

Key Performance Indicator Analysis of LTE Indoor Network (Case Study : Mall Mtos Makassar)

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Abstract-In today’s digital era, reliable and fast connectivity has become an important need for many people *Long Term Evolution* is a standard for high-speed wireless data communication for mobile phones and other data devices. This study aims to analyze the *Key Performance Indicator* of the LTE Indoor Network at Mall Mtos Makassar. The mall Mtos Makassar building is a shopping center, a place to watch, a place to play, etc. The Mall Mtos building has 3 large and complex floors. This measurement was carried out with 3 telecommunication operators, namely Telkomsel, Indosat Ooredoo, and XI Axiata. The parameters analyzed include *Reference Signal Received Power*, *Reference Signal Received Quality*, *Signal to Interface Noise Ratio*, *Received Signal Strength Indicator*, and *Throughput Uplink Downlink*. The research method used includes the *walk test* method with 3 floors of Mall Mtos Makassar with *Idle* and *Dedicated mode measurements*. The result of the analysis on measurement from the 1st to 3rd floors shows the signal performance between operators, thus the Telkomsel Operator shows a relatively better performance compared to the Indosat Ooredoo and XI Axiata Operators.

Keywords: LTE, Walk Test, RSRP, SINR, Throughput

I. Introduction

Along with the development of telecommunications technology, LTE networks have become the backbone of modern communications, enabling high-speed internet access with large capacity. Mall Mtos Makassar a major shopping center in the city of Makassar, experiences a high level of visits every day. This requires telecommunication operators to ensure optimal LTE network quality in the Mall, in order to support online activities for both visitors and employees in Mall Mtos Makassar. However, complex indoor environmental conditions are often a challenge in providing stable and quality network services.

Key Performance Indicators (KPI) measure and evaluate the performance of the Long-Term Evolution network. They also help network operators identify and analyze the quality of service provided to users and ensure that the network is running optimally.

This meter will also see the amount of 4G network quality that will be measured, including Telkomsel, Indosat Ooredoo, and XI Axiata operators at the Mtos Makassar Mall. This provides a more comprehensive understanding of how the advantages and disadvantages of each operator in providing network services inside the Mtos Makassar Mall room. The results are expected to provide insight for operators to improve service quality and help manage in ensure good connectivity for visitors. This will have significant value and can contribute to improving the quality of LTE network services inside the Mtos Makassar Mall room.

II. Results and Discussion

To facilitate this research, there are stages in this preparation as follows.

A. Flowchart

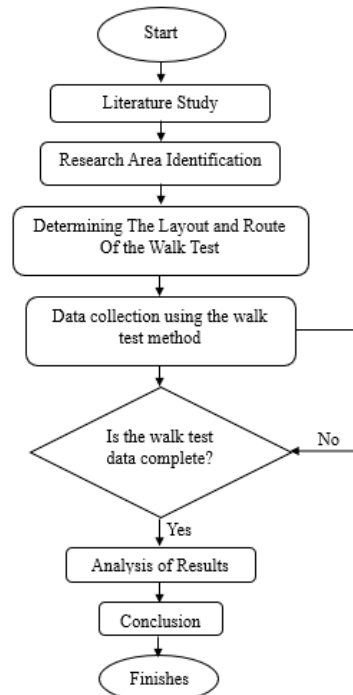


Figure 1. Flowchart

B. Tools and Materials

In the data collection process, this study uses the Walk Test measurement method.

The tools are as follows.

1. Laptop/PC is used to view the walk test result parameters.
2. The mobile phone functions in the walk test as a terminal for calls, uploading and downloading data, and measuring the signal strength received by the customer.
3. SIM Card functions to measure the signal strength received by customers. SIM cards used are Telkomsel, Indosat Ooredoo, and XI Axiata operators.
4. Data cable functions to connect PC to cellphone.
5. TEMS Pocket software functions to collect data during walk test measurement.
6. TEMS Investigation 23.1 software functions as a navigation tool and plotting parameters on the walk test route taken.
7. Map Info Pro software function to create walk test routes and process walk test result data.

C. Data Collection Techniques

In the process of complying this research report, the methods used in data collection include:

- Literature Study
- Identification of Research Areas
- *Observation and Walk Test*
- Data Processing and Analysis
- Drawing Conclusions

III. Results and Discussion

Measurement of Indoor LTE network quality at Mall Mtos Makassar which is a place for shopping, watching, playing, etc. This measurement was carried out from the 1st floor, 2nd floor, and 3rd floor with providers Telkomsel, Indosat Ooredoo, and XI-Axiata. The aim is to identify network quality at Mall Mtos Makassar by considering the RSRP, RSRQ, SINR, RSSI, and Throughput parameters.

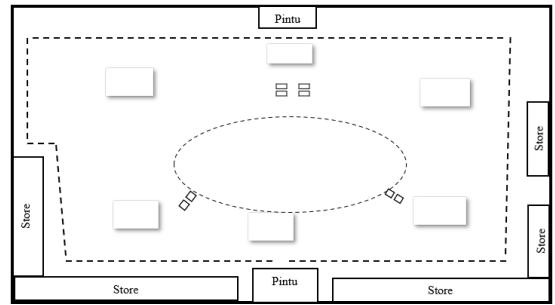


Figure 2. Floor 1 Walk Test Measurement Route

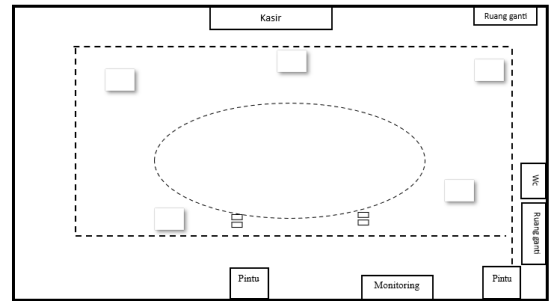


Figure 3. Floor 1 Walk Test Measurement Route

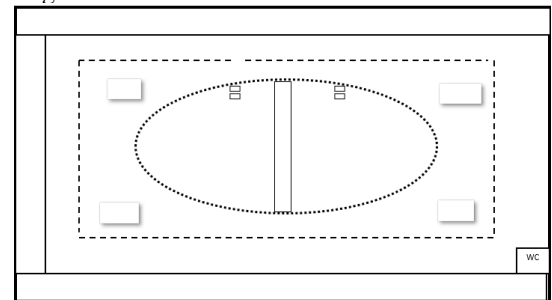


Figure 4. Floor 1 Walk Test Measurement Route

A. Analysis of Idle dan Dedicated Measurement Results Walk test RSRP

The following are the results of RSRP data measurements. For Idle and Dedicated mode results.

Table 1. Idle dan dedicated walk test measurement results

RSRP (dBm)	Telkomsel					Jumlah Data
	-70 s/d 25	-80 s/d -70	-90 s/d -80	-100 s/d -90	-140 s/d -100	
Floor 1	2274	51603	51809	6203	1070	112959
Floor 2	6967	33033	51077	21240	4286	116603
Floor 3	362	21239	72398	10810	0	104809
Amount	9603	105875	175284	38253	5356	334.371
Percentage %	3%	32%	52%	11%	2%	100%
Floor 1	23870	59019	17736	0	0	100625
2nd floor	23870	59019	17736	0	0	100625
3nd floor	157	20705	64400	26135	9728	121125
Amount	47897	138743	99872	26135	9728	322.375

requPercentage %	15%	43%	31%	8%	3%	100%
Indosat Ooredoo						
Floor 1	59668	60532	13975	0	0	134175
Floor 2	66111	51260	6045	66	0	123482
Floor 3	71393	48668	7714	0	0	127775
Amount	197172	160460	27734	66	0	385.432
Percentage %	51%	41%	7%	1%	-	100%
Floor 1	35562	63637	13853	0	0	113052
Floor 2	55148	49625	2088	0	0	106861
Floor 3	56668	40585	10472	0	0	107725
Amount	147378	153847	26413	0	0	327.638
Percentage %	45%	47%	8%	-	-	100%
XL A xiata						
Floor 1	4	25910	83778	0	0	109692
Floor 2	0	68460	30126	0	0	98586
Floor 3	38740	45203	11627	0	0	95570
Amount	38744	139573	125531	0	0	303.848
Percentage %	13%	46%	41%	-	-	100%
Floor 1	94988	42777	237	0	0	138002
Floor 2	59590	36028	46	0	0	95664
Floor 3	57134	54699	0	0	0	111833
Amount	211712	133504	283	0	0	345.499
Percentage %	61%	38%	1%	-	-	100%

Description: White: *Idle*, Light Blue: *Dedicated*

Based on the result of the analysis of the LTE indoor network KPI measurement at Mall Mtos Makassar, using the TEMS Pocket and Mapinfo Pro applications. In the walk test signal measurement at Mall Mtos Makassar.

From the measurement result of the 1st floor to the 3rd floor with 2 idle modes and dedicated mode, for the Telkomsel operator with idle mode, the signal quality is mostly in the week category, especially on the 3rd floor. And for the dedicated mode signal measurement, there must be significant improvements. Then for the Indosat Ooredoo provifer, it has the best performance in idle mode with a strong signal and dominates the entire 1st to 3rd floor. Dedicated mode then for the XI Axiata provider, shows quite good performance for idle mode with the majority of signals in the strong category. While for dedicated mode, it shows very good signal quality

B. Idle and Dedicated Walk test measurement result RSRQ

Based on the result of the analysis of the LTE indoor network KPI measurement at Mall Mtos Makassar, using the TEMS Pocket and MapInfo Pro application. In the walk test signal measurement at Mall Mtos Makassar.

From the measurement result from floor 1 to floor 3, the Telkomsel provider has a signal quality that is

mostly in the good category for idle mode. And for dedicated mode, there is an increase in quality with the majority of signals being in the very good category. Then for the Indosat Ooredoo provider, from the two measurements, idle mode and dedicated mode have equally good performance on all floors. Then for the XI Axiata provider, it shows varying performance with a dominance of very good and good signals on all floors in idle and dedicated modes.

From the overall provider analysis result in the RSRQ parameter, Indosat Ooredoo showed the best performance, followed by Telkomsel provider which showed significant quality improvement. And for XI Axiata showed good performance for idle and dedicated measurement.

Table 2. Idle and Dedicated Walktest Measurement Result

Telkomsel						
RSRPQ (dB)	-9 s/d 20	-14 s/d -9	-19 s/d -14	-24 s/d -14	-40 s/d -24	Jumlah Data
Floor 1	8419	94101	51809	0	0	112959
Floor 2	34572	77382	4338	311	0	116603
Floor 3	24884	76034	3778	113	0	104809
Amount	67875	247517	59925	424	0	334371
Percentage %	15%	71%	13%	1%	-	100%
Floor 1	60183	37905	2537	0	0	100625
Floor 2	37292	35817	0	0	0	73108
Floor 3	65296	54641	1046	142	0	121125
Amount	162771	128363	3583	142	0	294858
Percentage %	54%	43%	2%	1%	-	100%
Indosat Ooredoo						
Floor 1	7546	118417	8120	92	0	134175
Floor 2	1662	100532	21195	632	0	124021
Floor 3	1991	111225	14559	0	0	127775
Amount	11199	330174	43874	724	0	385971
Percentage %	3%	85%	11%	1%	-	100%
Floor 1	7079	98440	7533	0	0	113052
Floor 2	23493	81570	1798	0	0	106861
Floor 3	15108	88871	3746	0	0	107725
Amount	45680	268881	13077	0	0	327638
Percentage %	15%	82%	4%	-	-	100%
XL Axiata						
Floor 1	4	25910	83778	0	0	109692
Floor 2	0	68460	30126	0	0	98586
Floor 3	38740	45203	11627	0	0	95570
Amount	79250	159244	55957	9397	0	303848
Percentage %	27%	54%	15%	4%	-	100%
Floor 1	94988	42777	237	0	0	138002
Floor 2	59590	36028	46	0	0	95664
Floor 3	57134	54699	0	0	0	111833

Amount	15613	121884	196524	11478	0	345499
Percentage %	4%	36%	57%	3%	-	100%

Measurement: White: *Idle*, Light Blue: *Dedicated*

C. Analysis of Idle and Dedicated Measurement Result Walk test RSSI

Based on the results of the analysis of the LTE indoor network KPI measurement at Mall Mtos Makassar, using the TEMS Pocket and Map Info Pro applications. In the walk test signal measurement at Mall Mtos Makassar.

From the measurement results from floor 1 to floor 3, the Telkomsel provider has very good performance with almost all data in idle mode and dedicated mode measurements. Then for the Indosat Ooderoo provider, it has very good performance with almost all data in idle mode and dedicated mode measurements. Then for the XL Axiata provider, it shows very good performance in both idle mode and dedicated mode measurements from all sample data.

The overall analysis of RSSI parameters shows very good performance for idle mode and dedicated mode. Telkomsel providers have a slight decrease in idle mod on some floors, while Indosat Ooredoo and XL Axiata providers remain consistently very good on all floors.

Table 3. Idle and Dedicated Walktest Measurement Result

Telkomsel						
RSSI (dB)	0 s/d - 70	-70 s/d - 85	-85 s/d - 100	-100 s/d - 110	-110 s/d - 120	Jumlah Data
Floor 1	111889	1070	0	0	0	112959
Floor 2	112086	4517	0	0	0	116603
Floor 3	104809	0	0	0	0	104809
Amount	328784	5587	0	0	0	334371
Percentage %	98%	2%	-	-	-	100%
Floor 1	100625	0	0	0	0	100625
Floor 2	73108	0	0	0	0	73108
Floor 3	112791	8334	0	0	0	121125
Amount	286524	8334	0	0	0	294858
Percentage %	97%	3%	-	-	-	100%
Indosat Ooredoo						
Floor 1	134175	0	0	0	0	134175
Floor 2	124021	0	0	0	0	124021
Floor 3	127775	0	0	0	0	127775
Amount	385971	0	0	0	0	385971
Percentage %	100%	-	-	-	-	100%
Floor 1	0	113052	0	0	0	113052
Floor 2	106861	0	0	0	0	106861

Floor 3	107725	0	0	0	0	107725
Amount	214586	113052	0	0	0	327638
Percentage %	65%	45%	-	-	-	100%

XL Axiata

Floor 1	109692	0	0	0	0	109692
Floor 2	98586	0	0	0	0	98586
Floor 3	95570	0	0	0	0	95570
Amount	303848	0	0	0	0	303848
Percentage %	100%	-	-	-	-	100%
Floor 1	138002	0	0	0	0	138002
Floor 2	95664	0	0	0	0	95664
Floor 3	111833	0	0	0	0	111833
Amount	345499	0	0	0	0	345499
Percentage %	100%	-	-	-	-	100%

Description: White: *Idle*, Light Blue: *Dedicated*

D. Analysis of Idle and Dedicated Measurement Result Walk Test SINR

Table 4. Idle and Dedicated Walk Test Measurement Result

Telkomsel					
SINR (dB)	20 s/d 30	10 s/d 20	0 s/d 10	-40 s/d 0	Jumlah Data
Floor 1	0	0	59672	53287	112959
Floor 2	0	3989	92714	19900	116603
Floor 3	0	2554	83811	18444	104809
Amount	0	6543	236197	91631	334371
Percentage %	-	2%	70%	28%	100%
Floor 1	0	0	93086	7539	100625
Floor 2	0	0	68229	4879	73108
Floor 3	0	1094	115398	4633	121125
Amount	0	1094	276713	17051	294858
Percentage %	-	1%	93%	6%	100%
Indosat Ooredoo					
Floor 1	0	30476	85036	18663	134175
Floor 2	47	30818	635517	29639	124021
Floor 3	0	30542	70762	26471	127775
Amount	47	91836	791315	74773	385971
Percentage %	1%	24%	56%	19%	100%
Floor 1	0	37500	59288	16264	113052
Floor 2	0	50927	51187	4747	106861
Floor 3	0	40422	60637	6666	107725
Amount	0	128849	171112	27677	327638
Percentage %	-	39%	52%	9%	100%
XL Axiata					
Floor 1	0	99340	10352	0	113053
Floor 2	0	96384	2202	0	98586
Floor 3	0	0	16634	78936	95570

Amount	0	19572 4	29188	78936	307209
Percentage %	-	64%	10%	26%	100%
Floor 1	0	0	32594	10540 8	138002
Floor 2	0	0	14631	81033	95664
Floor 3	0	0	15977	95856	111833
Amount	0	0	63202	28229 7	345499
Percentage %	-	-	18%	82%	100%

Description: White: *Idle*, Light Blue: *Dedicated*

Based on the results of the analysis of the LTE indoor network KPI measurement at Mall Mtos Makassar, using the TEMS Pocket and Map Info Pro applications. In the walk test signal measurement at Mall Mtos Makassar.

From the measurement results from floor 1 to floor 3, the Telkomsel provider, shows good signal quality especially in dedicated mode, although there are still some areas that have low SINR. The Indosat Ooderoo provider shows a significant increase in signal quality in dedicated mode but still needs improvement for some areas on each floor. Then the XL Axiata provider, shows the best signal quality among providers for both idle and dedicated modes, with the SINR distribution tending to be in the poor signal quality range.

For overall SINR parameter measurement Telkomsel is the most stable provider in terms of signal quality based on SINR sample data, followed by Indosat Ooderoo and XL Axiata. Further network optimization is needed, especially for areas showing low SINR.

E. Analysis of Uplink and Downlink Measurement Result Walk test Throughput

Based on the results of the analysis of the LTE indoor network KPI measurement at Mall Mtos Makassar, using the TEMS Pocket and Map Info Pro applications. In the walk test signal measurement at Mall Mtos Makassar.

From the measurement results from floor 1 to floor 3, the Telkomsel provider is superior in maintaining consistent Uplink Downlink throughput and the Indosat Ooredoo provider shows the ability to achieve higher, although not optimal on all floors. Then for the XL Axiata provider, significant network improvements are needed, especially on floors 1 and 2, to improve signal quality.

From the overall analysis results, Telkomsel and Indosat Ooredoo have better network quality for uplink and downlink needs at Mall Mtos Makassar, Meanwhile, the provider XL Axiata needs to make major improvements to meet the same standards.

Table 5. Idle and Dedicated Walk Test Measurement Result

		Telkomsel					Jumlah Data
Throughput (Kbps)		12.000 to 110.000	7.200 to 12.000	1.500 to 7.200	324 to 1.500	0 to 324	
Floor 1	0	0	0	43396	2259	45655	
Floor 2	0	0	0	29855	3084	32939	
Floor 3	0	0	0	39606	1857	41463	
Amount	0	0	0	112857	7200	120057	
Percentage %	-	-	-	94%	6%	100%	
Floor 1	34539	369	316	363	128	35715	
Floor 2	35108	1541	956	362	180	38146	
Floor 3	42758	1309	751	273	226	45317	
Amount	112405	3219	2023	998	534	119178	
Percentage %	94%	6%	-	-	-	100%	
		Indosat Ooredoo					Jumlah Data
Throughput (Kbps)		12.000 to 110.000	7.200 to 12.000	1.500 to 7.200	324 to 1.500	0 to 324	
Floor 1	0	0	0	1417	38566	39983	
Floor 2	0	0	0	49646	7801	57447	
Floor 3	0	0	0	2683	34497	37180	
Amount	0	0	0	53746	80864	134610	
Percentage %	-	-	-	39%	61%	100%	
Floor 1	42618	661	714	381	161	44535	
Floor 2	56697	1236	1049	331	234	59547	
Floor 3	60570	774	546	235	326	62451	
Amount	159885	2671	2309	947	721	166533	
Percentage %	96%	1%	1%	1%	1%	100%	
		XL Axiata					Jumlah Data
Throughput (Kbps)		12.000 to 110.000	7.200 to 12.000	1.500 to 7.200	324 to 1.500	0 to 324	
Floor 1	24839	11381	14267	8398	1618	53105	
Floor 2	9268	3470	7096	21905	20236	61975	
Floor 3	0	0	0	28104	25630	53734	
Amount	34107	14851	21363	58407	47484	168814	
Percentage %	19%	9%	13%	34%	27%	100%	
Floor 1	21536	12287	15940	5744	5947	61454	
Floor 2	11995	5366	9422	3999	4903	35685	
Floor 3	27226	3427	3402	1408	1914	37377	
Amount	60757	21080	28764	11151	12764	134516	
Percentage %	46%	16%	21%	8%	9%	100%	

Description: White: *Idle*, Light Blue: *Dedicated*

IV. Conclusion

Based on the analysis of the results by referring to the KPI, the following can be concluded for the LTE Indoor network at Mall Mtos Makassar:

- Signal Strength for each Provider, For the Telkomsel Provider at Mall Mtos Makassar, it is in the fairly good to normal category. However, there is a significant decrease in signal quality on the 3rd floor, where several areas show weak to very weak signals, this indicates that Telkomsel's signal coverage is still not evenly distributed throughout the mall, especially on higher floors.
- Provider Indosat Ooredoo has good signal strength on the 1st and 3rd floors, with the majority of areas showing strong and consistent signals. Floor 1 has several areas with weaker signals. Indosat's signal strength in this mall is quite good although several points need to be improved. Provider XL Axiata shows that the area strength in this mall is in the weak signal category, especially on the 2nd and 3rd floors which require significant improvement to improve signal coverage at Mall Mtos Makassar.
- From the analysis of KPI results, the majority of results showed good performance from all the providers measured, with 1 best provider, namely the Indosat provider, having good network quality in the Mtos Makassar Mall building.

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