

# LTE Network Area Coverage on FDD and TDD Technology

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## ABSTRACT

FDD (Frequency Division Duplexing) and TDD (Time Division Duplexing) Technology I is a duplex technology on the 4G LTE network. FDD technology in Indonesia is deployed in the 900 MHz, 1800 MHz and 2100 MHz frequency bands. Meanwhile, TDD technology uses frequency of 2300 MHz. In order to see the performance from the side of coverage, a measurement of the signal strength is conducted by direct measurements in field so that the appropriate technology and frequency band can be determined for the measurement area. The measurements have been done by two samples of different frequencies, namely 1800 MHz for FDD and 2300 MHz for TDD. Measurement of coverage is conducted on the same existing BTS and different BTS for both FDD and TDD modes. The parameter used in this measurement is the RSRQ value as one of the basic parameters of KPI (Key Performance Indicator). The results of drivetest data obtained the farthest coverage area of 789 m, namely the FDD (Frequency Division Duplexing) technology with frequency of 1800 MHz and TDD with frequency of 2300 MHz for 633 m.

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## 1. Introduction

The development of telecommunications grow rapidly. Advances in telecommunications are relevant with the rise on data transmissions. This led to the emergence of the broadband era that could solve the problem of sending larger data in a faster time. LTE (Long Term Evolution) technology is one of the technologies on broadband era that can offer data access speeds of up to 100 Mbps or about 4 times of HSPA + technology [1][2]. One of the problems to implement LTE in Indonesia is frequency allocation. LTE does provide some alternative frequency allocations [3] that can be used, such as 700, 850, 900, 1800, 2100 and 2300 MHz and with adjustable bandwidth, namely 5, 10, 15 and 20 MHz.

LTE networks in Indonesia use two duplex technologies [4] are LTE FDD (Frequency Division Duplex) dan LTE TDD (Time Division Duplex)[2]. Indonesia uses the 1800 MHz and 900 MHz frequencies for FDD, meanwhile LTE TDD is at 2300 MHz [5]. LTE TDD has powerful downlink speed characteristic and uplink speed tends to be weak. This benefits both operators and users, because generally the use of downlinks is greater than uplinks. Meanwhile, LTE FDD has balanced downlink and uplink access characteristics.

Therefore, a study that discusses duplex technology was conducted to see the maximum coverage in Padang. Data retrieval was conducted on the BTS FDD 1800 MHz and 2300 MHz TDD types. The method used is the Coverage Planning method based on bandwidth variations by comparing how much coverage can be reach by the respective TDD and FDD technologies.

Along with the data in one E-node B site [6] and TDD and FDD at the same time, this study discusses comparison analysis at E-node B site with a frequency of 1800 MHz for FDD [7] and 2300 MHz for TDD. Moreover, it can determine the coverage area of LTE achieved by each of the TDD and FDD technology.

## 2. Literature Review

The study on coverage area has been done before. The study conducted by [8] This study calculates the signal strength to calculate the losses that occur at a frequency of 2300 MHz along Cihampelas Street in Bandung, which has a track length of 2.7 Km. The study method used is a quantitative method that uses primary data from the measurement results, then compares it with empirical methods in the form of ideal calculations. The calculation in the outdoor environment uses the Okumura Model by considering the topology and propagation losses along Cihampelas Street in Bandung such as Skywalk Cihampelas and multi-storey buildings. The results of this study are expressed in tables and graphs using Matlab so that it is easy to draw the results of the analysis from the study conducted, which is known that the propagation losses that occur affect the Reference Signal Received Power of the cellular communication network based on 4G-LTE technology. Study on LTE coverage area has also been conducted in the Samarinda area. [9] Samarinda is one of the areas that already uses LTE technology. LTE technology is a 4G technology, an advanced evolution of the cellular communication system standard determined by 3GPP (Third Generation Partnership Project) Release 8 which is capable of performing IP-based services. The city of Samarinda uses LTE frequency allocation at a frequency of 1800 MHz. However, because Samarinda is a new area to implement LTE networks, to improve network performance so that it has good quality and high work results, measuring the quality of the LTE network in North Samarinda City is conducted by using the Drive Test method. This measurement was conducted using the Nemo Handy software. The survey was conducted on customers who use one of the largest operators in Indonesia. The results of this study provide recommendations on the results of the data obtained during the field survey which are used for optimization steps. This optimization aims to obtain a predetermined KPI value. By reconfiguring the BTS, then performing an optimization simulation, it can be seen that the RSRP parameter has improved by 44.4% and the SINR parameter is 25.1%. Other studies also discuss TDD and FDD duplexers. [10] A duplexer is a device that can isolate a receiver from the transmitter when they share the same antenna with each other, so that communication can run in full duplex. Combining two bandpass filters with pseudo-interdigital method for LTE (long term evolution) applications. This method is superior to the duplexer with the hybrid method. The duplexer works on the 7th FDD LTE band, namely the uplink frequency of 2500-2570 MHz and downlink 2620-2690 MHz. From the measurement results obtained as follows: the center frequency value on the uplink 2639 MHz and on the downlink 2659 MHz, insertion loss at the uplink 1.561 dB and downlink 1.74 dB, bandwidth  $\pm$  70 MHz, isolation 23.03 dB, and the return loss value 23, 5 dB on the uplink and 23.45 dB downlink.

Other studies also discussed about the use of TDD and FDD at frequency of 700 Mhz. [11] Technology LTE (Long Term Evolution) will provide a positive impact on the deployment of telecommunications services, especially in rural areas which have a small broadband penetration, so as to decrease the digital divide between urban, sub-urban and rural. The LTE FDD network design at the 700 MHz band frequency uses a 15 MHz and 10 MHz bandwidth scenario in the Sub-Urban and Rural areas of Banyumas which is conducted using the coverage, capacity and simulation approach using Atoll software to analyze the performance of the LTE network. The coverage approached using the Okumura-Hatta propagation model needs 13 e\_NodeB to cover the whole observation spot. While the capacity approach in the 10 MHz bandwidth scenario requires 8

e\_NodeB (MIMO 2x2) and 4 e\_NodeB (MIMO 3x3) and in the 15 MHz bandwidth scenario it requires 4 e\_NodeB using either 2x2 MIMO or 3x3 MIMO. Based on the signal quality simulation, the average RSRP value is -72.2 dB and the SINR average is 6.83. Meanwhile, the CQI index value is 7.17, so the user device that can receive the service is the one that has a 64QAM modulation specification with a code rate of 466 and an efficiency of 2.7. In the parameter of the throughput value, there are differences between two scenarios, where the 15 MHz bandwidth has a throughput of up to 52 Mbps while the 10 MHz bandwidth is only 16 Mbps.

Other studies stated that FDD is digital dividend. [12] This study aims to determine the results of the calculation of the 700 MHz frequency link budget for LTE, determine the comparison of user capacity in dense-urban, urban, sub-urban and rural areas, determine the estimated number of LTE subscribers, determine the optimum number of LTE operators and the distribution bandwidth. This study uses descriptive quantitative analysis techniques. The results showed that the largest coverage was rural areas, followed by sub-urban, dense urban and urban areas, respectively. The capacity of users per site within 1 km<sup>2</sup> is from largest to small, respectively, namely rural, sub-urban, urban and dense urban areas. The largest estimate of the number of LTE subscribers in Indonesia is in dense-urban areas, reaching 500 users / Km<sup>2</sup> in the 8th year. The optimum number of LTE-700 MHz operators is 3 operators with a bandwidth distribution of 15 MHz for each.

Other studies have also made plans to expand the coverage area using LTE (FDD) for Garut.[13] LTE network conditions in the Garut district are not yet fully even. Garut regency area is a tourist destination that is visited by many tourists in West Java. In this area, there are some leading tourist attractions such as Cikembulan Animal Park, Darajat Peak, and Cipanas Baths, which are visited by thousands of tourists every day. The demand of voice and data communication services are really necessary in this area. Based on results of survey, there are a lot of problems that have blank spots (RSRP > -100 dBm), poor quality of signal (SINR > -20 dB), and slow in several districts. In order to solve this problem, it is necessary to plan for the expansion of the LTE network in these sub-districts. The expansion planning is conducted using two scenarios, namely LTE (FDD) at 1800 MHz and LTE-A using the carrier aggregation method at 850 MHz and 1800 MHz combined with SFR. In this study, after the expansion planning was carried out, it was found that the coverage area improved by 331.76 km<sup>2</sup> (92.29142%) with quality that met KPI standards. The simulation results of coverage area expansion using LTE (FDD) obtained the number of sites as many as 88, the average RSRP parameter value is -65.91 dBm, the average SINR is 18.02 dB, throughput is 24.962 Mbps, and user connected is 93.3%. While the simulation results of the expansion of the coverage area using LTE-A (Carrier Aggregation) combined with SFR, the number of sites is 69, the average RSRP parameter value is -48.88 dBm, the average SINR is 22.5 dB, the throughput is 28.923 Mbps, and user connected 94.5%. In other study, FDD LTE is also used for microcell. [14] Based on the survey results and drive test that using the operator standard 3 at Jalan Kebon Kopi area, Cimahi City, the value of LTE parameter obtained is in the bad category. This is indicated by the parameter value of RSRP < -90 dBm, SINR < 5 dB, and throughput < 1 Mbps. Apart from that, the identification of the Operating Support System (OSS) operator 3 shows that the consumption of telecommunication traffic in the region is high. Therefore, microcell planning is conducted on band 3 FDD LTE 1800 MHz using the cell splitting method. This cell splitting method plays a role in generating new cells and providing more channels to improve performance and improve the capacity of the LTE network. Planning simulation results show an improve in the average RSRP value of 8.28 dBm, SINR of 3.6 dB, and a throughput of 1.475 Mbps.

### 3. Method

#### FDD Frequency Band

FDD stands for Frequency Division Duplexing, a way of delivering data using two different channels between transmit and receive. This method is also used today in Indonesia (except Bolt) and many Southeast Asian countries. It has the advantage of being less exposed to interference and good reception [15]. In FDD, separate uplink and downlink are used, which allows devices to transmit and receive data at the same time. The distance between the uplink and downlink channels is referred to as the duplex distance. The uplink channel operates at a lower frequency. This is done because higher frequencies experience greater attenuation than lower frequencies, therefore, enabling the cell phone to take advantage of lower sending rates.

By using FDD it is possible to send and receive signals simultaneously with different frequencies. With this technique, a guard frequency is required to separate sending and receiving frequencies simultaneously, and a frequency filtering process that must be accurate.

#### TDD Frequency Band

TDD stands for Time Division Duplexing, where data is transmitted and received in the same frequency channel, only with a short time lag separation. The advantage of this method, because sending and receiving data only uses one channel, the available capacity can be bigger than FDD. It is suitable for data transmitted asymmetrically, for example for internet browsing, video surveillance or broadcast [16].

TDD mode allows full duplex operation using a single frequency band and time division multiplexing of uplink and downlink signals. Each channel is multiplexed on a time basis so that each channel has a different time slot.

#### List of 4G LTE Bands in Indonesia

The frequency bands currently owned by cellular operators are as follows:

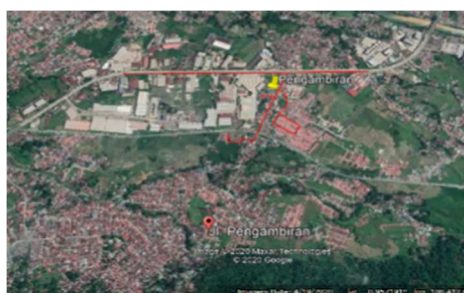
1. Telkomsel (total 135 MHz) with details:
  - Band 1 (2100 MHz) in the amount of 15 MHz FDD
  - Band 3 (1800 MHz) in the amount of 22,5 MHz FDD
  - Band 8 (900 MHz) in the amount of 15 MHz FDD
  - Band 40 (2300 MHz) in the amount of 30 MHz TDD
2. XL Axiata (total 90 MHz) with details:
  - Band 1 (2100 MHz) in the amount of 15 MHz FDD
  - Band 3 (1800 MHz) in the amount of 22,5 MHz FDD
  - Band 8 (900 MHz) in the amount of 7,5 MHz FDD
3. Indosat Ooredoo (total 95 MHz) with details:
  - Band 1 (2100 MHz) in the amount of 15 MHz FDD
  - Band 3 (1800 MHz) in the amount of 20 MHz FDD
  - Band 8 (900 MHz) in the amount of 12,5 MHz FDD
4. Smartfren (total 52 MHz) with details:
  - Band 5 (850 MHz) in the amount of 11 MHz FDD
  - Band 40 (2300 MHz) in the amount of 30 MHz TDD
5. Hutchinson 3 Indonesia (total 50 MHz) with details:
  - Band 1 (2100 MHz) in the amount of 15 MHz FDD
  - Band 3 (1800 MHz) in the amount of 10 MHz FDD

#### 6. Bolt (total 30 MHz) with details:

- Band 40 (2300 MHz) in the amount of 30 MHz TDD

#### Determining the service area

In determining service areas, mapping is carried out. This is useful for supporting the area where the signal will be measured using the drivetest method. The designated areas are areas where TDD technology and FDD technology exist. In relation to determining the area, it can be seen from the MKOM data of the Telkomsel operator of the Padang City cluster. So, the specified area is in the Arai Pinang Pegambiran area. The author uses the google earth application to support the existence of settlements in the area. The following is a display of the drivetest path shown in red in Figure 1.



**Figure 1.** Drivetest path view

#### Data retrieval

In data collection, an area mapping is needed which is useful for determining the BTS service area. Then after creating the path, data collection is conducted on the installed BTS for both TDD and FDD technology using the drivetest method. In the drivetest data collection, two important things are needed, namely the network connection and the data taken. In data collection, we use Telkomsel operator data connection. Then the data taken is FDD 1800 MHz and TDD 2300. The drivetest data collection uses TEMS Pocket Samsung Galaxy S5 SM-G900I (LTE / WCDMA / GSM). The data collection of the drivetest using the TEMS pocket is conducted using a four-wheeled vehicle connected to the Global Positioning System (GPS). So that the data is obtained in real time.

The Drivetest measurement uses the TEMS Pocket application and the Drivetest measurement mode consists of 2, namely (Yanuari, 2015):

##### 1) Drivetest Idle Mode

Measurement of signal quality received by MS (Mobile station) is idle or does not download / upload process. This mode is only used to determine the signal strength of an area with a low signal / no service indication.

##### 2) Drivetest Dedicated Mode

Measurement of signal quality is conducted when the upload / download process occurs. To measure and identify the quality of voice (voice) and data. A dedicated test mode is used to get the throughput values, RSRP values and CINR values. In the Drivetest process, TEMS Pocket software is used, which is a software to measure the parameters and performance of a telecommunications network, be it 2G, 3G or 4G networks.

The basic parameters of the 4G signal quality indicator used:

##### 1) RSRP (Reference Signal Received Power)

RSRP is the LTE power signal received by the user in a certain frequency. The farther the distance between the site and the user, the smaller the RSRP received by the user. RS is a Reference Signal or RSRP at each coverage point. Users who are out of range will not get LTE service. The following is the receiver power range in Table 1.

**Table 1.** Range score of RSRP (dBm)

RSRP	Color	Strength (dBm)
Excellent	Blue	$-80 \leq x$
Good	Green	$-95 \leq x < -80$
Low	Yellow	$-110 \leq x < -95$
Bad	Red	$X < -110$

## 2) SINR (Signal to Interference Noise Ratio)

According to Efriyendro [1] "SINR (Signal to Interference Noise Ratio) is the ratio between the average power received and the average interference and noise". The better the signal, the greater the SINR value of a signal, the better the signal quality and vice versa. The following is the SINR range in Table 2.

**Table 2.** Range score of SINR (dB)

SINR	Color	Strength (dB)
Excellent	Blue	$20 \leq x$
Good	Green	$13 \leq x < 20$
Low	Yellow	$0 \leq x < 13$
Bad	Red	$X < 0$

## 3) Reference Signal Received Quality (RSRQ)

RSRQ is a parameter that determines the quality of the received signal. RSRQ can be calculated by the following formula:

$$RSRQ = \frac{(RSRP * N)}{RSSI} \quad (1)$$

**Table 3.** Standard Score of RSRQ (Reference Signal Received Quality)

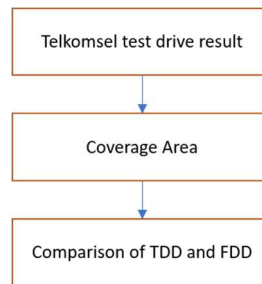
SINR	Color	Strength (dB)
Excellent	Blue	$-9 \leq x$
Good	Green	$-15 \leq x < -9$
Low	Yellow	$-19 \leq x < -15$
Bad	Red	$X < -20$

## 4. Results

After data collection is done is the analysis of the drivetest results. The drivetest results are compared with the KPI (Key Performance Indicator) value. KPI (Key Performance Indicator) are parameters that are indicators of the good or bad (performance) of a telecommunications network. There are at least five general color indicators that are used to determine the good or badness of a signal in the KPI, namely purple, blue, green, yellow and red [17]. Purple indicates that the signal is very good, blue indicates that the signal is good, green indicates that the signal is good enough, yellow indicates that the signal is weak or bad enough, and red indicates that the signal is very bad.

The results of this drivetest are processed using the Tera Discovery and MapInfo Pro applications. Broadly speaking, some of the things that are generated from the drivetest data cover the bad signal area, BTS site data and bad spot area. Then the study used these data to compare FDD (Frequency

Division Duplexing) and TDD (Time Division Duplexing) technology. The following advanced step-by-step chart is shown in Figure 2.



**Figure 2.** Advanced stage scheme of drivetest result

1) The result with RSRP Parameter

After using Tems Discovery and Mapinfo Pro, the RSRP results were obtained for FDD technology, the results of logfile plotting can be seen in Figure 3.



**Figure 3.** The layout of drivetest RSRP Telkomsel TDD result

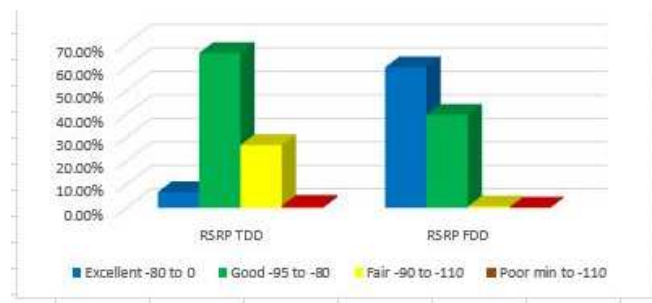
Based on Figure 3, it can be seen that the level of acceptance of Telkomsel operators on TDD technology based on KPI is of a fairly good quality because it is dominated by the Green indicator, and has values ranging from -95 dBm to -80 dBm respectively and some points for the Yellow indicator ranging from -110 dBm up to -95 dBm. Whereas for TDD technology, the results of logfile plotting can be seen in Figure 4.



**Figure 4.** The layout of drivetest RSRP Telkomsel FDD result

Based on Figure 4, it can be seen that the level of acceptance of Telkomsel operators on FDD technology based on KPI is of good quality because it is dominated by the Blue indicator, and has values ranging from -80 dBm each and for the Green indicator ranging from -95 dBm to -80 dBm. Then there is a little bit for the yellow indicator with values ranging from -110 dBm to -95 dBm.

The comparison of RSRP between TDD technology and FDD technology can be seen in the graph below.



**Figure 5.** Graph of RSRP Comparison between FDD and TDD Technology

In the FDD technology for RSRP based on the drivetest results it has a dominant indicator in blue and green which is the signal quality which is evenly distributed for signal quality. Which for good indicators, namely the range between -0 dbm to -80 dbm has a value of 59.83% and for fair indicators, namely the range between -80 dbm to -95 dbm has a value of 39.60% and for very bad indicators, namely the range between -110 dbm to min has a value of 0.00%,

While the TDD technology for RSRP based on the drivetest results has a dominant yellow indicator which is a poor signal quality which is a poor signal quality. Which for excellent indicators, namely the range between -0 dbm to -80 dbm has a value of 6.67% and for good indicators, namely the range between -95 dbm to -80 dbm has a value of 65.88%, for bad indicators, namely the range between -95 db to -110 dbm has a value of 26.67% and for very bad indicators, namely the range between -110 dbm to min has a value of 0.78%. From the graph, it can be seen that for the RSRQ parameter, TDD technology is better than FDD technology.

## 2) The result with SINR Parameter

For the SINR parameter of FDD technology, the results of plotting the logfile can be seen in the Figure 6.



**Figure 6.** The layout of drivetest SINR Telkomsel TDD result

Figure 6 shows that the signal quality of Telkomsel operators on TDD technology based on KPI has a fairly good quality because although there are some points that have poor signal quality, which consists of indicators of blue, yellow, green and red, and has a value that ranges from each other. 20 dB for the blue indicator and 13 dB to 20 dB for the Green indicator and then, for the Yellow indicator it has a value of 0 dB to 13 dB and the last one for the Red indicator has a value of 0.



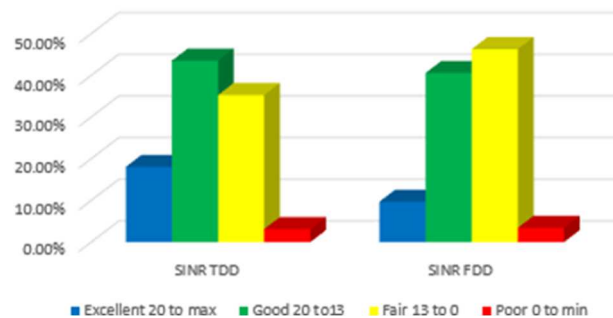
For the SINR parameter of FDD technology, the results of plotting the logfile can be seen in the Figure 7.



**Figure 7.** The layout of drivetest SINR Telkomsel FDD result

Figure 7 shows that the signal quality of Telkomsel operators on FDD technology based on KPI is evenly distributed, which consists of blue, green and yellow indicators, and has values ranging from 20 dB each for the blue indicator and 13 dB to 20 dB for the green indicator and for the yellow indicator, the value is 0 dB to 13 dB.

The SINR comparison between TDD technology and FDD technology can be seen in the graph below.



**Figure 8.** Graph of SINR Comparison between FDD and TDD Technology

In the FDD technology for SINR, based on the drivetest results, it has a dominant indicator in green and yellow which is the signal quality which is evenly distributed for signal quality. Which for excellent indicators, namely the range between 20 db to max has a value of 9.71%, for good indicators, namely the range between 20 db to 13 db has a value of 40.57%, for fair indicators, namely the range between 13 db to 0 db has a value of 46.29%, and for poor indicators, namely the range between 0 db to min has a value of 3.43%,

3) Meanwhile, the TDD technology for SINR based on the drivetest results has a dominant green indicator which is a good signal quality which is a good signal quality. Which is for excellent indicators, namely the range between 20 db to max has a value of 18.04%, for good indicators, the range between 20 db to 13 db has a value of 43.53%, for fair indicators, namely the range between 13 db to 0 db has a value of 35.29%, and for poor indicators, namely the range between 0 db to min has a value of 3.14%. From the graph, it can be seen that for the SINR parameter, TDD technology is better than FDD technology because FDD technology has a higher poor indicator value.

## 4) Result with RSRQ Parameter

For the RSRQ parameter of FDD technology, the results of plotting the logfile can be seen in Figure 9.



**Figure 9.** The layout of drivetest RSRQ Telkomsel FDD result

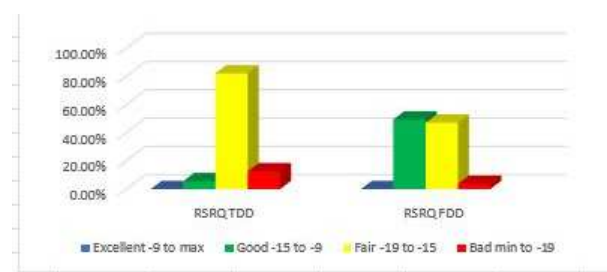
Figure 9 shows the quality signal quality of the signal received by Telkomsel operators on FDD technology based on KPI has good quality because it is dominated by green and yellow indicators, which have values ranging from Min to -3 dB. Then for the indicator yellow, the range score is from 1 4 dB to -9 dB. Hal is evident in the results of plotting drivetest and legend (color indicator KPI). Whereas for TDD technology, the results of logfile plotting can be seen in Figure 10.



**Figure 10.** The layout of drivetest RSRQ Telkomsel TDD result

Figure 10 shows the quality of the signal, the quality of the signal received by Telkomsel operators on TDD technology based on KPI has a fairly poor quality because it is dominated by the yellow indicator which has a value ranging from Min to -14 dB. Then the yellow indicator has a value. The range is -19.5 dB -14 dB. This can be seen in the results of plotting drivetest and legend (KPI color indicator).

The comparison of RSRQ between TDD technology and FDD technology can be seen in the graph in Figure 11.



**Figure 11.** Graph of RSRQ Comparison between FDD and TDD Technology

In the FDD technology for RSRQ based on the drivetest results, it has a dominant indicator in green and yellow which is the signal quality which is evenly distributed for signal quality. Which for good

indicators, namely the range between -9 db to -15 db has value of 49.29% and for fair indicators, namely the range between -15 db to -19 db has value of 47.01% and for very bad indicators, namely the range between -19 db to min has a value of 3.70%,

Meanwhile, the TDD technology for RSRQ based on the drivetest results has a dominant yellow indicator which is a poor signal quality which is a poor signal quality. Which for good indicators, namely the range between -9 db to -15 db has a value of 5.49% and for fair indicators, namely the range between -19 db to -15 db has a value of 81.96% and for very bad indicators, namely the range between -19 db to min has a value of 12.55%. From the graph, it can be seen that for the RSRQ parameter, TDD technology is better than FDD technology.

#### 5) The Comparison of Coverage area between FDD and TDD Technology

To compare the coverage area, it is seen from the level of power acceptance farthest from each sector. In FDD technology for the coverage area obtained in the drivetest results. For the initial sector, which is 0 degrees, a coverage area of 789.1 meters is obtained with a bandwidth on the cell of 15 MHz. The measurement results can be seen in Figure 12.



**Figure 12.** Measurement results in sector 1 for FDD

Meanwhile, in sector 2 with a 120 degree azimuth, a coverage area of 342.2 meters is obtained with the cell bandwidth of 15 MHz. The measurement results can be seen in Figure 13.



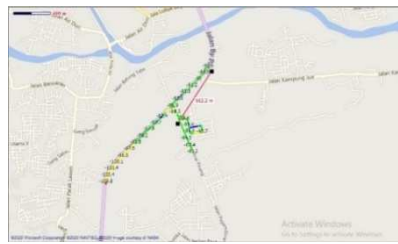
**Figure 13.** Measurement results in sector 2 for FDD

Meanwhile, in the last sector with 240 degrees azimuth, the coverage area is 872.1 meters with the cell bandwidth of 15 MHz. The measurement results can be seen in Figure 14.



**Figure 14.** Measurement results in sector 3 for FDD

Meanwhile, the TDD technology for the level of power acceptance obtained in the drivetest results. For the initial sector, which is 0 degrees, a coverage area of 663.3 meters is obtained with a bandwidth on that cell of 20 MHz. The measurement results can be seen in Figure 15.



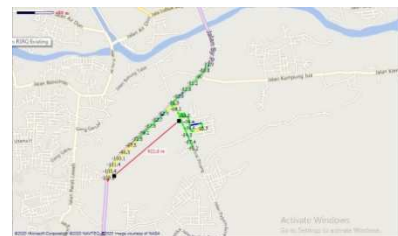
**Figure 15.** Measurement results in sector 1 for TDD

Meanwhile, in sector 2 with a 120 degree azimuth, a coverage area of 338.7 meters with a bandwidth on the cell of 20 MHz. The measurement results can be seen in figure 16.



**Figure 16.** Measurement results in sector 2 for TDD

Meanwhile, in the last sector with 240 degrees azimuth, the coverage area is 922.8 meters with the cell bandwidth of 20 MHz. The measurement results can be seen in Figure 17.



**Figure 17.** Measurement results in sector 3 for TDD

Based on the measurement results, it can be seen that the farthest coverage area is obtained on FDD technology.

## 5. Conclusion

Range measurement in both technologies is done by measuring the distance from the BTS to the farthest range that can be reached on a PCI. Measurement of the coverage area for each sector 1,2 and 3 on FDD technology, respectively, namely 789.1m, 342.2m, and 1040m, but on TDD technology, namely 633.3m, 338.7m and 922.8m. The use of frequency in FDD technology, namely 1800 MHz, has a wider coverage area, because the frequency of TDD technology, namely 2300 MHz, has a smaller cell size and the number of users in one BTS cell is more than the 1800 MHz

frequency. The use of 1800 MHz frequency is better for coverage area, meanwhile, 2300 MHz frequency usage is better for improving data services and capacity.

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