Physical Tunning Influence on 4G Network in Minangkabau International Airport

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ABSTRACT

The growth of cellular telephone subscribers experienced a significant increase compared to other industries. With large and widespread number of subscribers, many operators have established new Base Transceiver Stations (BTS) to keep up with the increase number of subscribers. However, the addition of BTS is not a total solution to offset the increase number of subscribers. The purpose of this study is to analyze the signal quality, coverage area and network repairs by using physical tuning method. In Telkomsel operator drive test data in Minangkabau International Airport area, the RSRP parameter obtained an average sample data area around the site in the range -110 to 0, with a red indicator of 3.35%, an orange indicator of 18.96% and a yellow indicator amounted 36.3%. In this way, this research optimizes physical tuning method, including Re-azimuth which successfully directs the antenna to the badspot area, then changes the height of the antenna which makes it covered farther and tilting the Antenna which succeeds in making the coverage area more optimal. For the next bad spot area, optimization should be done in real time in the field so that the improvement can be resolved properly.

1. Introduction

Long Term Evolution (LTE) technology is the fourth generation of cellular technology being developed. LTE has advantages in terms of data speed and spectral efficiency [1]. This innovation can offer better assistance to customers [2]. Long Term Development of 3GPP (Third Era Organization Undertaking). LTE, known as the fourth generation (4G), is a combination of Universal Mobile Telecommunications System (UMTS) and High Speed Downlink Packet Access (HSDPA) technologies. LTE networks can transfer data at speeds of up to 50 Mbps on the uplink side and 100 Mbps on the downlink side, to provide fast [3]. Besides, it has data transfer speeds, LTE can also provide better service coverage, reduce operational costs, support the use of various receiving cables, be flexible in the use of data transmission and can also be adapted to existing advances. LTE offers flexible bandwidth up to 20 MHz, with a maximum bandwidth of 1.4 to 20 MHz. LTE has radio access and core networks that can improve performance, reduce network latency, and provide interoperability with existing 3GPP technologies [4].

As far as the development of telephone support, there has been a significant increase in development across different businesses. Client progress must also be accompanied by good quality assistance. A number of operators have prepared new Base Transceiver Stations (BTS) to keep pace with the growing number of subscribers spread throughout the world [5]. However, the addition of BTS has not fully offset the increase in subscribers; New issues, such as the occurrence of Bad Spot Areas and Overshoots, have appeared [6]. The large number of BTS that are established will require careful planning so that the coverage area can provide maximum results. Thus, the increase in network quality definitely will not be proportional to the increase in user. The quality of user network reception is often affected by the state of the wireless cellular network. This condition requires investigation and organizational improvement so that the quality obtained can be ideal and is expected to meet the client's assumptions [7]. Further, by the increasing number of subscribers and the need for various services, cellular network conditions need to be improved from time to time [8]. These improvements will demand reliable and satisfactory availability, coverage and quality of cellular networks [9].

One of the indications of poor signal coverage of Telkomsel, one of the network provider, in the region is the emergence of a complaint about the weak LTE signal in the Minangkabau International Airport area by one of the national operators. Then, signal quality has an impact on user signal levels and also the substandard user experience that customers have around Minangkabau International Airport [10]. In a previous study by Sirait and Nurhidayanto (in [11]), the the 4G network optimization in Bojong Nangka Village was carried out by tilting, re-azimuth and adding antenna height. Based on their study, optimization using the Antenna Physical Tuning method can improve coverage at a site and can improve the Received Signal Reference Power (RSRP) signal quality in the area. Therefore, in this research, optimization was carried out by physical tuning method to improve Telkomsel's signal quality at Minangkabau International Airport.

2. Research Methodology

This research was undertaken in the form of cellular network optimization by using the Physical Tunning method in the Minangkabau International Airport area, Ketaping, Subdistrict Batang Anai, Padang Pariaman Regency, West Sumatra. This optimization study used a qualitative non-participatory observational method, namely by comparing each parameter before optimization after optimization to a predetermined path from the eNodeB point [12].

In this study, the researcher conducted a literature study on the research to be studied. Literature study served as a method for collecting theoretical reference data that was relevant to the cases or problems found. In the second stage, the researcher determined the area. Determining this area serves to assist researchers in collecting data later which must be in accordance with the problems to be studied. The researcher collected data in the Minangkabau International Airport area due to the place had many customer complaints that Telkomsel's network was not good and there are areas that were not covered by 4G networks or badspots area.

After determining the path to be followed, the next step is data collection for the problem to be studied. Retrieval of this data using TEMS Pocket software. TEMS Pocket functions for quality data capture and network determination. The data that will be retrieved in the TEMS Pocket software is Received Signal Reference Power (RSRP), Signal to Interference and Noise Ratio (SINR), Received Signal Reference Quality (RSRQ), Streaming Throughput, Streaming Latency. Retrieval of this data using the operator Telkomsel. Before retrieving data, a TEMS configuration must be carried out with the server, because for 4G data it checks the strength of RSRP, SINR, RSRQ, Throughput and streaming Latency.

In the data processing process, the researcher used TEMS Discovery software to process the data that will be displayed and see the network quality value and service quality value that has been taken. In the data processing process, the researcher looked at the results and compared them with the predetermined performance indicator values. Then in the analysis of the results, network optimization was carried out on network quality in the Minangkabau International Airport area. Thus, the results of this study were in the form of data and recommend providers to increase their network value in that area.

3. Results And Discussion

The results and discussion of this study are divided into several sub-chapters which later discuss the data prior to optimization, then implementation of optimization, and also the comparison after optimization.

3.1. Measurement Results Before Optimization

Before the optimization was carried out, the researchers measured the Minangkabau International Airport area which consisted of several sites. The results can be seen in Table 1. The data collection process was carried out by drive test with the route shown in Figure 1.

Table 1. Minangkabau International Airport SITE

Site ID	Site Name	Longitude	Latitude
PAR133	Bandara Ketaping	100,3123669	-0,786813055
PAR511	Batang Anai	100,292768	-0,782324
PAR267	Minang International Airport	100,2861	-0,78664
PAR186	Intersection of MIA Airport	100,314359	-0,794186

Table 2. RSRP Values

Legend	Range (dBm)	No. of Sample	Percentage
	< -110	29	3.35%
	≥ -110 – < -100	164	18.96%
	≥ -100 – < -85	314	36.3%
	≥ -85 – < -75	266	20.75%
	≥ -75 – < 0	92	10.64%
TOTAL		**865**	**100%**

Dealing with the activities that have been carried out, it can be seen that to determine the signal quality of an operator, it is necessary to collect data directly in the field and it is called as the drive test. The drive test is carried out to get the actual results received by the user. The results of the drivetest are in the form of a logfile which is obtained from the results of data collection using TEMS Pocket and processed using TEMS discovery. The output of the drive test obtained several parameters, namely PCI, RSRP, SINR and THROUGHPUT.

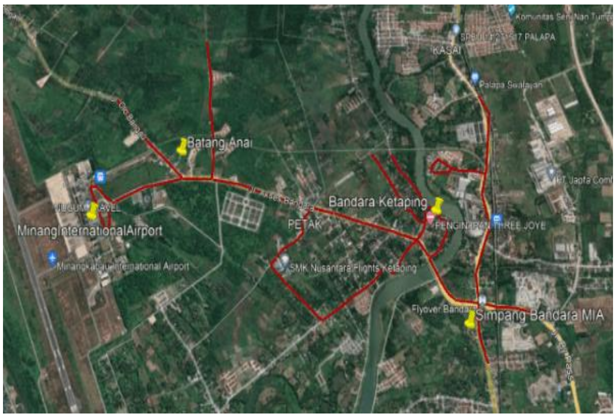

Figure 1. Drive Test Route

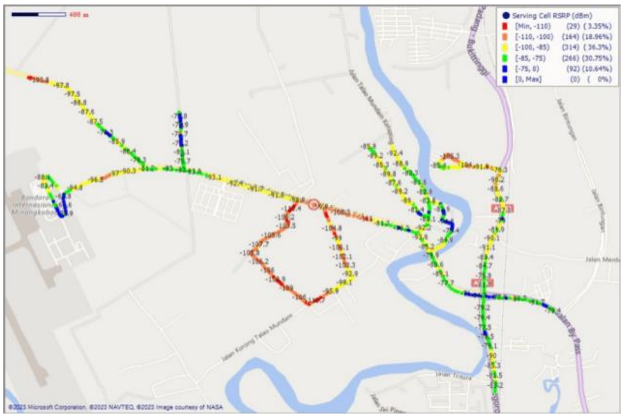

Figure 2. Plot result of RSR

Reference Signal Received Power (RSRP)

RSRP is a parameter that states the level of signal strength received by the UE in units of dBm. The farther the distance between the site and the UE, the smaller the RSRP value received by the UE, and vice versa [13], [14], [15]. Figure 2 is the plot result of the RSRP in the Minangkabau International Airport area. Table 2 indicates that the results of the RSRP plots that have been tested before. Where the RSRP values for the Minangkabau International Airport area are bad because they are dominated by yellow and orange where the signal strength with parameter values in the very bad category (< -110 dBm) obtained 29 data samples with a percentage of 3.35%, bad category (≥ -110 dBm x < -100 dBm) obtained 164 data samples with a percentage of 18.96%, quite good category (≥ -100 dBm x < -85 dBm) obtained 314 data samples with a percentage of 36.3%, good category (≥ -85 dBm x < -75 dBm) obtained 266 data samples with a percentage of 20.75%, and for the very good category (≥ -75 dBm x <0 dBm) obtained 92 data samples with a percentage of 10.64%.

Table 3. Throughput Values

Legend	Range (Kbps)	No. of Sample	Percentage
	≥14000	311	36.16%
	≥ 7000 – <14000	143	16.63%
	≥ 1000 – < 7000	312	36.28%
	≥ 512 – < 1000	46	5.35%
	< 512	48	5.58%
TOTAL		860	100%

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Table 4. SINR Values

Legend	Range (dB)	No. of Sample	Percentage
	≥20	58	6.71%
	≥13 – <20	171	19.77%
	≥0 – <13	585	67.63%
	<0	51	5.9%
TOTAL		865	100%

In table 2 above it can be seen that the measurement results show the average value in the area around the site is in the range -100 to 110 to 0. From these results, based on the operator KPI standard values it is concluded that the area is in the category " bad". So it can be seen that the RSRP of the Telkomsel operator's 4G LTE network in the area studied is still relatively weak. This causes user equity to have difficulty accessing and using Telkomsel operator signal services in that area. Here it needs to be maximized again so that it can meet the excellent criteria in accordance with KPI standards, which is above -80 dBm.

Physical Cell Identity

Physical Cell Identity (PCI) is a parameter with a value between 0 and 503 which is used to provide the identity of each transmitter to send information to each particular cell user [16], [17], [18]. Figure 3 shows the results of the Minangkabau International Airport area PCI plot. Each sector has a PCI that is different from one another. From the cell it can be seen that the International Minang Kabau area has 4 different sites. It can be seen from the figure that the Batang Anai site has PCI from other sites serving the Batang Anai site. PCI in sector 2 Batang Anai and sector 3 from the Bandara Ketaping Site experience cross feeders. Cross feeder is a condition that occurs when the sector of the site is switched or not in accordance with the proper configuration.

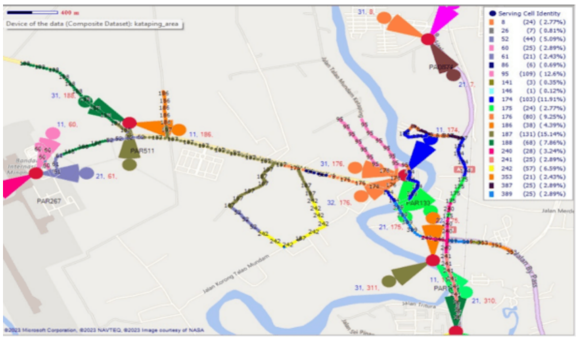

Figure 3. Plot Result of PCI

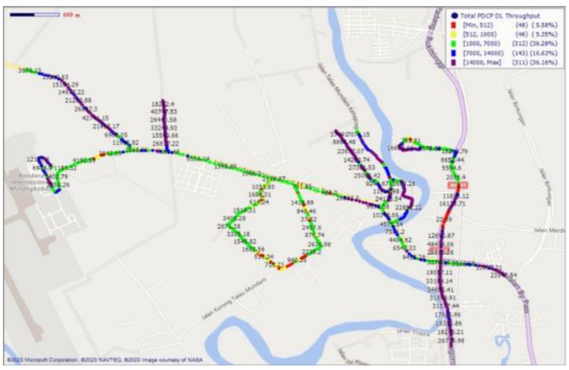

Figure 4. Plot Result of Troughput

Troughput

Throughput on the LTE drivetest is the Data rate (Kbit/s) value from UE to EnodeB [19], [20], [21]. Throughput in the Minangkabau International airport area can be seen from the results of the Drivetest data retrieval logfile in Figure 4 and the plot results of throughput values are explained in table 3. From the above table, it can be seen in the very bad category (< - 512 Kbps) 48 data samples with a percentage of 5.58%, bad category (≥ -512 x < -1000) 46 data samples with a percentage of 5.35%, pretty good category (≥ -1000 x < -7000) obtained 312 data samples with a percentage of 36.28%, good category (≥ 7000 x <14000) obtained 143 data samples with a percentage of 16.63%, and for very good category (≥ 14000) obtained 311 data samples with a percentage of 36.16%. Therefore, regarding to the percentage value of the number of samples, it can be seen that the download throughput value in that area is included in the fairly good category with a range of 1000 kbps to 7000 kbps.

Signal to Interference Noise Ratio (SINR)

SINR is a KPI parameter that shows the signal quality on the 4G LTE network. This parameter shows the ratio of noise to signal interference. The higher the SINR value, the better the signal quality because it shows a low level of noise interference to the signal. With low noise it will reduce obstacles or latency signal which will increase the quality and speed of the signal on the 4G network [22], [23]. Figure 5 shows the results of the SINR plot in the Minangkabau International Airport area. Based on the results of the SINR values plot for the Minangkabau International Airport area, as shown in Table 4, it can be indicated that the quality of the SINR parameters contains 865 samples obtained during the download process around the route. The measured data, in table 4 can be seen are in the very bad category (< 0 dB) obtained 51 data samples with a percentage of 5.9% quite bad category (≥ 0 dB x < -13 dB) obtained 585 data samples with a percentage of 67, 63%, good category (≥ -13 dB x <-20 dB) obtained 171 data samples with a percentage of 19.77%, very good category (≥ 20 dB) obtained 58 data samples with a percentage of 6.71%. The SINR value of the 4G LTE network in the Minangkabau International Airport area is not good because it is dominated by a yellow indicator. So it can be concluded based on the signal strength ratio between the main signal emitted and the interference compared to the background noise that arises (mixed with the main signal) that Telkomsel's network in the Minangkabau International Airport area is bad (yellow and red).

3.2 Simulation of Atoll Optimization

The further step after analyzing the data from the drivetest results and after obtaining problems in various site areas, such as bad spot areas and poor network in the study area as evidenced by the high percentage of “very bad” categories in the RSRP, SINR and Throughput parameters, the next step is to carry out optimization which is simulated using Atoll software. The Atoll software was chosen because it makes it easier to see the network coverage area by using the existing eNodeB data site.

Dealing with the results of the previous RSRP, SINR and throughput plotting parameters, the next step is optimization, this is done to improve the coverage area in the Bad spot area. Figure 6. shows how the coverage area was before optimization. The coverage area before on the PAR511ML_Batang Anai site and the PAR133ML_ Bandara Ketaping site which has been carried out using the Atoll software, can be seen how the coverage area of each cell that covers that area looks like. The coverage area display is based on Telkomsel's Key Performance Indicator data. Dealing with the results of data processing that has been carried out on the parameters and has been analyzed previously, there are several bad spots, which affect network quality.

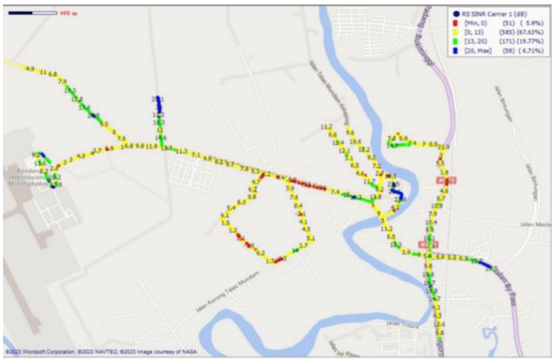

Figure 5. Plot Result of SINR

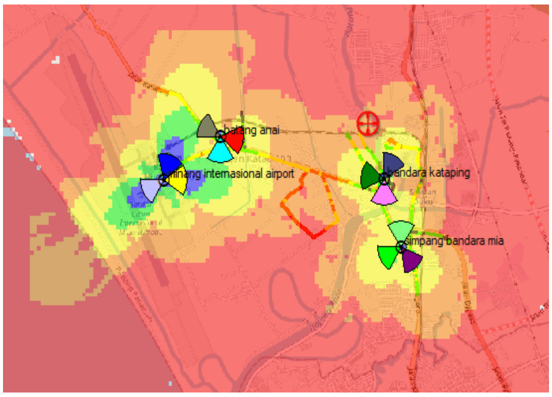

Figure 6. Coverage Area Before Optimization

Bad Spots Point in Sector 1

Figure 7 is a display of 1 SINR Bad Spots, the distance between the site and the Bad Spots is about 621.2 m. Seen in the Bad Spots area which is marked in blue on the drivetest route which is indicated by the color "red" which means the network quality is bad. Factors that cause the Bad Spots area are obstacles and cross feeders.

Bad Spots Point in Sector 2

Figure 8 is the processing results of the drive test on tems discovery, it can be seen that areas that have poor signal quality are marked with yellow and red sample points, in the bad spot area there are bad SINR problems. Bad spots are areas that experience poor 4G signal quality, as well as a lot of blocking from trees which causes the signal received by the UE to deteriorate and interference occurs.

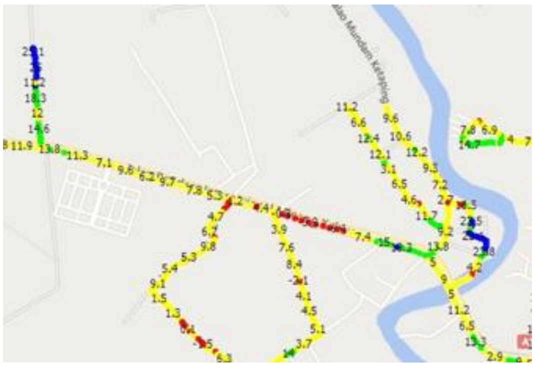

Figure 7. The Display of SINR Bad Spots in Sector 1

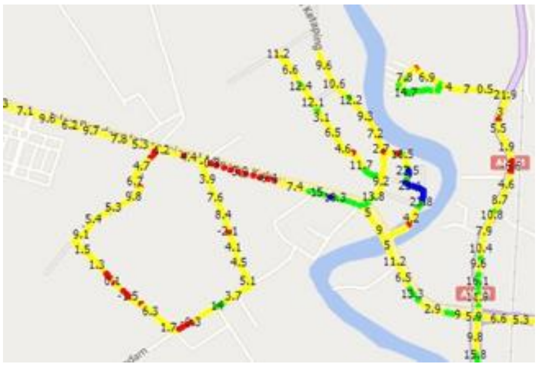

Figure 8. The Display of SINR Bad Spots in Sector 2

Table 5. Antenna Data Before Optimization

Data Antenna	Site Bandara Ketaping	Site Batang Anai	Site MIA Airport Intersection	Site Minangkabau International Airport
Type Antenna	Commscope Andrew TBXLHA-6565C-VTM	Tongyu TDQ182020DE-65F	Rosenberger S-Wave EW/EW/EW/EW-65-18DV2/12I-64K	ROSENBERGER BA-G6W6W6X65V-11-TK
PCI	174	186	309	60
	175	187	310	61
	176	188	311	62
Azimuth	30	100	0	20
	180	180	140	90
	280	300	240	240
Mechanical Tilt	0	2	0	0
	0	2	0	0
	0	0	0	0
Electrical Antenna	4	0	5	2
	8	0	8	2
	4	2	8	2
Height Antenna	30 m	32 m	33 m	15 m
Altitude	8 m	8 m	8 m	8 m
Beamwidth Vertical	7.2	5	6	10

3.2 Antenna Data Before Optimization

In the process of installing a new BTS, the antenna is a very important device. In a cellular communication system, it must use a wireless network (without cables), so the most effective device to use is an antenna because there are components that can convert electrical waves into electromagnetic waves and vice versa. Before installing the BTS, the design related to the antenna is very important to pay attention to the antenna data so that later the required antenna data are azimuth, mechanical tilt, electrical tilt, antenna type and antenna height [24]. The following are the there will be no direction of the signal emission from the installed antenna. recommended antenna data values according to the planning in table 5.

Network Optimization Using Physical Tuning Method

After analyzing the results of the drive test, there are several problems from bad spots which result in poor network quality in the Minang Kabau International Airport area in which it leads to the not optimal beam direction and antenna tilt according to planning, thus, to minimize the occurrence of bad spots optimization, it is carried out using the physical tuning method on the antenna. This antenna physical tuning method aims to determine the direction of the azimuth, mechanical tilt, and electrical tilt of the sectoral antenna. To get the direction of the signal beam and the optimal tilt angle for the antenna, calculations can be undertaken manually or using a tilting calculator.

Azimuth Direction Change

Figure 9(a) shows that this area is a Bad Spot area because the Azimuth on the Bandara Ketaping antenna is 280º and the Azimuth on the Batang Anai antenna is 180º not pointing or not covering the bad spot area. In Figure 9(b) can be seen that the Ketaping and Batang Anai Airport sites have covered the bad spot area but with an orange indicator which was previously red. After re-azimuth on the antenna site at Ketaping and Batang Anai Airports, they have covered the Bad Spots area where the indicator color was orange which was previously red. A specific difference between the Bad Spots area before and after the re-azimuth is marked within the square. The azimuth direction is changed according to the optimization direction. Table 6 shows the azimuth-changed antennas

Table 6. Antenna Data Before Optimization

Name Site	Sector	Before	After
PAR133ML_Bandara Ketaping	2	180	120
PAR133ML_Bandara Ketaping	3	280	260
PAR511ML_Batang Anai	1	100	70
PAR511ML_Batang Anai	2	180	160

Table 7. Antenna Data Before Optimization

Site Name	Sector	Antenna Height	
		Before	After
PAR133ML_Bandara Ketaping	1	32	40
	2	32	40
	3	32	40
PAR511ML_Batang Anai	1	30	40
	2	30	40
	3	30	40

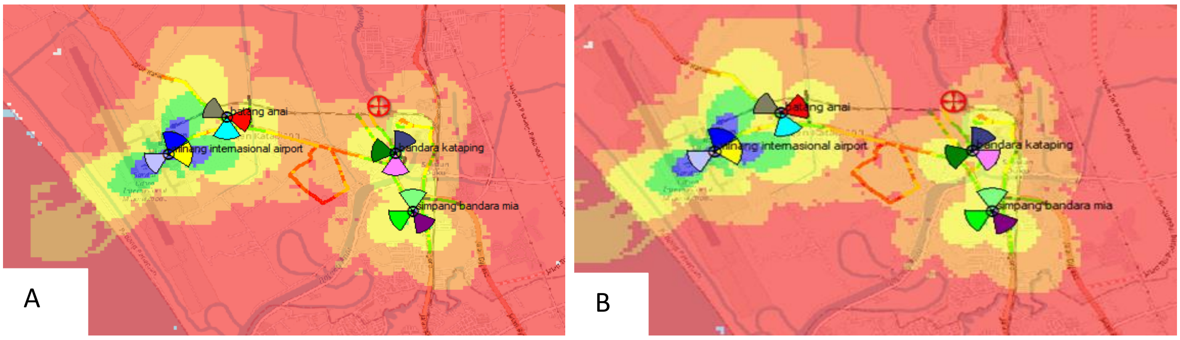

Figure 9. Coverage Area on The Antenna Beam (A) Before Re-Azimuth and (B) After Re-Azimuth. (The square marker shows a specific difference between the bad spots area before and after the re-azimuth)

3.3 Antenna Height Change

Antenna height changes during optimization also affect the transmit power of an antenna where the area is not covered because the area has a bad spot. In Figure 10(a) shows that the coverage area before changing the height of the antenna but having done a re-azimuth which has changed the direction of the antenna to the bad spot area, and has not yet achieved maximum optimization, then further optimization of the Physical tuning method by changing the antenna height, as shown in table 7.

After changing the height of the antenna, the coverage area has changed to be wide because the change in antenna height also affects the coverage area of the antenna. It can be seen that in the previous bad spot area the emission indicator from the antenna was "red" now it changes to an "orange" indicator and the "yellow" color indicator beam widens and covers the bad spot area. Figure 10(b) shows the coverage area after changing the antenna height, and a detailed comparison of the coverage area before and after changing the antenna is marked within the square.

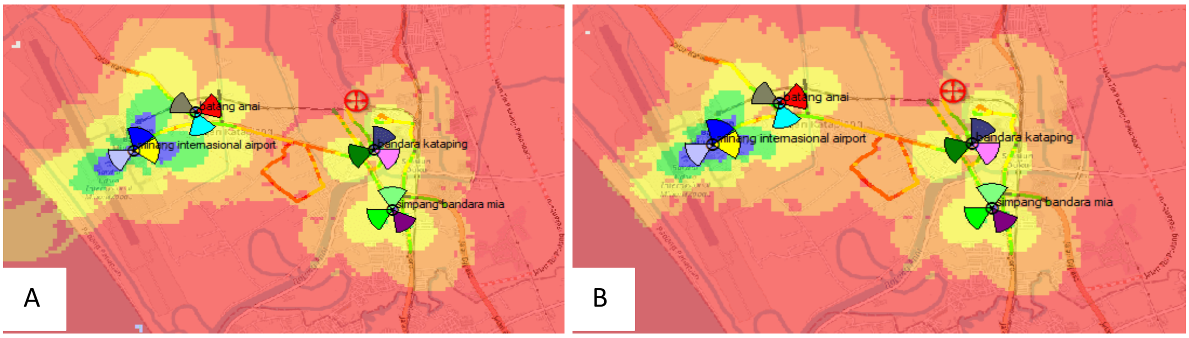

Figure 10. Coverage Area (A) Before Changing Antenna Height and (B) After Changing Antenna Height. The square marker shows the specific area of Bad Spots before and after changing the antenna height.

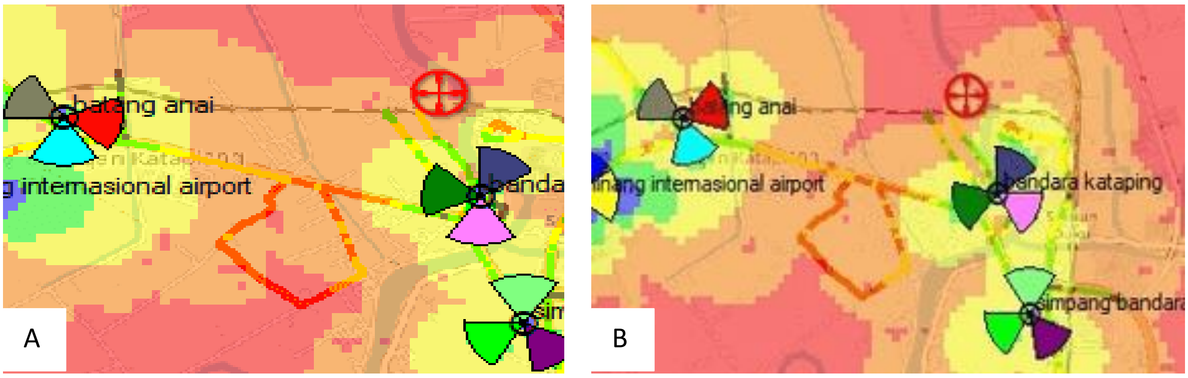

Figure 11. The Area of Bad Spots (A) Before Changing The Antenna Tilting and (B) After Changing Antenna Tilting

The Calculation and Change of Antenna Tilting

Optimization of the antenna tilting method is a step that is carried out based on the data obtained from the analysis of the drive test. Optimization with the antenna tilting method is carried out to get good network performance services in terms of coverage and network quality in one area.

In optimizing the antenna tilting method, it focuses on optimizing only the physical part, such as determining the azimuth, mechanical tilt, and electrical tilt of sectoral antennas. To get the direction of the signal beam and the optimal tilt angle for the antenna, calculations can be done manually or using a tilting calculator. Table 8 shows the antenna data before tilting.

In accordance with the calculation of the tilting antenna site PAR511ML_ Batang Anai sector 2, the optimal antenna tilt degree is 2˚ with a mechanical tilt of 0˚ and an electrical tilt of 2°. With the same tilt angle of 2º, the mechanical tilt is changed to 0º, which was 2 before, and the electrical tilt is changed to 2º, which was 0º previously.

The azimuth at the PAR511ML_ Batang Anai sector 2 site was changed from 180˚ to 160˚ because the 180˚ azimuth direction was not optimal. Figure 11(a) illustrates the coverage area in the bad spot area before tilting the antenna and Figure 11(b) shows the bad spot area after antenna tilting.

Table 8. Antenna Data Before Tilting

Site Name	Antenna Height	Mechanical Antenna	Electrical Antenna	Altitude	Sector	Beamwidth
PAR133ML_Bandara Ketaping	40	0	4	8	3	7.2
PAR511ML_ Batang Anai	40	2	0	8	3	5

Table 9. Antenna Data After Optimizing

Antenna Data	Bandara Ketaping Site	Batang Anai Site
Type Antenna	Commscope Andrew TBXLHA-6565C-VTM	Tongyu TDQ182020DE-65F
PCI	174	186
	175	187
	176	188
Azimuth	30	170
	120	160
	260	300
Mechnical Tilt	0	2
	0	0
	2	0
Electrical Antenna	4	0
	8	2
	2	2
Height Antenna	40 m	40 m
Altitude	8 m	8 m
Beamwidth Vertical	7.2	5

From figure 11, it can be seen that there has been a change in the horizontal direction at the PAR133ML_Bandara Ketaping and PAR511ML_ Batang Anai sites. Previously the horizontal direction of the sector antenna was 280 to 260 at the Bandara Ketaping site and 180 to 160 at the Batang Anai site. After changing the tilting of the antenna, the area that was previously a "red" indicator becomes an "orange" indicator.

The results of this study are in line with research conducted by (Sirait, 2020) where after optimization showed an improvement in network quality by looking at network parameters, namely RSRP, SINR, and RSRQ. The percentage value of RSRP increased from 82.32% to 83.51%, for SINR decreased from 89.51% to 86.8%, and RSRQ [25]. Likewise, the study (Yuliana, 2019) also found that after carrying out the actual tuning improvements from the pre-determined sites, an increase in network conditions was obtained that was clearly superior to the previous condition, where the RSRP was not exactly -100dBm increased from 56.69% to 81.46% and SINR with a value of more than 0 dB also increased from 68.17% to 80.71% [26]. Table 9 and Figure 12 are data from the results of calculations and recommendations for changes in azimuth, changes in antenna height and changes in antenna tilting.

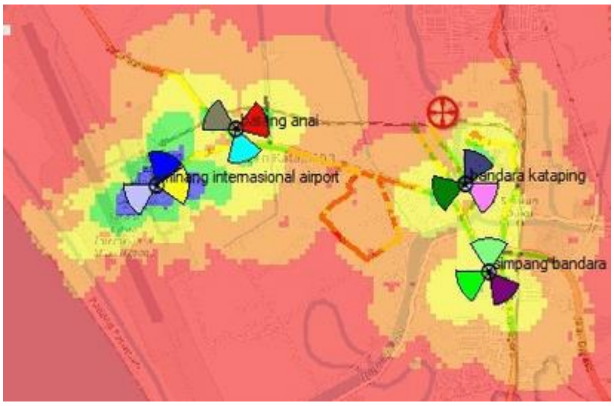

Figure 11. Result of Bad Spots OptimizationTilting

4. Conclusion

Data processing drive test operator Telkomsel in the Minangkabau International Airport area obtained RSRP Parameter data in the range -110 to 0 with a red indicator of 3.35%, an orange indicator of 18.96% and a yellow indicator of 36.3%. The SINR parameter was obtained from data in the range of 13 dB to 0 dB with a percentage of 67.63%. As well as the download throughput parameter obtained in the range of 1000 kbps to 7000 kbps with a percentage of 36.28%. From the results of the drive test, it was found that the distance from the site to the bad spot area was very close. The occurrence of bad spots in this area was caused by the direction of the antenna beam that has not yet led directly to the bad spot area

Optimization of the physical tuning method in the Minangkabau International Airport area was Re-Azimuth at PAR511ML_Batang Anai sector 1 100º and sector 2 180º. Then Re-Azimuth site PAR133ML_The Airport of Ketaping sector 2 120º and sector 3 260º, then at the PAR511ML_Batang Anai site sector 1 70º and sector 2 160º so that the antenna has been directed to the badspot area. Changes in the height of the antenna at the PAR133ML_ Bandara Ketaping site and the PAR511ML_Batang Anai site were changed to a height of 40 m and it caused in a farther covered badspot area. Changes in antenna tilting in tilting calculations to site PAR133ML_Bandara Ketaping sector 3 mechanical 2º and electrical 2º, then at site PAR511ML_ Batang Anai sector 2 mechanical 0º and electrical 2º resulting in a more optimal coverage area in that area. It is recommended that for the next bad spot area, the optimization should be done in real time in the field so that the improvement can be resolved in a real way.

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