



Noise Level Analysis Using Noise Modeling Method on the Railway Line of Saugnaga Village, Ogan Komering Ulu Regency

Lindawati^{1*}

Universitas Baturaja,
Indonesia

Muhammad Rizka

Fadli Wibowo²

Universitas Baturaja,
Indonesia

Balqis Fataya Said³

Universitas Sriwijaya,
Indonesia

***Corresponding author:**

Lindawati, Universitas Baturaja,
Indonesia. ✉ lindaunbara@gmail.com

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Abstract

Background: Railway transportation plays an important role in supporting passenger mobility and the distribution of goods. However, railway operations can generate environmental noise, particularly in residential areas located near railway tracks. Excessive noise exposure may disturb residents' comfort and daily activities.

Objective: This study aims to analyze railway noise levels, identify the spatial distribution of noise using noise modeling, and describe residents' perceptions of railway noise in Saung Naga Village, Baturaja Barat District, Ogan Komering Ulu Regency.

Methods: Noise measurements were conducted at three locations and at three distances 5, 10, and 15 m from the railway track. Measurements were performed using a sound level meter (SLM) during daytime (06:00–22:00 *WIB*) and nighttime (22:00–06:00 *WIB*) periods. The measurement data were processed to determine equivalent continuous sound levels, including *L_s*, *L_m*, and *L_{sm}*. Noise distribution was modeled using *Surfer* and *Google Earth Pro*. In addition, interviews were conducted with 30 residents living near the railway track.

Results: The 24-hour equivalent continuous sound levels (*L_{sm}*) ranged from 65.92 to 87.29 dBA. All nine measurement points exceeded the 55 dBA noise standard for residential areas. The highest *L_{sm}* value was recorded at Location 2 at a distance of 5 m, reaching 87.29 dBA, whereas the lowest value was recorded at Location 2 at a distance of 15 m, reaching 65.92 dBA. The interview results indicated that residents perceived the railway noise as high and reported disturbances related to sleep, concentration, and comfort.

Conclusion: Railway noise in Saung Naga Village exceeds the applicable residential noise standard and is perceived as a significant environmental disturbance by nearby residents. Increasing the number of measurement points, conducting periodic noise monitoring, and evaluating the feasibility of installing noise barriers are recommended as mitigation measures.

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INTRODUCTION

Trains are one of the modes of transportation that play an important role in supporting community mobility and the distribution of goods. Their ability to transport large numbers of passengers and goods makes trains an efficient means of transportation. In addition to providing benefits for mobility and economic activities, the presence of a railway network adjacent to residential areas can also cause environmental impacts, one of which is noise. Transportation noise, including noise generated by trains, is one of the sources of environmental noise that requires attention because it can affect people's comfort and quality of life (World Health

Organization ([Minkin et al., 2025](#); [Organization, 2018](#)) .

In Ogan Komering Ulu Regency, particularly in Saung Naga Village, West Baturaja District, railway lines and stations are located relatively close to residential areas. This condition means that daily train operations have the potential to expose residents living near the railway line to noise. Noise generated by trains can originate from various sources, including engines or locomotives, friction between wheels and rails, braking systems, horns, and other operational activities. Noise characteristics can vary depending on the type of train, travel speed, railway conditions, train frequency, and the distance between the noise source and the receiver.

Noise is an unwanted sound that can interfere with human activities. Repeated exposure to environmental noise can cause discomfort, annoyance, sleep disturbances, difficulty concentrating, and various other health impacts. WHO identifies transportation noise as one of the environmental factors that can affect human health and well-being. WHO guidelines indicate that environmental noise is associated with a variety of health impacts, including sleep disturbances, cognitive impairment, cardiovascular and metabolic disorders, and decreased quality of life ([Minkin et al., 2025](#); [Organization, 2018](#); [Shiotani et al., 2023](#)) . WHO also specifically identifies railway noise as a source of transportation noise that requires control because high levels of exposure can adversely affect the health of people living near railway lines ([Minkin et al., 2025](#); [Organization, 2018](#)).

Train noise is not only related to the measured sound pressure level but also to the responses of exposed populations. Research on residential environments around railway lines has shown that noise and vibration can be associated with residents' dissatisfaction and annoyance. [Maljaee et al. \(2024\)](#) , for example, found that exposure to noise and vibration from railway activities was associated with dissatisfaction among residents living around railway lines. Other research has also shown that exposure to train noise and vibration can affect noise annoyance and interfere with the daily activities of people living around railway lines.

In the Indonesian context, environmental noise control has been regulated through the Decree of the Minister of State for the Environment Number KEP-48/MENLH/11/1996 concerning Noise Level Standards. Based on these provisions, the noise level standard for residential and settlement areas is 55 dB(A). Meanwhile, railway stations are included in the category of special areas, with a standard of 60 dB(A), as specified in Annex I of the decree. This provision serves as one of the bases for evaluating whether the noise level received by communities in residential areas remains within the established limit.

Direct noise level measurements can be performed using a Sound Level Meter (SLM), an instrument used to quantitatively measure sound pressure levels. [Jamaludin et al. \(2014\)](#) and [Widyastuti & Hidayat \(2024\)](#) designed and tested an SLM as a sound intensity measurement instrument and demonstrated that the instrument could be used to quantitatively measure sound intensity levels. The use of an SLM is also consistent with the environmental noise measurement method specified in the Decree of the Minister of State for the Environment Number KEP-48/MENLH/11/1996. Under these provisions, measurements can be performed using a sound level meter by recording sound pressure levels in dB(A) at specified time intervals ([Indonesia, 1996](#); [Jamaludin et al., 2014](#); [Widyastuti & Hidayat, 2024](#)).

Noise measurements at multiple observation points can provide information about variations in noise levels with distance from the sound source. In general, the closer a location is to the noise source, the greater the potential exposure, although the actual noise level is also influenced by environmental conditions, the characteristics of the sound source, physical barriers, and sound propagation conditions. Therefore, measurements at several distances from the railway line are important for determining the characteristics of changes in the noise levels received by the community.

In addition to direct measurements, noise mapping can be used to describe the spatial distribution of noise levels. The noise mapping approach allows measurement results from multiple observation points to be visualized, making it possible to identify noise distribution patterns within an area. Research on noise mapping in residential areas around railway tracks has also shown that measurements using SLMs combined with spatial mapping can be used to identify areas with the potential to experience noise exposure levels exceeding environmental quality standards. This approach can help identify locations that require attention and inform noise

control strategies (Fitriani et al., 2025).

Noise mapping becomes increasingly important when railway lines are located near residential areas with relatively high population densities. Spatial information not only shows the noise level at a given point but can also provide an overview of noise dispersion patterns based on distance and the characteristics of the surrounding environment. Thus, combining field measurements with spatial modeling can provide more comprehensive information than measurements taken at a single observation point.

Saung Naga Village, West Baturaja District, Ogan Komering Ulu Regency, is one of the areas where residential settlements are adjacent to a railway line. Regular train operations have the potential to expose people living near the tracks to repeated noise. This condition is important to study because the distance between residential buildings and the railway line is relatively short; therefore, the level of noise exposure experienced by the community needs to be determined empirically.

Although research on railway noise has been conducted in various regions, studies that specifically combine noise measurements at several distances from railway tracks, calculations of daytime and nighttime noise levels, spatial modeling, and community perceptions in the residential area of Saung Naga Village remain limited. This research is expected to provide an empirical description of the noise levels generated by railway activities and to illustrate their spatial distribution patterns in residential areas.

Based on this background, this study aims to: (1) measure noise levels generated by railway activities at three locations at distances of 5, 10, and 15 meters from the railway track; (2) calculate daytime (Ls), nighttime (Lm), and 24-hour (Lsm) noise levels; (3) model noise distribution patterns using Surfer and Google Earth Pro software; and (4) determine the public's perception of noise generated by train activities.

METHOD

Primary data were obtained directly from the research objects through field observations and interviews. Field observations were conducted directly at the research site to obtain accurate information and measurements related to noise levels generated by train activities. Observations involved measuring the research object using appropriate measurement instruments and recording the conditions observed at the study site.

Interviews were conducted through direct conversations between the researchers and members of the community living around the railway tracks. The interviews were conducted to obtain information regarding the community's perceptions of and experiences with train noise. The interview data were used to complement and support the results of the noise measurements. Through direct interviews, the researchers obtained firsthand information from local residents regarding the effects of train noise on their daily lives.

Secondary data for the preparation of this thesis were obtained through a literature review. The literature review involved referring to various relevant scientific journals, books, articles, and other sources. These sources were used to provide a theoretical foundation and support the analysis and discussion of the research findings.

The data analysis process in this study began with measurements of train noise using a Sound Level Meter (SLM). Measurements were conducted at three different distances from the railway track, namely 5 meters, 10 meters, and 15 meters, to obtain data on variations in noise levels at different distances from the noise source. After the measurement stage was completed, interviews were conducted with residents of Saung Naga Village, West Baturaja District. The interviews were conducted to explore the community's perceptions of train noise and its effects on their daily lives.

The collected noise measurement data were then processed using Microsoft Excel. After the data processing was completed, the results were analyzed and visualized using Surfer software to illustrate the spatial distribution of noise levels in the study area. The resulting noise distribution model was used as a basis for identifying patterns of noise dispersion and assessing the potential disturbance caused by train activities in the surrounding residential area.

This study was conducted in Saung Naga Village, West Baturaja District, Ogan Komering Ulu Regency, South Sumatra. The study was conducted at three observation locations along the

railway line: Location 1 at Sta. 277+560, Location 2 at Sta. 277+560, and Location 3 at Sta. 277+150. These locations were selected because they represented areas where residential settlements were located relatively close to an active railway line and were therefore relevant for studying noise levels generated by train activities.

The study area was crossed by an active railway line connecting various cities in South Sumatra and was subject to regular train operations for both passenger and freight transportation. These characteristics made the area relevant for examining noise exposure associated with railway activities and its distribution in the surrounding residential environment.

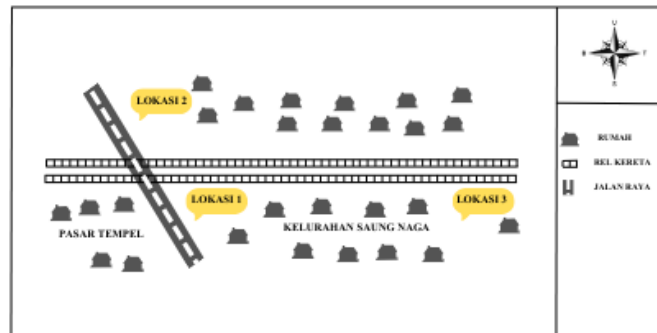


Figure 1. Research Location

RESULTS AND DISCUSSION

Overview of PT. FOOD

Baturaja Station is one of the important transportation nodes in South Sumatra. Since the beginning of the 20th century, its existence has supported the development of the railway network in Indonesia. Under the management of Regional Division IV Tanjungkarang, the station serves passenger travel between cities as well as freight transportation, making its role directly relevant to the lives of the local community and the industrial sector. For mobility needs, Baturaja Station provides the main route to Palembang through Kertapati Station and to Lampung through Tanjungkarang Station. The Rajabasa and Kuala Stabas trains are daily transportation options for residents, with travel times of approximately five to six hours and relatively affordable fares. The availability of these services makes rail transportation an efficient and economical mode of transportation for people in Baturaja and its surrounding areas.

In addition, the station plays an important role in supporting energy distribution through the Babaranjang line. This line is used to transport coal from the Bukit Asam mine in Tanjung Enim to the Port of Tarahan in Lampung. The large volume of coal transported makes Baturaja a vital node in the energy logistics chain and contributes significantly to the regional and national economy. The facilities at Baturaja Station are adequate to support these activities. The station has four active tracks and three platforms that support passenger boarding as well as loading and unloading activities. Since its opening in 1923, the station has continued to develop into a regional transportation and logistics hub. Through the combination of passenger services and freight transportation, railway operations in Baturaja not only facilitate people's mobility but also strengthen the strategic role of the region within the South Sumatra railway network.

Data collection

Noise-level measurements were conducted in Saung Naga Village, West Baturaja District, Ogan Komering Ulu Regency, on Friday, December 5, 2025, through Saturday, December 6, 2025. Noise measurements were conducted at three locations, with three measurement points at each location, at distances of 5, 10, and 15 m from the noise source. The measurements produced noise-level data that were subsequently used to create noise-distribution patterns using Surfer software.

Data Collection Results

Noise Measurement Methods

The measurements in this study were conducted using a sound level meter mounted on a

tripod 50 cm above the ground. Noise data were collected during two periods: daytime, represented by (L_S), from 06:00 WIB to 22:00 WIB, and nighttime, represented by (L_M), from 22:00 WIB to 06:00 WIB. Each measurement lasted 10 minutes at each measurement point, with readings taken every 5 seconds. Measurements were conducted at predetermined observation times representing the daytime and nighttime intervals. From each measurement period, seven sets of measurement results were obtained for each point. Because there were nine measurement points across three locations, the data collection produced a total of 63 sets of measurement results. All of these data were used as the basis for describing the noise-distribution pattern at the research site.

Noise Measurement Results

Location Noise Data 1 Distance 5 M

An example of the (L₁) data calculation at Location 1, 5 m from the railway track, is presented below. Measurements were taken every 5 seconds for 10 minutes at 08:00 WIB, representing the period from 06:00 to 09:00 WIB.

1 Minute Calculation

Leq (1 minute leq formula) = $10 \log_{10} [1/60 (10^{0.1L_1} + 10^{0.1L_2} + \dots + 10^{0.1L_{12}}) + 5]$ dB

Leq (1 minute) = $10 \log_{10} [1/60 (10^{0.1 \times 78.2} + 10^{0.1 \times 78.3} + 10^{0.1 \times 76.7} + 10^{0.1 \times 71.4} + 10^{0.1 \times 77.3} + 10^{0.1 \times 86.6} + 10^{0.1 \times 80.3} + 10^{0.1 \times 73.3} + 10^{0.1 \times 78.8} + 10^{0.1 \times 79.9} + 10^{0.1 \times 77.3} + 10^{0.1 \times 70.6}) + 5] = 79.49$ dB

10-Minute Calculation

Leq(10 minute leq formula) = $10 \log_{10} [1/10 (10^{0.1L_1} + 10^{0.1L_2} + \dots + 10^{0.1L_{10}})]$ dB

Leq(10 minutes) = $10 \log_{10} [1/10 (10^{0.1 \times 79.49} + 10^{0.1 \times 80.95} + 10^{0.1 \times 76.22} + 10^{0.1 \times 87.30} + 10^{0.1 \times 80.79} + 10^{0.1 \times 74.00} + 10^{0.1 \times 74.60} + 10^{0.1 \times 74.41} + 10^{0.1 \times 73.41} + 10^{0.1 \times 69.53})] = 80.12$ dB

Noise Measurement Data – 5 seconds

Name: Jeksen Arvan

Survey Point: 5 Meters Location 1

Time: L1 Represents 06:00–09:00

Table 1

Measurement Data

Minute to-	1	2	3	4	5	6	7	8	9	10	11	12
1	78,2	78,3	76,7	71,4	77,3	86,6	80,3	72,3	78,8	79,9	77,3	70,6
2	90,6	70,3	72,3	71,6	72,3	74,6	80,2	68,6	73,3	76,6	78,0	72,2
3	73,6	78,8	73,7	79,9	70,6	77,3	68,6	78,7	77,7	76,6	73,3	70,2
4	80,7	82,6	80,3	66,6	70,7	71,7	60,6	82,2	80,3	90,6	96,6	70,2
5	73,3	78,8	77,7	60,2	61,3	73,6	80,2	83,3	60,6	89,6	70,7	72,3
6	73,2	71,1	72,2	67,6	76,6	78,6	72,3	78,6	63,6	68,6	72,3	71,1
7	78,0	73,6	71,1	72,2	77,2	76,6	60,6	67,7	71,1	72,2	72,3	78,8
8	76,6	77,7	68,6	66,6	78,0	70,7	71,7	73,3	68,5	78,7	73,3	60,7
9	62,6	70,2	77,2	68,6	77,2	68,6	60,6	62,2	80,6	63,6	68,6	66,6
10	68,6	73,3	76,6	60,2	66,6	62,3	68,8	60,2	66,6	70,2	60,6	60,6

Based on Table 1, the measured noise levels at a distance of 5 m from the railway track varied considerably during the observation period. The measured values ranged from approximately 60.2 to 96.6 dBA. This variation indicates that the sound level around the railway track was not constant but changed throughout the measurement period. The highest value, 96.6 dBA, was recorded during the 11th 5-second interval of the fourth minute, while several of the lowest values were approximately 60 dBA.

The variation in noise levels may have been caused by changes in train activity and

environmental conditions during the measurement period. When a train passed or certain railway operations occurred, the sound pressure level could increase significantly. Conversely, when there was no dominant railway activity, the noise level could decrease and become more strongly influenced by ambient noise. Thus, the data in Table 1 indicate that areas located only 5 m from the railway track are exposed to relatively high and highly variable noise levels.

The results of these measurements formed the basis for processing the sound-energy data in the next stage. Because decibels are expressed on a logarithmic scale, measurement values cannot be averaged arithmetically to obtain an equivalent noise level. Therefore, the measurement data in Table 1 were further transformed using a logarithmic approach, as shown in Table 2.

Table 2
Li×0.1 value

Minute to-	1	2	3	4	5	6	7	8	9	10	11	12
1	7,82	7,83	7,67	7,14	7,73	8,66	8,03	7,23	7,88	7,99	7,73	7,06
2	9,06	7,03	7,23	7,16	7,23	7,46	8,02	6,86	7,33	7,66	7,80	7,22
3	7,36	7,88	7,37	7,99	7,06	7,73	6,86	7,87	7,77	7,66	7,33	7,02
4	8,07	8,26	8,03	6,66	7,07	7,17	6,06	8,22	8,03	9,06	9,66	7,02
5	7,33	7,88	7,77	6,02	6,13	7,36	8,02	8,33	6,06	8,96	7,07	7,23
6	7,32	7,11	7,22	6,76	7,66	7,86	7,23	7,86	6,36	6,86	7,23	7,11
7	7,80	7,36	7,11	7,22	7,72	7,66	6,06	6,77	7,11	7,22	7,23	7,88
8	7,66	7,77	6,86	6,66	7,80	7,07	7,17	7,33	6,85	7,87	7,33	6,07
9	6,26	7,02	7,72	6,86	7,72	6,86	6,06	6,22	8,06	6,36	6,86	6,66
10	6,86	7,33	7,66	6,02	6,66	6,23	6,88	6,02	6,66	7,02	6,06	6,06

Table 2 shows the transformation of the noise values from Table 1 into the form (0.1L_i). This transformation is part of the calculation of equivalent noise levels because decibel values are logarithmic. The transformed values allow each measurement to be converted into a sound-energy term for subsequent calculation.

The transformed values follow the measurement pattern shown in Table 1. Measurements with higher noise levels produce larger transformed values, whereas measurements with lower noise levels produce smaller values. For example, a noise level of 96.6 dBA produces a transformed value of 9.66, whereas a noise level of 60.2 dBA produces a value of 6.02.

Thus, Table 2 represents the mathematical transformation required to convert field-measurement data into a form that can be used in sound-energy calculations. The transformed values were subsequently used to obtain the Leq value for each observation period, as presented in Table 3.

Table 3
Leq 10 Minutes

Period	Leq 10 Minutes
1 minute	79,4937
2 minutes	80,95
3 minutes	76,22
4 minutes	87,3
5 minutes	80,797
6 minutes	74
7 minutes	74,6
8 minutes	74,41
9 minutes	73,416
10 minutes	69,53

Based on Table 3, the equivalent noise level (L_{eq}) for each 10-minute observation period shows considerable variation. The highest L_{eq} value was recorded during the fourth period, at 87.30 dBA, whereas the lowest value was recorded during the tenth period, at 69.53 dBA. These differences indicate that the noise intensity at the study site changed substantially during the observation period.

The relatively high L_{eq} values recorded during some periods indicate the presence of strong noise sources around the railway tracks. The fourth period, which reached 87.30 dBA, represented the highest exposure and may indicate more dominant railway activity during that period. Conversely, the value of 69.53 dBA in the tenth period represented a relatively lower noise condition compared with the other periods, although it remained relatively high for a residential environment.

These results demonstrate the importance of using L_{eq} to characterize noise conditions more representatively. The L_{eq} value does not merely reflect the highest individual measurement; rather, it represents the equivalent sound-energy level over the observation period. Therefore, the results in Table 3 provide the basis for determining noise levels over longer periods and for subsequently calculating daytime, nighttime, and 24-hour noise levels.

Table 4
Noise Level Calculation Results

Period	$(L_i^{*0,1})$
1 minute	7,94937
2 minutes	8,095
3 minutes	7,622
4 minutes	8,73
5 minutes	8,0797
6 minutes	7,4
7 minutes	7,46
8 minutes	7,441
9 minutes	7,3416
10 minutes	6,953

Table 4 presents the transformation of the L_{eq} values into the form $(0.1L_i)$ as part of the noise-data processing procedure. The results show that periods with higher L_{eq} values also have larger transformed values. The largest transformed value, 8.73, occurred during the fourth period, corresponding to an L_{eq} value of 87.30 dBA in Table 3. The smallest transformed value, 6.953, occurred during the tenth period, corresponding to an L_{eq} value of 69.53 dBA.

The results in Table 4 demonstrate that the data processing is performed in stages to account for the logarithmic nature of decibel units. This stage is important because equivalent noise calculations must consider the energy contribution of the entire measurement period rather than simply calculating the arithmetic mean of the decibel values.

Thus, Table 4 represents the intermediate stage connecting the measured L_{eq} values with the subsequent sound-energy calculations in Table 5. The transformed values are then used to obtain the final equivalent noise level representing the conditions during the observation period.

Table 5
Final Calculation Results

Minute to-	$(10^{\{0,1(L_i)\}})$ DST.	$AB = AA \times 5/60$	LO LOG (AB)
1	1.067.946.931	889.955.577,57	79,4937
2	14.948.565.658	12.457.213.138,2	80,9542
3	502.936.634,7	419.113.862,23	76,2233
4	6.482.626.228	5.402.188.852,4	87,3257
5	1.441.825.981	1.201.521.165,1	80,7973

Minute to-	$(10^{\{0,1(L1)\}})$ DST.	$AB = AA \times 5/60$	LO LOG (AB)
6	303.104.332,1	252.586.694,34	74,0241
7	343.027.489,3	285.856.524,11	74,5615
8	331.353.742,9	276.128.811,91	74,4111
9	263.470.409,4	219.558.567,45	73,4155
10	107.620.432,5	89.683.369,373	69,5271

Table 5 presents the final results of the noise-data processing based on the sound-energy contribution of each measurement period. The results show differences in noise levels between periods, with Leq values ranging from 69.53 to 87.30 dBA. The highest value was obtained during the fourth period, at 87.30 dBA, whereas the lowest value was obtained during the tenth period, at 69.53 dBA.

Based on the complete calculation, the combined 10-minute equivalent noise level for the observation data at this measurement point was approximately 80.11 dBA, which is consistent with the reported value of approximately 80.12 dBA after rounding. This value indicates that the noise condition at the measurement location, 5 m from the railway track, was relatively high. The value is also substantially higher than the 55 dBA environmental noise standard applicable to residential areas and settlements under the study's reference standard.

These results are important because the measurements were conducted in an area adjacent to residential settlements. The high noise level indicates that railway activities have the potential to disturb the comfort of people living near the railway track. This value is subsequently used as one of the components in calculating daytime (Ls), nighttime (Lm), and day-night (Lsm) noise levels.

Thus, Table 5 not only presents the mathematical calculation results but also provides an initial representation of the actual noise exposure at the observation point. These results subsequently serve as the basis for comparing noise levels according to time and distance and for performing spatial modeling using Surfer and Google Earth Pro.

Finish on Excel sheet:

$AB = 1,028,231,487$

$AB = 1,028,231,148.7$

$LO\ LOG\ (AB) = 80.1209$

1. Processing for daytime with a time range of 06.00- 22.00

$L_s = 10 \log 1/16 [(T1 \times 10^{0.1 \times L1} + \dots + T4 \times 10^{0.1 \times L4})] \text{dB}$

$L_s = 10 \log 1/16 [(3 \times 10^{0.1 \times 80.12} + 2 \times 10^{0.1 \times 79.74} + 6 \times 10^{0.1 \times 77.91} + 5 \times 10^{0.1 \times 72.5})] = 78.626 \text{ dB}$

2. Processing for the night with a time range of 22.00-06.00.

$LM = 10 \log 1/8 [(T5 \times 10^{0.1 \times L5} + T6 \times 10^{0.1 \times L6} + T7 \times 10^{0.1 \times L7})] \text{dB}$

$LM = 10 \log 1/8 [(2 \times 10^{0.1 \times 82.33} + 3 \times 10^{0.1 \times 81.63} + 3 \times 10^{0.1 \times 84.64})] = 83.148 \text{ dB}$

3. The last calculation is to determine the total environmental noise (24 hours).

$LSM = 10 \log 1/24 [(16 \times 10^{0.1 \times L_s} + 8 \times 10^{0.1 \times (L_m + 5)})] \text{dB}$

$LSM = 10 \log 1/24 [(16 \times 10^{0.1 \times 78.626} + 8 \times 10^{0.1 \times (83.148 + 5)})] = 80,697 \text{ Db}$

Table 6

Noise Level Measurement Results Based on Measurement Time

Code	Measurement Time	Time Range	Noise Level (dBA)	Remarks	Duration (Hours)
L1	08.00	06.00–09.00	80,12	T1	3
L2	10.00	09.00–11.00	79,74	T2	2
L3	15.00	11.00–17.00	77,91	T3	6
L4	18.00	17.00–22.00	77,76	Q4	5
LS (Day)		Daylight	78,626		16
L5	22.00	22.00–24.00	82,33	Q5	2
L6	24.00	24.00–03.00	81,63	T6	3

Code	Measurement Time	Time Range	Noise Level (dBA)	Remarks	Duration (Hours)
L7	05.00	03.00–06.00	84,64	T7	3
LM (Night)		Night	83,14882		8
LSM (Day–Night)		All day	80,69725		24

Description: LS = the average noise level of the daytime period; LM = the average noise level of the night period; LSM = average noise level during the day and night period (24 hours).
The unit of noise level is dBA.

The noise level was evaluated over a 24-hour period using daytime measurements, resulting in an Ls value of 78.62 dBA, while the nighttime measurements produced an Lm value of 83.15 dBA. Based on the day–night calculation with the prescribed nighttime correction, the Lsm value was 84.25 dBA.

Location 1 Noise Recap Data at a Distance of 10 m

Table 7
Noise Level Measurement Results Based on Time Period

Code	Measurement Time	Time Range	Noise Level (dBA)	Remarks	Duration (Hours)
L1	08.00	06.00–09.00	72,11	T1	3
L2	10.00	09.00–11.00	73,62	T2	2
L3	15.00	11.00–17.00	71,66	T3	6
L4	18.00	17.00–22.00	70,85	Q4	5
LS (Day)		Daylight	71,824		16
L5	22.00	22.00–24.00	73,00	Q5	2
L6	24.00	24.00–03.00	74,58	T6	3
L7	05.00	03.00–06.00	71,02	T7	3
LM (Night)		Night	73,11676		8
LSM (Day–Night)		All day	72,29925		24

Description: LS = noise level of the daytime period; LM = nighttime period noise level; LSM = noise level for 24 hours.

The noise level was evaluated over a 24-hour period using daytime measurements, with an Ls value of 71.82 dBA, while the nighttime measurements produced an Lm value of 73.12 dBA. Based on the combined day–night calculation with the +5 dB nighttime correction, the Lsm value was 75.02 dBA.

Location 1 Noise Recap Data at a Distance of 15 m

Table 8
Noise Level Measurement Results

Leq 10 (10 minutes)	Measurement Time	Time	dBA	Remarks	HOURS
L1	08.00	06.00–09.00	75,80	T1	3
L2	10.00	09.00–11.00	79,36	T2	2
L3	15.00	11.00–17.00	73,95	T3	6
L4	18.00	17.00–22.00	69,92	Q4	5
LS (DAY)	16 HOURS	DAYLIGHT	74,814		16
L5	22.00	22.00–24.00	68,49	Q5	2
L6	24.00	24.00–03.00	65,89	T6	3
L7	05.00	03.00–06.00	71,75	T7	3
LM (NIGHT)	8 HOURS	NIGHT	69,46071		8
LSM (Day and Night)	24 HOURS	EVERY DAY	73,64384		24

Description: LS = noise level of daytime period; LM = nighttime period noise level; LSM = noise level for 24 hours.

Noise measurements were carried out for 24 hours consisting of daytime measurements with a noise level of L_s of 71.82 dBA, while at night a noise value of L_m of 73.11 dBA was obtained. Based on the combined calculation of day and night noise, the L_{sm} value of 72.29 Dba was obtained.

Location 2 Noise Recap Data at a Distance of 5 m

Table 9

Location Noise Recap 2 Distance 5 M

Leq 10 (10 minutes)	Measurement Time	Time	dBA	Remarks	HOURS
L1	08.00	06.00–09.00	90,06	T1	3
L2	10.00	09.00–11.00	88,13	T2	2
L3	15.00	11.00–17.00	88,42	T3	6
L4	18.00	17.00–22.00	88,14	Q4	5
LS (DAY)	16 HOURS	DAYLIGHT	88,667		16
L5	22.00	22.00–24.00	79,33	Q5	2
L6	24.00	24.00–03.00	84,03	T6	3
L7	05.00	03.00–06.00	77,54	T7	3
LM (NIGHT)	8 HOURS	NIGHT	81,38484		8
LSM (Day and Night)	24 HOURS	EVERY DAY	87,29392		24

Noise measurement was carried out for 24 hours consisting of daytime measurements with a noise level of L_s of 88.66 dBA, while at night a noise value of L_m of 81.38 dBA was obtained. Based on the combined calculation of day and night noise, the L_{sm} value of 87.29 dBA was obtained.

Location 2 Noise Recap Data at a Distance of 10 m

Table 10

Location Noise Recap Data 2 Distance 10 M

Leq 10 (10 minutes)	Measurement Time	Time	dBA	Remarks	HOURS
L1	08.00	06.00–09.00	70,60	T1	3
L2	10.00	09.00–11.00	68,92	T2	2
L3	15.00	11.00–17.00	53,22	T3	6
L4	18.00	17.00–22.00	66,46	Q4	5
LS (DAY)	16 HOURS	DAYLIGHT	66,618		16
L5	22.00	22.00–24.00	65,61	Q5	2
L6	24.00	24.00–03.00	70,99	T6	3
L7	05.00	03.00–06.00	79,71	T7	3
LM (NIGHT)	8 HOURS	NIGHT	76,09569		8
LSM (Day and Night)	24 HOURS	EVERY DAY	72,20774		24

Noise measurement was carried out for 24 hours consisting of daytime measurements with a noise level of L_s 66.61 dBA, while at night a noise value of L_m 76.09 dBA was obtained. Based on the combined calculation of day and night noise, the L_{sm} value of 72.20 Dba was obtained.

Location 2 Noise Recap Data at a Distance of 15 m

Table 11

Location 2 Noise Recap Data 15 M Distance

Leq 10 (10 minutes)	Measurement Time	Time	dBA	Remarks	HOURS
L1	08.00	06.00–09.00	68,13	T1	3
L2	10.00	09.00–11.00	67,44	T2	2
L3	15.00	11.00–17.00	63,89	T3	6
L4	18.00	17.00–22.00	64,54	Q4	5
LS (DAY)	16 HOURS	DAYLIGHT	65,705		16
L5	22.00	22.00–24.00	67,26	Q5	2
L6	24.00	24.00–03.00	64,85	T6	3
L7	05.00	03.00–06.00	66,86	T7	3
LM (NIGHT)	8 HOURS	NIGHT	66,33034		8

Leq 10 (10 minutes)	Measurement Time	Time	dBA	Remarks	HOURS
LSM (Day and Night)	24 HOURS	EVERY DAY	65,92356		24

Noise measurements were carried out for 24 hours consisting of daytime measurements with a noise level of Ls 65.70 dBA, while at night a noise value of Lm 66.33 dBA was obtained. Based on the combined calculation of day and night noise, the Lsm value of 65.92 dBA was obtained.

Location 3 Noise Recap Data at a Distance of 5 m

Table 12

Location Noise Recap Data 3 Distance 5 M

Leq 10 (10 Minutes)	Measurement Time	Time	Dba	Remarks	HOURS
L1	08.00	06.00–09.00	73,70	T1	3
L2	10.00	09.00–11.00	67,46	T2	2
L3	15.00	11.00–17.00	74,10	T3	6
L4	18.00	17.00–22.00	79,38	Q4	5
Ls (Day)	16 Hours	Daylight	76,214		16
L5	22.00	22.00–24.00	70,71	Q5	2
L6	24.00	24.00–03.00	81,16	T6	3
L7	05.00	03.00–06.00	77,51	T7	3
Lm (Night)	8 Hours	Night	78,63691		8
LSM (Day and Night)	24 HOURS	EVERY DAY	77,17972		24

Noise measurement was carried out for 24 hours consisting of daytime measurements with a noise level of Ls of 76.21 dBA, while at night a noise value of Lm of 78.63 dBA was obtained. Based on the combined calculation of day and night noise, the Lsm value of 77.17 Dba was obtained.

Location 3 Noise Recap Data at a Distance of 10 m

Table 13

Location Noise Recap Data 3 Distance 10 M

Leq 10 (10 minutes)	Measurement Time	Time	dBA	Remarks	Hours
L1	08.00	06.00–09.00	83,36	T1	3
L2	10.00	09.00–11.00	79,39	T2	2
L3	15.00	11.00–17.00	69,2	T3	6
L4	18.00	17.00–22.00	66,11	Q4	5
LS (DAY)	16 HOURS	DAYLIGHT	77,474		16
L5	22.00	22.00–24.00	86,22	Q5	2
L6	24.00	24.00–03.00	63,03	T6	3
L7	05.00	03.00–06.00	79,33	T7	3
LM (NIGHT)	8 HOURS	NIGHT	81,38589		8
LSM (Day and Night)	24 HOURS	EVERY DAY	79,19765		

Noise measurement was carried out for 24 hours consisting of daytime measurements with a noise level of Ls of 77.47 dBA, while at night a noise value of Lm of 81.38 dBA was obtained. Based on the combined calculation of day and night noise, the Lsm value of 79.19 Dba was obtained.

Location 3 Noise Recap Data at a Distance of 15 m

Table 14

Location 3 Noise Recap Data 15 M Distance

Leq 10 (10 minutes)	Measurement Time	Time	dBA	Remarks	Hours
L1	08.00	06.00–09.00	68,9	T1	3
L2	10.00	09.00–11.00	68,12	T2	2
L3	15.00	11.00–17.00	66,09	T3	6
L4	18.00	17.00–22.00	72,37	Q4	5
LS (DAY)	16 HOURS	DAYLIGHT	69,630		16
L5	22.00	22.00–24.00	60,58	Q5	2
L6	24.00	24.00–03.00	60,77	T6	3

Leq 10 (10 minutes)	Measurement Time	Time	dBA	Remarks	Hours
L7	05.00	03.00–06.00	65,39	T7	3
LM (NIGHT)	8 HOURS	NIGHT	63,07654		8
LSM (Day and Night)	24 HOURS	EVERY DAY	68,32468		

Noise measurement was carried out for 24 hours consisting of daytime measurements with a noise level of L_s 69.63 dBA, while at night a noise value of L_m 63.07 dBA was obtained. Based on the combined calculation of day and night noise, an L_{sm} value of 68.32 Location Noise Data 3 Distance 15 M was obtained.

Recap of l_s , l_m , and l_{sm} Values by Location and Distance

Table 15

Recap data of l_s , l_m and l_{sm}

Distance	Description	Location 1 (dBA)	Location 2 (dBA)	Location 3 (dBA)
5 meters	LS	78,62	88,66	76,21
	LM	83,14	81,38	78,63
	LSM	80,69	87,29	77,17
10 meters	LS	71,82	66,61	77,47
	LM	73,11	76,09	81,38
	LSM	72,29	72,20	79,19
15 meters	LS	74,81	65,70	69,63
	LM	69,46	66,33	63,07
	LSM	73,64	65,92	68,32

The calculation results show that the noise level at 3 locations with 9 measurement points at distances of 5, 10, and 15 meters has exceeded the noise threshold set in the Decree of the Minister of the State for the Environment No. 48 of 1996, which is 55 dBA, the details of the results of the measurement can be seen from the following figure 3:

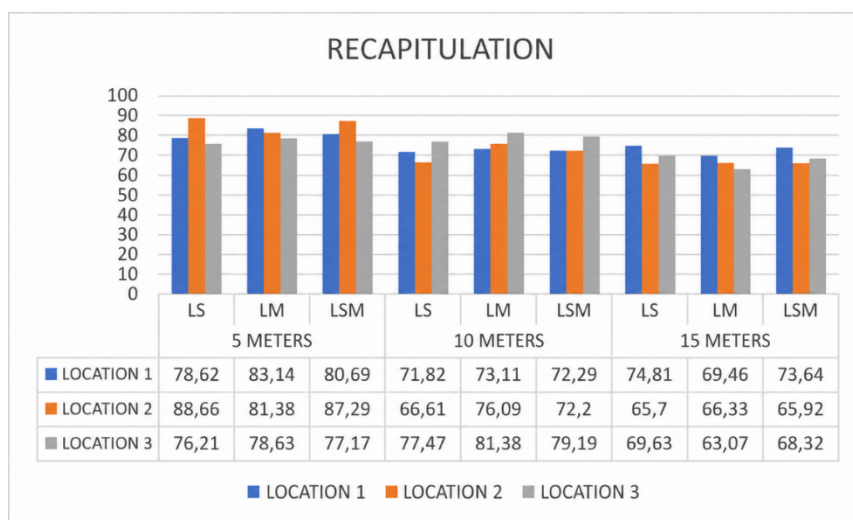


Figure 3. Graph of recap data l_s , l_m and l_{sm}

Noise Modeling

Noise modeling was conducted using Surfer, Google Earth Pro, and Garmin GPS. The measurement data were combined with the L_{sm} noise data obtained from three measurement locations, each with three measurement distances 5, 10, and 15 m resulting in a total of nine measurement points. All data were processed and visualized as a noise-distribution map. The results are presented in the following map in figure 4.

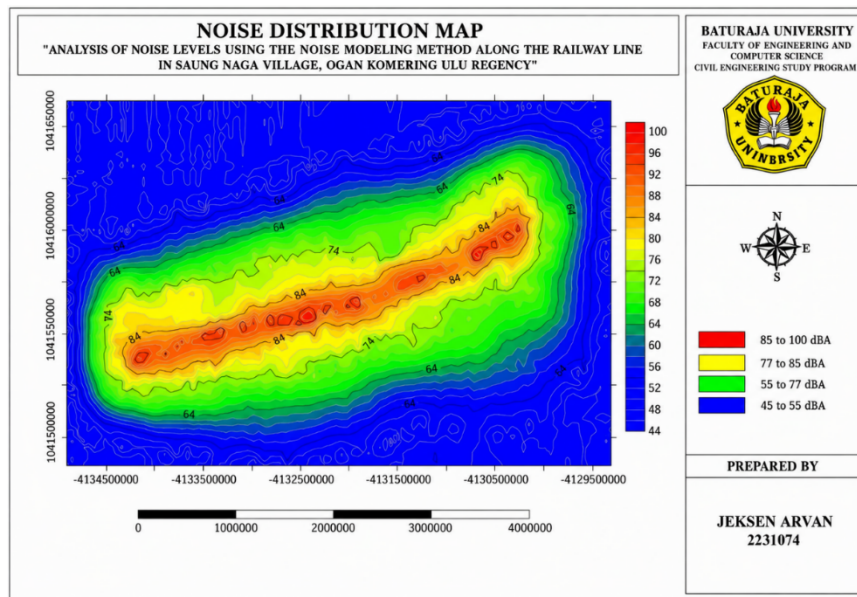


Figure 4. Noise Distribution Map

Interview

The interview was conducted on Monday, December 22, 2025, in Saung Naga Village, West Baturaja District, Ogan Komering Ulu Regency. The interview was conducted to supplement the data on public perceptions in the area surrounding the railway track, within a maximum distance of 15 m from the noise source. A total of 30 respondents were selected to represent community perceptions. The respondents were divided into three age groups: adolescents aged 10–19 years, comprising 11 respondents; adults aged 19–59 years, comprising 12 respondents; and older adults aged 60 years and above, comprising 7 respondents. The interview results are presented in Table 16 and Figures 5–7.

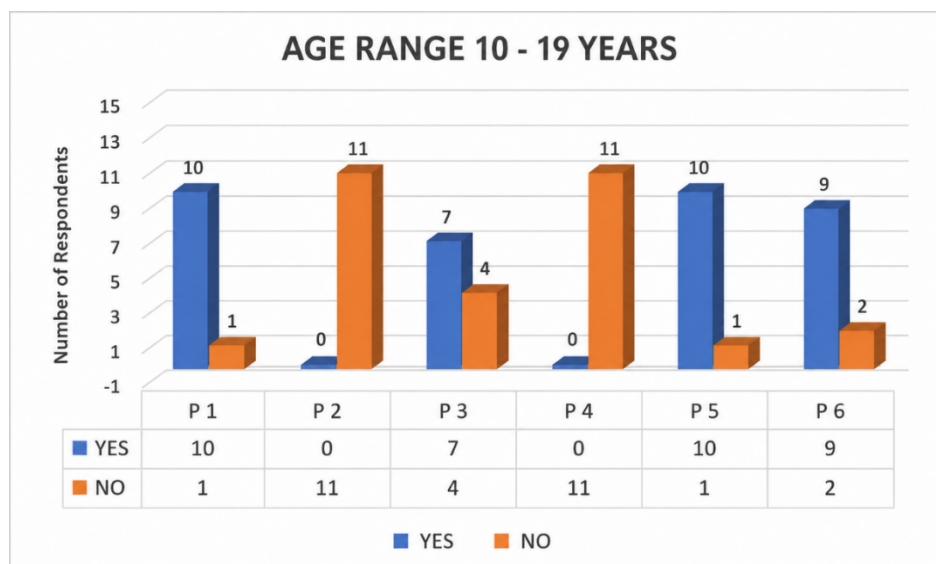


Figure 5. Data Graph Recap of Interviews with Teenagers

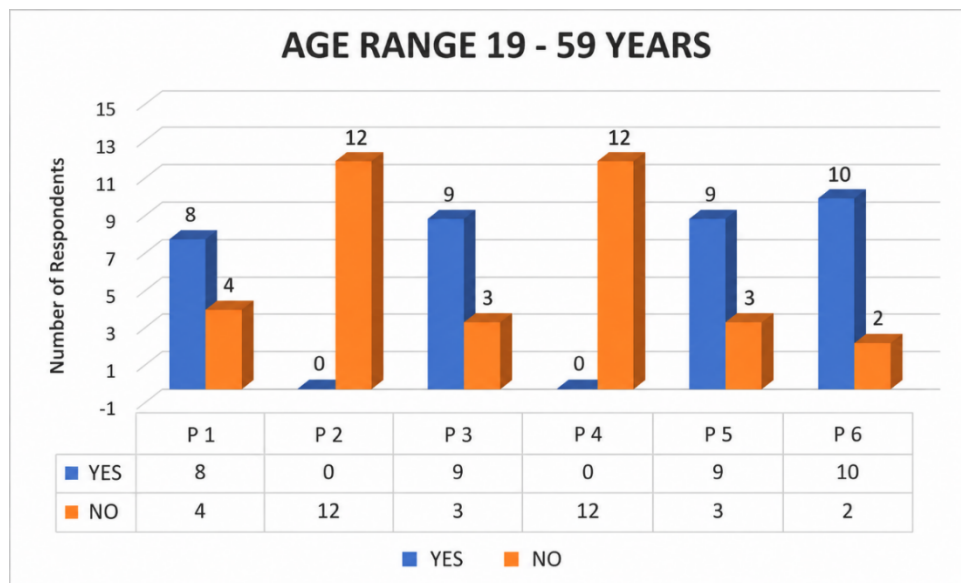


Figure 6. Graph of Interviews Recap Data with Adults

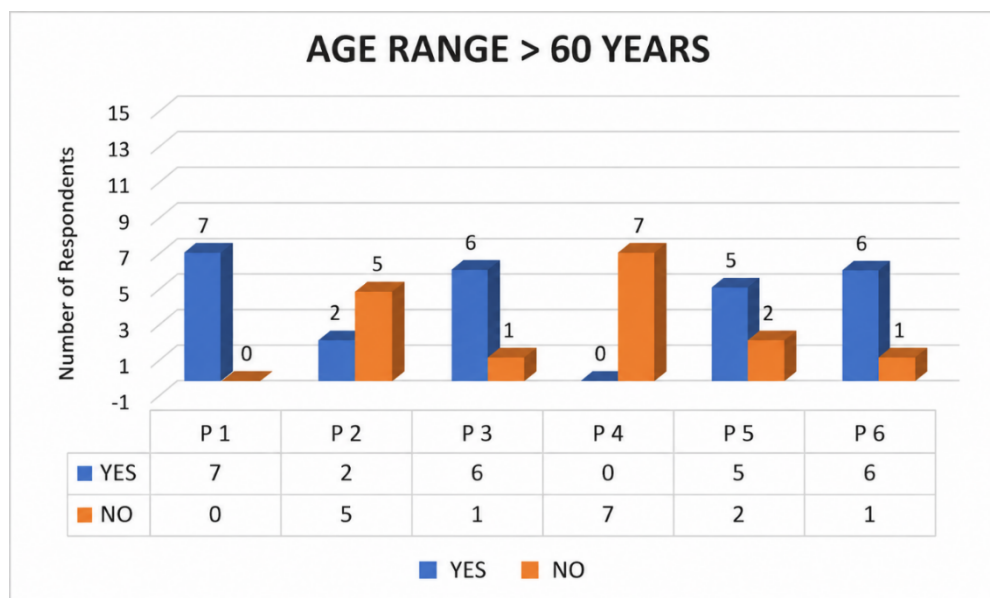


Figure 7. Data Graph Recap of Interviews with the Elderly

The questions listed in the table were converted into symbols so that the reading of the interview results and graphs is simpler.

Table 16

Interview Question Symbols and Questions

Symbols	Questions
P 1	What do you think is the noise in this area high?
P 2	What do you think noise causes Increased heart rate?
P 3	What do you think noise causes Trouble sleeping?
P 4	What do you think noise causes anxiety?
P 5	What do you think noise causes headaches?
P 6	What do you think noise interferes with concentration?

Discussion

The results of the study showed that railway activities in the residential area of Saung Naga Village produced relatively high noise levels and, in general, exceeded the applicable noise standards for residential areas and settlements. Measurements at three locations at distances of

5, 10, and 15 m from the railway track showed relatively high noise exposure during various observation periods. This condition indicates that the proximity of residential settlements to railway lines is an important factor that needs to be considered in environmental-quality management. Transportation noise has been identified as one of the major sources of environmental noise that can affect people's comfort, sleep quality, health, and quality of life (World Health Organization (Münzel et al., 2024; Organization, 2018; Welch et al., 2023)).

At a distance of 5 m, the measured noise levels indicated relatively high exposure. At Location 1, for example, the L_s value reached 78.62 dBA, the L_m value was 83.15 dBA, and the ($L_{\{SM\}}$) value was 84.25 dBA. These values indicate that substantial noise exposure occurred not only during the day but also at night. This condition is important because nighttime noise can have more serious consequences for the quality of people's rest. A systematic review by Smith et al. (2022) showed consistent evidence of an association between environmental noise exposure and sleep disturbances. Recurrent sleep disturbances may constitute a pathway connecting noise exposure with various other health effects.

The high noise levels observed in this study also demonstrate a gap between actual field conditions and the noise standards applicable to residential areas. The results show that noise levels at various measurement points remained above 55 dBA, which was used as the reference value for residential areas and settlements. From an environmental-health perspective, these conditions warrant attention because high and repeated exposure to noise can increase the likelihood of annoyance, sleep disturbances, activity disturbances, and physiological stress responses (Halperin, 2014; Organization, 2018; Smith et al., 2022; Stanovská et al., 2024).

In particular, Organization (2018) and Minkin et al. (2025) identifies railway noise as a source of transportation noise for which epidemiological evidence exists regarding annoyance and sleep disturbance. The impact of noise is determined not only by sound pressure level but also by exposure time, frequency of occurrence, exposure duration, sound characteristics, and the environmental conditions at the receiver. Therefore, people living very close to railway lines may be more likely to experience disturbances caused by repeated train pass-bys (Minkin et al., 2025; Organization, 2018).

When analyzed according to distance, the results show that noise levels generally varied with increasing distance from the noise source. At some locations, the decrease was more pronounced at a distance of 15 m. At Location 2, for example, the L_{sm} value at a distance of 15 m was 68.46 dBA, while the corresponding values at Locations 1 and 3 were 74.70 and 69.17 dBA, respectively. These findings suggest that increasing the distance from the noise source can contribute to a reduction in received sound levels; however, a distance of 15 m was not sufficient to reduce the noise level below the standard for residential areas.

The relationship between distance and noise exposure is also supported by research by Maljaee et al. (2024), which showed that residential distance from railway lines is one of the factors associated with public dissatisfaction with noise and vibration. The study measured noise levels at various points and found that actual noise levels in areas surrounding railway lines could exceed applicable standards. Thus, the results of the present study in Saung Naga Village reinforce the finding that settlements located close to railway lines have the potential to experience greater noise exposure.

However, the results also show that noise levels did not always decrease linearly across the observation points. These differences indicate that distance is not the only factor determining the noise level received by the public. Characteristics of the sound source, train speed, train type, rail condition, travel frequency, topography, buildings, vegetation, and meteorological conditions can affect sound propagation. Therefore, measurements at multiple points are necessary to characterize spatial variations in noise more accurately. This approach also provides an important basis for noise mapping to evaluate the spatial distribution of noise exposure.

Another important finding is that nighttime noise levels were higher than daytime levels at several points. At Location 1, 5 m from the railway track, for example, the L_m value of 83.15 dBA was higher than the L_s value of 78.62 dBA. Similar conditions were observed at Location 3 at a distance of 5 m, where the L_m value was 78.64 dBA and the L_s value was 76.21 dBA. High nighttime noise levels warrant particular attention because a relatively quiet nighttime environment is important for maintaining sleep quality.

Smith et al. (2022), through a systematic review and meta-analysis, showed that environmental noise at night is associated with sleep disturbances. The findings update evidence previously considered by the WHO in developing environmental-noise guidelines. Thus, the high (L_M) values observed at some study sites are relevant to the potential for sleep disturbance among community members, although the present study did not directly measure sleep quality.

The association between railway noise and sleep disturbance is also supported by previous research specifically examining railway-noise exposure. Croy et al. (2013) and Sun et al. (2025) showed that nighttime exposure to railway noise can affect sleep structure and heart-rate responses during sleep. These findings indicate that railway noise occurring at night may not only be perceived as a subjective disturbance but may also elicit physiological responses during sleep.

In addition to sleep disturbance, transportation noise has also been associated with cardiovascular responses. Münzel et al. (2018, 2021, 2024) explained that exposure to transportation noise can activate stress responses and the autonomic nervous system, which may subsequently affect cardiovascular function. The evidence has continued to develop through studies showing that exposure to transportation noise, including railway noise, has the potential to affect vascular function, sleep quality, and stress regulation (Münzel et al., 2024). Therefore, although this study did not conduct clinical examinations of community members, the measured noise levels indicate the importance of preventive attention from an environmental-health perspective.

The objective measurements in this study were also supported by the results of interviews with community members. A total of 30 respondents, consisting of 11 adolescents, 12 adults, and 7 older adults, were interviewed. Most respondents stated that the noise level in the study area was relatively high. These findings indicate consistency between the objective data obtained from the sound level meter (SLM) measurements and the subjective perceptions of community members.

The consistency between measured noise levels and public perception is important because the impact of noise cannot be assessed solely through dBA measurements. Noise annoyance is a subjective response influenced by the characteristics of the noise source, frequency of events, exposure time, individual sensitivity, and the context of the living environment. Maljaee et al. (2024) showed that noise and vibration from railway activities can be associated with community dissatisfaction in areas surrounding railway lines. More recent research has also shown that railway noise can be a significant source of annoyance among people living in residential areas near railway lines (Park et al., 2025).

Thus, the high noise levels measured in Saung Naga Village can be understood as an environmental problem with both physical and social dimensions. Physically, noise can be identified through elevated dBA values. Socially, this condition is perceived by community members as a noisy environment with the potential to disrupt comfort. Mucci et al. (2020) and Jiang et al. (2025), in a systematic review of urban noise, also showed that transportation noise can be associated with sleep disturbances and psychological stress, indicating that public perception is an important component in evaluating the impacts of environmental noise.

Spatial modeling using Surfer and Google Earth Pro provided additional information about the distribution of noise in the study area. Data from nine measurement points were used to describe noise-distribution patterns according to location and distance from the railway tracks. The noise-mapping approach is advantageous because it can identify areas experiencing relatively high exposure and help determine areas requiring priority control. The development of strategic noise mapping also demonstrates that mapping is an important instrument for identifying noise exposure and supporting environmental-management planning.

The combination of measurement and modeling is more informative than measurements at a single point alone. Field measurements provide actual noise values at specific locations, whereas spatial modeling provides a broader representation of the distribution. The combination of these approaches allows researchers to identify trends in noise-level changes with distance while also identifying areas with potentially higher exposure. Therefore, the use of Surfer and Google Earth Pro in this study can be considered an attempt to transform point-based measurement data into spatial information that is easier to use for environmental evaluation.

The results showed that even at a distance of 15 m, some locations still had relatively high

Lsm values. At Locations 1, 2, and 3, the Lsm values at 15 m were 74.70, 68.46, and 69.17 dBA, respectively. These conditions indicate that increasing the distance to 15 m did not completely resolve the noise problem. This may occur because railway noise sources have relatively high sound levels and occur repeatedly, while residential environments may amplify or sustain exposure through sound reflection from buildings.

From an environmental-control perspective, the results of this study indicate that relying solely on the distance between houses and railway tracks is insufficient. A control approach that addresses the source, propagation path, and receiver is required. One strategy that can be considered is the installation of noise barriers. Additional measures may include improving building quality, using materials with better sound-insulation properties, implementing appropriate spatial arrangements, and managing railway operations.

Noise barriers are particularly relevant in areas that have already developed into residential settlements where relocation is not feasible. Barriers can reduce the sound energy reaching the receiver by obstructing the direct sound-propagation path. However, their effectiveness depends on their design, height, length, position, material, and the geometric relationship among the source, barrier, and receiver. Therefore, the spatial modeling results from this study can provide preliminary information for identifying potential locations for noise-barrier installation.

Noise control should also consider that railway noise is influenced by train operating characteristics. Train speed, train type, wheel and rail conditions, braking, horn use, and travel frequency can affect the noise level received by the public. Therefore, a long-term control strategy should ideally not focus solely on the residential environment but should also consider noise control at the source.

Overall, the results of this study show that the combination of sound level meter measurements, Ls, Lm, and Lsm calculations, spatial modeling, and community perceptions provides a more comprehensive picture of noise conditions associated with railway activities in Saung Naga Village. The relatively high measured noise levels and the community's perception that the area is relatively noisy indicate consistency between objective and subjective indicators. These findings are consistent with previous research suggesting that railway noise can contribute to annoyance, sleep disturbances, and other health impacts ([Maljaee et al., 2024](#); [Seidler et al., 2023](#); [Smith et al., 2022](#); [Welch et al., 2023](#)).

Thus, railway noise in the residential area of Saung Naga Village should be regarded as an environmental-quality problem requiring continuous control. This study provides empirical evidence that noise exposure at several measurement points remains high, including at a distance of 15 m from the railway tracks. This condition reinforces the importance of developing data-based mitigation strategies, spatial noise mapping, and consideration of public perceptions. Such an approach is expected to support a balance between the function of railway transportation and the protection of the quality of the residential environment.

CONCLUSION

The following conclusions can be drawn from this study. 1) The results of noise measurements in Saung Naga Village, located in West Baturaja District, Ogan Komering Ulu Regency, showed that at a distance of 5 m from the noise source, the Lsm values at the three measurement locations were 84.25, 88.03, and 80.21 dBA, respectively. At a distance of 10 m, the values were 75.02, 76.62, and 82.61 dBA, respectively. At a distance of 15 m, the measured Lsm values were 74.70, 68.46, and 69.17 dBA, respectively. These data indicate that although noise levels generally decrease with increasing distance, the noise levels measured within the 5–15 m range remain above the 55 dBA standard specified in the Decree of the Minister of State for the Environment No. 48 of 1996 for residential areas and settlements. 2) Based on interviews with 30 respondents, consisting of 11 adolescents, 12 adults, and 7 older adults, the majority stated that the noise level in the study area was relatively high. This finding indicates that the noise is not only technically measurable but is also directly perceived by community members across the different age groups.

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AUTHOR CONTRIBUTION STATEMENT

Lindawati: Conceptualization, methodology, investigation, data collection, formal analysis, and writing original draft. Muhammad Rizka Fadli Wibowo: Methodology, data validation, formal analysis, visualization, and writing review and editing. Balqis Fataya Said: Supervision, validation, interpretation of results, writing review and editing, and final manuscript review. All authors contributed to the development of the manuscript, reviewed its final version, and approved the manuscript for publication.

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