Analysis Of Traffic Noise Level At Siti Rahmah Islamic Hospital And Semen Padang Hospital Of Padang City

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Abstract. This study aims to determine the traffic noise level at Siti Rahmah Islamic Hospital and Semen Padang Hospital. Both are located near the Padang Bypass highway, traversed by heavy vehicles and high traffic. The measurements are carried out using a Sound Level Meter for 10 minutes on weekdays and holidays. The analytical technique used is Leq analysis and the Inverse Square Law. Noise maps were created using IDW interpolation in GIS. The results showed the level of traffic noise at Siti Rahmah ranged from 52.3 to 60.1 dBA, while at Semen Padang between 60.1 to 68.3 dBA. The pattern is increasing on weekdays and fluctuating on holidays. The evaluation shows the level of the RSI. Siti Rahmah generally meets the standards, while everything exceeds at Semen Padang Hospital. Efforts to reduce the impact of traffic noise are by making noise barriers, either structurally, vegetation barriers, or a combination of both.

Keywords: traffic, noise, hospital

1 Introduction

Traffic noise is one of the environmental problems that often occur in urban areas. Traffic noise, according to the World Health Organization (WHO), can cause headaches, sleep disturbances, stress, high blood pressure, and hormonal effects. Noise can also impair performance, alter social behavior, and cause other disruptions [1].

Noise in the hospital area in particular is a serious problem because it increases the risk of disease for patients. This happened in a hospital located near the highway. The purpose of this research is to determine the amount of traffic in the vicinity of Siti Rahmah Islamic Hospital and Semen Padang Hospital. Both hospitals are located on the Padang Bypass highway, traversed by heavy vehicles and high traffic. This condition makes them prone to high-level of noise exposure.

2 Methods

This research was conducted at the Islamic Hospital (RSI) Siti Rahmah and Semen Padang Hospital. Figure 1 shows the locations of the two hospitals in Padang City.

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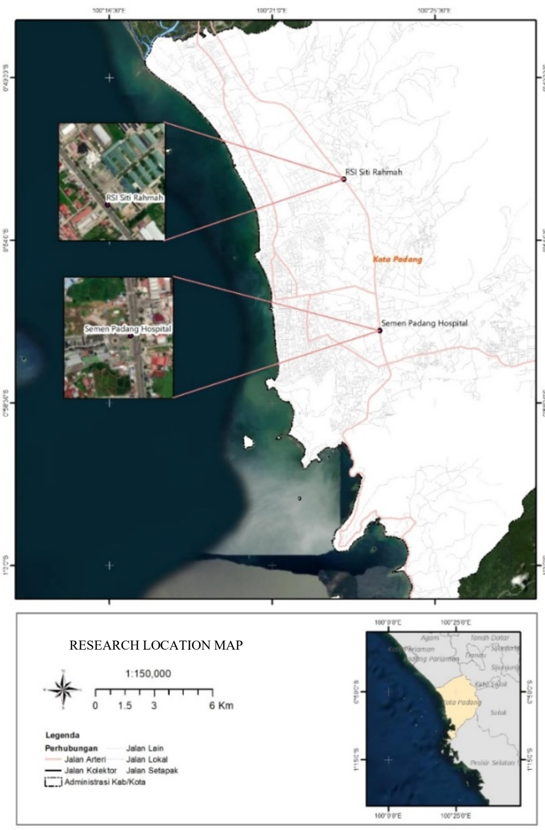

Fig. 1. Research location.

2.1 Data Collection

A Sound Level Meter is used to measure traffic noise at a distance of 4 meters from the edge of the highway and a height of 1.2 meters. The recording is done every 5 seconds for 10 minutes in the morning (07.00), afternoon (13.00), afternoon (17.00), and evening (20.00) on weekdays and holidays.

2.2 Analysis Methods

2.2.1 Equivalent Noise Level (Leq)

An Equivalent Noise Level Analysis (Leq) is used to calculate the average noise level over a one-hour period (Leq). The equivalent noise level statement is a model for expressing the average sound pressure level over a given time interval. The mathematical model is presented in equation (1).

$$L_{eq} = 10\log(\sum_{i=1}^{n} Fi.10^{Li/10})\ \text{dBA} \qquad (1)\ [2]$$

where:
Leq = equivalent noise level
Fi = the faction of the time the noise level occurs at a certain measurement time interval
Li = the median value of the noise level at a certain measurement time interval (dBA)

2.2.2 Inverse Square Law

The Inverse Square Law can be used to calculate the approximate sound pressure level at a given distance. The inverse square law is a physics principle that states that a point source radiates sound waves uniformly in all directions in a spherical shape, and that the energy intensity of the sound wave at a certain point away from the source is minimized as a function of the total surface area of the sphere that coincides with the point. The sound pressure level decreases by about 6 decibels for every doubling of the distance from the source point, according to this law. [3]

To determine the sound attenuation at a given distance using the inverse square law, an assumption is made that there are no obstructions between the source, and the location of the sound level is determined. The formula for calculating sound attenuation by distance is:

$$Lp(R_2) = Lp(R_1) - 20.\log_{10}(R_2/R_1) \qquad (2)\ [4]$$

where:
$Lp(R_2)$= Sound pressure level at point R_2 (dBA)
$Lp(R_2)$ = Known sound pressure level at point R_1 (dBA)
R_1 = Distance from noise source to point R_1
R_2 = Distance from noise source to point R_2

2.2.3 Noise Map

Traffic noise maps was made using the IDW interpolation method in GIS using the Leq value.

3 Results and discussion

Table 1 shows the equivalent traffic noise level at a distance of 4 meters from the roadside on weekdays and holidays.

Table 1. The Equivalent Traffic Noise Level

No	Location	Weekdays (dBA)				Holidays (dBA)			
		(07.00)	(13.00)	(17.00)	(20.00)	(07.00)	(13.00)	(17.00)	(20.00)
1	RSI. Siti Rahmah	73.2	74.0	75.4	80.9	75.2	81.0	73.4	74.0
2	Semen Padang Hospital	79.7	82.4	85.0	85.4	77.2	81.8	79.1	84.8

The Semen Padang Hospital has a higher noise level than the RSI. Siti Rahmah. On weekdays, the noise level at Semen Padang Hospital is 79.7, 82.4, 85.0, and 85.4 dBA, and on holidays, it is 77.2, 81.8, 79.1, and 84.8 dBA. Meanwhile, the noise level at Siti Rahmah Hospital is 73.2, 74.0, 75.4, and 80.9 dBA on weekdays, and 75.2, 81.0, 73.4, and 74.0 dBA on holidays. Figure 2 depicts the daily noise pattern.

Fig. 2. Equivalent traffic noise level (Leq).

The difference in daily patterns can be seen clearly. On weekdays, both locations showed an increasing pattern from morning to night. While on holidays, it shows a fluctuating pattern, which increases during the day, then decreases in the afternoon, and increases again at night.

3.1 Leq In Front of The Building Facade

The equivalent noise level (Leq) in Table 1 is the noise level at 4 meters from the highway's edge. The Leq calculation is then performed in front of the building facade facing the highway to determine the noise level at the affected building site. In the indirect method, the inverse square law is calculated in equation (2). This method was chosen because direct measurements at the affected site may include noise other than traffic noise, which can make interpretation difficult. The point of impact is defined as the distance between the building facade and the highway.

The level of traffic noise in front of the building facade facing the highway can be seen in Table 2. The maximum level at Siti Rahmah Hospital is 60.1 dBA on holidays, while at Semen Padang Hospital is 68.9 dBA on weekdays.

Table 2. Traffic noise level in front of the building facade

No.	Location	Weekdays (dBA)				Holidays (dBA)			
		07.00	13.00	17.00	20.00	07.00	13.00	17.00	20.00
1	RSI. Siti Rahmah	52.3	53.1	54.5	60.0	54.3	60.1	52.5	53.1
2	Semen Padang Hospital	62.6	65.3	67.9	68.3	60.1	64.7	62.0	67.7

3.2 Noise Level Evaluation

Table 3 compares the maximum traffic noise level in front of the building facade (Table 2) to the standard level of KEPMEN-LH no. 48 of 1996 [5].

Table 3. Evaluation of maximum traffic noise level.

No.	Location	Maximum leq in front of the building facade (dBA)	Noise level standard (dBA)	Status
1	RSI. Siti Rahmah	60.1	55.0	Exceeded standard
2	Semen Padang Hospital	68.5	55.0	Exceeded standard

The maximum traffic noise level right in front of the facade of the two hospitals has exceeded the standard noise level set at 55 dBA.

3.3 Noise Map

Variations in traffic noise levels can be seen in Figure 3 on holidays and weekdays. The red color indicates high noise, which is generally greater than 70 dBA, the yellow color indicates medium noise, which is between 60 and 65 dBA, and the green color indicates low noise, which is less than 55 dBA. It is clear that the RSI area. Siti Rahmah transitions from red to green. The noise level in front of the facade is generally within the acceptable range (green), but it exceeds the acceptable range during holidays. Meanwhile, the Semen Padang Hospital area is colored yellow to red. Traffic noise in front of the facade remains above average (yellow). This is due to the high level of traffic noise and the building's proximity to the highway. The distance of the Semen Padang Hospital building from the highway, which is 50 meters, has not been able to reduce the high traffic noise. Meanwhile, the distance between the RSI building and Siti Rahmah is 80 meters, which helps to reduce the impact of traffic noise.

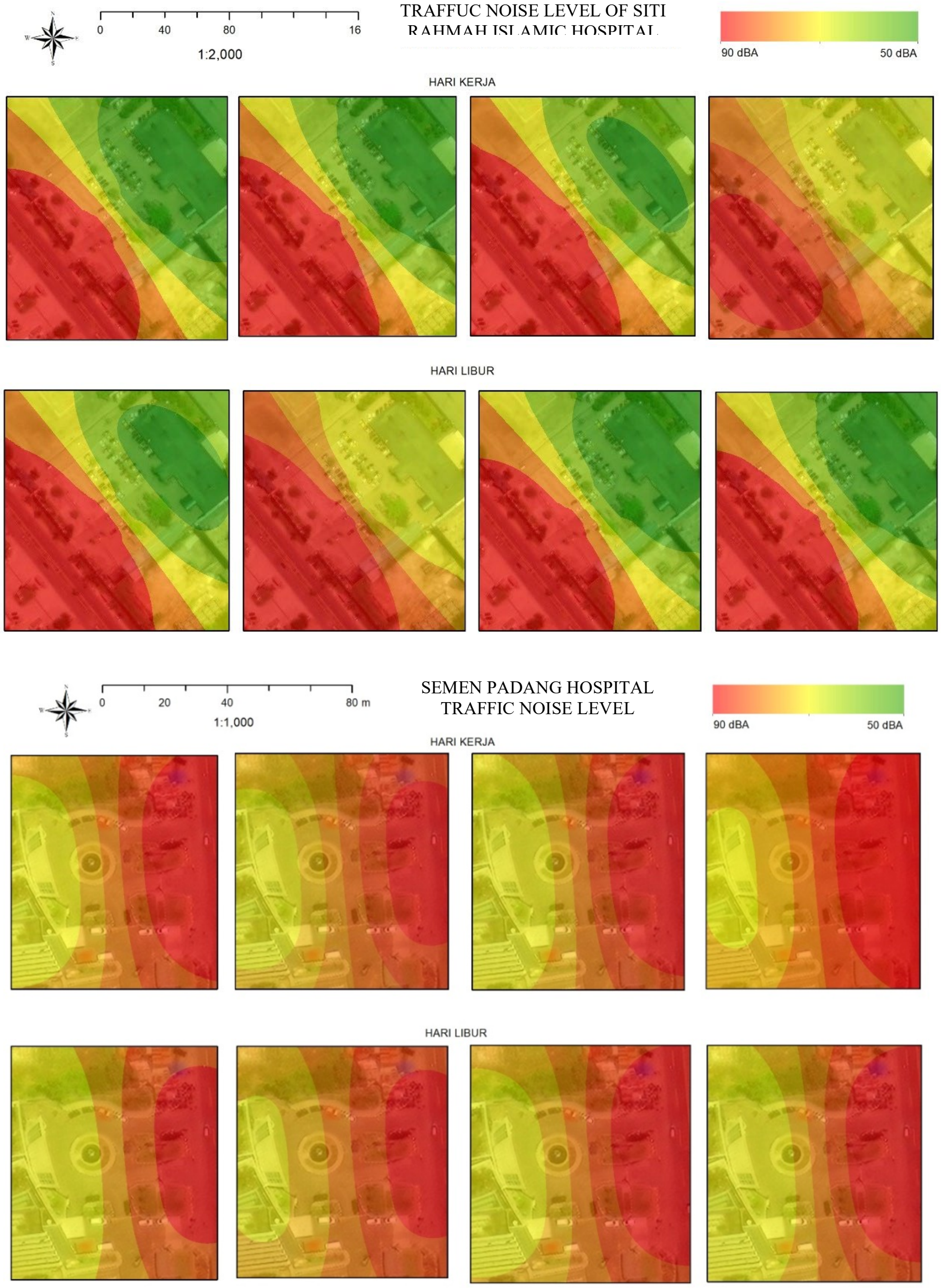

Fig. 3. Noise Maps

Efforts that can be made to reduce the impact of traffic noise are by making noise barriers, either structurally with physical buildings, or with vegetation. The vegetation is high enough, wide, and dense, it can reduce traffic noise by 10 to 15 dBA. Noise reduction through vegetation is also more environmentally friendly, natural, and attractive. The type of vegetation, leaf density, and thickness of the vegetation belt planted parallel to the road all influence denoising effectiveness. Planting vegetation barriers is highly recommended, especially in public places near highways.

4 Conclusion

The level of traffic noise at RSI Siti Rahmah ranged from 52.3 to 60.1 dBA, while at Semen Padang Hospital it ranged from 60.1 to 68.3 dBA. On weekdays, the noise level rises from morning to night. It exhibits a fluctuating pattern while on vacation, with noise increasing during the day, decreasing in the afternoon, and increasing again at night. The evaluation found that the traffic noise level at RSI. Siti Rahmah generally met the standard, whereas it exceeded the standard at Semen Padang Hospital. Noise barriers, both structural and vegetative, or a combination of both, can be used to reduce the impact of traffic noise.

5 References

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