location in the field between the Lubuk Minturun site and receiver 4, there are no obstacles or obstructions because the site and mobile station are quite close. A simulation of the ground contour between the Lubuk Minturun site and receiver 4 can be seen in Figure 21 below.

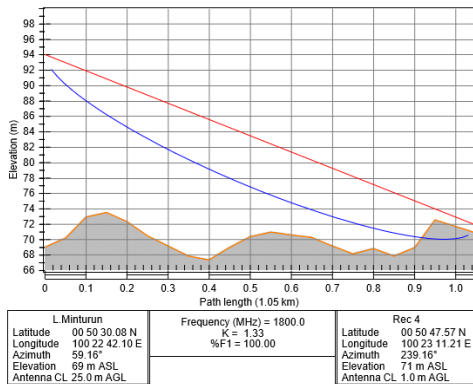


Fig. 21 Simulation of Pathloss Site Lubuk Minturun Frequency 1800 MHz to Receiver 4 (Source: Pathloss 5.0)

Measurement of Lubuk Minturun site to receiver 5 with a distance of 0.16 km obtained a result of -85.1 dBm where the signal quality at the time of measurement includes signal quality in the yellow zone (KPI) with a range of ≥ -100 to < -85 , while in the calculation results of the COST-231 model by comparing using the regional classification formula, the urban area obtained a value of -106.7 dBm while the suburban/rural area obtained a value of -103.7 dBm, with data that includes site height, mobile station height, distance between sites with mobile stations, and 1800 MHz transmitter frequency. At the Lubuk Minturun site to receiver 5, it can be seen that the receiver power value for calculations that is closer to the measurement results is in the classification for sub-urban/rural areas with a difference in value of -18.6 dBm compared to the difference in value in the classification of urban areas which is -21.6 dBm, which is closest to the COST-231 model with the classification of sub-urban and rural areas. For the location in the field between the Lubuk Minturun site and receiver 5, there are no obstacles or obstructions because the site and mobile station are a fairly close distance. A simulation of the ground contour between the Lubuk Minturun site and receiver 5 can be seen in Figure 22 below.

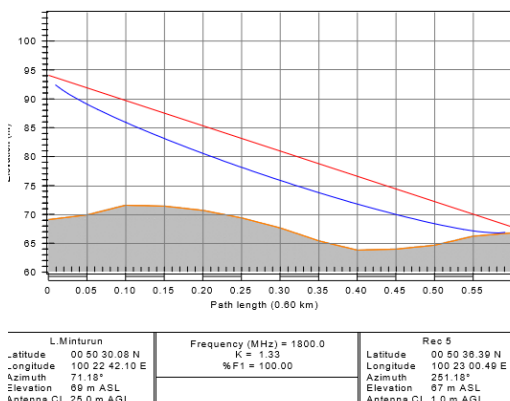


Fig. 22 Simulation of Pathloss Site Lubuk Minturun Frequency 1800 MHz to Receiver 5 (Source: Pathloss 5.0)

Measurement of Lubuk Minturun site to the receiver 6 with a distance of 0.16 km obtained a result of -81.2 dBm where the signal quality at the time of measurement with a range of -85 to -70 is pretty good, while in the calculation of the COST-231 model by comparing using the regional classification formula, the urban area obtained a value of -86.3 dBm while the suburban/rural area obtained a value of -84.5 dBm, with data that includes site height, mobile station height, the distance between sites with mobile stations, and 1800 MHz transmitter frequency. At the Lubuk Minturun site to the receiver 6, it can be seen that the receiver power value for calculations that is closer to the measurement results is in the classification for sub-urban/rural areas with a difference in the value of -3.3 dBm compared to the difference in value in the classification of urban areas which is -5.1 dBm, while in the calculation of weather conditions and propagation mechanisms are not included in the formula, which is closest to the COST-231 model with the classification of suburban and rural areas. For the location in the field between the Lubuk Minturun site and receiver 6, there are no obstacles or obstructions because the site and mobile station are very close distance. A simulation of the ground contour between the Lubuk Minturun site and receiver 6 can be seen in Figure 23 below.

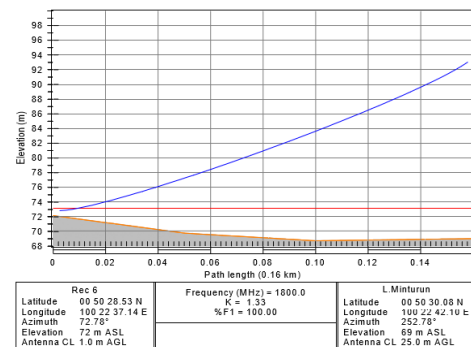


Fig. 23 Simulation of Pathloss Site Lubuk Minturun Frequency 1800 MHz to Receiver 6 (Source: Pathloss 5.0)

Measurement of Lubuk Minturun site to the receiver 7 with a distance of 0.40 km obtained the result of -80.2 dBm where the signal quality at the time of measurement with a range of -85 to -70 is pretty good, while in the calculation of the COST-231 model by comparing using the regional classification formula, the urban area obtained a value of -100.5 dBm while the suburban/rural area obtained a value of -97.5 dBm, with data that includes site height, mobile station height, distance between sites with mobile stations, and 1800 MHz transmitter frequency. At the Lubuk Minturun site to receiver 7, it can be seen that the receiver power value for calculations that is closer to the measurement results is in the classification for sub-urban/rural areas with a difference in value of -17.3 dBm compared to the difference in value in the classification of urban areas which is -20.3 dBm, which is closest to the COST-231 model with the classification of sub-urban and rural areas. For the location in the field between the Lubuk Minturun site and receiver 7, there are no obstacles or obstructions because the site and mobile station are very close distance. A simulation of the ground contour between the

Lubuk Minturun site and receiver 7 can be seen in Figure 24 below.

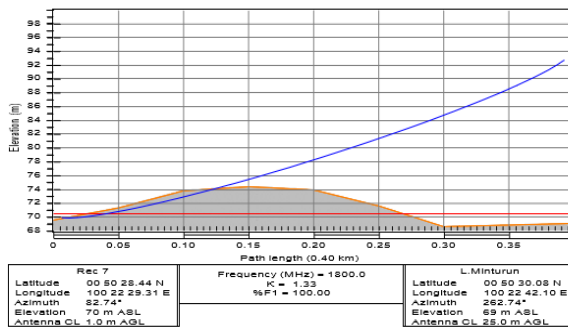


Fig. 24 Simulation of Pathloss Site Lubuk Minturun Frequency 1800 MHz to Receiver 7 (Source: Pathloss 5.0)

In the calculation results obtained data that has a difference that is not much different from the measurement results, the difference in these results occurs in urban and sub-urban / rural classifications. This happens because of reflection, diffraction, and scattering. In the Okumura-Hatta propagation model, there are 3 regional classification formulations, namely urban, suburban, and rural areas, proof in the Lubuk Minturun Sub-district area, the calculation of the Okumura-Hatta model which is closer to the calculation with the classification of urban areas.

The calculation value in Okumura-Hatta modeling using a frequency of 900 MHz is much better when compared to the value obtained in the measurement, this happens because the calculation only considers the propagation distance without any obstacles and interference so that the value of the receiving power will be obtained more, while the value obtained during the measurement must consider trees, houses or natural hills which will result in the value obtained worse than the calculation results.

In proving between measurements and calculations using the COST-231 model for the Lubuk Minturun site, there are results between measurements and calculations. For proof in the Lubuk Minturun area, the calculation of the COST-231 model that is closer is the calculation with the sub-urban/rural classification.

The results of the above calculations state that the farther or greater the distance between the mobile station and the site, the greater the value of propagation path loss or path loss, and if the smaller or shorter the distance between the site and the mobile station, the value of propagation path loss or path loss will be smaller as well.

IV. CONCLUSION

Based on the results of the calculation and analysis of the comparison of the Okumura-Hatta and COST-231 models in Lubuk Minturun Village, it can be concluded that in the calculation using 2 propagation models, namely Okumura-Hatta and COST-231, before performing the calculation, it is necessary to adjust the site criteria with the propagation modeling that will be used. in the comparison between the Okumura-Hatta and COST-231 propagation models for

results that are closer to the measurement results of the received power level value is the COST-231 model with a maximum frequency of 2 GHz, while the Okumura-Hatta model with a frequency range of 150-1500 MHz in the calculation of the received power level value is not too by the measurement results in the Lubuk Minturun area, which can be caused by having undulating surface contours and natural conditions and buildings.

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