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Factors Affecting Traffic Noise Based On Road Environment Aspects

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ABSTRACT

The purpose of this study is to analyze factors affecting traffic noise on arterial and collector roads in Kendari. The factors are road environment aspects, including building density, tree density, leaf lush volume, types of road environment ground surface, as well as temperature. Analytical approach with simple and multiple regression methods was used with SPSS software ver. 22.0. The results show that based on the determination coefficient, partially, tree density has the highest effect by 19%, then leaf lush volume 9.7%, temperature 9.1%, building density 8.7%, and types of road environment ground surface 5.8%. However in this study, the factors significantly affecting the noise are only tree density, leaf lush volume, and temperature. It is based on the value of sig-α < 0.05. Simultaneously, the variability of noise levels can be explained by the variables of tree density, leaf lush volume, and the air temperature by 31.1%, while 68.9% is explained by other factors not examined in this study

Keywords: factors; effects; road environment; noise

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1. INTRODUCTION

TRAFFIC noise is a problem that cannot be avoided due to interacting transportation system. The problem currently happens in big cities and medium-sized cities around the world, including Indonesia. At certain intensity, the traffic noise can be bad for humans because it can disrupt the health and comfort of people in the surrounding settlements and road users. The disruption can be psychological disorder that tends to lead to stress and hearing loss.

Therefore, in any activities in the field of traffic and road transport, it should be performed prevention and control of environmental pollution to comply with environmental quality standards [1]. The question now is how the control measures in order to reduce traffic noise are performed. To provide a comprehensive solution, it is first necessary to understand the factors that can affect the level of noise.

Several studies have examined the factors affecting the level of noise from the traffic aspects, among others; prediction and simulation models of traffic noise based on groups of vehicles divided into 8 groups: bus, car, double cabins taxi, jeeps, trucks, motorcycles, three-wheeled vehicles, and vans. However, this model is only used for a steady flow of traffic condition with the assumption that the movement of traffic is free without any obstruction such as zebra crossing or traffic light [2]. Traffic noise prediction model can be used effectively under the conditions of the cities in Iran. The variables used include the total volume of vehicles, speed, percentage of truck vehicles, length and width of road, Gradients, and observation distance. The measuring distance of noise from the road side is 3m [3].

Simple and multiple regression model of local traffic effects on noise levels for arterial roads in Bali with the locus of Ngurah Rai By-Pass and Sunset Street used independent variable of traffic volume (MC, LV, HV), speed (MC, LV, HV) , and distance from observation point to the nearest and furthest center line [4]. From the results of another study, effects of the green system on the noise level in three landscape conditions: tree plants, shrubs, and trees-shrubs combination, a combination of trees and shrubs with average leaf lush of 75% evenly distributed from ground level to a height of 5 meters can reduce the noise by 8.2 dBA, or about 25% [5]. The composition of vegetation consisting of trees, shrubs and bushes can reduce noise up to 12.25% and decrease the temperature to 8.18% [6].

Noise characteristics of a road should be different with the characteristics of noise in another way. This difference occurs because the traffic noise level is determined by many factors, such as motor vehicles passing through (number of vehicles, types of vehicles, average speed of vehicles), characteristics of the road, and other conditions in the surrounding road [7]. Traffic noise is influenced by a number of parameters that do not depend on the vehicle itself, such as; traffic parameters, road parameters, environment parameters, weather parameters, and residence parameters [8]. The study of factors affecting the noise in a region is not only seen from the aspects of traffic, but it is also required a study of road environment aspect. Therefore, later it can be used as information in the handling of noise either in source or propagation path of the noise.

2. MATERIALS AND METHODS

A. Research Location

The research was conducted in Kendari, Southeast Sulawesi (Indonesia) with the locus of arterial and collector roads becoming a major center for the movement of traffic including public transport distribution channels. The selection of Kendari as the research location because this city was one of the medium-sized cities with the characteristics of heterogeneous traffic, in which the growth rate of motor vehicle was quite high, at an average of 19% per year.

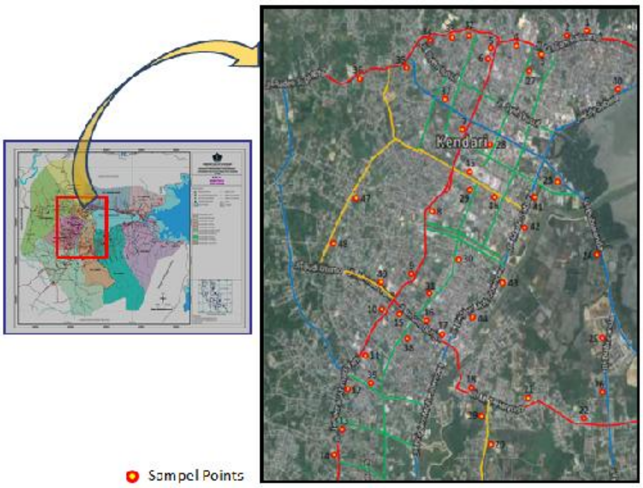


Figure 1. Location and Point of Research Sample

B. Data Collection

The number of observations sample were 49 points on arterial and collector roads. Criteria for determining the sample point used incidental sampling technique by considering the function of road and environmental conditions of the road. Surveys of noise and temperature were conducted for 10 minutes at each observation sample point. SLM microphone was placed at a distance of 6m from the edge of pavement. To obtain the value of equivalent continuous noise level (L_{eq}), it was calculated by the following equation [7] [8]:

$$L_{eq} = L_{50} + 0{,}43\ (L_1 - L_{50}) \quad (1)$$

Where, L_{eq} is equivalent continuous noise (dBA), L_{50} is noise exceeded 50%, and L_1 is noise exceeded 1%.

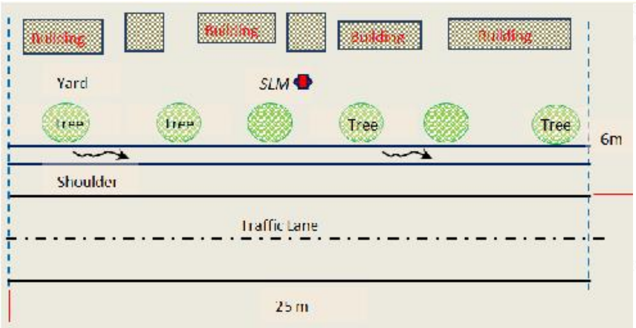


Figure 2. SLM Placement Scheme

Types of environmental surfaces between road side and buildings (yard) were identified according to the types of surface namely; (1) grass, (2) land, (3) paving-block, (4) concrete rebates. The identification was performed on each observation segment along 25m. Percentage of building density was calculated by the equation:

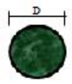
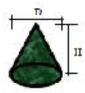
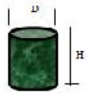
$$D_{bg} = \frac{\Sigma(Ld1+Ld2+..+Ldn)}{Ps} \times 100\% \quad (2)$$

Where, D_{bg} is building density (%), L_{di} is width of buildings walls (m), Ps is observation segment length (m). Tree density was calculated by the equation:

$$D_{Ph} = \frac{\Sigma(Pk1+Pk2+..+Pkn)}{Ps} \times 100\% \quad (3)$$

Where, D_{ph} is tree density (%), P_{ki} is width of leaf canopy (m), Ps is observation segment length (m). Leaf volume calculation used the equations in Table 1 [9].

Table 1. Leaf Lush Volume Based on Canopy Shape

No	Canopy Shape	Sketch	Equation	Description
1.	6.4.1.1 Grobular		4/3.π.r³	a. Grobular is round shape b. r = ½ D r – radius
2.	Conus		1/3.π.r².H	Conus is conical shape
3	Cylender		π r² H	

Leaf volume in Table 1 applied to the leaf lush percentage of 100%. If less than 100%, then the leaf volume was multiplied by the percent value of the leaf lush in Figure 3.

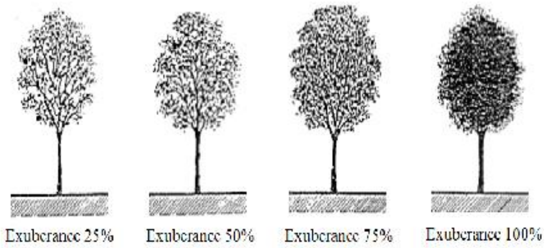


Figure 3. Estimated Leaf Lush Percentage

3. RESULT AND DISCUSSION

Variables becoming the predictor consisted of; building density (D_{bg}), trees density (D_{ph}), leaf lush volume (V_{da}), types of road environment ground surface (P_{bu}), temperature (S_u). These were independent variables constituting component forming the model. The response variable was the noise level (NL). Analytical approach in determining the factors affecting noise used statistical method of simple and multiple-regression with SPSS ver. 22.0.

Simple regression analysis is a method to determine the partial effects of each predictor variable on the response variable. The effects of the variables were seen from the probability of significance and coefficient of determination (R^2). The confidence level used was 95%, meaning the significance value (p-value) less than or equal to 5%, and had a coefficient close to 1 ($R^2 \approx 1$).

The analysis results in Table 2 show that the tree density has the highest effect, that is by 19%, then leaf lush volume 9.7%, temperature 9.1%, building density 8.7%, and type of ground surface road environment 5.8 %. However, if seen from the significance value, it turns out that the building density and type of ground surface road environment are not significant because p-value is > 0.05. Most relationship between predictor variable and response are non-linear. Multiple-regression model used several predictor variables and one response variable. The goal was to determine the effects of predictor variable simultaneously. Based on the output of Table 2, the variables used were the variable having significant value (p-value) < 0.05, they were; tree density (D_{ph}), leaf lush volume (V_{da}), and temperature (S_u).

Table 3. Multiple Regression Model

No	Model	F-count	F-table	SEE	SD	p-value	R^2
1	$N_L = 69.9 - 0.02Dph - 0.004Vda + 0.051Su$	3.24	2.81	1.05	0.94	0.034	31.6
2	$Log\ N_L = 1.85 - 0.016Dph - 0.003Vda + 0.017Su$	3.15	2.81	0.00	0.14	0.023	31.1

Table 3 showed the alternative models of multiple regression analysis.Therefore, the reflection effect of the building wall is almost non-existent, similarly in the type of ground surface, on which the number of observation samples that do not have obstacles such as trees are only 18% of the total sample. It is possible that this is the cause of the relationship between ground surface type and noise not significant.

Table 2. Model and Effects of Partial Variables

No	Model	p-value	R^2
1	$N_L = 66.3 + 0,987*\ln(Dbg)$	0.055	8.7
2	$N_L = 77.5*Dph^{0.023}$	**0.019**	**19**
3	$N_L = 77.27*Vda^{-0.006}$	**0.028**	**9.7**
4	$N_L = 69.76*Pbu^{0.016}$	0.168	5.8
5	$N_L = 63.91 + 0,196Su$	**0.033**	**9.1**

Based on the examination of statistical parameters in Table 3, the selected model is number 2 because it meets all the test parameters, namely; Fcount 3.15 > F_{table} 2.81, standard error of the estimate 0.00 < standard deviation of 0.14, sig (p-value) 0.023 < 0.05, and determination coefficient of 31.1%. Although the building density and the type of road environment ground surface does not have significant effect in this study, based on the study of theory, the two variables affect the noise level. This is possible because in this study, the distance between front building wall and sound level meter (SLM) varies, of which approximately 70% have the distance between 5-20 m.

Therefore, the reflection effect of the building wall is almost non-existent, similarly in the type of ground surface, on which the number of observation samples that do not have obstacles such as trees are only 18% of the total sample. It is possible that this is the cause of the relationship between ground surface type and noise not significant.

Good or bad multiple linear regression model has requirements that must be met, that is classical assumption. The classical assumption tests are, among others: normality, heteroscedasticity, multicollinearity, and autocorrelation.

In Table 4 it can be seen that all the variables have the value of asymp. sig-KS > 0.05, meaning that the data are relatively equal to the average, so it can be said that the residual meets the normality assumption. Detection of the presence of multi-collinearity symptoms can be seen from VIF value. It is said there are no multi-collinearity symptoms if VIF < 10. In Table 5, the VIF value of D_{ph}, V_{da}, and S_u variables are smaller than 10, meaning that there are no multicollinearity symptoms. Independency test aims at detecting the presence of autocorrelation symptoms by seeing the value of Durbin-Watson statistics.

The requirement: du < DW_{count} < 4-du (du: upper limit of Durbin-Watson). The value of DW_{count} = 1.849 (output model summary). The value is in the required range, so there are no autocorrelation symptoms. Heteroscedasticity symptoms can be determined by scatter plot diagram between NL predictive variable (Fits) and residual variable.

Table 4. One-Sample Kolmogorov-Smirnov Test

		Dph	Vda	Su	NL
N		34	34	34	34
Normal Parameters[a,b]	Mean	54.6471	64.8235	34.2647	70.2941
	Std. Deviation	15.28493	45.63191	1.83912	1.81758
Most Extreme Differences	Absolute	.103	.130	.121	.118
	Positive	.103	.130	.087	.081
	Negative	-.078	-.088	-.121	-.118
Test Statistic		.103	.130	.121	.118
Asymp. Sig. (2-tailed)		.200[c,d]	.154[c]	.200[c,d]	.200[c,d]

a. Test distribution is Normal.

From Figure 4, it can be concluded that there is no heteroscedasticity symptoms because the plots are evenly spread above and below axis 0 without forming a specific pattern.

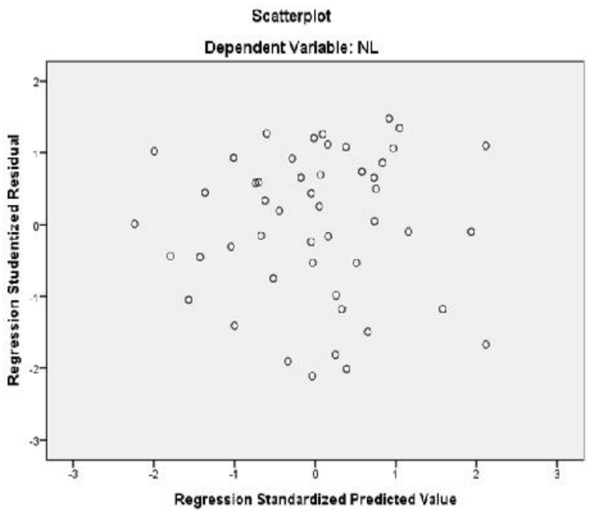


Figure 4. Scatter Plot Diagram

Table 5. Coefficients

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Dph	.494	2.024
	Vda	.491	2.035
	Su	.975	1.025

4. CONCLUSIONS

Simultaneously, the variability of noise level can be explained by the variables of tree density, leaf lush volume and temperature by 31.1%, while 68.9% is explained by other factors not examined in this study.

Based on the determination coefficient, partially the tree density has the highest effects by 19%, then leaf lush volume by 9.7%, temperature by 9.1%, building density by 8.7%, and type of road environment ground surface 5.8 %. However in this study, the factors significantly affecting the noise are only tree density, leaf lush volume, and temperature. It is based on the value of sig-α < 0.05.

Tree obstruction is a factor that makes it difficult to identify in detail the effects of ground surface types on noise, because the sound of vehicle received by SLM has been absorbed by the trees. Therefore, to analyze the effects of ground surface, it needs to perform measurement in a place without obstacles. Likewise, of the effects of building density, the placement of SLM should be in the range of 1-5m reflective distance from building wall and without obstruction from the source of noise.

5. REFERENCES

[1] Undang-Undang Republik Indonesia Nomor 22 Tahun 2009 Tentang Lalu Lintas dan Angkutan jalan.

[2] Sooriyaarachchi, R.T., & Sonnadara, D.U.J., (2008). “Modelling Free Flowing Vehicular Traffic Noise”. Engineer. Volume. 40(2), pp: 43-47.

[3] Golmohammadi, R., Abbaspour, M., Nassiri, P., Mahjub, H., (2009). A compact model for predicting road traffic noise. Journal Environ Health Sci. Eng, Vol. 6(3), pp: 181-186.

[4] Wedagama, D.M.P. (2012). “The Influence of Local Traffic on Noise Level (Case Studi: By Pass Ngurah Rai and Sunset Road, Bali)”. Bumi Lestari Journal of Environment. ISSN 1411-9668. Vol. 12(1), pp: 24-31.

[5] Umiati, S., (2011). “Pengaruh Tata Hijau Terhadap Tingkat Kebisingan Pada Perumahan Jalan Ratulangi Makassar”. Jurnal Teknika, Vol. 2, pp: 12-19.

[6] Pudjowati, U.R., Yanuwiadi, B., Sulistiono, R., Suyadi., (2013). "Effect of Vegetation Composition on Noise and Temperature in Waru-Sidoarjo Highway, East Java, Indonesia". International Journal of Conservation Science. ISSN 2067-533X. Vol. 4(4), pp: 459-466.

[7] Mediastika, C.E., (2005). Akustika Bangunan: Prinsip-Prinsip dan Penerapannya di Indonesia, Erlangga, Jakarta.

[8] Handayani, D., (2007). "Pengkajian Faktor - Faktor Tingkat Kebisingan Jalan Perkotaan". Jurnal Puslitbang Jalan dan Jembatan. Vol. 24(2).

[9] Balitbang PU., (2005). Pedoman Mitigasi dampak kebisingan akibat lalu lintas jalan, Pd T-16-2005-B. Jakarta: Departemen Pekerjaan Umum Republik Indonesia.