

4G LTE Network Quality and TCP/IP Performance of Telkomsel Provider in the Lolong Belanti Area

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ABSTRACT

Lolong Belanti is one of the sub-districts in North Padang District, Padang City, West Sumatra Province. In Lolong Belanti cellular telecommunications is growing very rapidly and has become an important need for the community. Therefore, research needs to be done so that it can be a reference for providers to improve the quality and quantity of 4G LTE networks in Lolong Belanti. The measurement results on weekdays obtained the percentage of good to excellent 4G network categories have a percentage value of RSRP 99.04%, SINR 12.14% and Throughput 98.51% and the average value of download bandwidth 28.26 Mbps, upload bandwidth 23.92 Mbps, throughput 1,282,003 kbps, packet loss 0.103%, delay 5.92 ms and jitter 5.97%. While on holidays, the percentage of 4G network categories is good to very good having a percentage value of 97.91% RSRP, 12.28 SINR and 98.51% Throughput and has an average value of 13.68 Mbps download bandwidth, 17.94 Mbps upload bandwidth, 647.688 kbps Throughput, 0.26% packet loss, 17.428 ms delay and 17.566 ms jitter. The quality of Telkomsel's 4G LTE network provider in Lolong Belanti Village on holidays is better than on weekdays. And the comparison of TCP/IP performance for Bandwidth Download, Bandwidth Upload, Throughput and Packet Loss is superior on weekdays compared to holidays, and for Delay and Jitter is better on holidays than on weekdays.

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INTRODUCTION

Lolong Belanti is one of the sub-districts in North Padang District, Padang City, which has an area of 104.89 hectares. To the north it borders Ulak Karang Selatan Village, to the east it borders Gunung Pangilun Village, to the south it borders Flamboyan Baru Village, to the west it borders the Indonesian Ocean (B. Kelurahan *et al.*, 2019). It has a population of 7,875 people in 2017 (Bps, 2022). 4G LTE technology is considered the main technology to meet the increasing demands for ISPs (Internet Service Providers). 4G LTE technology is a technology that can produce high speed data services for mobile devices by promising large bandwidth. 4G LTE technology is closely related to data communications technology because all communications are IP-based. Good data communication technology must comply with established protocols, one of which is the TCP/IP protocol.

In general, internet access services in Indonesia are almost evenly distributed throughout Indonesia. However, not all providers can provide maximum quality and quantity of 4G LTE networks. This also happens in Lolong Belanti Village which is in North Padang District. Therefore, cellular telecommunications service providers are required to maximize the quality and quantity of 4G LTE networks that are better and according to standards by paying attention to several things, namely how wide the antenna coverage is, the capacity availability of a network and the signal quality of network services.

LITERATURE REVIEW

RSRP (Referenced Signal Received Power)

RSRP is the power of the signal received from the eNodeB to the UE. In 2G technology this parameter can be analogous to RxLevel, while in 3G it is RSCP (R. Efriyendro and Y. Rahayu, 2017). The range of RSRP values used can be seen in table 1.

Table 1. Range RSRP (dBm)[5]

No	Color Indicator	values (dBm)	Description
1		≥ -75 dBm	Excellent
2		-85 dBm $\leq$ RSRP < -75 dBm	Very Good
3		-100 dBm $\leq$ RSRP < -85 dBm	Good
4		-110 dBm $\leq$ RSRP < -100 dBm	Fair
5		< -110 dBm	Poor



QoS (Quality of Service)

Quality of Service or what is abbreviated as QoS is a measurement of how good the network is and is an effort to meet different service needs in IP network traffic by providing bandwidth and overcoming delays and jitter (Rasudin, 2014) (I. A. Ferdhana and A. Fitriansyah, 2021). Bandwidth is often used as a synonym for data transfer speed (Transfer rate), namely the amount of data that can be carried that can flow from one place to another in a certain time (F. I. Safitri Syahlanti, and F. Trias Pontia W, 2019). Throughput is the effective data transfer speed (rate), which is measured in bps (bits per second). Throughput is the total number of successful packet arrivals observed at the destination during a certain time interval (Rasudin, 2014). The range of throughput values used can be seen in table 2.

Table 2. Range Throughput (kbps)(M. Purwahid and J. Triloka, 2019)

No	Values (kbps)	Description
1	>2,1 Mbps	<i>Excellent</i>
2	1200 to 2,1 Mbps	<i>Very Good</i>
3	700 to 1200 kbps	<i>Good</i>
4	338 to 700 kbps	<i>Fair</i>
5	0 to 338 kbps	<i>Poor</i>

METHOD

There are two measurements carried out in this research, namely measuring drive test parameters using the TEMS pocket and Teme discovery applications and measuring QoS parameters using the speedtest by Ookla and Wireshark applications. Drive test parameter measurements are used to analyze the quality of Telkomsel's 4G network, while QoS parameter measurements are carried out to determine TCP/IP performance.

Planning Drive Test Data Retrieval

Drive test data collection is carried out using the dedicated mode method. This method is a measurement of signal quality by carrying out activities such as downloading and uploading followed by channel switching (long call/short call to a certain destination number).

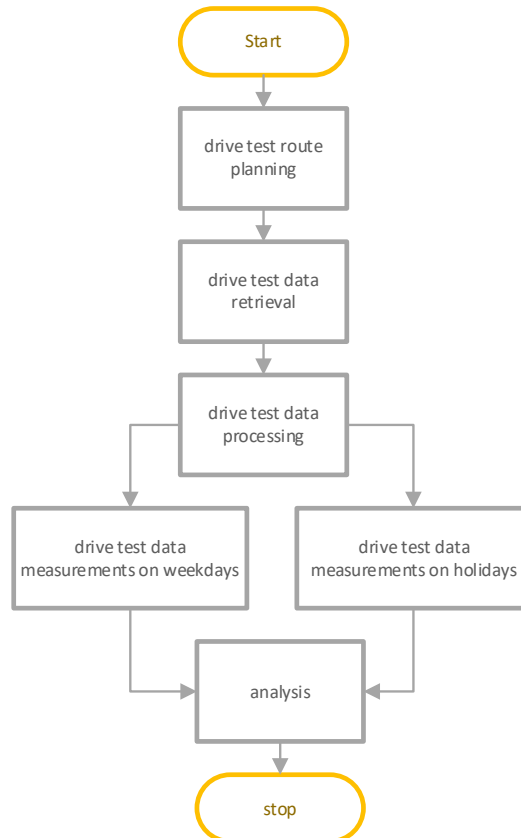


Figure 1. Block Diagram of Drive Test Parameter Measurement

Figure 1 shows how the block diagram of this measurement looks like. The 4G network parameters to be measured are RSRP, RSRQ, and SINR. Next, carry out a drive test using TEMS Pocket. After that, process the data from the drive test results with TEMS Discovery. The final step is to analyze signal quality based on the three 4G network parameters.

QoS parameter data collection was carried out using the field observation method (Binus, University, 2021). This method is a direct observation and measurement of the three locations covered by one of Telkom's BTS (Base Transceiver Station) on Mount Pangilun. Measurements were carried out using Wireshark twice for each location by carrying out data service activities, namely video streaming via Google Chrome to get throughput, package loss, delay and jitter values as well as a speed test to get bandwidth values (S. Sari, 2016).

Determine the Test Drive Path

Before taking drive test measurements, it is necessary to determine the path that will be taken during the drive test process. This route makes the data retrieval process easier. The test drive route can be seen on Google Earth. The routes taken are the Gajah Mada road, the Mount Pangilun road and several roads that can be passed around the PAD043 site. The path or route that will be taken can be seen in Figure 2.



Figure 2. Test Drive Data Retrieval Path

Drive Test Data Retrieval

Measurement of drive test parameters using the TEMS pocket application. TEMS pocket is a tool commonly used for maintenance and troubleshooting of cellular networks. The measurement results from TEMS pocket will be stored in a logfile in the form of trp or trip. The appearance of the TEMS pocket can be seen in Figure 3.

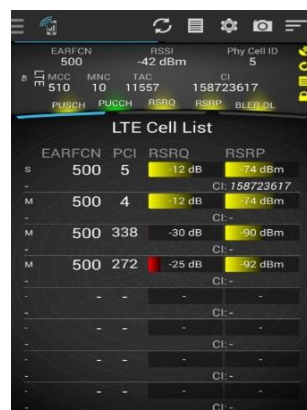


Figure 3. Tems Pocket display

Processing Drive Test Data Results

After carrying out the drive test measurement process using the TEMS pocket application. Next, the data that has been obtained is processed and displayed based on the desired parameters in the TEMS discovery application. TEMS

discovery is the most comprehensive network analysis and optimization software for testing cellular network performance (Fazri Maulana, 2021) . The data processed is the logfile data from the drive test in trp format. The TEMS discovery display can be seen in Figure 4.

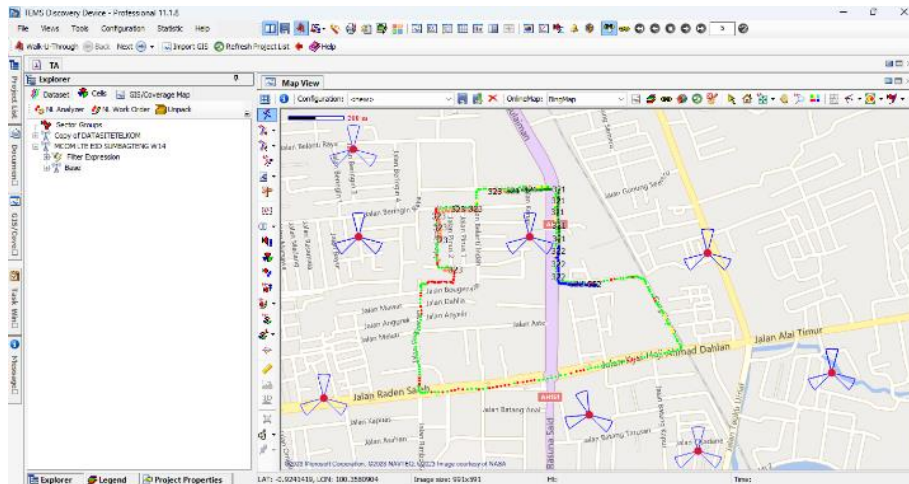


Figure 4. Temps Discovery display

Determining the QoS Data Collection Location

After carrying out the drive test measurement process. The next step is to determine the location where QoS data will be collected. Data collection was carried out at three locations covered by the PAD043 site, namely at PCI (Physical Cell Identity) 237, 238 and 239. The locations where data collection will be carried out can be seen in figures 6 and 7.

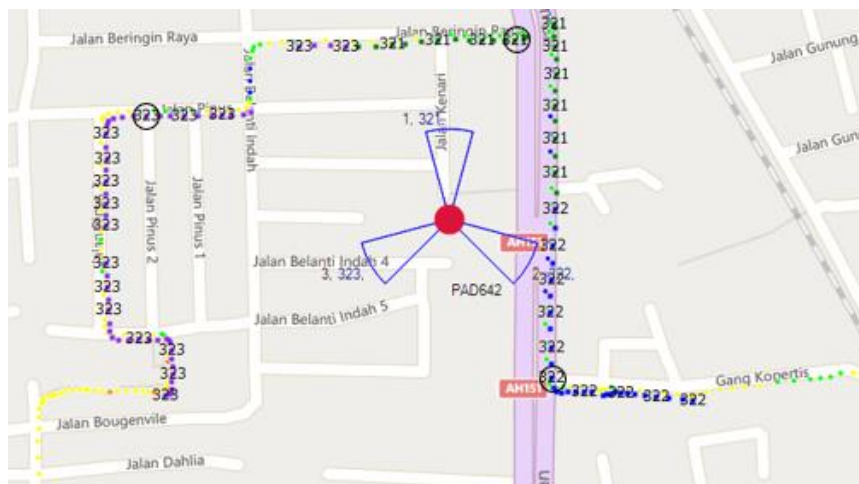


Figure 6. QoS Data Collection Locations on Weekdays

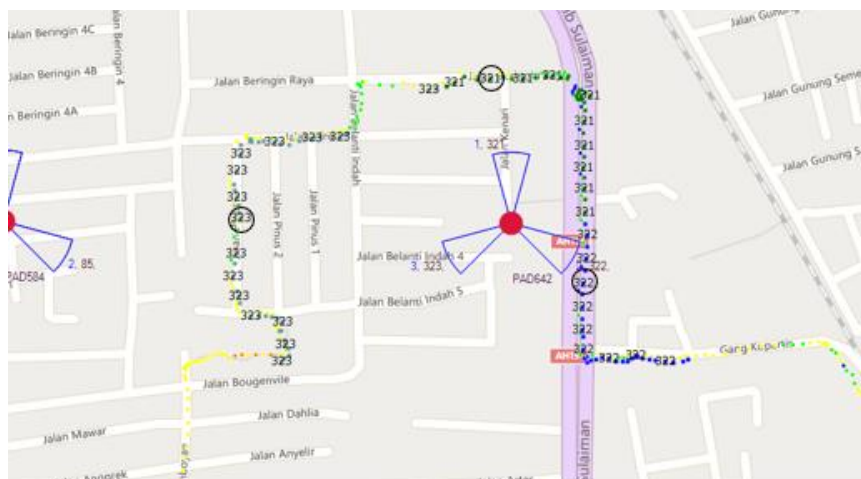


Figure 7. QoS Data Collection Locations on Holidays

RESULT

The results of this drive test were processed using the Tems Discovery application to see the mapping and quality of the 4G LTE signal and for QoS parameters to be seen using the Wire Shark application in Lolong Belanti Village. After the data is obtained, the data is analyzed based on the measured parameters.

The results of measuring the Telkomsel provider's RSRP parameters on weekdays and holidays obtained from the drive test measurement results can be seen in figures 8 and 9 and can also be seen in tables 3 and 4.

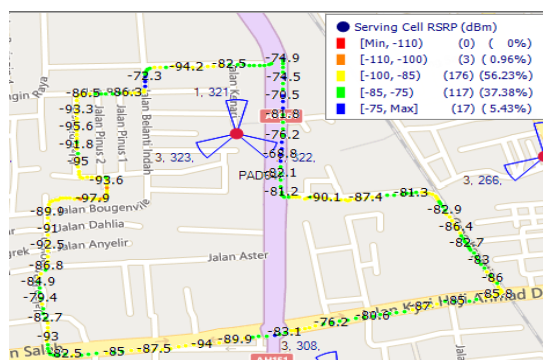


Figure 8. RSRP Measurement Results on Weekdays

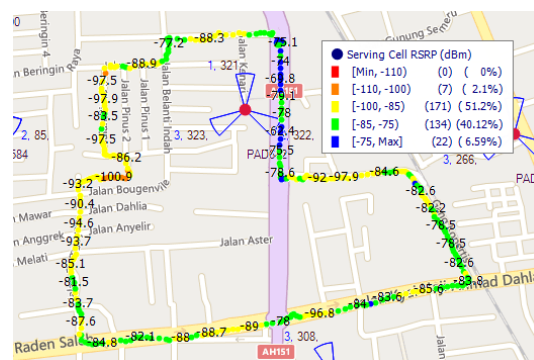


Figure 9. RSRP Measurement Results on Holidays

Table 3. RSRP on Weekday (dBm)

Color	Range	Number of Points	Percentage of Total Data
Poor	≥ -110	0	0%
Fair	≥ -110 and < -100	3	0,96%
Good	≥ -100 and < -85	176	56,23%
Very Good	≥ -85 and < -75	117	37,38%
Excellent	≥ -75	17	5,43%

Table 4. RSRP on holiday (dBm)

Color	Range	Number of Points	Percentage of Total Data
Poor	≥ -110	0	0%
Fair	≥ -110 and < -100	7	2,1%
Good	≥ -100 and < -85	171	51,2%
Very Good	≥ -85 and < -75	134	40,12%
Excellent	≥ -75	22	6,59%

Figure 8 and table 3 show the data from the drive test results on weekdays. It can be seen that there were 313 samples obtained during the recording process around the route. Signal receivers in the Excellent category are marked with a blue indicator that has a received power of ≥ 75 dBm from 17 samples with a percentage value of 5.43%. This is different on holidays. Signal receivers in the Excellent category are marked with a blue indicator which has a receiving power of ≥ 75 dBm from 22 samples with a percentage value of 6.59%. Signal receivers in the Very Good category are marked with a green indicator which has a received power of ≥ 85 dBm and < 75 dBm from 134 samples with a percentage value of 40.12%.

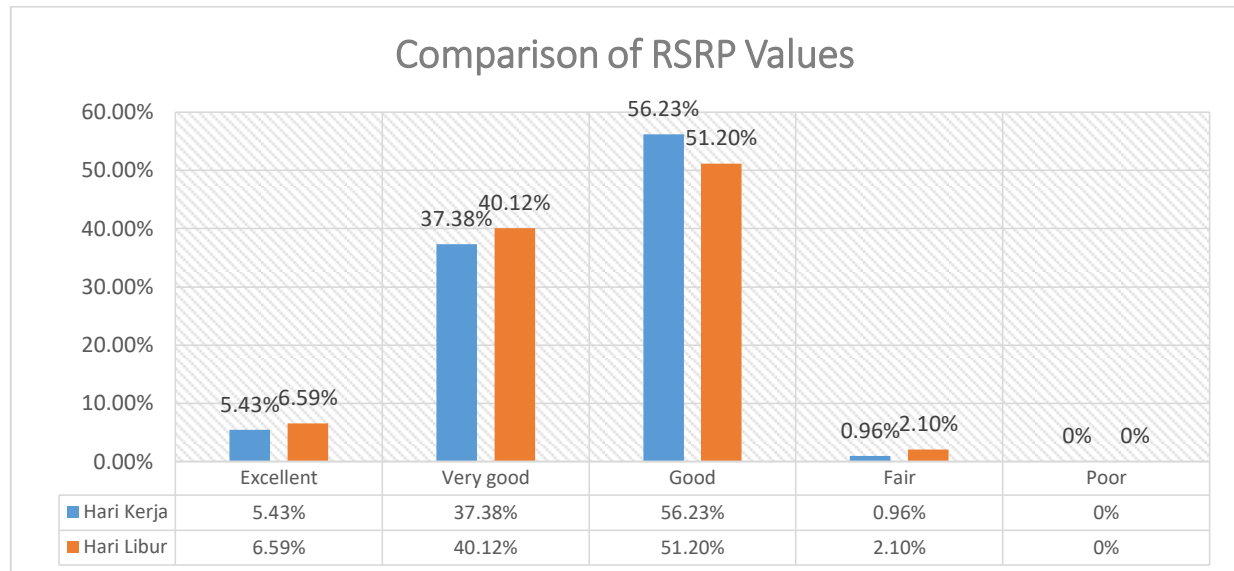


Figure 10. RSRP Comparison Chart on Weekdays and Holidays

Signal to Interference Noise Ratio (SINR)

The results of measuring the Telkomsel provider's SINR parameters on weekdays and holidays obtained from the drive test measurement results can be seen in figure 11 and figure 12 and can also be seen in table 5 and table 6.

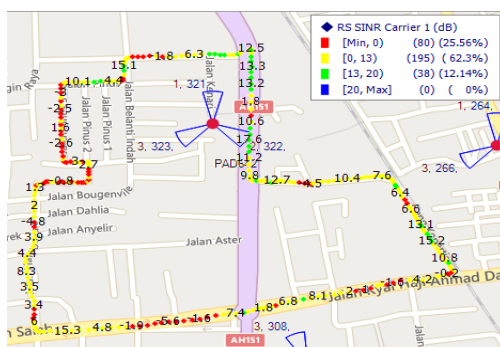


Fig11. Drive Test Results for SINR Parameters on Weekdays

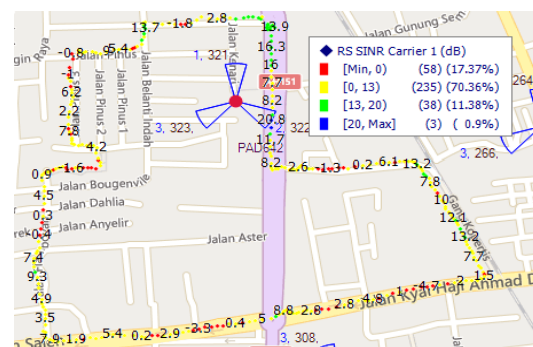


Fig 12. Drive Test Results for SINR Parameters on Holidays

Table 5. SINR on weekday

Color	Range	Number of Points	Percentage of Total Data
Bad	≥ 0	80	25,56%
Low	≥ 0 and < 13	195	62,3%
Good	≥ 13 and < 20	38	12,14%
Excellent	≥ 20	0	0%

Table 6. SINR on holidays

Color	Range	Number of Points	Percentage of Total Data
Bad	≥ 0	58	17,37%
Low	≥ 0 and <13	235	70,36%
Good	≥ 13 and <20	38	11,38%
Excellent	≥ -20	3	0,9%

Figure 11 and table 5 show the data from the drive test results on weekdays. It can be seen that there were 313 samples obtained during the recording process around the route. Signal receivers in the excellent category are marked with a blue indicator which has a received power of ≥ -20 dB from 0 samples with a percentage value of 0%. Signal receivers in the good category are marked with a green indicator that has a received power of ≥ 13 dB and <20 dB from 38 samples with a percentage value of 12.14%. Signal receivers in the low category are marked with a yellow indicator which has a received power of ≥ 0 dB and <13 dB from 195 samples with a percentage value of 62.3%. Signal receivers in the bad category are marked with a red indicator which has a receiving power of ≥ 0 dB from 80 samples with a percentage value of 25.56%.

Figure 12 and table 6 show the data from the drive test on holidays. It can be seen that there were 334 samples obtained during the recording process around the route. Signal receivers in the Excellent category are marked with a blue indicator that has a received power of ≥ -20 dB from 3 samples with a percentage value of 0.9%. Signal receivers in the Good category are marked with the green category which has a received power of ≥ 13 dB and <20 dB from 38 samples with a percentage value of 11.38%. Signal receivers in the Low category are marked with a yellow indicator which has a received power of ≥ 0 dB and <13 dB from 235 samples with a percentage value of 70.36%. Signal receivers in the Bad category are marked with a red indicator which has a receiving power of ≥ 0 dB from 58 samples with a percentage value of 17.37%.

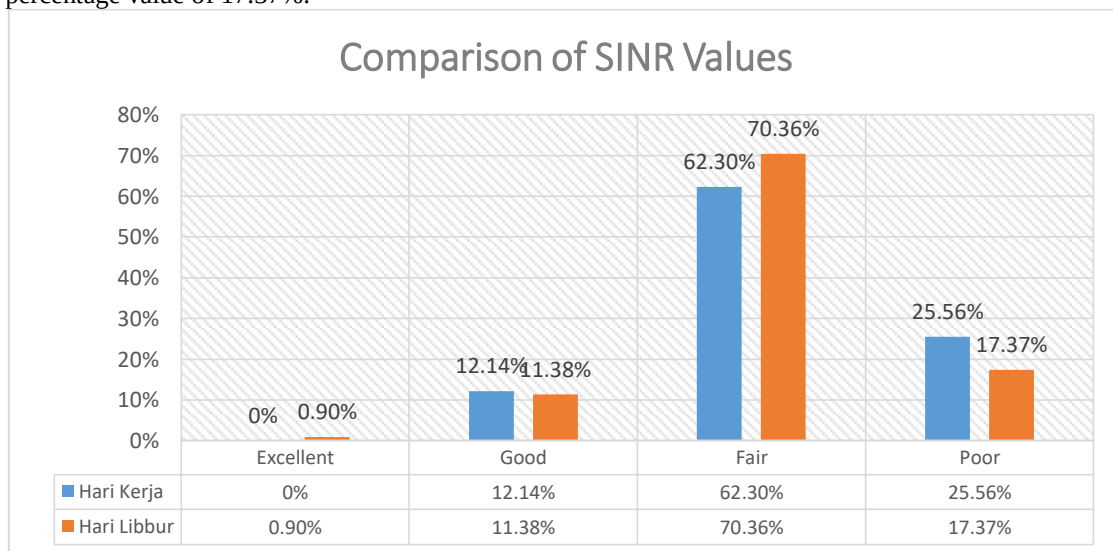


Fig 13. Comparison diagram of SINR on weekdays and holidays

Throughput

Throughput in the 4G LTE drive test is the data rate (Kbit/s) from the UE to the eNodeB. Comparison of the quality of throughput values for weekdays and holidays can be seen in figure 14 and figure 15 as well as table 7 and table 8.

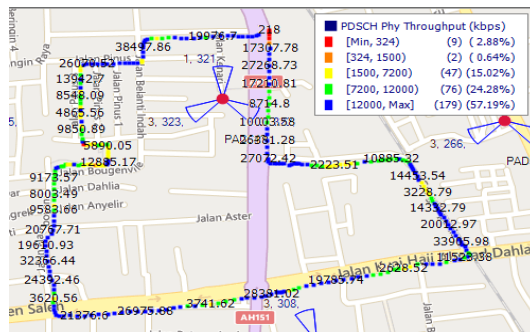


Fig 14. Drive Test Results of Throughput Parameters on Weekdays

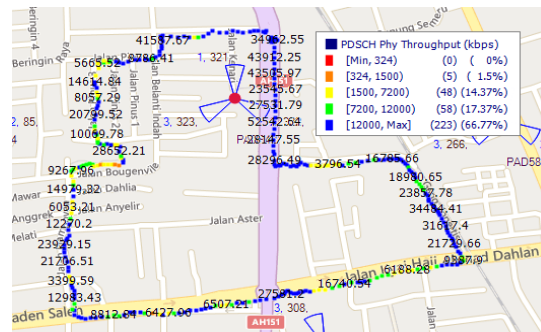


Fig 15. Drive Test Results for Throughput Parameters on Holidays

Table 7. Drive Test Throughput on weekday

Color	Range	Number of Points	Percentage of Total Data
Very Poor	≤ 324	9	2,88%
Poor	$324 \leq \text{Throughput} \leq 1500$	2	0,64%
Fair	$1500 \leq \text{Throughput} \leq 7200$	47	15,02%
Good	$7200 \leq \text{Throughput} \leq 12000$	76	24,28%
Excellent	≥ 12000	179	57,19%

Tabel 8. Drive Test Throughput on holidays

Color	Range	Number of Points	Percentage of Total Data
Very Poor	≤ 324	0	0%
Poor	$324 \leq \text{Throughput} \leq 1500$	5	1,5%
Fair	$1500 \leq \text{Throughput} \leq 7200$	48	14,37%
Good	$7200 \leq \text{Throughput} \leq 12000$	58	17,37%
Excellent	≥ 12000	223	66,77%

From figure 14, table 7, management of Throughput results on weekdays, the results are in the excellent category with a blue legend with a speed of ≥ 12000 kbps consisting of 179 samples with a percentage of 57.19%. The Good category with the legend marked in green, speed $7200 \text{ kbps} \leq \text{Throughput} \leq 12000 \text{ kbps}$ consists of 76 samples with a percentage of 24.28%. The Fair legend category is yellow with a speed of $1500 \text{ kbps} \leq \text{Throughput} \leq 7200 \text{ kbps}$ has 47 samples with a percentage of 15.02%. The Poor category with an orange legend with a speed of $324 \text{ kbps} \leq \text{Throughput} \leq 1500 \text{ kbps}$ consists of 2 samples with a percentage of 0.64% and the Very Poor category with a red legend with a speed of $\leq 324 \text{ kbps}$ consists of 9 samples with a percentage of 2.88%.

From figure 15 and table 8, throughput management results on holidays show results in the excellent category with a blue legend with a speed of $\geq 12,000$ kbps consisting of 223 samples with a percentage of 6.77%. The Good category with the legend marked in green speeds $7200 \text{ kbps} \leq$ and $\leq 12000 \text{ kbps}$ consists of 58 samples with a percentage of 17.37%. The Fair legend category in yellow with speeds of $1500 \text{ kbps} \leq$ and $\leq 7200 \text{ kbps}$ has 48 samples with a percentage of 14.37%. The Poor category with an orange legend with a speed of $324 \text{ kbps} \leq$ and $\leq 1500 \text{ kbps}$ consists of 5 samples with a percentage of 1.5% and the Very Poor category with a red legend with a speed of $\leq 324 \text{ kbps}$ consists of 0 samples with a percentage of 0%.

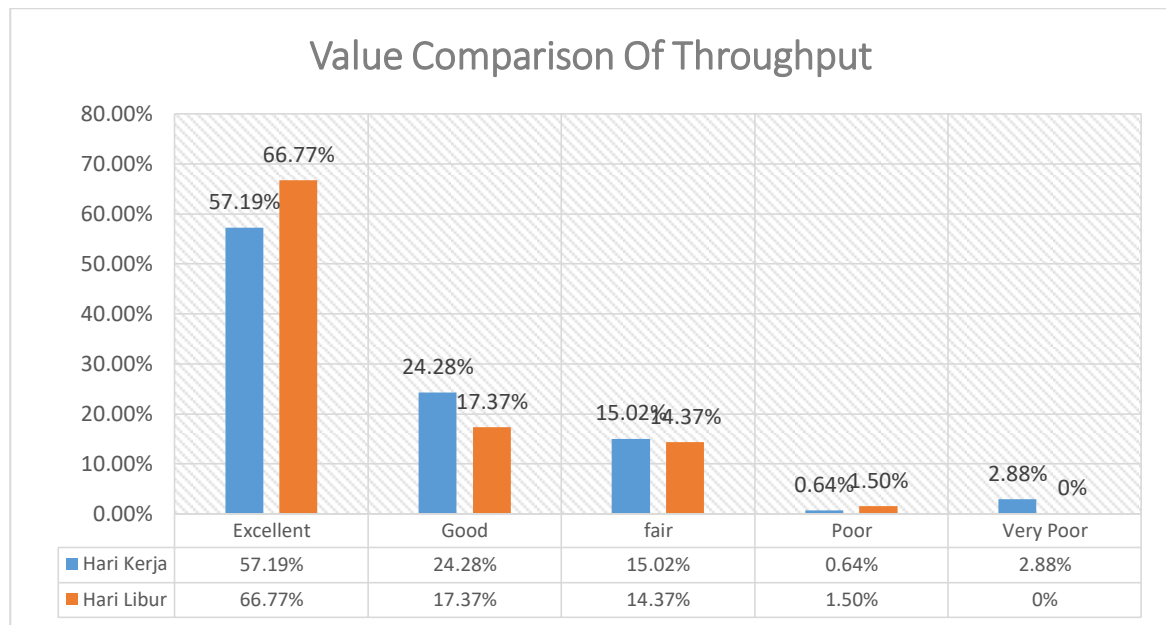


Fig 16. Comparison of Throughput Values on Weekdays and Holidays

QoS Measurement Results

The following are the results of measuring QoS parameters on weekdays and holidays

Table 9. Comparison Results of QoS Measurements on Weekdays and Holidays

QoS Parameter	Weekdays			Holidays		
	PCI 321	PCI 322	PCI 323	PCI 321	PCI 322	PCI 323
Bandwidth Download (Mbps)	17,75	40,39	26,63	23,38	12,35	5,32
Bandwidth Upload (Mbps)	26,14	20,87	24,74	27,07	13,80	12,95
Throughput (kbps)	1,221,536	1,047,776	1,576,696	306,072	425,392	763,448
Packet Loss (%)	0,12	0,09	0,10	0,07	0,65	0,07
Delay (ms)	6,09	7,54	4,1291	26,06	16,19	10,034
Jitter (ms)	6,14892	7,59	4,162	26,86	15,65	10,188

DISCUSSION

In general, internet access services in Indonesia are almost evenly distributed throughout Indonesia. However, not all providers can provide maximum quality and quantity of 4G LTE networks. This also happens in Lolong Belanti Village which is in North Padang District. Therefore, cellular telecommunications service providers are required to maximize the quality and quantity of 4G LTE networks that are better and according to standards by paying attention to several things, namely how wide the antenna coverage is. , the capacity availability of a network and the signal quality of network services.

CONCLUSION

Based on the results of this research, conclusions can be obtained as follows:

1. On weekdays, the quality of the 4G LTE network in the Good to Excellent category has an RSRP percentage value of 99.04%, Throughput 96.49% and SINR 12.14%. The quality of the 4G LTE network in the Poor to Fair category has an RSRP percentage value of 0.96%, Throughput 3.52% and SINR 87.86%. Meanwhile, on holidays the quality of the 4G LTE network is in the Good to Excellent category, the RSRP percentage value is 97.91%, Throughput 98.51% and SINR 12.28%. The quality of the 4G LTE network in the Poor to Fair category has an RSRP percentage value of 2.1%, Throughput 1.5% and SINR 87.73%.
2. On weekdays the average download bandwidth value is 28.26 Mbps, the average upload bandwidth value is 23.92 ms, the average throughput value is 1,282 kbps, the average packet loss value is 0.103%, the average delay value 5.9 ms and the average jitter value is 5.96 ms. Meanwhile, on holidays the average download bandwidth value is

13.68 Mbps, the average upload bandwidth value is 17.94 ms, the average throughput value is 498.304 kbps, the average packet loss value is 0.26%, the average value delay 17.43 ms and average jitter value 17.56 ms.

3. From the research results, it was found that the comparison of the quality of the 4G LTE network of Telkomsel provider in Lolong Belanti Village on holidays is better than on weekdays. And the comparison of TCP/IP performance for Download Bandwidth, Upload Bandwidth, Throughput and Packet Loss is superior on weekdays compared to holidays, and for Delay and Jitter it is better on holidays than on weekdays.

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