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Optimization of Telkomsel 4G LTE Network in Taman Panorama Baru Area

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ABSTRACT

The Bukittinggi City New Panorama Tourism Park is one of the most visited destinations, requiring optimal cellular network quality to support communication and data services. This study aims to analyze the performance of Telkomsel's 4G LTE network in the area, plan necessary improvements, and optimize network performance using Atoll software. The initial data were collected through a drive test by measuring key parameters such as Reference Signal Received Power (RSRP), Signal to Interference plus Noise Ratio (SINR), and throughput. Field measurements revealed that several areas still exhibited RSRP values ≤ -110 dBm, low SINR, and existing bad spots, indicating that the service quality had not yet reached optimal performance. Network optimization was carried out by adjusting antenna parameters including azimuth, tilt, and transmit power using the Automatic Cell Planning (ACP) method. The simulation results in Atoll after optimization showed improved RSRP coverage, a significant increase in SINR, and higher predicted throughput compared to the initial condition. However, discrepancies were found between simulation and field results, particularly in throughput, due to propagation model limitations, physical obstructions, and environmental variations. In conclusion, the implemented optimization successfully enhanced the overall network performance, although further evaluation is required to better align the simulation outcomes with real field conditions.

INTRODUCTION

In today's digital era, mobile communication is a basic need, especially in tourist areas that are crowded with visitors. Mobile telecommunication is a form of mobile communication that can serve many users in a wide area coverage. The system offers good network quality and is competitive with landline telephone services. Along with the development of technol-ogy, there is now a fourth-generation network, namely 4G LTE (Long Term Evolution), which offers better data transfer speeds and service quality than the previous generation (3G). However, the coverage of the 4G LTE network in Indonesia is still uneven. Therefore, various service providers, including Telkomsel, continue to strive to expand and optimize network coverage (Yulianto & , Munnik Haryanti, 2021).

PT. Telkomsel maintains superior network quality through regular optimization. One method used is Drive Test, which collects field data on signal strength using tools like G-NetTrack Pro to measure network performance (Muhammad Harun Ashar & Dinda, 2023).

4G LTE technology provides users with freedom from space constraints, as well as being a solution to ensure a stable connection and fast data access on a sustainable basis (Alshouiliy & Agrawal, 2021). Ser-vice providers compete to expand their network reach in Indonesia. Despite the increase, the distribution of 4G LTE networks is still uneven in several regions. Therefore, a more in-depth analysis of the performance of the 4G LTE network is needed to optimize its functionality and improve user satisfaction. Signal quality data collection is carried out through the drive test method (Budiman & Hairah, 2021).

LTE architecture is known as SAE (System Architecture Evolution), which is a develop-ment of the previous generation of system architectures. In general, LTE uses EPS (Evolved Packet System) technology, which consists of three main components, namely UE (User Equipment), E-UTRAN (Evolved UMTS Terrestrial Radio Access Network), and EPC (Evolved Packet Core) (Shodikin, n.d.).

U-TRANS is an LTE architecture system that has the function of handling the radio side of access from the EU to the core network (Alam et al., 2023). In contrast to the previous technology that separated NodeB and RNC into separate elements, in the LTE E-UTRAN system there is only one component, namely Evolved Node B (eNodeB) which has combined the functions of both. Physically eNodeB is a base station located on the surface of the earth (BTS Greenfield) or placed on top of buildings (BTS Rooftop) (Abdallah et al., 2022). EPC is a new system in the evolution of mobile communication architecture, a system where the core part of the network uses all-IP (Imani et al., 2020).

RSRP (Reference Signal Received Power) is a measure of the strength of the reference signal received by a device in a cellular network (Yulianto & , Munnik Haryanti, 2021). RSRP measures cell signal strength to evaluate

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network quality; higher values indicate stronger, more stable connections, while lower values indicate weaker signals and reduced performance (Harpawi & Yuli Triyani, 2024).

SINR is a strong comparison of signal compared to background noise. The user's SINR value at the cell edge will indirectly affect the user's throughput, if the SINR value is large, the throughput is also large, but if the SINR is small, the throughput value is smaller (Hadj-Kacem et al., 2020).

Throughput is the number of bits that a terminal successfully receives in a network over a period, in bits per second (bps). The throughput value indicates the average number of bits received by the entire terminal in the network. Since throughput is perceived directly by the user, this parameter has a major influence on user satisfaction levels (Andhika Setyo Utomo et al., 2025).

Key Performance Indicators (KPIs) are metrics used in a Performance Management System to measure and ensure organizational performance aligns with strategic goals (Nurul Indawati et al., 2024).

Drive test is a method of measuring network quality in a mobile communication system that aims to collect data from the quality measurement of a network from the direction of BTS (Base Transceiver Station) to MS (Mobile Station) or vice versa in real time in the field using mobile phones that are specially designed for measurement (Belo, 2021). With drive tests, it can be found how the signal quality of the network.

Automatic Cell Planning (ACP) is a network optimization method that automatically calculates and selects optimal parameter configurations to improve eNodeB performance and expand network coverage (Zain et al., 2022). ACP improves eNodeB performance through iterative sorting and tuning algorithms to find optimal antenna configurations, enhancing coverage and network performance. (Adwel et al., 2023).

However, previous studies mainly focus on general LTE performance improvement using ACP without specifically analyzing its impact in tourist areas with high user density, such as Taman Panorama Baru. In addition, limited studies discuss the detailed comparison of network performance before and after ACP optimization based on drive test data in this specific area. Therefore, this study aims to analyze the performance of the Telkomsel 4G LTE network in the Taman Panorama Baru area before and after ACP optimization using drive test measurements. The contribution of this research is to provide a comprehensive evaluation of RSRP, SINR, and throughput improvements, as well as to determine whether ACP optimization is sufficient to meet KPI targets or if further optimization is required.

METHOD

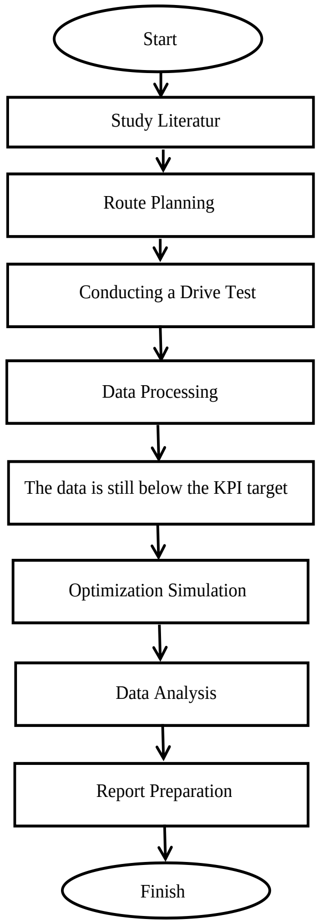

Figure 1. Research Flow Chart

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This research began with a literature study to gain an understanding of the basic theory of the 4G LTE network, network quality parameters, and optimization methods that are in accordance with the research objectives. After that, a drive test route was designed in the research area to determine the path of field data collection. The next stage is the implementation of drive tests to measure the main parameters of the network such as RSRP, SINR, and throughput. The measurement data obtained is then processed and analyzed to determine whether the network quality meets the set Key Performance Indicator (KPI) standards. Based on the results of the analysis, it is known that the data has not met the KPI requirements, so an optimization simulation process was carried out using Atoll software by adjusting antenna parameters such as azimuth, tilt, and transmit power. Furthermore, an analysis of the simulation results was carried out to compare the network conditions before and after optimization. The final stage of this study is the preparation of a report containing the results of analysis, evaluation, and recommendations for improving the quality of the network in the study area.

RESULT

Based on the activities that have been carried out, to find out the performance of an operator's network, it is necessary to collect data directly in the field or commonly known as drive tests. Drive test is a method of measuring network quality by collecting data in real time on a specific route using a special device or a smartphone-based measurement application. In this study, the drive test process was carried out with the help of the GNet Track Pro application which can record network technical data in the form of logfiles. The data obtained is then processed and visualized using MapInfo, so that the distribution of network quality in the research area can be clearly mapped and easily analysed.

The main parameters observed in this drive test are RSRP, SINR and Throughput. The selection of these three parameters is not without reason, these three parameters are interrelated so that a thorough analysis is needed to understand the state of the network in real terms. A high RSRP does not always guarantee optimal throughput if the SINR value is low due to high interference. Similarly, a good SINR can help maximize network capacity so that throughput increases.

this section, the researcher will explain the results of the research obtained. Researchers can also use images, tables, and curves to explain the results of the study. These results should present the raw data or the results after applying the techniques outlined in the methods section. The results are simply results; they do not conclude.

Reference Signal Received Power (RSRP) is a key parameter used in drive test measurements to evaluate the strength of the LTE reference signal received by a user device from the eNodeB. This parameter reflects the quality of cell coverage in the observed area and serves as an important indicator in network performance analysis. A higher RSRP value indicates stronger signal strength and better coverage, while a lower value represents weaker signal conditions.

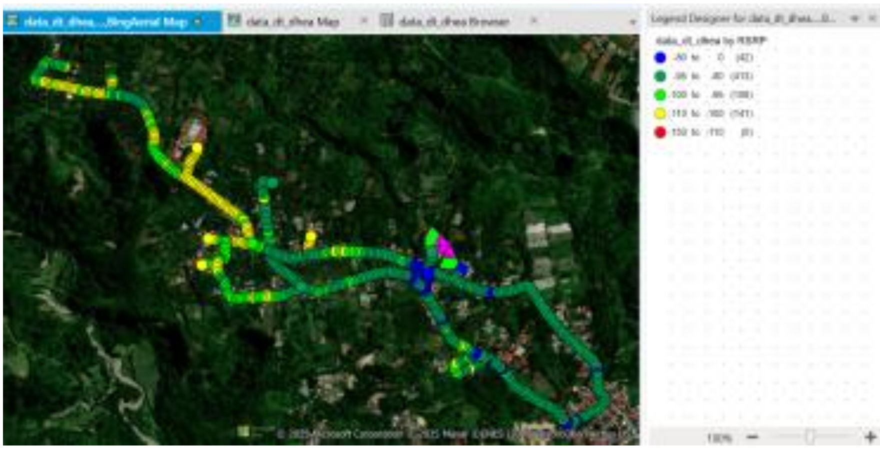

Figure 2. Plotting RSRP Drive Test Results

Table 1. RSRP Measurement Results

Range	Sample	Precentage
[-80 ≤ RSRP < 0] Excellent	42	6%
[-95 ≤ RSRP < -80] Very Good	413	59%
[-100 ≤ RSRP < -95] Good	108	15%
[-110 ≤ RSRP < -100] Poor	141	20%
[-150 ≤ RSRP <-110] Bad	0	0%
Total	704	100%

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In Figure 2 and Table 1. The results of the 4G RSRP measurement from 704 samples show 6% of the categories of excellent, 59% very good, 15% good, 20% poor, and 0% bad. Based on Telkomsel's KPI, at least 90% of samples must have an RSRP above -100 dBm, but the results have only reached 80%, so they have not met the target. A high percentage of the poor category indicates areas with suboptimal signal coverage due to distance, physical barriers, or antenna configuration.This condition shows that in terms of signal power (RSRP), the network coverage is relatively good because most of the values are in the very good category. However, the quality of a strong signal is not always directly proportional to the quality of service that users receive.

SINR Display the Signal to Interference plus Noise Ratio (SINR) parameter assesses the quality of the signal based on the ratio between the main signal power and interference and noise.

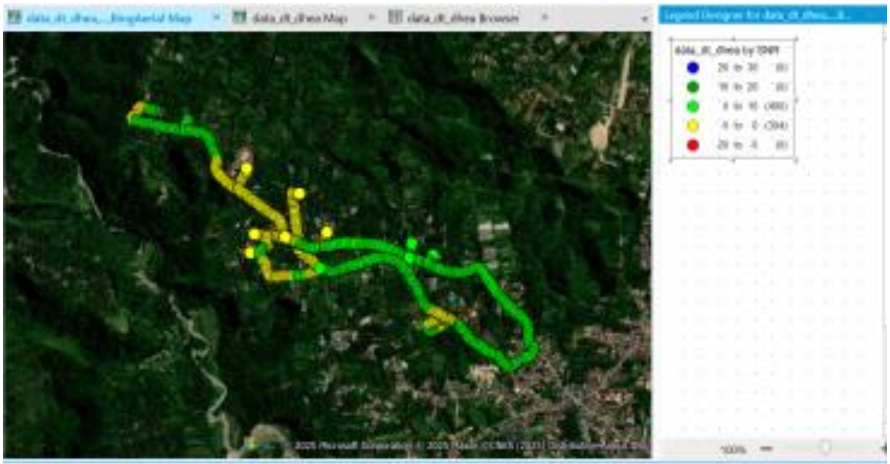

Figure 3. Plotting SINR Drive Test Results

Table 2. SINR Measurement Results

Range	Sample	Precentage
[20 ≤ SINR < 30] Excellent	0	0%
[10 ≤ SINR < 20] Very Good	0	0%
[0 ≤ SINR < 10] Good	400	57%
[-5 ≤ SINR < 0] Poor	304	43%
[-20 ≤ SINR <-5] Bad	0	0%
Total	704	100%

In Figure 3. and Table 2. The results of SINR measurements on 704 samples show that there are no samples in the excellent and very good categories, as many as 400 samples or 57% are in the good category, and 304 samples or 43% are in the poor category, and there are no samples in the bad category. Based on Telkomsel's KPI, at least 80% of the sample must have a SINR above the threshold, but the result only reaches 57%, so it does not meet the standard. Low SINR quality is caused by interference between cells, suboptimal antenna configuration, and high user density. This condition reduces the efficiency of data transmission and has an impact on a suboptimal user experience.

Downlink throughput measures the average speed of data transfer from the network to the user's device and reflects the perceived capacity when accessing the data service. Its value is affected by signal strength (RSRP), signal quality against interference (SINR), bandwidth, and the number of users in a cell. The better the signal quality and the lower the interference, the higher the throughput obtained and the improved Quality of Experience (QoE) of the user.

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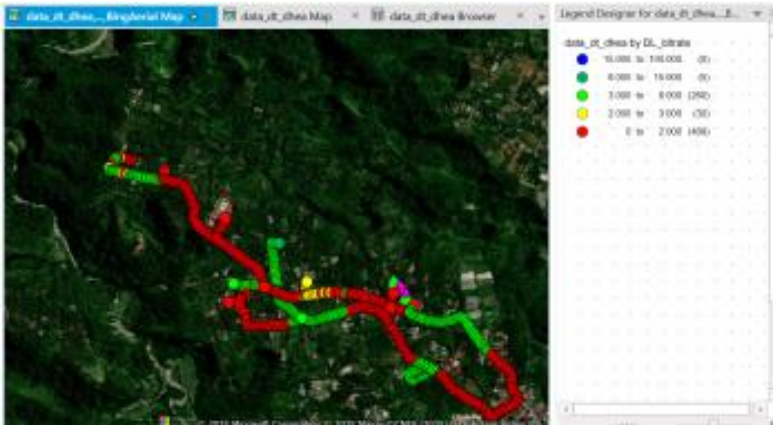

Figure 4. Plotting Drive Test Throughput Results

Table 3. Troughput Measurement Results

Range	Sample	Precentage
[15.000≤ x <100.000] Excellent	0	0%
[8.000≤ x <15.000] Very Good	5	1%
[3.000≤ x <8.000] Good	260	37%
[2.000≤ x <3.000] Poor	30	4%
[0≤ x <2000] Bad	409	58%
Total	704	100%

Based on Figure 4. and Table 3. The throughput measurement results of a total of 704 samples show for the very good category 1% or 5 samples, good 37% or 260 samples, poor 4% or 30 samples, and bad 58% or 409 samples, without excellent samples. According to Telkomsel's KPI, at least 80% of the sample must have a throughput of ≥2,000 Kbps, but the measurement results only reach 42%. This low performance is suspected to be due to suboptimal SINR quality or only 57% ≥ 0 dB.

Before optimization using the ACP method, Reference Signal Received Power (RSRP) is used to evaluate the strength and coverage of the LTE signal in the study area. A higher RSRP value indicates better signal coverage; however, overall service quality is not solely determined by RSRP, as it is also influenced by parameters such as SINR and throughput. The analysis of RSRP before optimization helps identify areas with weak signal strength, which can be used as a basis for antenna adjustment and network performance improvement.

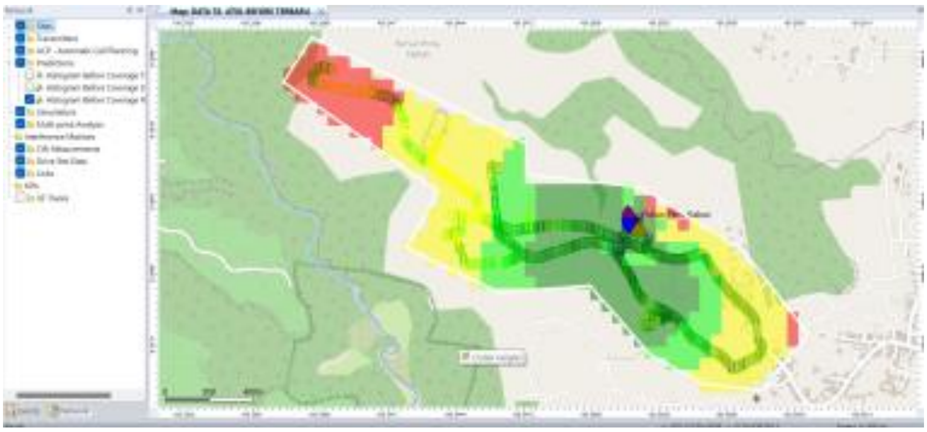

Figure 5. RSRP Existing Site Simulation Results

Based on the results of the RSRP simulation in Figure 5. The optimal coverage (green color) is only found in the area around the BTS, while on the left and right the signal testing area decreases to yellow and red. This decrease is caused by distance, topographic or vegetation obstacles, as well as imprecise antenna beam angles. The dominance of yellow and red areas indicates the potential for bad spots that reduce service quality and throughput.

SINR (Signal To Interference Noise Ratio) Under the conditions before optimization, the SINR parameter is used to assess the quality of the signal received by the device in terms of interference and noise interference. The SINR value

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at this stage reflects the real condition of the network without any adjustments to antenna configurations or parameter optimization.

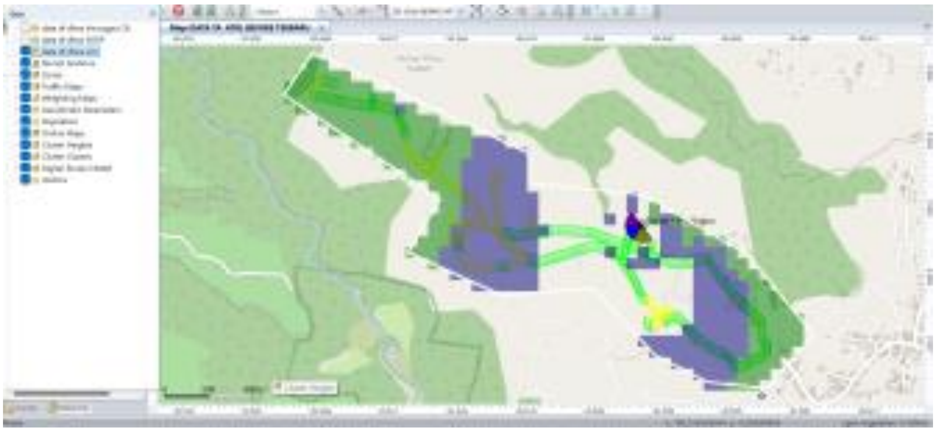

Figure 6. SINR Existing Site Simulation Results

Based on Figure 6. The results of the SINR simulation show that the dark blue area has the best signal quality with low interference around the BTS. However, there are some areas that are not optimally covered due to antenna radiation patterns, imprecise slope or azimuth, as well as physical obstacles such as buildings or trees that cause a decrease in signal quality.

Throughput In pre-optimization conditions, the downlink throughput parameter indicates the actual data capacity that the user receives. This value reflects network performance without any adjustment of the antenna configuration. Although RSRP and SINR are good, throughput is still affected by resource allocation, number of users, and interference. These measurements are important for assessing the service experience and identifying areas with low network capacity as the basis for optimization planning.

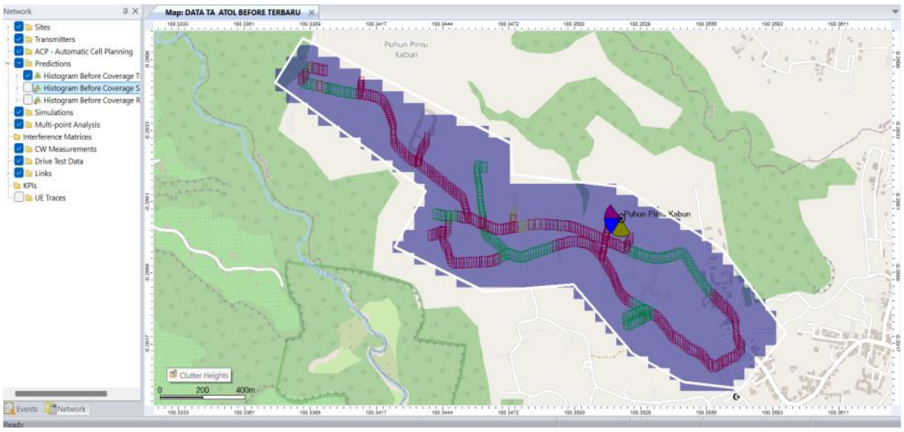

Figure 7. Throughput Existing Site Simulation Results

In Figure 7. The dark blue area shows the best signal coverage, but the drive test results show many red spots (bad spots). This shows the difference between the simulation and field conditions due to interference, high network load, overshoot, or blank spots around the site.

After optimization using the Automatic Cell Planning (ACP) method, network performance shows improvement through the adjustment of antenna parameters such as height, azimuth, and tilt to enhance signal coverage. ACP utilizes integrated algorithms to analyze measurement and simulation data in order to determine the optimal configuration efficiently without extensive manual intervention. In this condition, Reference Signal Received Power (RSRP) represents the signal strength received by user devices across the network. The RSRP value is influenced by antenna parameters, including tilt, azimuth, and height, which are optimized to achieve more uniform signal distribution. Higher RSRP values indicate better signal quality, enabling more stable connectivity throughout the coverage area.

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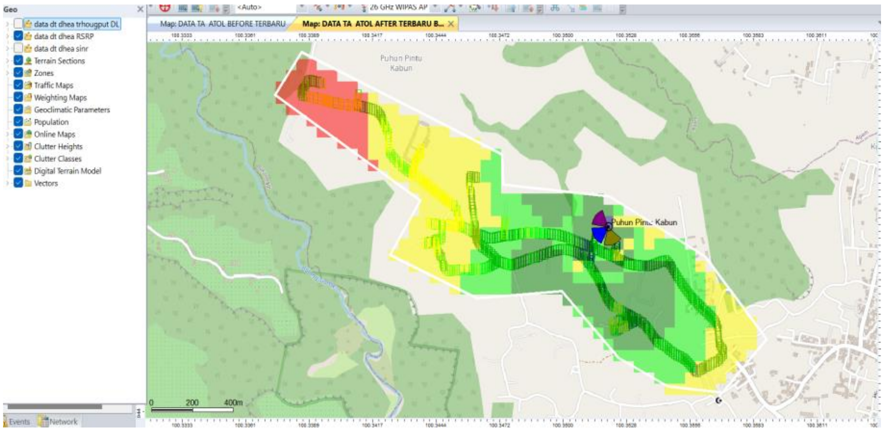

Figure 8. RSRP Optimization Results

In Figure 8. optimization with ACP improves signal quality in the Taman Panorama Baru tourist area of Bukittinggi City. The area previously red has now transitioned to yellow and green, indicating an expansion of coverage with stronger signals, although there are still some points with weak signals.

Table 4. Comparison Of RSRP Before and After ACP

Range	Site Existing	ACP
[-80 ≤ RSRP < 0] Excellent	0%	0.64%
[-95 ≤ RSRP < -80] Very Good	29.40%	24.46%
[-100 ≤ RSRP < -95] Good	18.20%	27.47%
[-110 ≤ RSRP < -100] Poor	39.70%	37.12%
[-150 ≤ RSRP <-110] Bad	12.70%	10.30%

Table 4. showing a comparison of RSRP parameters before and after the optimization simulation using the ACP method, it can be seen that in the poor and bad categories there is a percentage decrease, and for the excellent and good categories there is a percentage increase. And the average value increased from -100.43 dBm to -100.23 dBm. Based on Telkomsel's KPI, at least 80% of the sample must have an RSRP above -100 dBm, in Table III. the result before ACP optimization was carried out only reached 47.6%, and after that it reached 52.57%, both conditions have not reached the KPI target from Telkomsel.

SINR (Signal To Interference Noise Ratio) After ACP optimization, SINR shows better signal quality against interference. Antenna adjustments maximize signal strength and reduce interference, so the network can provide a more stable and efficient connection.

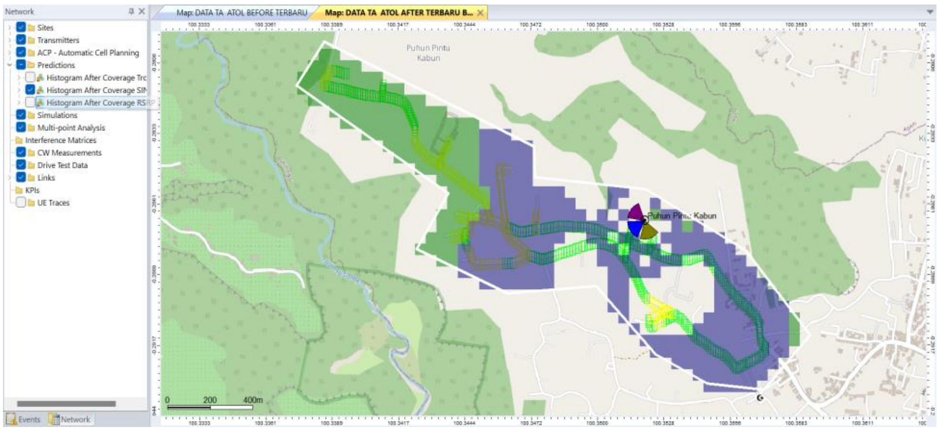

Figure 9. SINR Optimization Results

Figure 9. shows that ACP optimization significantly increases SINR coverage. Areas with excellent signal quality (dark blue) become wider and more integrated, reducing the signal gaps that previously existed. However, some locations are still not fully covered, influenced by topographic factors such as hills or vegetation, interference from other sources, and user density at certain points that reduce network quality.

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Table 5. Comparison Of SINR Before and After ACP

Range	Site Existing	ACP
[20 ≤ SINR < 30] Excellent	53%	66%
[10 ≤ SINR < 20] Very Good	47%	34%
[0 ≤ SINR < 10] Good	0%	0%
[-5 ≤ SINR < 0] Poor	0%	0%
[-20 ≤ SINR <-5] Bad	0%	0%

Based on Table 5. for the superior category there has been an increase, and the average value has increased from 24.49 dB to 24.55 dB after the ACP optimization method was carried out. Based on Telkomsel's KPI target, at least 80% of samples are above 0 dB. In Table 4.8. Before and after ACP optimization, the sample percentage above 0 dB reached 100%, so it has exceeded the KPI target set by Telkomsel.

DISCUSSION

Before optimization, RSRP distribution was uneven, with strong signals near the BTS and weaker signals dominating other areas, resulting in a majority of values in the poor category (39.7%) and an average of -100.43 dBm. After ACP optimization, signal distribution improved, shown by an increase in the good category and a decrease in the bad category, although the average RSRP only slightly increased to -100.23 dBm and still did not meet the KPI target.

SINR performance was already good before optimization and improved further after ACP, with an increase in the excellent category and a slight rise in the average value, indicating reduced interference. Meanwhile, throughput was already excellent before optimization, although drive test results revealed discrepancies due to interference and network load.

These results are consistent with previous studies that reported significant improvements in LTE network performance after applying ACP. For instance, a study by Yuhanef et al. showed that ACP optimization increased average RSRP to around -98.59 dBm and significantly improved SINR and throughput performance (Yuhanef et al., 2024). Similarly, other studies demonstrated that ACP can enhance coverage quality and even meet KPI standards for RSRP and SINR after optimization (PURNAMA et al., 2020). However, compared to those studies, the improvement in RSRP in this research is relatively limited, indicating that ACP alone may not be sufficient under certain network conditions.

Overall, ACP effectively improved network performance, particularly in signal quality and interference reduction; however, further optimization, such as network densification, is still required to meet KPI targets and achieve optimal coverage. This study has several limitations that may affect the validity of the results, including the limited drive test area which may not fully represent overall network conditions, as well as variations in network traffic and environmental factors during measurement that could influence the obtained RSRP, SINR, and throughput values.

CONCLUSION

The quality of Telkomsel's 4G LTE network in the Taman Panorama Baru tourist area based on drive test results shows that RSRP is mostly in the very good category (59%) and SINR in the good category (57%), while throughput remains poor. In contrast, pre-optimization simulations indicate that RSRP is dominated by poor values (39.70%), SINR is mostly excellent and very good, and throughput is excellent.

After ACP optimization through antenna tilt and azimuth adjustments, network performance improves, with SINR increasing significantly (e.g., from 48.84% to 74.46%) and RSRP rising from 47.6% to 52.57%, although still below the KPI target. Overall, ACP is effective in improving network quality, especially in enhancing signal performance and reducing interference. However, further improvement in RSRP is needed, which can be achieved through additional optimization such as network densification. This study provides practical insights for optimizing LTE networks in high-density tourist areas.

REFERENCES

Abdallah, A. A., Jao, C.-S., Kassas, Z. M., & Shkel, A. M. (2022). A Pedestrian Indoor Navigation System Using Deep-Learning-Aided Cellular Signals and ZUPT-Aided Foot-Mounted IMUs. *IEEE Sensors Journal*, *22*(6), 5188–5198. https://doi.org/10.1109/JSEN.2021.3118695

Adwel, M. H., Mulyono, M., Purnamirza, T., & Susanti, R. (2023). Optimasi Jaringan 4G LTE Menggunakan Metode Automatic Cell Planning (ACP) di Wilayah Kubu Gulai Bancah. *REMIK: Riset Dan E-Jurnal Manajemen Informatika Komputer*, *7*(1 SE-), 233–245. https://doi.org/10.33395/remik.v7i1.12033

Alam, M. J., Hossain, M. R., Azad, S., & Chugh, R. (2023). An overview of LTE/LTE-A heterogeneous networks for 5G and beyond. *Transactions on Emerging Telecommunications Technologies*, *34*(8).

E-ISSN : 2807-9035
Volume 6, **Number** 1, May 2026
https://doi.org/10.47709/brilliance.v6i1.8303

https://doi.org/10.1002/ett.4806

Alshouiliy, K., & Agrawal, D. P. (2021). *Confluence of 4G LTE, 5G, Fog, and Cloud Computing and Understanding Security Issues* (pp. 3–32). https://doi.org/10.1007/978-3-030-57328-7_1

Andhika Setyo Utomo, A., Supandi, S., & Ricky Rozzaqi, A. (2025). ANALISIS KINERJA JARINGAN WIRELESS BERDASARKAN PARAMETER QOS (THROUGHPUT, DELAY, PACKET LOSS) TERHADAP VARIASI TRAFIK JAM OPERASIONAL PADA PENGGUNA DI LINGKUNGAN SEKOLAH DI SMP NEGERI 1 NGARINGAN. *SIBATIK JOURNAL: Jurnal Ilmiah Bidang Sosial, Ekonomi, Budaya, Teknologi, Dan Pendidikan*, *4*(9 SE-Articles), 2691–2970. https://doi.org/10.54443/sibatik.v4i9.3428

Belo, E. (2021). ANALISIS PERFORMANSI JARINGAN 4G LONG TERM EVOLUTION (LTE) BERDASARKAN DATA DRIVE TEST PADA PT. INDOSAT KUPANG. *Jurnal Media Elektro*, *10*(2 SE-Articles). https://doi.org/10.35508/jme.v10i2.5117

Budiman, E., & Hairah, U. (2021). Kinerja Jaringan 4G LTE Operator Mobile di Ibukota Kalimantan Timur dimasa Pandemi Covid19 Mobile Operator 4G Network Performance in Capital of East Kalimantan during the Covid19 Pandemic. *Pekommas*, 3. https://doi.org/10.30818/jpkm.2021.

Hadj-Kacem, I., Braham, H., & Jemaa, S. Ben. (2020). SINR and Rate Distributions for Downlink Cellular Networks. *IEEE Transactions on Wireless Communications*, *19*(7), 4604–4616. https://doi.org/10.1109/TWC.2020.2985681

Harpawi, N., & Yuli Triyani. (2024). Performansi Throughput Jaringan 4G Pada Lantai 2 Blok 6 Kampus PCR. *Jurnal Elektro Dan Mesin Terapan*, *10*(1), 35–42. https://doi.org/10.35143/elementer.v10i1.6195

Imani, M., Qiyasi, A., Zarif, N., Ali, M., Noshiri, O., Faramarzi, K., Arabnia, H. R., & Joudaki, M. (2020). A survey on subjecting electronic product code and non-ID objects to IP identification. *Engineering Reports*, *2*(6), e12171. https://doi.org/https://doi.org/10.1002/eng2.12171

Muhammad Harun Ashar, & Dinda. (2023). Analisis Performansi Jaringan 4G Telkomsel Menggunakan Metode Drive Test. *Bulletin of Computer Science Research*, *3*(5), 364–371. https://doi.org/10.47065/bulletincsr.v3i5.273

Nurul Indawati, Fajri Anggy Efendi, & Muhammad Alkirom Wildan. (2024). Implementasi Sistem Manajemen Kinerja yang Efektif dan Efisien dalam Organisasi. *MES Management Journal*, *3*(3 SE-Articles), 706 – 711. https://doi.org/10.56709/mesman.v3i3.589

PURNAMA, A., NUGRAHA, E. S., & AMANAF, M. A. (2020). Penerapan Metode ACP untuk Optimasi Physical Tuning Antena Sektoral pada Jaringan 4G LTE di Kota Purwokerto. *ELKOMIKA: Jurnal Teknik Energi Elektrik, Teknik Telekomunikasi, & Teknik Elektronika*, *8*(1), 138. https://doi.org/10.26760/elkomika.v8i1.138

Shodikin, M. (n.d.). ANALISIS PERANCANGAN LTE HOME PADA JARINGAN 4G LTE BERBASIS OPEN RADIO ACCESS NETWORK. *Jurnal Pepadu*, *2*(4 SE-Articles), 408–420. https://doi.org/10.29303/pepadu.v2i4.2255

Yuhanef, A., Yusnita, S., & Khairani, R. A. (2024). *Improving 4G LTE network quality using the automatic cell planning*. *13*(2), 231–238. https://doi.org/10.11591/ijict.v13i2.pp231-238

Yulianto, H., & , Munnik Haryanti, S. M. (2021). Perbaikan Dan Peningkatan Coverage Jaringan 4G LTE. *Jurnal Teknologi Industri*, *10*(1), 6. https://doi.org/10.35968/jti.v10i1.777

Zain, R. M., Putri, H., & Febriany, D. (2022). *OPTIMASI JARINGAN 4G LTE MENGGUNAKAN METODE AUTOMATIC CELL PLANNING (ACP) DI KECAMATAN SUKAJADI 4G LTE NETWORK OPTIMIZATION USING AUTOMATIC CELL PLANNING (ACP) METHOD IN SUKAJADI SUB-DISTRICT*. *9*(2), 1232–1249.