The Analysis of Community Radio Performance in the Central Java Province is Conducted through the Utilization of a Radio Mobile Simulator

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Abstract: Radio broadcasting is one of the electronic media complementary to print media in the presentation of information and entertainment. Community radio is an FM radio station owned, managed, provided, initiated and established by a community. Community radio is also often referred to as social radio, educational radio, or alternative radio. Community radio frequency allocation according to the Regulations of the Minister of Communications and Informatics of the Republic of Indonesia Number: 3 In 2017, only three channels are available, namely Channels 202, 203, and 204 (frequency 107.7 MHz, 107.8 MHz and 107.9 MHz), while one channel of 200 is allocated to the Public Broadcasting Authority (LPP) and the Private Broadcaster. (LPS). Due to the limited number of community radio channels, there is not much community radio established, in addition to monitoring and optimizing the use of frequencies as well as to maintain the existence of the community radio it is necessary to conduct an analysis of the performance of those community radio. Besides, the results of the analysis also show how many channels can still be used to establish community radio in their territory. A mobile radio simulator is used to get a complete picture of the activity of the frequency channels as well as the community radio performance used in Central Java. The results of the analysis show that the community's radio frequency allocation is well used and the broadcasting power emitted in accordance with government regulations with EIRP and RSL rates is -6,02 dBm
Keywords: Community Radio, EIRP, RSL, Mobile Simulator Radio

I. INTRODUCTION

Because of the limited number of community radio channels available, it is necessary to preserve the existence of the community radio. Because of that limitation, people have difficulty setting up a new community radio, and don't know how many canals can still be used to set up a community radio in their territory. The research is aimed at analyzing the performance of several community radio stations in the Central Java region using radio mobile applications. The research limits are the existing community radio in Central Java Province as well as the technical and policy rules on frequency allocation established by the Ministry of Communications and Informatics [1]. Radio broadcasting is one of the electronic media that is in demand by the public to obtain a variety of information and entertainment. Radio is also a type of mass communication media as a transmitter of communication that to this day still gets the attention of the public [2][3][4][5][6]. Radio broadcasting is also one of the terrestrial broadcast services that uses electronics and telecommunications technology in processing, sending information and entertainment material to listeners [7][8]. To reach the target audience, reception is heavily dependent on radio broadcasting technology, distance and propagation path between the transmitter and the receiver. One of these radio broadcasting technologies works on a Very High Frequency (VHF) band with a frequency range of 87.5-108 MHz that provides FM radio services and broadcasts. Community radio is an FM radio station owned, managed, provided, initiated and established by a community [9][2][10][11][12][13].

Community radio is also often referred to as social radio, educational radio, or alternative radio. The allocation of community radio frequencies is regulated by the Ministry of Communications and Informatics of the Republic of Indonesia No. 3: In 2017, only three channels are available: Channels 202, 203, and 204 (frequencies 107.7 MHz, 107.8 MHz and 107.9 MHz)[[14], while the channel 1 s.d. 200 is allocated to the Public Broadcasting Authority (LPP) and the Private Broadcaster (LPS) [15][16] Due to the limitation of the number of available community radio channels, it may cause a decrease in the presence of radio communities and communities having difficulties in establishing community radio, as well as not knowing how many canals can still be used to establish community radio in their territory [17][18][19]. To get a clear picture of the surveillance and use of community radio channels, then it is necessary research to determine the performance of the licensed community radio by considering technical aspects such as measurement of the effective isotropic radiated power and received signal level of each community radio channel, so that this analysis can determine the form of deviation from the use of these `frequency channels. To support this research, radio mobile simulation software (SRM) is used. With SRM, technical identification of community radio channels and transmitter performance as well as EIRP and RSL analysis can be found. The channels used on community radio are 107.7 MHz, 107.8 MHz and 107.9 MHz on VHF bands. The research was carried out in the district of Central Java, taking 9 community radios scattered across different regions in Central Java [20].

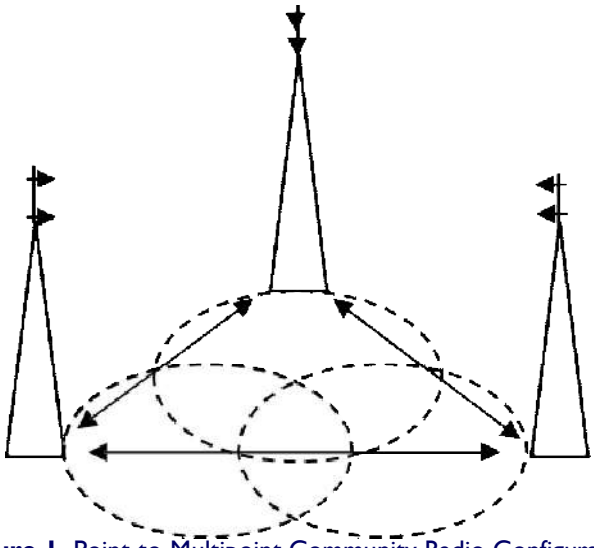
II. MATERIALS AND METHODS

A. Literature Review

A strong evaluation of the field strength of FM radio transmitters has been carried out at the frequency 98,5 MHz–103.6 MHz, where research on the transmission power and propagation from the transmitter can affect the technical quality of service on the receiver. While it has conducted measurement and assessment of the quality of receiving FM radio broadcasts bordered by West Kalimantan to find out the reception quality of the signal in accordance with the requirements of the government [21]. For the measurement of the wave radius, the Radio Republic of Indonesia transmitter (RRI) has been carried out by [22]. To look at the impact of the development of information technology and its impact on community radio, then [15], has been conducted on the patterns of radio utilization and the impact of information technology on radio [23]. Technical analysis for the setting of community radio frequency channels has also been carried out with reference to the regulations of the allocation of frequencies and the availability of the frequence channels existing in Indonesia [24]. An analysis of the development and problems of the radio community in Indonesia has been carried out by several researchers . The impact of interference on neighbouring radio channers has been researched by [12][9][25] while the prediction of the development of the community radio have been analysed by [6]. All the research that has been done only emphasizes the use and use of community radio frequency channels, none emphasises the monitoring of the use of transmitter power, coverage area, EIRP and RSL of each community radio. The data can be used as analytical material. In assessing whether there is any abnormality in the use of community radio frequency channels. Thus this research will emphasize that the abnormalities of the measured signal from a community radio, can be known from on-site monitoring and data processing through mobile radio software (SRM).

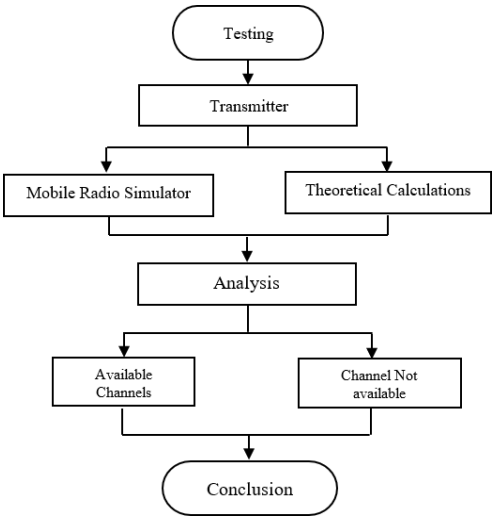
B. Model Research Methods System

The research was made by testing comparisons between measurements using a Radio Mobile application and field calculations using theoretical equations of formulas. Where from the results of the two methods can be drawn conclusions are recommendations of technical parameters that can be met a community radio when it will be established in the territory of Semarang district, Kendal and Demak. There are several community radio configurations implemented by some community radio, generally point-to-multipoint as listed in Figure 1, below.



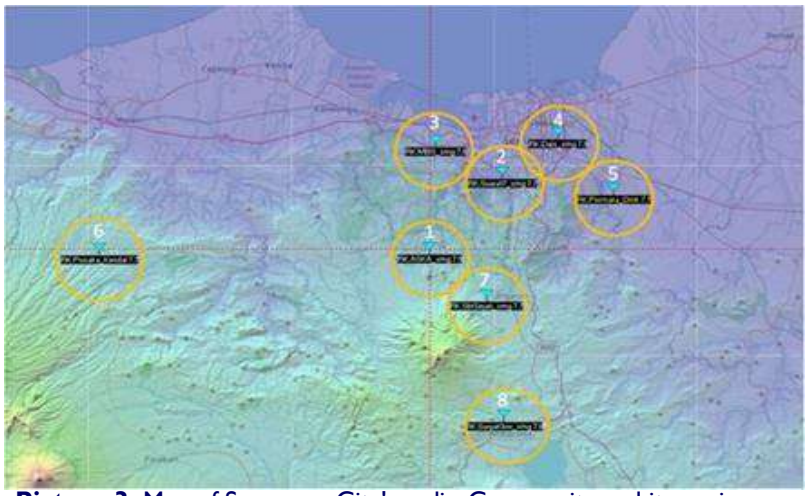
Picture 1. Point-to-Multipoint Community Radio Configuration

At this stage, the frequency and technical parameters of the transmitter station are determined. The radio frequencies used by the community are 107.7 MHz, 107.8 MHz and 107.9 MHz as well as other technical parameter such as the transmission power / power emitted by the device, and the height of the antenna used by transmitter with transmitter configuration, i.e. point-to-point and point- to multipoint.



Picture 2. Analysis of Community Radio channel usage Model System

In this phase, we analyze the source data from the SIMS database on the radio frequency spectrum license generated by SDPPI which contains technical parameters (location of the transmitter station, transmission power, antenna height) that will be processed using the Mobile Radio Simulator. To analyse the performance of the mobile radio simulator by comparing the use of the Mobile Radiosimulator with theoretical calculations. In addition to analyzing the limitations of the radio frequency channels of the community by finding out the patterns of the repetition of the frequencies on the channel 202, 203 and 204 then it is necessary to calculate the protection ratio between the radio stations with the location of the transmitter that has been known whether can co-channel, adjacent-1 or adyacent-2. The results of the analysis can identify the availability of channels in the district/ City of Semarang, Kendal, and Demak. Community radio broadcasting radio frequency waves on the basis of regulations in Indonesia there are only 3 canals namely channel 1 at the frequencies of 107.7 MHz, channel 2 at the Frequency of 107,8 MHz and channel 3 at theFrequency 107.9 MHz. In the process of determining the location of community radio broadcasters in Kota Semarang took as many as 3 areas as reference for the radio community directly bordering with the City of semarang are District of Semang, Demak, and Kendal. Where the region can be seen in Figure 3 below.



Picture 3. Map of Semarang City's radio Community and its environs

Table 1. Community Broadcast Radio Technical Parameters

Community Broadcast Radio	Freq. (MHz)	Coordinate		Power (Watt)	Loss (dB)	Gain (dBi)	Antenna height (m)	Regency/ City
		Lat.	Long.					
Radio Aska	107.9	7.089891	110.33537	20	1	1.5	20	Semarang
Radio Suara 17	107.7	7.020972	110.39787	30	1	1.5	10	Semarang
Radio MBS	107.8	6.991569	110.33970	50	1	1.5	20	Semarang
Radio Dais	107.9	6.984666	110.44651	30	1	-3	20	Semarang
Radio Permata	107.7	7.035527	110.49382	30	1	1.5	10	Demak
Radio Pusaka	107.7	7.090808	110.04901	30	1	1.5	10	Kendal
Radio Sahabat Sejati	107.7	7.133333	110.38402	30	1	1.5	10	Semarang
Radio Surya Kebenaran	107.8	7.243652	110.38402	30	1	1.5	10	Semarang

From Table 1, an analysis can be carried out on the use of the technical parameters of existing community radios, almost all community radios have a transmit power (Power) below 50 watts, only MBS community radios have a maximum transmit power of 50 watts. The potential for interference with surrounding community radio is very small, so MBS community radio can use 50 watts of power. Meanwhile, the largest gain is the Dais community radio
- 3dBi because the transmitter station is located in a lowland location/closer to sea level.

Table 2. Results of measuring location height and coverage area

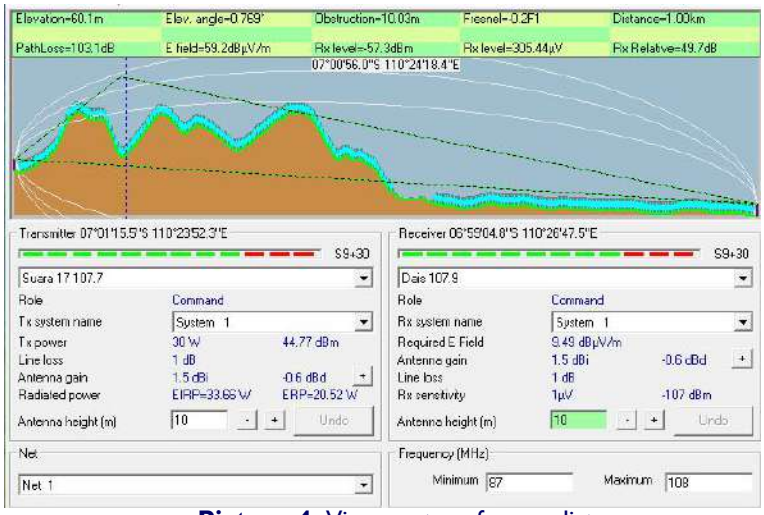
No.	Subdistrict	Coordinate		Location Height (mdpl)	Coverage Area (Km)			
		Latitude	Longitude		North	East	South	West
1.	Banyumanik	S 7° 04' 19,98"	E 110° 25' 14,16"	225	3,51	3,08	3,01	3,94
2.	Candisari	S 7° 01' 09,15"	E 110° 25' 45,08"	85,3	1.93	3,29	0,86	0.86
3.	Gajah Mungkur	S 7° 00' 42,59"	E 110° 24' 29,69"	82,9	1,94	1,22	1,86	1,15
4.	Gayamsari	S 6° 59' 53,50"	E 110° 26' 54,16"	9	1,07	1,45	6,30	1,58
5.	Genuk	S 6° 58' 06,90"	E 110° 28' 47,41"	7,1	4,72	4,51	4,15	3,79
6.	Gunungpati	S 7° 04' 14,19"	E 110° 21' 59,86"	277,9	15,95	4,08	11,66	8,01
7.	Mijen	S 7° 01' 09,15"	E 110° 19' 09,54"	181	4,44	3,93	3,36	5,07
8.	Ngaliyan	S 6° 59' 27,11"	E 110° 19' 08,28"	82,9	10,09	4,01	2,58	2,79
9.	Pedurungan	S 6° 59' 55,39"	E 110° 28' 04,50"	12,4	3,94	1,72	5,79	6,65
10.	Semarang Barat	S 6° 59' 00,13"	E 110° 23' 04,21"	8,5	3,93	2,79	3,72	2,58
11.	Semarang Selatan	S 6° 59' 55.04"	E 110° 25' 45.08"	12,1	1,79	1,36	3,08	2,72
12.	Semarang Tengah	S 6° 58' 50.13"	E 110° 25' 12.74"	9	3,58	1,65	5,37	3,15
13.	Semarang Timur	S 6° 58' 17.96"	E 110° 26' 06.53"	7	1,79	1,36	1,43	2,22
14.	Semarang Utara	S 6° 57' 37.83"	E 110° 24' 30.63"	6,1	3,07	1,72	1,79	2,15
15.	Tembalang	S 7° 02' 37.88"	E 110° 27' 41.16"	91,1	8,37	7,65	4,44	3,01
16.	Tugu	S 6° 57' 58.31"	E 110° 19' 29.73"	1,2	6,15	6,66	5,65	5,94

In measuring the height of the location and service area of community radio establishments in each sub-district based on technical parameters in the existing radio database with a Tx transmitter power of 30 watts, Loss 1 dB, Gain 1.5 dBi, and antenna height 10 meters. Where the magnitude of the field strength/power in the service area is applied based on Minister of Communications and Information Technology Regulation No. 3 of 2017 of 66 dBμV/m at a maximum distance of 2.5 km. The results of measuring the height of the transmitter location and coverage area in each sub-district in Semarang City are in Table 2.

III. RESULT AND DISCUSSION

1) RSL Measurement Results with Mobile Radio

The signal strength will be measured as well as knowing the sound quality obtained from measuring different distances. And here is one of the capture results from a distance of 1 kilometer.



Picture 4. View capture from a distance

Table 3. Results of measuring location height and coverage area

No.	Distance from Rakom Suara 17 transmitter to Rakom Dais (kilo meters)	Receiver Signal Level / RSL (dBm)	Signal Quality
1.	1	-57.3	Very good
2.	1.5	-65.8	Good
3.	2	-65.8	Good
4.	2.5	-64.4	Good

5.	3	-67.8	Good
6.	3.5	-74.1	Good
7.	4	-73.7	Good
8.	4.5	-74.1	Good
9.	5	-77.1	Not good
10.	5.5	-80.1	Not good
11.	6	-81.7	Not good
12.	6.5	-84.8	Not good
13.	6.71	-86.1	Not good

From the RSL test simulation results above, several information was obtained, including that the signal strength from the closest distance was -57.3 dBm. From this distance there is an obstacle/obstacle as high as 10 meters. Meanwhile, at a distance of 2.5 kilometers from the service area, the signal quality has begun to decline. In these conditions the signal strength received is -64.4 dBm.

2. Calculation of Signal Reception Level (RSL) Using Formula Theory

To obtain the results of the analysis of the power reception level calculation, the assumptions and limiting values related to the calculation are first determined. The following parameter data is entered based on SIMS-S data into table form:

Table 3. RSL Calculation Parameter Components

No.	Technical Parameters	Community Radio Units and Quantities		
		Dais	MBS	Suara 17
1.	Frequency of work	107.9 MHz	107.8 MHz	107.7 MHz
2.	ERP maximum transmit power (PTX)	44.77 dBm	46.98 dBm	44.77 dBm
3.	Tx transmitter antenna gain (GTX)	-3 dBi	1.5 dBi	1.5 dBi
4.	Gain of Rx receiver antenna (GRX)	1 dBi	1 dBi	1 dBi
5.	Tx transmitting antenna height (h1)	20 meter	20 meter	10 meter
6.	Height of Rx receiving antenna (h2)	1.5 meter	1.5 meter	1.5 meter
7.	Transmitter attenuation (LRX)	1 dB	1 dB	1 dB

RSL calculations are carried out in 2 different conditions, namely Light Of Sight (LOS) conditions at a distance of 1 kilometer, 1.5 kilometers, 2 kilometers, 2.5 kilometers, 3 kilometers. This condition is a direct free space path without any obstacles from the transmitter to the receiver. Meanwhile, in the second condition, the room is partitioned and the height of the area is different, so that it becomes an obstacle which will affect the strength of the signal received.

A. LOS (Line Of Sight) Condition

In LOS conditions, the propagation path is in free space and is measured at distances of 1 km, 1.5 km, 2 km, 2.5 km, 3 km. So the equation used is the FSL (Free Space Loss) formula.

FSL (dB) = 20 log (d) + 20 log (f) + 32.5

Where:

f = Working frequency (MHz)

d = Length of propagation path (Km)

Calculation of RSL at a distance, d = 1 kilometer

Known: d = 1 Km

f = 107.7 MHz

FSL (dB) = 20 log d (Km) + 20 log f (MHz) + 32.5

= 20 log 1 + 20 log 107.7 MHz + 32.5

= 0 + 40.64 + 32.5 = 73.14 dB

EIRP = PTX + GTX + LTX

= 44.71 dBm + 1 dBi – 1 dB

= 44.71 dBm

RSL = EIRP– Lpropagation + GRX – LRX

= 44.71 dBm – 73.14 dB + 1 dBi – 1 dB = -28.43 dBm

B. NLOS (Non-Line-of-Sight) Condition

In this condition there are partitions as obstacles in the room. The presence of this obstacle causes the signal level to weaken because the propagation path is Non-Line-of-Sight. RSL measurements will be carried out for NLOS conditions at the distance below using the following propagation equation:

L Propagation = 69.55 + 26.16 Log f – 13.82 Log h1 – a(h2) + (44.9 – 6.55 Log h1) Log d a(h2) = (1.1 Log f – 0.7)h2 – (1.56 Log f –0.8)

Where :

F = Working frequency of Community Radio (MHz)

h1 = Tx Antenna Height (m) h2 = Rx Antenna Height (m)

a(h2) = Antenna Height-Gain correction factor (dB)

d = Distance between Community Radio and Receiver (Km)

Calculation of RSL at a distance, d = 1 kilometer

Lpropagation = 69.55 + 26.16 Log f –13.82 Log h1 – a(h2) + (44.9 – 6.55 Log h1) Log d
= 69.55+53.16-6.55-a(h2)+(44.9-5.09)0
= 122.74-a(h2)
a(h2) = (1.1 Log f – 0.7)h2 – (1.56 Log f +0.8)
= 2.95- 3.96 = -1.51
Lpropagation = 122.74-a(h2)
= 122.74-(-1.51) = 124.25 dB
EIRP = 47.27 dBm
RSL = EIRP – Lpropagation + GRX - LRX
= 47.27 dBm – 124.25 dB + 1 dBi – 1 dB = -76.97 dBm

C. Comparison Results of Simulation and RSL Calculations

Once the RSL results using the mobile radio application are known, they will then be compared with the results of mathematical calculations. The results of the comparison data are as follows:

Table 4. Comparison results of RSL Suara 17 towards Dais

No.	Distance (km)	RSL Radio Mobile simulation results (dBm)	Results of Formula Theory (dBm)	Data Difference (dBm)
1.	1	-57.3	-85.8143	-28.51431407
2.	1.5	-65.8	-89.3361	-23.53613925
3.	2	-65.8	-91.8349	-26.03491398
4.	2.5	-64.4	-93.7731	-29.37311424
5.	3	-67.8	-95.3567	-27.55673916
6.	3.5	-74.1	-96.6957	-22.59567495
7.	4	-73.7	-97.8555	-24.15551389
8.	4.5	-74.1	-98.8786	-24.77856434
9.	5	-77.1	-99.7937	-22.69371415
10.	5.5	-80.1	-100.622	-20.52156786
11.	6	-81.7	-101.377	-19.67733907
12.	6.5	-84.8	-102.073	-17.2725812
13.	6.71	-86.1	-102.349	-16.24876447

There are differences between simulations using the Mobile Radio application and calculations using formula equations. In the simulation, the closest distance is 1 kilometer, the measurement results show that the average signal strength / RSL is -57.3 dBm, whereas if you use the calculation formula, the closest distance RSL is -85.8 dBm. The difference between the two is -28.5 dBm. At this distance, the conditions for the propagation path are free and there are no obstacles. Meanwhile, at the farthest distance, namely 6.71 kilometers, the simulation results using the Mobile Radio application show an average result of -86.1 dBm, while from the formula calculation results it is - 102.3 dBm or there is a difference of -16.2 dBm.

D. Analysis of Simulation Results with Mobile Radio

From the simulation results with Mobile Radio that Suara 17 Community Radio, Dais Community Radio, and MBS Radio are at a distance of 1 kilometer, the RSL obtained is the best result because it is the closest distance to the Community Radio Transmitting Station. Apart from the distance, there are also no obstacles that hinder signal propagation. At this distance the average RSL is:

Table 5. Analysis of Distance and RSL simulation results with Mobile Radio

No.	Community Radio Transmitter		Closest Distance		Farthest Distance	
	From	Far End	Distance (km)	RSL (dBm)	Distance (km)	RSL (dBm)
1.	Suara 17	Dais	1	-57.3	6.71	-86.1
		MBS	1	-55.1	7.2	-71.8
2.	Dais	Suara 17	1	-43.1	6.71	-85.1
		MBS	1	-38.1	11.81	-76.7
3.	MBS	Suara 17	1	-26.3	7.2	-63
		Dais	1	-26.2	11.81	-65.5

Based on Table 5, the closest distance to the largest RSL for MBS Community Radio in the direction of Dais Community Radio is -26.2 dBm. And the lowest signal level at the furthest distance from Suara 17 Community Radio towards Dais Community Radio was -86.1 dBm. The signal level is low because there is an obstacle in the form of a hill.

E. Analysis of Calculation Results using Formula Theory

In RSL calculations, the equations used are differentiated based on the way the waves propagate in the transmission line. The first method is during Free Space Loss, a condition where radio waves propagate in free space so that there are no obstructions in the transmission channel. This method is carried out at the closest distance of 1 kilometer where the RSL is -85.81 dBm to the farthest distance of 11.81 meters with an RSL value of - 103.32 dBm as shown in Table 6.

Table 6. Analysis of Distance and RSL simulation results with Formula Theory

No.	Community Radio Transmitter		Closest Distance		Farthest Distance	
	From	Far End	Distance (km)	RSL (dBm)	Distance (km)	RSL (dBm)
1.	Suara 17	Dais	1	-85.81	6.71	-103.31
		MBS	1	-85.81	7.2	-102.34
2.	Dais	Suara 17	1	-85.83	6.71	-100.64
		MBS	1	-85.83	11.81	-107.28
3.	MBS	Suara 17	1	-85.82	7.2	-102.97
		Dais	1	-85.82	11.81	-103.32

IV. CONCLUSION

Research on Radio Community Establishment Opportunity Analysis in Central Java Using Mobile Radio Simulator was carried out in 3 (three) regions with radio references of existing communities that directly border with Semarang City area namely Semarang District, Demak, and Kendal. As for the data obtained from the Directorate of Operations Generated by SDPPI, the Ministry of Communications and Informatics, the number of community radio that already have a Radio Station License (ISR) to date is 8 (eight) community radio in 3 (three) regions. Technical parameters on the existing community radio are the minimum power consumption of 20watt, the maximum power of 50 watt, and the most power use of 30 watt. Where for losses of 1 dB and gains of 1.5 dBi, each transmitter with a maximum antenna height of 20 meters. The coverage of the community radio service area results from the analysis of each district in Semarang City, the nearest 0.86 km south of Candisari district and the most distant 15.9 km north of Gunungpati district. Based on the results of the analysis and discussions that have been carried out in this study, the possibility for establishment of community radio in Semarang City based on the pattern of reuse of the channel and the coordinate point of the location of the transmitter is Candisari district with coverage area of 0.86 km south and west of the direction of the emitter location. In this phase, two activities are carried out: measurement and testing. As for the measurement of the height of the location, the distance point to point, and point to multipoint, while the testing is done against the location where the contour of the ground is uneven due to the characteristics of the mountainous region of Semarang. On the measurement of the service area of community radio establishment in each district based on technical parameters on the radio database exists with transmitter power Tx 30 watt, Loss 1 dB, Gain 1,5 dBi, and the height of the antenna 10 meters. Where the size of the strong field/ power in the area of service area applied according to the Ministry of Communications and Informatics Regulation No. 3 Year 2017 of 66 dB V/m at a maximum distance of 2.5 km.

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