

# The Effects of Motorcycle Proportion to Traffic Noise on Residential Area

Rais Rachman<sup>1\*</sup>, Louise E. Radjawane<sup>2</sup>, Alpius<sup>3</sup>

<sup>1,2,3</sup>*Department of Civil Engineering, Universitas Kristen Indonesia Paulus, Makassar, Indonesia*

\*Corresponding author. Email: [rais.rachman@ukipaulus.ac.id](mailto:rais.rachman@ukipaulus.ac.id)

## ABSTRACT

One of the roads in a residential area that connects the city of Makassar and Gowa Regency is Daeng Tata Lama. Daeng Tata Lama street is dominated by motorcycles. The addition of this volume of traffic load has the effect of noise pollution on residential area in the section. The aim of this study are to determine traffic performance on Daeng Tata Lama street and to determine the effect of the proportion of motorcycle on noise in residential area, Daeng Tata Lama street. Traffic performance of the Daeng Tata Lama street is 0.656, this value indicates that the flow is still in stable condition, but the speed of vehicle begins to adjust to the segment volume. The noise on Daeng Tata Lama section has exceeded the standard noise level, 73 dB(A). The average combination of noise for the proportion of motorcycles 25-50% is 62 dB (A), 50 - 75% is 68.82 dB (A), and for 75 - 100% is 76.97 dB (A).

*Keywords: traffic performance, motorcycle proportion, noise, residential*

## 1. INTRODUCTION

Intersection of Malengkeri street- Sultan Alauddin street- Syekh Yusuf street- Sultan Hasanuddin street connects Gowa Regency and Makassar City. The high volume at the intersection forces motorists use alternative segments as a road access to Gowa Regency and Makassar City. One of the roads in the residential area that is used as an alternative road to Makassar City or Gowa Regency is Daeng Tata Lama street. Daeng Tata Lama street was dominated by motorcycle. The addition of traffic volume has the effect of noise pollution on residential areas in the section. The aim of this study are to determine traffic performance and to determine the effect of the proportion of motorcycle to traffic noise on residential area.

## 2. LITERATURE REVIEW

### 2.1 Traffic Performance

The degree of saturation is the ratio between the volume of peak hour traffic conditions and capacity, the normal limit is the degree of saturation, which is 0.75 (Indonesia Highway Capacity Manual, 1997). The mathematical equations of degree of saturation and capacity can be seen in Eq.(1):

$$DS = Q/C \quad (1)$$

Degree of saturation (DS), volume (Q - passenger car unit/hour), and capacity (C passenger car unit/hour).

Capacity values are obtained from Eq.(2):

$$C = C_0 \times F_{CW} \times F_{CS} \times F_{SP} \times F_{SF} \quad (2)$$

Capacity (C - passenger car unit/hour), base capacity ( $C_0$  - passenger car unit/hour), lane width factor ( $F_{CW}$ ), city size factor ( $F_{CS}$ ), split proportion factor ( $F_{SP}$ ), and side friction factor ( $F_{SF}$ ).

Value of basic capacity based on type of road. (Indonesia Highway Capacity Manual, 1997). For 4 / 2D, 4 / 2UD road types, and one-way road the base capacity value is calculated per lane, while 2 / 2D base capacity value is calculated in two-way totals. The value of road split proportion factor according to the type of undivided road and division of direction is expressed in percent. Distribution of directions for peak hour volume. For the value of city size adjustment factor based on the population of a city, the higher value of the city size adjustment factor. Road type 4/ 2D, 4/ 2UD, and one-way road, effective width of traffic lane calculated per lane. For 2 / 2UD road types, the effective width of the traffic lane is calculated in a total of two directions. The wider the effective traffic lane the greater the value of the lane width adjustment factor. Pedestrians, public transport, stopped vehicles, non-motorized vehicles, frontage roads are categorized as side friction.

### 2.2. Noise

Noise is unwanted sound from a business or activity at a certain level and time that can cause disruption to health and

comfort in the environment (Ministry No.48/MenLH/II/1996). Criteria for noise limits vary according to land use. In terms of health, the influence of noise can affect the psychological and cause discomfort. Criteria for noise limits can be seen in Table 1 and the mathematical equation to find the equivalent noise level is

$$L_{eq} = 10 \log \left[ \frac{1}{N} \sum_{i=1}^n (10^{\frac{L_i}{10}}) \right] \quad (3)$$

Equivalent noise level ( $L_{eq}$ ), number of data (N), and value (Li).

$L_{eq}$  value is calculated compared to the standard value of the noise level set with a tolerance of +3 dB (A).  $L_{eq}$  value is an equivalent noise level that shows a value that takes into account the total sound intensity over a certain period of time from the sound level that varies from time to time.

Table 1. Criteria for noise limits

No	Land Use	Noise Rate (dB)
1.	Housing	55
2.	Residential	70
3.	Trading	65
4.	Office	50
5.	Urban open space	70
6.	Industry	60
7.	Government	70
8.	Recreation	55
9.	Hospital	55
10.	School and place of worship	55

### 2.3. Previous Research

S. Djalante (2010) analyzes the noise level based on The Book of Road Traffic Noise method, with a combination of noise levels of 67,615 dB (A).

T. Tsubramani, M. Kavitha, dan K.P. Sivaraj (2010) analyze air noise and pollution using SIDRA software. The results of the noise are in the values 62.4 - 87.6 dB (A).

P. Balashanmugam., V. Nehrukumar, K. Balasubramaniyan, and G. Balasubramanian, (2013) investigates the average noise levels at crossroads, roundabouts, parking lots, garages, respectively, are L10 (93, 84, 86.2), L50 (89, 79.3, 82.8), L90 (85, 74.5, 79.7),  $LA_{eq}$  (90.5, 88.1, 88.8), TNI (90, 89.4, 76.6), LDN (103, 99.8, 103), LA min (76.5, 76.5, 82.1), LA max. (82.5, 83.1, 85.6).

Mansour Ali, and Forouhid Amir Esmael, (2014) claims that pollution due to traffic noise is a serious health problem, because the noise level has exceeded the standard set by The Noise Pollution (Regulation and Control) Rules, 2000. Residential areas have a noise level of 67.82 - 73.28 dB (A), schools have a noise level of 65-72.16 dB (A) and hospitals have a noise level of 68-71.33 dB (A), while the industrial area has a noise level of 67.66-73.83 dB (A).

M.U. Onuu, and O. Oluwasegu,(2015) found increasing of noise levels influenced by the number of vehicles, noise levels increase as vehicle speed increases, noise levels decrease with increasing atmospheric temperature and increased surface temperatures, and noise levels increase with increasing humidity.

### 3. METHODOLOGY

The study was conducted on the Daeng Lama section located on the border of Makassar City and Gowa Regency, where the road has a width of 3.5 m with a road type 2/2 UD. This road does not have sidewalks, therefore 0.5 m of road is pedestrian paths. The primary data needed is the number of vehicles, road geometric, noise, and spot speed. For traffic enumeration, measurements are carried out with 5-minute intervals in 10 hours of observation, the segment length is 50 m, while noise measurements are carried out every 5 seconds using a sound level meter. The location of the study is presented in Figure 1.



Figure 1. Study location

### 4. RESULT AND DISCUSSION

#### 4.1. Traffic Performance

Daeng Tata Lama section 2/2 UD type road length with 3 m effective road width has a volume of 455 pcu/hour during peak hour 06.50 - 07.50 am. Motorcycle has the largest proportion 94.04%, followed by light vehicles (5.20%), non-motorized vehicles (0.63%), and the smallest proportion was heavy vehicles (0.13%). Direction distribution of 23% for directions to Gowa Regency and 77% for directions to Makassar City. Factor for road width (FCw) 0.336, base capacity ( $C_0$ ) 2900 pcu /total two ways, city size factor (FCs) 0.86, road split proportion factor is 0.88, and side friction factor 0.94, using equation (1) the capacity is 693 pcu/hour and the degree of saturation 0.67 with using equation (2). The performance of Daeng Tata Lama street was still relatively stable, but the driver's speed has been affected by the volume.

#### 4.2. Flow, Speed, and Density Relationship

Relationship between speed and density using

Greenshields model has  $R^2$  0.452 for direction to Makassar and 0.709 to Gowa. Free flow speed was 35 km/h, maximum density is 17 vehicles/km/lane for directions to Makassar and 8 vehicles/km/lane to Gowa, the mathematical formula is  $35 - 2,083 k$  to Makassar and to Gowa  $35 - 4,217 k$ , Gowa with Greenberg model,  $R^2$  are 0.767 to Makassar and 0.856 to Gowa with equation are  $k / -4.003 - \ln 8955 / -4.003$  for directions to Makassar and  $\ln k / 0.0045 - \ln 23.91 / 0.0045$  to Gowa. The equation obtained by the relationship of speed and density with the Underwood Model for directions to Gowa is  $35 \exp(-k / 0.205)$ ,  $R^2$  value is 0.6248,  $35 \exp(-k / 0.4598)$  and  $R^2$  is 0.8795 for direction to Makassar.

Value of  $R^2 = 1$  for flow and density relationship, where the capacity is 147 pcu/h to Makassar and 70 pcu/hr to Gowa with the mathematical equation is  $35 k - 2,083 k^2$  for directions to Makassar and  $35 k - 4,217 k^2$  to Gowa. The relationship of flow and density results in modelling traffic for directions to Makassar  $k (\ln k / -4.003) - k (\ln 8955 / -4.003)$  and to Gowa,  $k (\ln k / 0.0045) - k (\ln 23.91 / 0.0045)$ . Whereas for the relationship of flow and speed has a coefficient of determination  $R^2 = 0.0846$  and 1 respectively for directions to Makassar and Gowa. The flow and density relationship produces the equation  $k 35 \exp(-k / 63)$  for the direction to Makassar and  $35k \exp(-k / 6)$  for the direction to Gowa. The value of  $R^2$  for the direction to Makassar is 1 and the direction to Gowa is 0.998.

While for the relationship of flow and speed has  $R^2 = 1$  and 0.97 direction to Makassar and Gowa, whereas the linear equations are  $16.8 V - 0.48 V^2$  for directions to Makassar and to Gowa  $8.3 V - 0.237 V^2$ . From the relationship of speed and density of direction to Makassar and The Greenberg model equation relates to flow and speed  $V 8955 \exp(-4.003 V)$  for directions to Makassar and  $23.91 V \exp(0.0045 V)$  to Gowa. The maximum density value is infinite. From the relationship of flow and speed, the value of  $R^2$  is 0.594 for directions to Makassar and 0.7713 for directions to Gowa. The equation of the relationship between the flow and speed of the Underwood Model for the direction to Makassar is  $63k (\ln 35 - \ln V)$  and  $6k (\ln 35 - \ln V)$  for the direction to Gowa. The maximum density value of the Underwood Model if passed is worth 62 vehicles/km/lane.

The Greenshield model has a better  $R^2$  than the other two models. The graphs of the relationship of flow, speed, and density are presented in Figures 2, 3, 4, 5, 6, and 7.

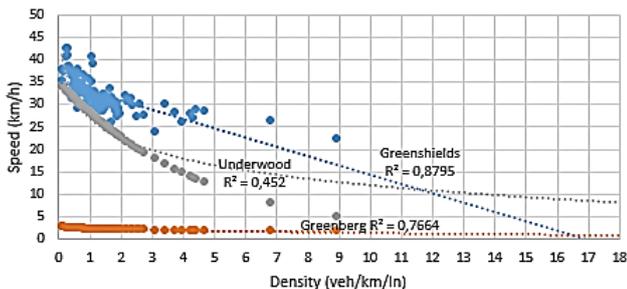


Figure 2. Relationship speed and density (to Makassar)

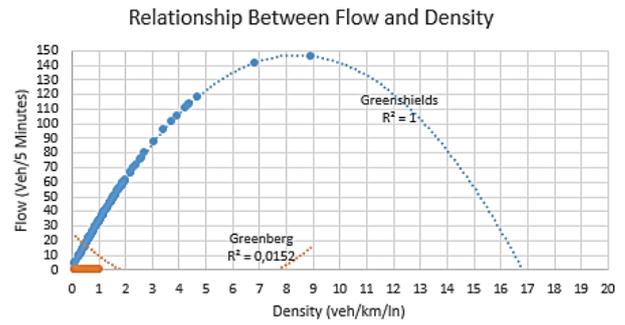


Figure 3. Relationship between flow and density (to Makassar)

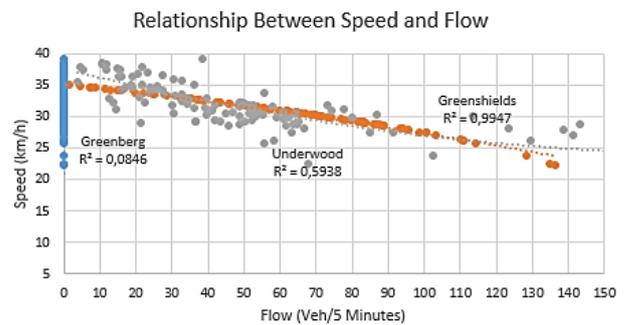


Figure 4. Relationship between flow and speed (to Makassar)

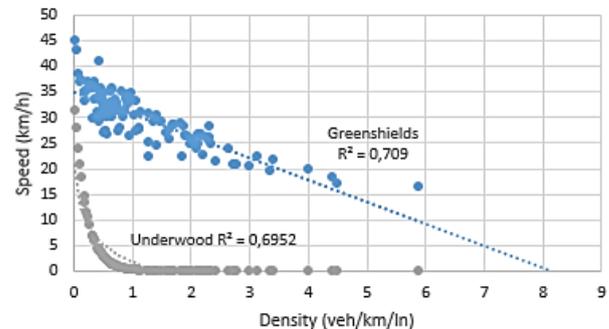


Figure 5. Relationship between speed and density (to Gowa)

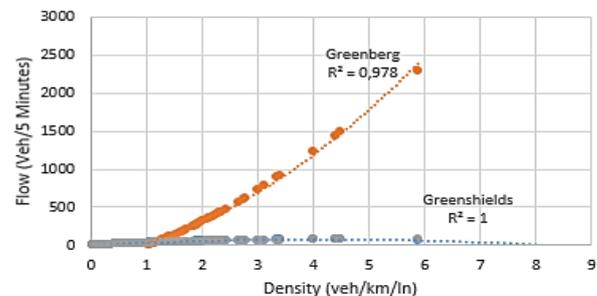


Figure 6. Relationship between flow and density (to Gowa)

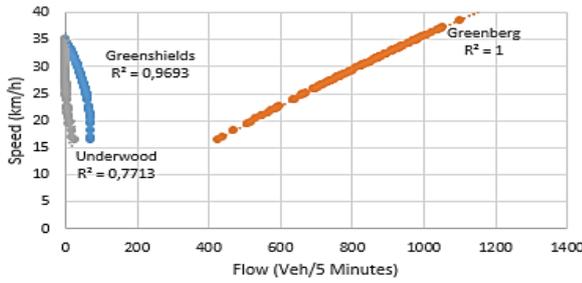


Figure 7. Relationships between flow and speed (to Gowa)

4.3. Traffic Noise

The Leq value obtained starts from 62 dB (A) to 84.86 dB (A). The cumulative average is 76.49 dB (A) with standard deviation is 4.49. When compared with the standard noise level for settlements 73 dB (A) [1], the noise in Daeng Tata Lama section has exceeded the standard noise level. Cumulative noise level Leq can be seen in Figure 8.

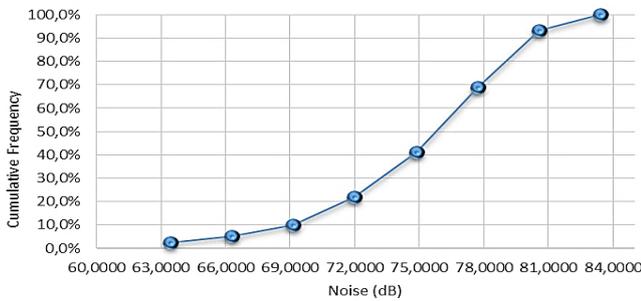


Figure 8. Cumulative frequency of traffic noise

4.4. Relationship between Motorcycle Proportion and Noise

The proportion of motorcycle has a positive linear relationship to noise, as seen in Figure 10, the addition of motorcycle causes an increase in noise level of 47%. The average combination of noise for the proportion of motorcycles 25-50% is 62 dB (A), 50 - 75% is 68.82 dB (A), and for 75 - 100% is 76.97 dB (A), while for the proportion of motorcycles 0-25% in this study is not available. Noise from motorcycle is caused by modified motorcycle exhaust, engine, tire type, wind pressure, and excessive gas pedal pressure. The relationship between the proportion of motorcycles and traffic noise can be seen in Figure 9 and Figure 10.

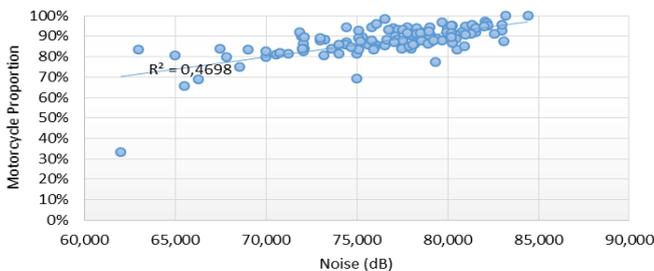


Figure 9. Relationship between motorcycle proportion and traffic noise on residential area

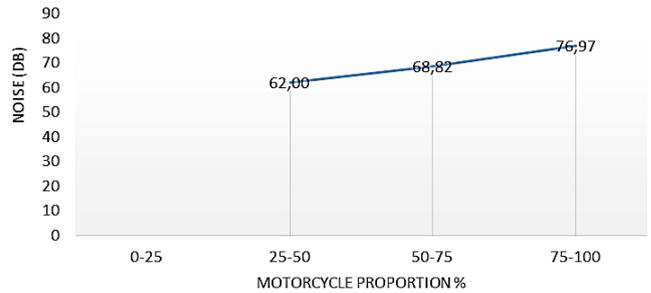


Figure 10. Relationship between motorcycle proportion and cumulative frequency of traffic noise on residential area

5. CONCLUSION

Traffic performance of Daeng Tata Lama street was 0.656, which indicates the flow is still in stable condition, but the speed of the driver begins to adjust to the segment volume. Compared with the standard noise level for settlements 73 dB (A), Daeng Tata Lama street has exceeded the standard noise level. The cumulative frequency of traffic noise to the proportion of motorcycles 25-50% is 62 dB (A), 50 - 75% is 68.82 dB (A), and for 75 - 100% is 76.97 dB (A).

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