Analysis of FM Broadcast Radio Signal Reception in Border Areas Using Several Antenna Models

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ABSTRACT
Information is now a basic need for every people, including the people in border areas. Therefore, it is an obligation for the government to provide information media that can be reached by all levels of society, one of which is FM radio broadcast media. This research aims to identify and assess the quality of FM radio broadcasts in the border area of Sambas Regency using several antenna models which in the area is a vulnerable area of signal leakage by neighbouring countries and far from Indonesian broadcast transmitters. The assessment of FM radio broadcast quality is carried out with the determination of SINPO (Signal, Interference, Noise, Propagation, Overall) values and field strength meter measurements. The data obtained were analysed using the Miles and Hubberman interactive data processing technique. From the research conducted, it was found that 10 Malaysian FM radio broadcast channels and 2 broadcast channels from Indonesia where the dominant broadcast was received better by the yagi antenna. There were also broadcasts whose frequencies fell out of compliance with the regulations.

1. INTRODUCTION
The world's increasingly advanced technological development has made information a basic need for society and has become an important commodity in social life in all countries. Border communities are no exception. They also have the right to obtain information as people in the city centre do.¹²
Regional isolation is one of the obstacles in providing infrastructure, so that information dissemination programmes to rural areas, inland areas, remote islands and border areas cannot be implemented properly. The large number of areas in Indonesia that have geographical barriers and limited government funding, in addition to the fact that there are still people who have not been able to enjoy the flow of information, the information distribution programme has been slow.³
In the context of information dissemination and equalisation in West Kalimantan, the government has made innovations for the development of land border areas with Malaysia whose conditions are still isolated. One of the land border areas between West Kalimantan (Indonesia) and Sarawak (Malaysia) is in Sambas Regency. Therefore, this research was conducted in order to find out more about the quality of FM radio reception using several antenna models at various points, especially near the border area of Sambas Regency.⁴⁵

2. LITERATURE REVIEW
The FM radio frequency planning in Indonesia, which is contained in the Radio Frequency Master Plan, is stipulated in the Regulation of the Minister of Communication and Informatics No. 3/2017 on "Radio Frequency Master Plan for the Purpose of Frequency Modulation Radio Broadcast". The Master Plan maps FM radio frequency channels in the service area, which includes the government administrative areas of provincial capitals, cities, district capitals and sub-districts. At this time, the government has also anticipated the expansion of government administrative areas, either in the form of district expansion or sub-district expansion, which has not been synchronised.⁶⁷
The use of FM radio broadcast frequencies currently works in the 87.5-108 MHz frequency band with a space between channels of 100 kHz (0.01 MHz). [1] The minimum distance between channels that can be used by radio stations, in one service area (which is generally a city or regency) is 800 kHz (0.08 MHz), except in big cities such as Jakarta, Bandung, Surabaya, Semarang, and Medan which only have a distance of 400 kHz. FM radio broadcasting is regulated by categorising transmitting power, effective antenna height and coverage radius into several classes including A, B, C and D. [8][9]
The division of licences for the use of frequency spectrum in Indonesia has been regulated in the Decree of the Minister of Communications Number: KM. 15 Year 2003 on the Master Plan of Radio Frequency for Telecommunication Special for the Purpose of Radio Broadcast Fm (Frequency Modulation), so that each broadcasting must be carried out in accordance with these provisions. But sometimes in broadcasting there are some things that happen that are not in accordance with the desired usually caused by disturbances.[10][11]

Disturbances in FM (Frequency Modulation) broadcasts can be caused by various factors and can affect the quality and clarity of the signal received by the listener. Some common interference such as interference. Interference can occur for many reasons. The following are some of the common interference models in FM broadcasting: Intermodulation, Desensitisation, Co-Channel Interference, Interference from digital signals. There is also interference in the form of noise and fading. One way to describe the value of the quality of a signal is to use the SINPO determination.[12][13][14]

3. METHODS
3.1. Place and Time of Research
The author conducted research used to compile this final project/thesis in the Sajingan Besar District, Sambas Regency. This research was conducted between December 2022 and March 2023.

3.2. Object of Research
The object of this research is the FM broadcast received by the radio receiver. The things that should be considered from the broadcasts received are:
1. Conformity between the identity and value of the frequency occupied according to the applicable regulations.
2. The quality of radio broadcast reception using SINPO provisions at each measurement point.
3. The field strength value of radio broadcasts measured using a field strength meter at each measurement point.

3.3. Equipment required
The equipment required consists of:
1. Map of the region or area where the measurement will be made.
2. Fill-in form
3. The equipment used consists of:
   a. FM radio receiver + Field Strength Meter + J-Pole, Dipole, and Yagi antennas + 50 Ohm 1 metre feeder cable.
   b. Smartphone installed with google earth software and camera.

3.4. Procedure for Measuring FM Radio Broadcasts
1. Preparation
   a. Determine the measurement location using an area map. Measurement locations are selected according to the needs, or those that can represent an area. The more locations the better, but it takes longer.
   b. Prepare all equipment, both tools and measuring instruments. Measuring instruments should be tried beforehand to see if there is any interference or damage. There may be equipment that needs to be calibrated.
2. Location data collection
   Choose a measurement site in a location where there are residential areas and electricity is available:
   a. Record the place name, street, village, sub-district of the measurement location.
   b. Record the date and time of measurement, geographical location (coordinates), location altitude.
3. Measurement of Radio Broadcast Receivability (FM)
The steps taken to measure the receiving power of FM radio broadcasts are:
   a. Prepare the radio receiver and Field Strength Meter.
   b. Arrange the antenna to connect to the measuring instrument.
   c. Set the frequency to be measured.
   d. Aim the antenna so that maximum signal reception is obtained,
   e. Record the measurement results on the form paper provided.
   f. Connect the antenna to the FM radio input. Analyse the signal output using the SINPO analysis method.
   g. Record the measurement results on the form paper provided.
   h. For other frequency measurements, follow the sequence of steps 3b to 3g.
Repeat the steps from the beginning for measurements using other antennas.

4. Identity recording and measurement of FM radio reception quality and coverage:
   a. Set the radio receiver on the frequency being measured, listen to the broadcast content to identify the broadcasting station being monitored.
   b. Record the broadcasting station name and SINPO quality value of the measured and monitored radio broadcast.
   c. It is very important to record the identity to ensure that what is being measured is from the radio station in question and not from another radio station.

3.5. Data Analysis Method

Qualitative data were analysed following the model developed by Miles and Huberman (1984), known as the interaction model. In full, the model is shown in Figure 1.

![Interactive Model Analysis](image)

Figure 1. Interactive Model Analysis

The data is grouped systematically, then analysed and then presented in the form of tables, pictures and meaningful narratives. If the presentation of the data is felt to still have irregularities, it is immediately reduced and or triangulated to confirm data from one source with other sources so that the data obtained becomes valid.\[15\]

4. RESULTS AND DISCUSSION

4.1. Findings on FM Broadcast Radio

<table>
<thead>
<tr>
<th>Name</th>
<th>Frequency</th>
<th>Power</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasional FM</td>
<td>88.1 MHz</td>
<td>1kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
<tr>
<td>Sarawak FM</td>
<td>88.9 MHz</td>
<td>1kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
<tr>
<td>Traxx FM</td>
<td>89.9 MHz</td>
<td>1kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
<tr>
<td>Ai FM</td>
<td>90.7 MHz</td>
<td>1kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
<tr>
<td>Red FM</td>
<td>91.9 MHz</td>
<td>1kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
<tr>
<td>Radio Klasik</td>
<td>92.9 MHz</td>
<td>1kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
<tr>
<td>Hot FM</td>
<td>94.3 MHz</td>
<td>2kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
<tr>
<td>CATS FM</td>
<td>99.3 MHz</td>
<td>1kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
<tr>
<td>Wai FM</td>
<td>101.3 MHz</td>
<td>1kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
<tr>
<td>Sada FM</td>
<td>106.1 MHz</td>
<td>1kW</td>
<td>Lat. 01°35'05&quot;N, Long. 110°11'22&quot;E</td>
</tr>
</tbody>
</table>

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*(Amru Hisyam Al Muflihin)*
4.2. Analysis of Indonesia FM Radio Broadcast Class Permit

In Appendix IV of the Decree of the Minister of Communications Number: KM. 15 Year 2003, Frequency Channel Mapping (Allotment) of Frequency Modulated (FM) Radio Broadcast XVII. West Kalimantan Province No.6 Part B, it can be seen that the frequency 97.7MHz with Channel 102 of RRI Sambas is classified as radio broadcast class C, therefore in accordance with the Indonesian Spectrum Policy and Planning 2010, the maximum ERP that can be transmitted by RRI Pro Sambas is 4kW with a service area of 12 km from the city centre. If we go back to the data results, we know that the ERP of RRI Sambas is at a value of 2.5kW which is certainly below the maximum value. And also the field strength measurement whose distance is closest to 12 km is at point 10 in Tambatan Village, Kec. Tlk. Keramat with a distance of 10.44 km from the transmitter, the highest field strength value is at 38.4dBμV/m. This value is already below the maximum allowed value of 66dBμV/m. We can also see at point 8 in Tri Kembang Village, Kec. Galing. with a distance of 13.31 km the highest field strength value is at 36.9 dBμV / m and begins to decrease relatively with increasing distance between the receiver and the transmitter. And we can also see at point 1 of the border area. The highest RRI Sambas field strength value falls at a value of 16.9dBμV/m which reviews from ITU-R BS.592 Table 2 the maximum value for an FM radio broadcast at the border of the country must be below 34 dBμV/m. So it is clear here that RRI Sambas broadcast has followed the existing provisions.

The ERP value of Relay RRI Pro 3 Pontianak broadcast with Class C broadcast licence is below the maximum value of 1.2 kW. Therefore, the ERP value of Relay RRI Pro 3 Pontianak is in accordance with the provisions. However, according to the master plan stipulated by the Minister of Transportation Decree No. Km 15 of 2003, the FM broadcast of RRI Pro 3 Pontianak Relay Singkawang should be on channel 70 of 94.5 MHz frequency. However, during the research it was found that the FM broadcast of RRI Pro 3 Pontianak Relay Singkawang was more dominant on channel 71 of 94.6 MHz frequency, shifting 1 channel.

4.3. Handling and Follow-up Procedures for Interference

Based on observations made in the field, there are several locations where FM radio broadcasts are received by Indonesia FM broadcasters, experiencing interference so that the sound quality is disturbed. Some of the locations that experienced interference include:

1. St. Lintas Kalimantan Poros Utara, Sijang, Kec. Galing 1°34′19.96"N 109°25′59.79"E.
   a. Frequency 94.5 MHz on dipole, j-pole, and yagi antennas, the cause of interference is poor signal reception. This is because the signal from the transmitter is blocked by hills or buildings, a distance that is too far makes the reception of signal strength less good. This is shown based on the observation and measurement results from SINPO which shows a value of 2.
   b. Frequency 97.7 MHz on dipole and j-pole antennas, the cause of interference is poor signal reception. This is because the signal from the transmitter is blocked by hills or buildings, a long distance makes the reception of signal strength less good. Signal reception starts to improve when using a yagi antenna. This is shown based on the results of observations and measurements from SINPO which shows a value of 2.

2. St. Lintas Kalimantan Poros Utara, Sijang, Kec. Galing 1°33′46.30"N 109°24′6.18"E.
   Frequency 94.6 MHz, the centre frequency of the broadcast is not in accordance with the regulations in force, where the FM radio broadcast obtained is an FM radio broadcast owned by Indonesia. This is based on observations and measurements from SINPO and field strength meter which show better signal quality when measured at 94.6 MHz frequency.

3. St. Linkar, Galing, Kec. Galing. 1°31′47.46"N 109°21′25.68"E.
   Frequency 94.6 MHz on dipole and j-pole antennas, the cause of interference is not very good signal reception (medium) and large propagation, this is because the signal from the transmitter is blocked by hills or buildings that block the signal from the transmitting antenna to the radio so as to produce sound quality is not very good. This is shown based on the results of observations and measurements from SINPO which shows a value of 2. And also the centre frequency of the broadcast is not in accordance with the regulations in force. This is based on observations and measurements from SINPO and field strength meters which show better signal quality when measured at a frequency of 94.6 MHz.

Table 2. Recap of Findings on Indonesia’s Use of FM Broadcast Frequency in Sambas Border Area

<table>
<thead>
<tr>
<th>Name</th>
<th>Frequency</th>
<th>Power</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>RRI Pro 3 Pontianak Relay</td>
<td>94.5</td>
<td>1kW</td>
<td>Lat. 00°53′28&quot;N, Long. 108°58′25&quot;E</td>
</tr>
<tr>
<td>(Kelas C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RRI Sambas (Kelas C)</td>
<td>97.7</td>
<td>2.5kW</td>
<td>Lat. 1°21′22.39&quot;N Long. 109°17′40.51&quot;E</td>
</tr>
</tbody>
</table>

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(At Rehman Amrul Hisyam Al Muflihin)
4. St. Lintas Kalimantan Poros Utara, Tri Kembang, Kec. Galing 1°28'23.34 "N 109°17'52.67 "E.
   a. Frequency 94.6 MHz on dipole, j-pole and yagi antennas, the cause of interference is not very good
      signal reception (medium) and large propagation, this is because the signal from the transmitter is
      blocked by hills or buildings that block the signal from the transmitting antenna to the radio so as to
      produce sound quality is not very good. This is shown based on the results of observations and
      measurements from SINPO which shows a value of 2. And also the centre frequency of the broadcast
      is not in accordance with the regulations in force. This is based on observations and measurements
      from SINPO and the field strength meter which show better signal quality when measured at 94.6
      MHz.

      At a frequency of 94.5MHz RRI Pro 3 Pontianak Relay Singkawang BALMON can issue a warning letter
      to the FM broadcast transmitter RRI Pro 3 Pontianak Relay Singkawang whose centre point falls at a frequency
      that should not be/frequency offset.

      What needs to get attention from the government of both parties between BALMON and RRI, especially
      RRI Sambas to strengthen or improve the quality of FM radio broadcast reception. The technical that can be
      done by establishing / increasing the height of the FM Transmitter station antenna close to the border line with
      the transmitting gain that needs to be adjusted to the frequency band to reach the border area to review
      the coverage that must be reached quite widely.

      In accordance with the mutual agreement, the Malaysian side can reduce the transmitter gain (limiting
      the power of the transmitter and the height of the transmitter tower) in the border area reviewing the many
      Malaysian FM broadcast frequencies that enter the Indonesian territory. Reducing or weakening the signal
      coming out of the transmitter so that the sideband does not clash with adjacent channels, but the consequence
      of this action is that the transmitting power of the station concerned becomes weak. To overcome this, the
      authorities should place each frequency channel at a considerable distance. Frequency channels should not be
      placed close together. Some of the ways this can be done are

      a. Adjusting the angle of the antenna (inclination of the antenna) so that the coverage area does not cross
         into neighbouring countries.

      b. Using directional antennas and lowering the transmitter power at night.

5. CONCLUSION

   From the results of the calculation analysis and assessment of the quality of FM radio reception in the
   border area of West Kalimantan, precisely in the Aruk Border area, Sambas Regency, it can be concluded that
   There are 10 Malaysian FM broadcasts and 2 channels for Indonesian FM broadcasts. And of the twelve
   measurement points, there are four points where the Indonesian FM radio broadcasts have interference. The
   interference found at these points is frequency offset. In addition, the quality of reception is very weak. This
   can be seen from the strength, noise, and propagation values due to the long distance between the reception
   location and the transmitter. The steps that can be taken to overcome this are by adding repeaters in the area.
   To reduce the received interference, it is possible to use a yagi antenna, which as the measurement results at
   the twelve points show reception with predominantly better quality than other antennas.

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