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Evaluation of 2G and 4G Cellular Network Performance Along the Trans Padang–Bungus Route

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***Abstract*— The quality of mobile telecommunication services is a vital parameter in supporting the connectivity of public transport passengers, particularly on routes with significant topographical challenges. This study aims to evaluate the performance of 2G and 4G LTE networks along the Transpadang Bungus Corridor route in Padang City to map signal quality and identify areas with low performance. The research materials involve the use of hardware in the form of smartphones integrated with TEMS Pocket software for field data collection, as well as TEMS Discovery for statistical data processing and geographical visualization. The method employed is a continuous drive test along the route to collect technical parameters in real-time. Measurement results indicate that on the 2G network, the RxLev parameter is dominated by the "Good" category ([-80, -70] dBm) at 25.62%, with exceptionally high RxQual stability reaching 87.53% in the "Excellent" category. However, on the 4G LTE network, the RSRP parameter shows coverage challenges where 14.03% of samples fall into the "Very Poor" category ([Min, -110] dBm) and 23.87% into the "Poor" category ([-110, -100] dBm), particularly in areas with geographical obstructions. RSRQ quality remains at a moderate level with 50.66% of samples in the [-15, -10] dB range, while data throughput is dominated by the 1000-7000 kbps range at 78.5%. The implications of this research provide strategic recommendations for cellular operators to perform optimization through antenna tilting adjustments or capacity increases in critical areas to enhance the user experience on the Transpadang route.**

***Keywords*— *Drive Test*; 2G; 4G LTE; Transpadang; TEMS Pocket; RSRP; RxLev.**

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I. Introduction

Mobile telecommunication services have become a vital infrastructure supporting modern social mobility, especially for public transport users such as the Transpadang bus service [1]. The Transpadang route in the Bungus Teluk Kabung corridor is a strategic path in Padang City, connecting urban economic centers with coastal areas [2]. However, geographical challenges dominated by hills and dense vegetation along this route often lead to significant signal fluctuations [3]. The primary issues frequently arising in mobile communication systems are service coverage and network quality levels [4]. This decline in quality directly impacts the Quality of Service (QoS) experienced by customers during their commute [5].

To maintain customer satisfaction, operators must conduct performance monitoring based on strict Key Performance Indicator (KPI) standards [6]. Regular evaluation is essential because inadequate KPI data can limit the efficiency of network planning [7]. In 2G networks, the primary parameters evaluated are Receive Level (RxLev) and Receive Quality (RxQual) [8]. Meanwhile, in 4G LTE networks, RSRP and RSRQ parameters serve as crucial indicators for determining coverage area and interference levels [9]. Poor signal quality is often triggered by shadowing phenomena or the excessive distance of users from the eNodeB position [10].

The drive test method remains the most effective solution for gathering real-time network performance data in the field [11]. Through this method, network quality information in specific regions can be obtained in real terms to identify "bad spot" areas [12]. Utilizing professional software such as TEMS Discovery allows for accurate statistical analysis and geographical visualization of measurement results [13]. These evaluation results will later serve as an important foundation for operators to implement network optimization steps [14]. Continuous service quality improvement is highly needed to guarantee connection continuity and data access speed for the community [15]. Ultimately, robust technology performance will have a significant positive impact on customer satisfaction levels in the telecommunications industry [16].

II. THE MATERIALS AND METHOD

A. Research Location

This research is focused on the Transpadang bus public transport route, specifically the Bungus Corridor, connecting the Padang City Center to the Bungus Terminal. The selection of this location is based on the challenging geographical characteristics of the route, which include urban areas, hills, and coastal regions that potentially affect signal stability [1]. The visualization of the test route, showing the starting point in the City Center and the endpoint in Teluk Kabung, along with the signal strength distribution, can be seen in **Figure 1** below:

Figure 1 Drive Test Track

B. Research Design

The stages of this research are systematically structured to ensure the accuracy of the data collected from the field to the final analysis. The procedure begins with hardware preparation and route determination, followed by real-time data collection (drive test) using TEMS Pocket software. The obtained data is then processed using TEMS Discovery to extract KPI values, which are analyzed to identify critical optimization points [11]. The overall research workflow is illustrated through the flowchart in **Figure 2**:

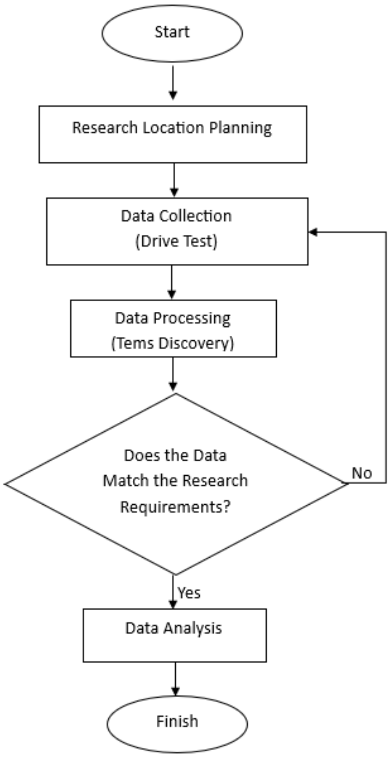

Figure 2 Diagram Of Design

C. Performance Indicators and Standardization

To evaluate network quality accurately, this study uses several technical parameters compared against telecommunications industry Key Performance Indicator (KPI) standards [6]. The details of the indicators used are as follows:

1. RxLev (Receive Level)

RxLev measures the signal strength level received by the device on the 2G network in dBm (Nissa et al., 2025). This parameter determines the coverage area of a Base Transceiver Station (BTS) (Saputra et al., 2018). The RxLev classification standard can be seen in Table 1.

Table 1 Rex Level Strength Value Standard

Signal Strength – *Rx Level* (dBm)	
Excellent	>=-70 and <0
Very good	>=-80 and <-70
Good	>=-90 *and* < -80
Fair	>=-95 and <-90
Poor	<-95

2. RxQual (Receive Quality)

RxQual is a signal quality indicator on the 2G network measured based on the Bit Error Rate (BER) [12]. A high RxQual value indicates noise or interference that can cause voice disconnection during calls (Hasnidar et al., 2021). The RxQual classification is summarized in Table 2.

Table 2 Rx Quality Value Standart

Quality – *Rx Qual* (dB)	
Excellent	<= 2 and >= 0
Good	<= 4 and > 2
Fair	<= 6 and > 4
Poor	>6

3. RSRP (Reference Signal Received Power)

RSRP is the primary parameter indicating the reference signal strength level on a 4G LTE network (Akram et al., 2023). Very low RSRP values indicate that users are in blank spot areas or experiencing propagation obstacles due to geographical conditions [12]. The RSRP category standard is presented in Table 3.

Table 3 RSRP Strength Value Standard

Signal Strength – *RSRP* (dBm)	
Excellent	*RSRP* ≥ -80
Very good	-95 ≤ *RSRP* < -80
Good	-100 ≤ *RSRP* < -95
Fair	-110 ≤ *RSRP* < -100
Poor	*RSRP* <- 110

4. RSRQ (Reference Signal Received Quality)

RSRQ is used to assess the quality of the received reference signal by considering interference and noise factors on the 4G network [4]. This parameter is crucial for determining data connection stability when the device is moving [6]. The RSRQ value limits are found in Table 4.

Table 4 RSRQ Strength Value Standard

Signal Quality – *RSRQ* (dB)	
Excellent	*RSRQ* ≥ -9
Very good	-10 ≤ *RSRQ* < -9
Good	-15 ≤ *RSRQ* < -10
Fair	-20 ≤ *RSRQ* < -15
Poor	*RSRQ* < -20

5. Throughput

Throughput represents the real data transfer speed successfully transmitted through the network within a certain period [15]. This value reflects the direct user experience when accessing internet services such as browsing or streaming [14]. The throughput category standard is shown in Table 5.

Table 5 Throughput Value Standart

Throughput – DL (Kbit/s)	
Excellent	*Throughput* ≥ 14000
Very good	7000 ≤ *Throughput* < 14000
Good	1000 ≤ *Throughput* < 7000
Fair	512 ≤ *Throughput* < 1000
Poor	*Throughput* < 512

III. Results and Discussion

Data collected along the Bungus Corridor route has been processed using TEMS Discovery. The results provide network performance visualizations through thematic maps and statistical charts to evaluate 2G and 4G LTE quality of service based on field conditions.

A. 2G Network Evaluation

1. Rx Lev (Receive Level)

Statistics show that the majority of reception levels are adequate, with 38.03% in the [-90, -80] dBm range and 25.62% in the [-80, -70] dBm range. Very strong signals [>-70 dBm] accounted for 18.1%. However, lower levels were recorded at 10.66% ([-95, -90] dBm) and 7.59% [< -95 dBm]. This decline is triggered by terrain obstructing the Line of Sight (LoS).

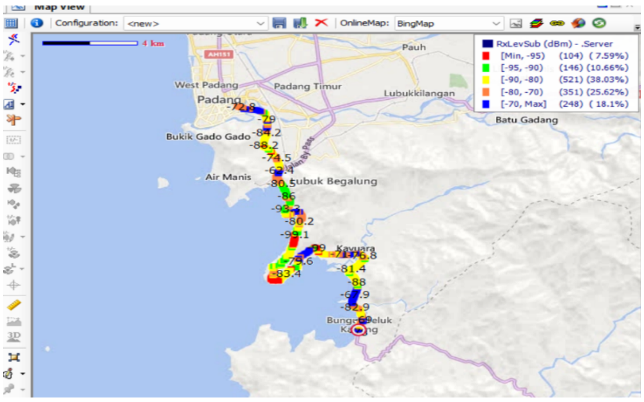

Figure 3 Plotting Rx Level

2. Rx Qual (Receive Quality)

2G signal quality is highly stable, dominated by the best categories. 87.53% of samples fall within the [0, 2] range. Additionally, 10.03% are in the [2, 3] range, followed by small percentages of 1.52% at [3, 4], 0.42% at [4, 5], and only 0.5% in the worst category (≥ 5). This demonstrates effective interference management despite power fluctuations.

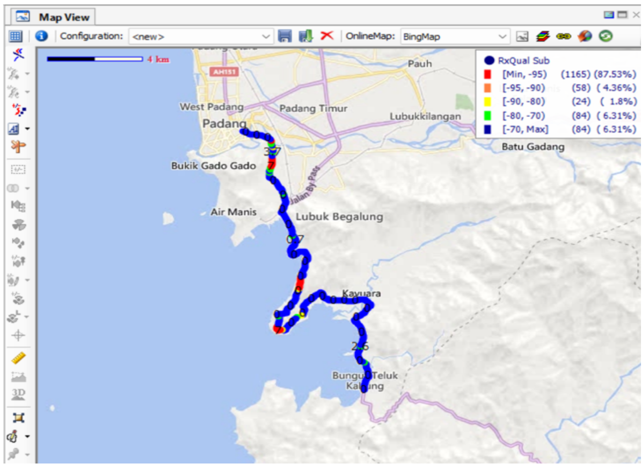

Figure 4 Plotting Rx Quality

B. 4G LTE Network Evaluation

1. RSRP (Reference Signal Received Power)

RSRP measurements show varied performance. The highest percentage is in the [-100, -90] dBm category at 26.9%, followed by [-110, -100] dBm at 23.87%. Better quality signals are in the [-90, -80] dBm (11.34%) and >-80 dBm (23.87%) ranges. Meanwhile, very weak signal areas (< -110 dBm) accounted for 14.03%.

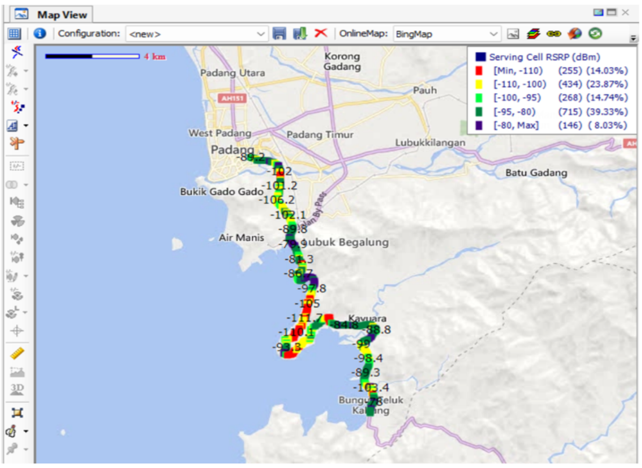

Figure 5 Plotting RSRP

2. RSRQ (Reference Signal Received Quality)

Signal quality is dominated by the [-15, -10] dB range at 50.66%, followed by [-20, -15] dB at 37.84%. Only 10.7% of samples fall into the best category (>-10 dB), with a minimal 0.8% in the <-20 dB category. This indicates traffic load or inter-cell interference at certain points.

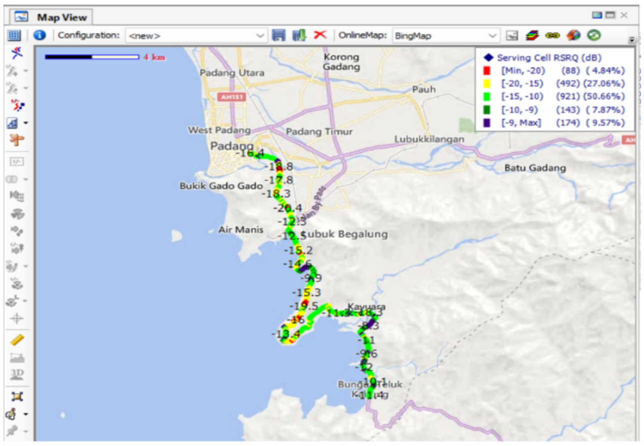

Figure 6 Plotting RSRQ

3. Throughput

Data transfer speeds show that most services are in the 1000 - 7000 kbps range at 78.5%. Low speeds (< 1000 kbps) were recorded at 14.03%. For high speeds, 4.9% are in the 7000 - 10000 kbps range, and only 2.57% reached above 10000 kbps.

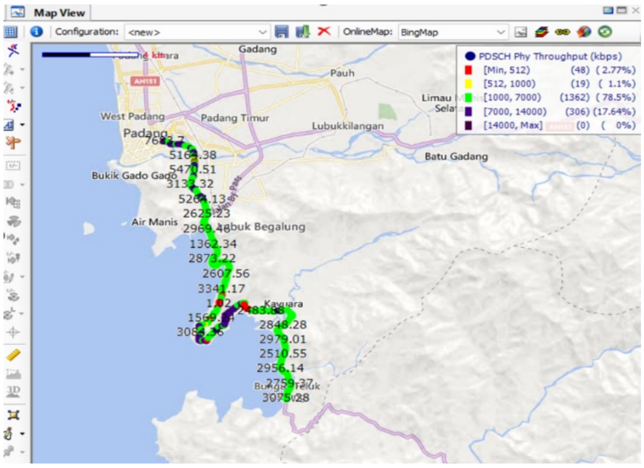

Figure 7 Plotting Throughput

IV. Conclusion

Based on the performance analysis of 2G and 4G LTE networks along the Transpadang Bus Bungus Corridor route, the following primary conclusions can be drawn:

1. 2G Network Performance: Voice service quality on the 2G network is classified as highly stable, with Rx Qual values dominated by the "Excellent" category at 87.53%. Nevertheless, the receive power level (Rx Lev) shows significant variation, with a signal accumulation in lower categories amounting to 18.25% (< -90$ dBm), influenced by hilly geographical obstacles along the route.
2. 4G LTE Network Performance: 4G LTE signal coverage still faces challenges at several critical points. Although 26.9% of RSRP samples fall into the "Normal" category, 14.03% of samples are in the "Very Poor" category, indicating signal shadowing phenomena in coastal areas and hill curves.

3. Signal and Data Quality: Reference signal quality (RSRQ) is dominated by the "Normal" category (50.66%). This directly impacts Throughput, where the majority of data transfer speeds (78.5%) fall within the 1000 - 7000 kbps range. This speed is considered sufficient for text and browsing services but is not yet optimal for consistently supporting intensive broadband services throughout the route.
4. Geographical Correlation: The topographical conditions of the Bungus route, consisting of hills and dense vegetation, are proven to be the primary factors causing signal degradation (*Poor* and *Very Poor* categories). Network optimization, such as antenna tilt adjustments or the addition of signal booster infrastructure at these critical points, is required.

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