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The Effect of Overshoot on 4G LTE Network Performance in East Sawahan Area

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ABSTRACT

Overshoot occurs when cellular network signal strength extends beyond its intended coverage zone, leading users to connect to distant cells instead of the nearest ones. This can result in significant drops in signal quality and network performance. To investigate this issue, a drive test methodology was employed throughout East Sawahan. This involved utilizing TEMS Pocket software for capturing real-world signal measurements while traversing the area. The collected data was then analyzed using TEMS Discovery software to pinpoint areas affected by overshoot. Network performance was assessed based on key performance indicators (KPIs) such as Received Signal Strength Indicator (RSRP), Signal-to-interference plus noise ratio (SINR), and Physical Cell Identity (PCI). These parameters provide insights into signal strength, interference levels, and cell identification, respectively. To address the overshoot problem and improve network performance, Atoll software was employed. This software facilitated the implementation of an antenna tilting technique. By adjusting the antenna tilt from 0 degrees to 6 degrees, the network coverage area was more precisely controlled. The results of this intervention were highly successful. By mitigating overshoot through antenna tilting, the network performance significantly improved. Signal quality, as measured by the aforementioned KPIs, demonstrably met the established standards set by the Key Performance Indicators (KPI).In conclusion, this study effectively resolved network performance issues arising from overshoot in East Sawahan. The drive test methodology, combined with Atoll software and antenna tilting, demonstrably enhanced network coverage and signal quality, ensuring a more reliable cellular network experience for users in the area.

INTRODUCTION

East Sawahan Village is part of the administrative area of East Padang District in Padang City, West Sumatra. This area has an area of 8.80 square kilometers and consists of 6 RWs and 18 RTs. The population is 5,401.(BPS, 2023).

The East Sawahan area is a densely populated area that has 7 BTS (Base Transceiver Station). Areas with complete infrastructure and various facilities such as office buildings, schools, hospitals, and train stations, with several adjacent BTS, have the potential for network interference such as overshoot(Studi Jaringan Telekomunikasi Digital, Negeri Malang, & Suroyya, 2019).

Furthermore, the measurement process is carried out using the drive test method. This drive test is carried out to gain an understanding of the quality of the existing network, as well as analyze the results of the driving test to obtain information about areas that experience overshoot and areas with bad quality (bad spot)(Studi Jaringan Telekomunikasi Digital, Negeri Malang, Aji Istantowi, et al., 2019). The impact of overshoot is a decrease in the quality of the signal received by the user so that it does not reach the established Key Performance Indicator (KPI) standard. The main cause of this overshoot is improperly tilting antenna settings (Yuliana et al., 2019).

Overshoot occurs when a cell/sector surpasses The boundary of the area that should be covered or covers an area that should not be the region of the cell with high signal strength so that the cell becomes dominant. A cell is usually planned to cover a specific area, and if it extends beyond the scope of another site, it can be referred to as an overshooting cell. (Hanif et al., 2019). This causes problems such as Badspot area so it is necessary to analyze overshoot problems that occur in bad spots that cause low RSRP (Reference Signal Received Power), and low SINR (Signal to Interference Noise Ratio) by reviewing PCI (Physical Cell ID) parameters(Hanif et al., 2019).

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METHOD

Research Methods

Checking Telkomsel's network quality using the Drive Test method aims to evaluate network quality in areas where real data has been collected. Through this method, it can be known the influence and cause of problems on existing 4G LTE parameters. Fig.1 below describes the working system of this study:

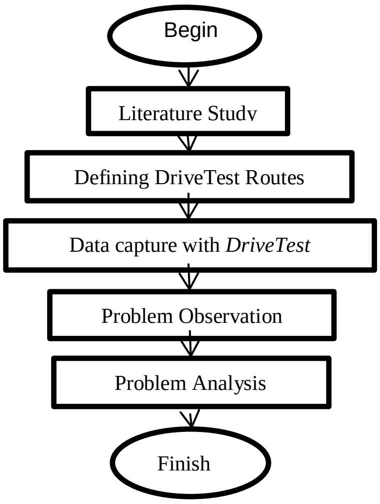

Figure 1. Data Retrieval Work System

Data Retrieval Techniques

Doing path planning ahead of time helps researchers determine which areas need to be traversed to collect drive test data. This aims to avoid repeated data collection so that the data analysis process can run well.

In planning the test drive path, the authors used the Google Earth application as a tool. In Path planning, two important things support DriveTest, namely area mapping and user identification.

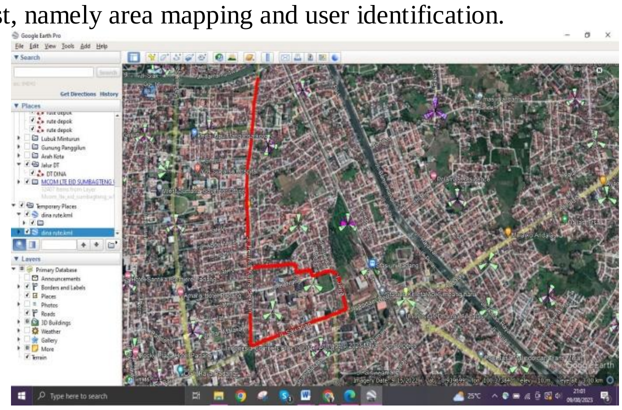

Figure 2. Drive test path

Figure 2 shows the drive test path shown with a red line. In this study, the author gave priority to the main roads in the East Sawahan area because the area has many users. The Google Earth application is used as a tool to see the presence of settlements in the region.

After the path is created, the next step is to retrieve data to analyze the problem that occurred. Data retrieval is done using TEMS Pocket software. Its function is to collect data on network quality and problems. Data captured through TEMS Pocket includes RSRP (Received Signal Reference Power), SINR (Signal to Interference and Noise Ratio), and PCI (Physical Cell ID). This data retrieval process uses TELKOMSEL operators on the 4G LTE network.

RESULT

Measurement Results

The results of this measurement are in the form of logfile data obtained through data retrieval using Tems Pocket and then processed using TEMS Discovery. The parameters used in the driving test are PCI, RSRP, and SINR according to the range of KPI values in each parameter (Karo Karo et al., 2020).

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Tabel 1. Target KPI (Tanjakan & Tangerang, 2019)

Parameter	Target KPI	Equation
RSRP	90%≥-100 dBm	$\frac{\textit{Sampel} \geq -100\text{dBm}}{\textit{Total sampel}}\ x\ 100$
SINR	80%≥0dB	$\frac{\textit{Sampel} \geq -100\text{dBm}}{\textit{Total sampel}}\ x\ 100$

Table 1 displays the target KPI parameters to be analyzed, in the RSRP parameter if the range of ≥ -100 dBm reaches 90%, it can be said that the RSRP in the area has met the KPI target. In the SINR parameter, if the range of ≥ -0 dB values reaches 80%, it can be said that SINR in the area has met the KPI target.

Physical Cell ID (PCI)

Cell ID is the physical identity code of each cell. Each cell will send information about its Cell ID so that users can recognize the site. In LTE networks, the technique of numbering the identity of each cell is limited to 504, so more efficient usage management is needed to reduce the risk of high network conflicts. The use of PCI aims to simplify the process of searching, *paging*, and *user handover*.(Chandra et al., 2021)

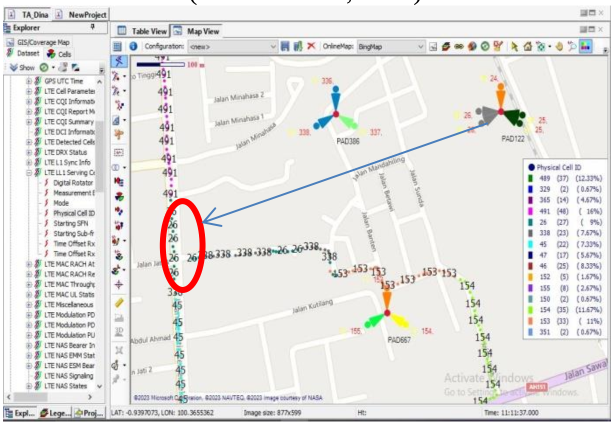

Figure 3. PCI plot

The results of the PCI plot at the site studied found an overshoot problem, where the PAD122_PJKA site in sector 3 with PCI 26 emitting signals that do not match the coverage area that is not the area of the cell marked by a red circle.

Where in that sector the beam from the neighboring site to the main site. The signal at the neighboring site is more dominant, causing the extent of the area and interference in BTS cells that experience overshoot. Therefore, it is necessary to make improvements to overcome the overshoot problem to fix service malfunctions(Sirait & Nurhidayanto, 2020).

Reference Signal Received Power (RSRP)

In data retrieval with a test drive, a data record is obtained containing samples of data contents received by the EU from eNodeB during the circumnavigation of a predetermined route(Kodoatie & Sama, 2020).

Table 2. Legend RSRP(Scholarship, 2022)

Legend	Range dBm	Sample	%
Excellent	**RSRP ≥ -71**	**18**	**5,98**
Good	**-71 ≤ RSRP < -81**	**106**	**35,22**
Fair	**-81 ≤ RSRP < -91**	**139**	**46,18**
Poor	**-91 ≤ RSRP<-101**	**38**	**12,62**
Very Poor	**RSRP < -101**	**0**	**0**
TOTAL	**SINR < 0**	**301**	**100,00**

Based on the equation of table 1, the calculation results are as follows:

RSRP KPI value = $\frac{263}{301}\ x\ 100\% = 87,37\%$

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The KPI target in Table 1 was not achieved because only 263 samples with a percentage of 87.37% of the existing target of > -100dBm as much as 90%. This result has not reached the predetermined KPI target, therefore RSRP plays an important role in knowing whether an area has been covered or not by the network so that this parameter can be used as a benchmark to choose the priority area first for improvement(Rahmaddian & Huda, 2020).

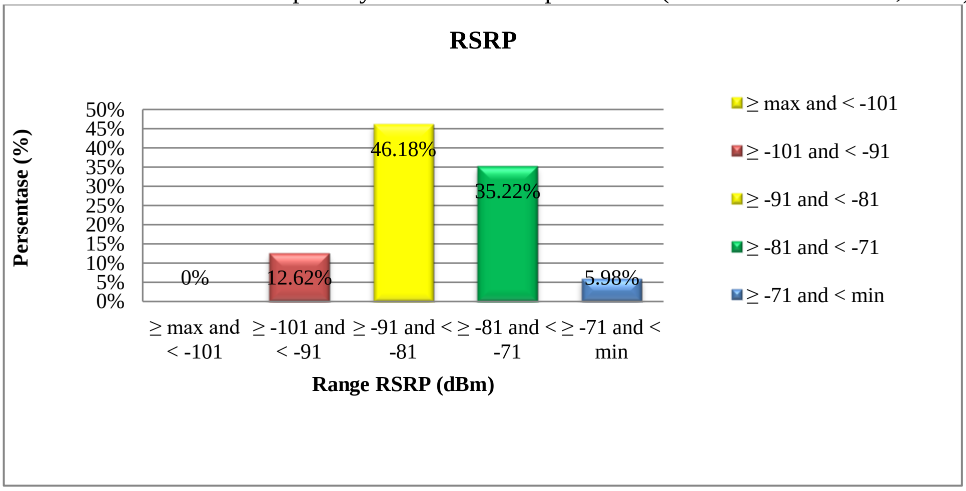

Figure 4. Percentage graph image of RSRP value

RSRP values are measured in units of dBm (milliwatt decibels), and the greater the value, the stronger the signal strength received by the EU device. Typically, RSRP is used to determine the quality of coverage and network performance in a particular location(Islam et al., 2020).

Signal Interference to Noise Ratio (SINR)

SINR is very important because it can affect data throughput and general network performance. If the SINR is low, it means that there is a lot of interference or interference that affects the signal quality. This can lead to decreased data transfer rates or even disconnections(Farida & Yunianto, 2020).

Table 3. Legend SINR(Scholarship, 2022)

Legend	Range dB	Sample	%
Excellent	SINR ≥ 20	1	0,16
Good	13 ≤ SINR < 20	14	4,65
Fair	0 ≤ SINR < 13	203	67,62
Very Poor	SINR < 0	83	27,57
TOTAL		301	100,00

Based on the equation in Table 1, the calculation results are as follows:

SINR KPI value = $\frac{218}{301}$ x $100\% = 72{,}42\%$

Of the KPI targets in Table 3, the SINR parameter of samples does not meet the KPI target. It can be concluded that the SINR parameter in the region KPI standard is not achieved so it has signal interference to power. Of course, this will have an impact on the 4G LTE network, especially in terms of speed when downloading files, so that the signal power received at the mobile station/user equipment is weak because of the interference signal power from cell-cell other and great received background noise(Bandung, 2021).

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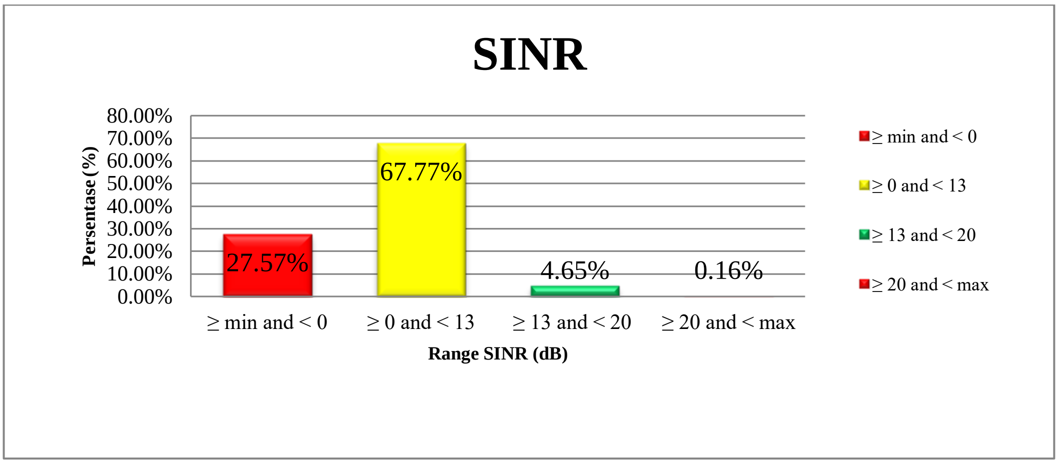

Figure 5. Graphic image of percentage value of SINR

DISCUSSION

Occurrence Overshooting Cell

Overshoot refers to a situation where a cell/sector overreaches an area or covers an area that should not be that region of the cell with a strong signal, resulting in the cell becoming dominant. Each cell is designed to cover a specific area, and if it covers another area of the site, then it is considered an overshooting cell.(PURNAMA et al., 2020).

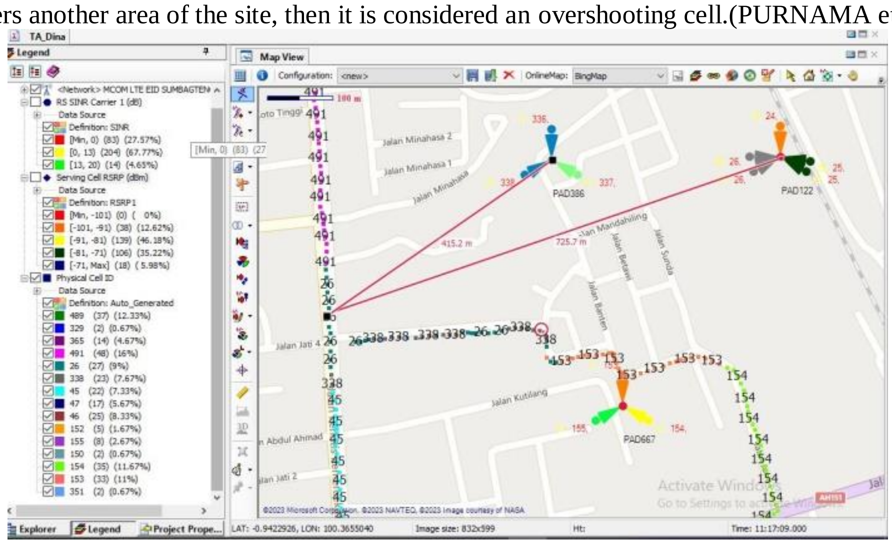

Figure 6. Site Overshoot

The occurrence of overshoot problems by sites PAD122_PJKA sector 3 with PCI 26 is due to the presence of sites that are close to each other so that the signal beam is equally strong between sites. Where the area should be covered by the PAD386_Jati site, causing interference with other cells and can interfere with signal quality and network performance.

The Effect of Overshoot on Network Performance

Site overshoot can cause interference with the base station or other cells in the vicinity. This can interfere with signal quality and overall network performance. Because both sites are equally dominant in serving, this is what causes the weakening of the coverage parameter(Yuliana et al., 2020).

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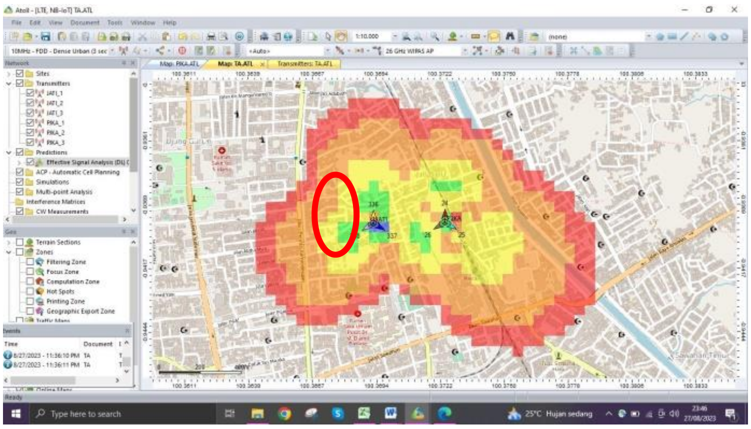

Figure 7. RSRP Coverage

As shown in Figure 5, when interference occurs, the impact of RSRP coverage will weaken. Interference occurs due to several factors, one of which is when a signal from one transmitter is overwritten or covered by another signal that has the same frequency and higher strength.

This is what causes the deterioration of signal quality in the coverage area of a transmitter. It can be concluded that the PAD122 site antenna beam is not optimal and the signal power emitted does not meet the desired target.

Improved Network Perforation

After analyzing the results of the Drive test, due to overshoot problems caused by non-optimal beam direction and planned antenna, changes were made to the antenna tilt method to analyze the increase in overshoot. The steps to improve the tilt of the antenna are carried out based on the data from the analysis of the drive test.

Table 4. Antenna data before repair

Type Antena	**Rosenberger S-Wave U-65-16DV10**	**Rosenberger S-Wave U-65-16DV10**	**Rosenberger S-Wave U-65-16DV10**
Sektor	1	2	3
PCI	24	25	26
Tinggi Antena	35m	35m	35m
Mechanical Tilt	4˚	0˚	2˚
Azimut	0˚	120˚	240˚
Electrical Tilt	2	2	2

Improvements to the tilt antenna method were made for better network performance services in terms of coverage area and network quality. Overshoot occurs in densely populated areas and urban areas with many BTS close together. Therefore, it is very necessary to re-plan the tilt and direction of the antenna beam to be right on target. When optimizing the tilting process, the antenna focuses only on optimizing physical aspects such as azimuth determination, mechanical tilt, and electrical tilt. Getting the best direction of the signal beam and the angle of inclination of the antenna can be done by doing calculations manually or using a tilting calculator(Ulfah, 2018). Tilting Antena To get an optimal coverage area than before, it is necessary to calculate the tilting antenna using the main beam distance in sector 3 which can be seen in figure 4, which is 726 m. For calculations, you can use the tilting antenna formula as follows:

$$
\begin{aligned}
A &= \tan^{-1}\left(\frac{Hb - Hr}{jarak}\right)\\
&= \tan^{-1}\left(\frac{(43)-(9)}{726}\right)\\
&= \tan^{-1}(0{,}04)\\
&= 6^{\circ}
\end{aligned}
$$

Based on the calculation of tilting the sector 3 antenna, the optimal degree of tilt of the antenna is 6°.

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Network Performance Results After Repair

After the improvement is carried out by recalculating the tilting antenna value from the simulation results using Atoll Planning software, the following are the results of parameter changes after the repair:

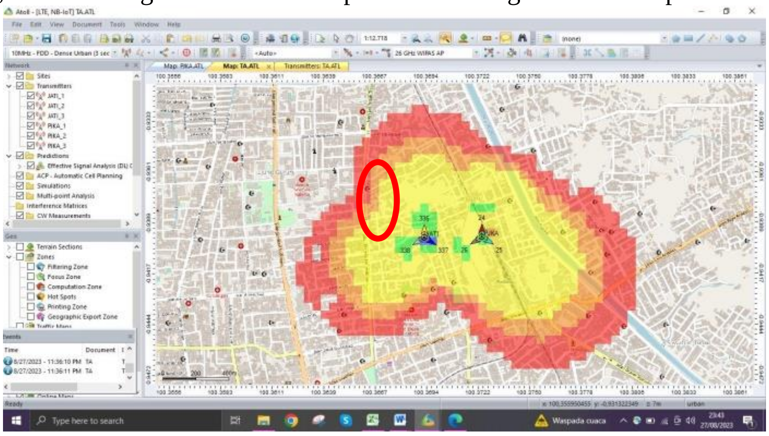

Figure 8. RSRP coverage after repair

Figure 8 shows the results of RSRP coverage, where from these results around the distribution area coverage area is optimal. From before, the signal quality affected by overshoot has an orange signal indicator, which means poor changes to yellow, which is fair.

When tilting the antenna is done, the direction of the antenna transmission is slightly lowered so that the coverage area is smaller. It can be seen in the results of the coverage area that is optimally covered which is only around the site under the azimuth direction and has not reached the coverage area of neighboring sites(Septiawan & Syamsuar, 2021). From the case in this study, it is proven that changes in the antenna tilting method are considered more effective in overcoming overshoot problems that cause poor signal quality due to interference (Ramadhan et al., 2018).

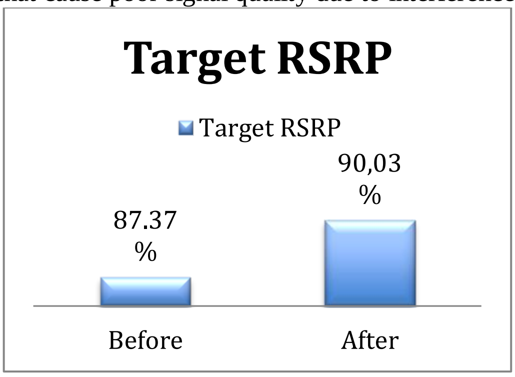

Figure 9. Percentage Grafik image of the result of changing the tilting method of the antenna

The graph above shows a comparison of conditions before and after network repairs. The simulation of LTE network performance shows that the improvements made have succeeded in increasing performance by 2.66% in coverage parameters, thus meeting the KPI targets set. In detail, the percentage increase increased from 87.37% to 90.03%.

CONCLUSION

Based on the analysis, several conclusions can be drawn as follows, Overshoot occurs at PAD122_PJKA sector 3 sites with PCI 26 reaching PAD386_Jati sites that should be served by PCI 338. Site overshoot can cause interference with the base station or other cells in the vicinity. This can interfere with signal quality and overall network performance. RSRP and SINR parameters affect the occurrence of overshoot resulting in suboptimal coverage area and weakened signal quality. The overshoot problem has been resolved by making changes to the antenna tilting method which was originally 2° to 6° slightly subdued at the PAD122_PJKA sector 3 site so that it could meet the specified target KPI with an increase of 2.66% from 87.37% to 90.03%.

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