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A Correlation Analysis of Noise Level and Traffic Flow: Case of One Way Road in Banjarmasin

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ABSTRACT— ***Noise on the highway cannot be avoided, given the increasing number of vehicles on the road. Such noise is known to be influenced by several factors, one of which is the distance from the noise source. A collection of exhaust sounds from vehicles in traffic is one such source of noise. This study aims to obtain the effect of traffic on the impact of noise generated on the open area without obstacles based on a predetermined distance of 0 meters, 17.5 meters, and 35 meters. From the result of the analysis, it is obtained that the traffic flow has a strong correlation level as a source of noise at the distance and noise levels show a decreasing level of correlation. At a distance of 0 meters (roadside) obtained correlation level is close to very strong (0.896). At a Distance of 17.5 meters, the correlation rate decreased to 0.823 and at a distance of 35 meters r-value to 0.814. The average noise change due to traffic activity is 0.29 dB per meter from roadside to 17.5 meters, and 0.15 dB per meter from 17.5 meters to 35 meters of the noise source. Thus, it can be concluded that the closer the distance to the traffic or noise source the greater the noise generated and the farther the distance from the traffic the less noise it generates.***

Keywords— traffic flow, noise level, distance, correlation

1. INTRODUCTION

Increased traffic flow on the road in addition to causing congestion also impact on air pollution and noise. Noise generated is not only because of the passing motor vehicle exhaust but can also be caused by friction between road and vehicle tires and vehicle horns [1]. At some level, these noises can still be tolerated by society, in the sense that the sound caused still does not cause a disturbance of comfort and other disturbance to the community, but at a higher level the sounds caused by the transportation vehicles can already be said as an annoyance called noise or noise pollution [2]. The rapid growth of transportation and the use of larger, powerful engines produces undeniable noise from our lives and is a serious danger to life. The objective of noise control is to provide an acceptable indoor or outdoor acoustic environment. So, the intensity and nature of all sounds in and around the building will be in accordance with the wishes of users [3].

Noise is defined as 'unwanted sound', considered a trigger and an environmental disturbance [4]. Traffic noise is the most important source of environmental disturbance, persistent interruption over long periods of time considered to be harmful to health [5]. In addition, traffic noise is very influential also with the comfort and value of land use, it is found that the increase in noise value can affect the declining value of a property in the area [6]. The higher the use of transportation services in urban areas causing traffic crowds in the region to increase. The high intensity of vehicles that pass on the city's highway certainly has an environmental impact along the road through which the vehicle. Motor vehicles when carefully reviewed cause the noise will be determined by the vehicle engine, type of motor fuel, type of cooling fan, exhaust gas system, suction from the carburetor, the type of tire (standard or radial), and vehicle form.

Noise due to transport traffic becomes the benchmark of aggravation of disturbed people compared to others such as pollution or congestion. From research conducted in Montreal, there is a relationship between noise levels and disruption of highway traffic and total environmental noise [7]. Such noise is known to be influenced by several factors, one of which is the distance from the noise source. Distance to the main road and the type of road is a strong predictor of noise disturbance [8]. The noise level is significantly affected by the distance from the noise source and decreases to the constant tending of the noise level at an increased distance [9].

Noise on the highway cannot be avoided, given the increasing number of roads and motor vehicles themselves. For example, the study area at Pierre Tendean Road in Banjarmasin is a one-way city street with heavy traffic. Along the way is an open area as a gathering place for human activities such as sports, sightseeing, eating and drinking, or just hanging out with friends. Visually, by looking at the large traffic flow in the area produces noise level that impacts less good so it is suitable to be a research location to know for sure the noise caused by the traffic flow. Based on the Regulation of the Minister of Health of the Republic of Indonesia [10], this area is included in the recreation zone with maximum allowed noise level of 55 dB. Different noise limits for each country such as India are required during the day at 65 dB and at night 55 dB [11], while some European countries for daytime are required at 60 dB and at night 50 dB [12].

Moving from the description above is known that the fluctuations in the number of moving motor vehicles will affect the amount of noise generated and noise will decrease as distance away from the sound source. In relation to the number of vehicles moving on the highway measured in units of passenger cars per unit of time, it is necessary to study the extent to which the correlation of traffic flow in passenger car unit (pcu) per hour as a source of noise at certain distances from the roadside (source of sound).

2. METHODS

Traffic flow and noise measurements are conducted simultaneously within the timeframe from 06:00 AM - 06:00 PM with measurement intervals per 10 minutes. The noise value is measured using a Sound Level Meter (SLM). The distance from the source of sound or traffic is determined at a distance of 0 meters (Point-1), 17.5 meters (Point-2), and 35 meters (Point-3). This distance determination is based on existing land availability. All points where noise measurements are set at the same conditions are open no obstacles to sound such as trees, mounds of land, buildings, and unaffected from other noise sources so that the noise that occurs at all points of observation really comes from the sound of the vehicle on traffic flow [13].

Traffic flow data (pcu/hour) and Noise level (dB) were analyzed using Ordinary Least Square (OLS) method with five equations of exponential, linear, logarithmic, polynomial, and power equations. The form of the equation showing the relationship between traffic flow (pcu/hour) and noise level (dB) is selected from the equation which has the highest correlation value and relationship quality. Equations are acceptable if the correlation level shows a minimal strong relationship. A strong or more relationship is indicated by the value of the correlation coefficient (r) ≥ 0.7 [14].

3. RESULTS

3.1 Traffic Flow and Noise Data

From the result of traffic survey conducted during 12 hours observation with normal weather conditions obtained the composition of each motorcycle vehicle (MC), light vehicle (LV), and heavy vehicle (HV). Further traffic data is processed in pcu/hour and can be described fluctuations in traffic flow as shown in Figure 1.

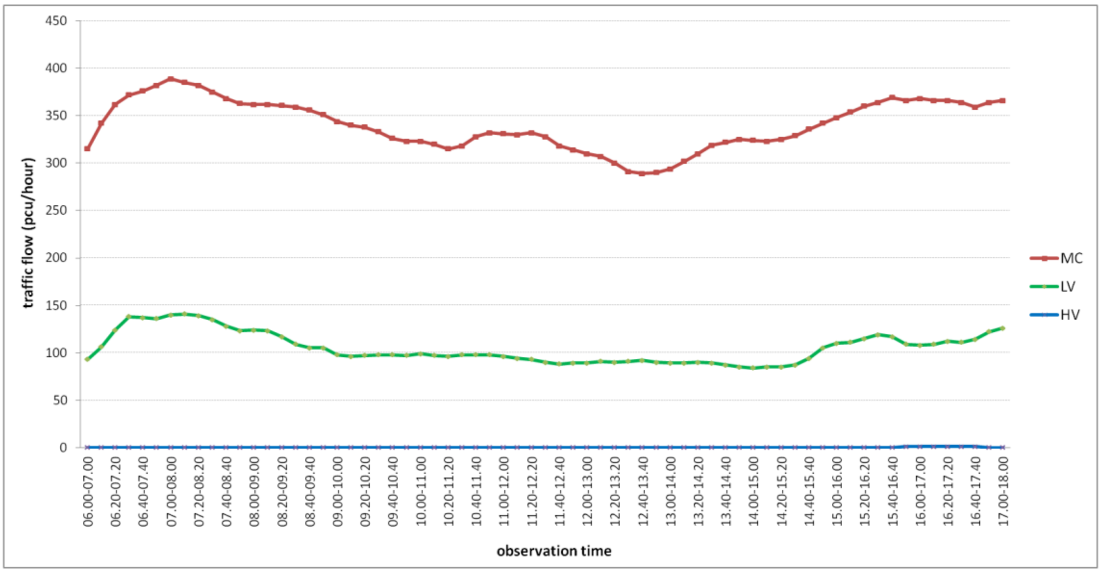

Figure 1: Traffic Flow Fluctuations during Observation

From Figure 1 it shows that the number of traffic flow during the day did not experience extreme changes with the peak of the busiest traffic occurred at 07.00 - 08.00 AM. The number of motor vehicle activity such as motorcycle (MC), light vehicle (LV), and heavy vehicle (HV) passing during the hour due to the needs of each motor vehicle users to go to work, school, and other activities. The motor vehicle composition that passes the road in the research location during the day is the motorcycle (MC) as much as 76.31%, light vehicles (LV) as much as 23.67% and heavy vehicles (HV) as much as 0.02%.

Measurement of noise is done at the same time range with distance of 0 meter (Point-1) noise data retrieval, 17.5 meters distance (Point-2), and distance of 35 meters (Point-3) from the roadside. The average noise value for each measurement interval at each observation point is shown in Figure 2.

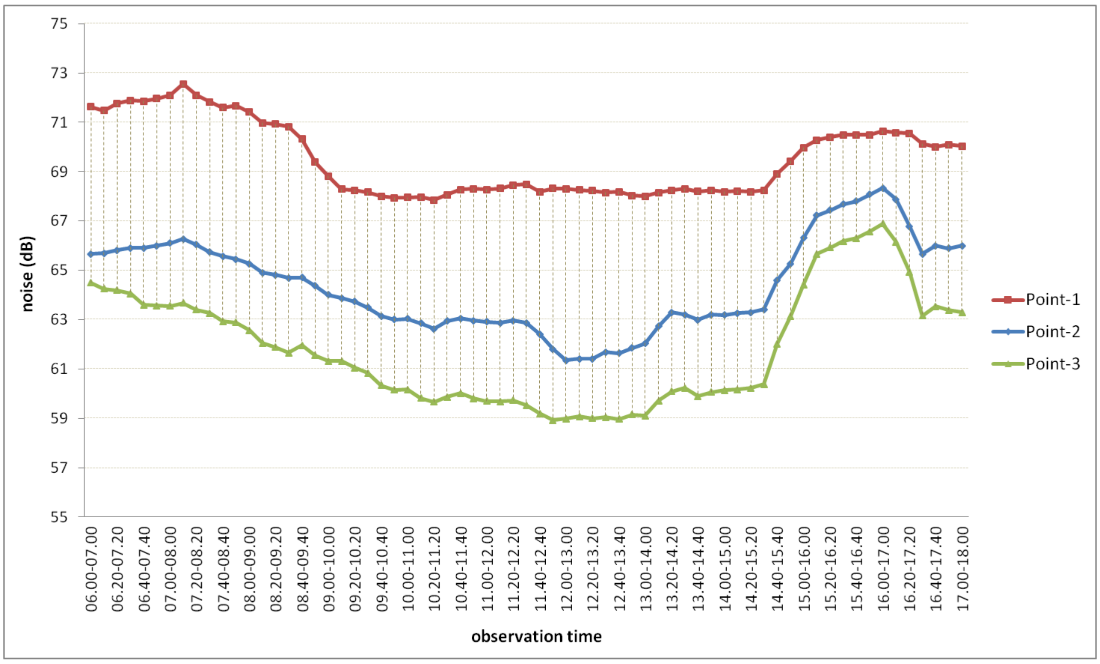

Figure 2: Fluctuation of Average Noise (dB)

From Figure 2 it can be seen that the pattern of noise change for each point of observation has a relatively similar pattern of change. The noise level decreases as distance away from observation distance. The noise level decreases between 6.00 and 6.19 dB from Point-1 to Point-2, while the noise level decrease from Point-2 to Point-3 is between 2.54 and 2.70 dB.

3.2 Correlation Analysis

To illustrate the relationship between traffic flow (pcu/hour) and noise (dB) data analyzed with OLS the equations are exponential, linear, logarithmic, polynomial, and power equations. Considering the resulting correlation at least shows the strongest and best relationship of the five equations, we get the relationship equation for the three points of observation as shown in Table 1.

Table 1: Equation Relationship between Traffic Flow and Noise

Observation point	Form of equation	correlation coefficient	description
Point-1	logarithmic, $y = 13.01 \ln(x) - 3.51$	0.896	Close to very strong
Point-2	polynomial, $y = -0.00074x^2+0.470x - 8.417$	0.880	Strong
Point-3	polynomial, $y = -0.00089x^2+0.564x - 25.20$	0.814	Strong

In general, the relationship between traffic flow and noise shows a close to very strong relationship. Judging from the value of the correlation level (r), the noise measurement from the sound source further decreased. This is likely due to wind factor that was not taken into account. From the three best equations in Table 1 we can illustrate the relationship between traffic flow and noise of each observation point as shown in Figure 3.

From Figure 3 shows that the greater the traffic flow the greater the noise effect that occurs. Increase in noise value due to traffic flow is not linear.

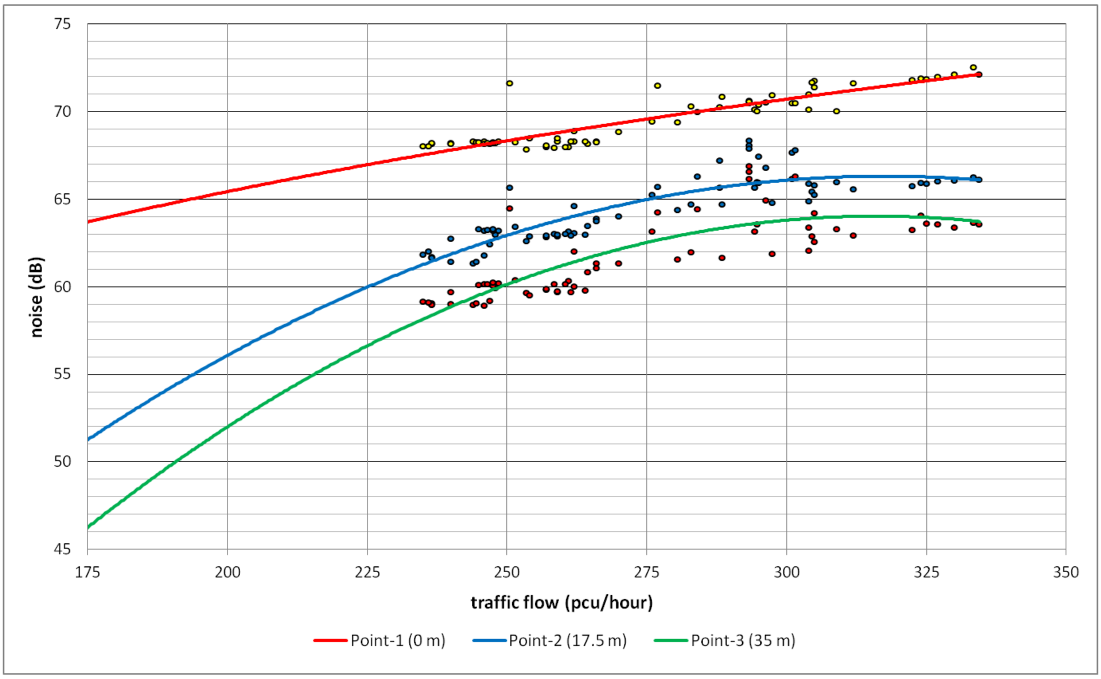

Figure 3: Relation Chart between Traffic Flow and Noise

4. DISCUSSION

In peak hour traffic condition, result of measurement at distance 0 meter (Point-1) got highest noise 72.55 dB, decrease to 68.33 dB at 17.5 meter distance (Point-2), and at distance 35 meter (Point-3) noise level to 66.90 dB. This corresponds to a change in noise level significantly influenced by distance from the noise source [9] and when viewed from the graph of the relationship formed noise level based on the non-linear decreasing distance. The decrease in the value of noise (dB) occurs from a distance of 0 meters (Point-1) to a distance of 17.5 meters (Point-2) of 0.29 dB per meter. While from a distance of 17.5 meters (Point-2) to a distance of 35 meters (Point-3) decrease occurs by 0.15 dB per meter. The longer it gets smaller until finally the value of noise (dB) becomes zero. So it can be said that the closer the distance to the traffic or the noise source the greater the noise captures and the further distance from the traffic the less noise is captured.

Judging from the designation of the area, based on regulations stipulated in Indonesia [10], traffic passing through the recreation area (maximum 55 dB) is not more than 195 pcu/hour for road distance with an activity environment not less than 17.5 m. In environmental conditions activities have a distance of 35 meters from the highway then the maximum traffic passing no more 215 pcu/hour.

In general, the contribution of this study can provide input that the noise value can be determined by looking at the amount of traffic passing. Based on the above relationship, the minimum distance between the building and the road can be determined with the consideration of the maximum noise limit. The disadvantage of this study is that the distance samples are few, so the decrease of noise per meter is not significantly explained.

5. CONCLUSION

The average noise value has a strong relation to the hourly traffic flow. This condition is useful to regulate the traffic flow on a regional designation so that the noise threshold does not exceed the recommended. The distance of the sound source (roadside) to the activity environment becomes one that can be considered. The further the activity environment from the roadside, the noise level decreases. This of course needs further research to get a more significant relationship. This research emphasizes on the condition of open area without any obstacle of sound propagation. Therefore, one way of reducing noise needs further research on the effect of obstacles such as trees, mounds of land, or buildings against noise caused by traffic flows. Given the sound barrier of course the distance of the activity environment to the sound source (roadside) can be shortened.

6. ACKNOWLEDGEMENT

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