Analysis of Traffic Volume Due to the Sound of Motor Vehicle in front of SMA Taruna Terpadu Boash During Covid-19

Syaiful Syaiful[1], Renea Shinta Aminda[2], Rulhendri Rulhendri[1], Haldiana Haldiana[2]

[1]Civil Engineering Departement Ibn Khaldun University Bogor, INDONESIA
[2]Management Department Ibn Khaldun University Bogor, INDONESIA
E-mail: syaiful@ft.uika-bogor.ac.id

ABSTRACT

Each motorized vehicle produces a variety of noise. This noise has a considerable impact on the tranquility of the area that is directly in contact with the highway. Therefore, setting the distance between the main school building and the highway must be taken into account, for the sake of realizing the comfort of the school students. The volume of motorcycles, the volume of private vehicles and public transportation has a significant effect on noise, from all the analysis calculations, the largest equation is obtained on the first day of the study, the third point (Sound Level Meter 3) a distance of 20.50m, with the calculation below, $y = 54.61 + 0.002x1 - 0.002x2 + 0.002x3 + 0.004x4$. This equation means that if there is no decrease in the volume of the motorcycle, the noise level at SLM3 is 55.21 dB$_A$. If there is an increase and decrease in the volume of the motorcycle it will have a significant effect on the noise. The second largest equation in the second day of research is at the second point (Sound Level Meter 2) a distance of 4.00m with an equation calculation of, $y = 57.22 - 0.012x1 - 0.021x2 - 0.022x3 - 0.014x4$. The meaning of the above equation is that if there is an increase in the volume of the motorcycle, the noise in SLM2 is 57.22dB$_A$. From the results obtained, there was a reduction in the number of motorbikes during the Covid-19 pandemic, because students who were studying did not come to school. The reduction in the number of motorbikes crossing the SMA Taruna Terpadu Boash reached 52%.

Keywords: traffic volume; noise; motor vehicle; sound level meter; pandemic Covid-19.

INTRODUCTION

Increased mobility of people requires adequate, safe, comfortable and affordable transportation facilities and infrastructure for the community. The increase in per capita income makes people able to buy vehicles such as motorcycles and four-wheeled vehicles as a means of personal transportation. The increase in the regional economy has also led to an increase in the need for public transportation facilities such as buses and trucks (Abdel-Wahed TA, et.al, 2017; Ahmad KA, et.al, 2018). As a result, the number of traffic flows and the types of vehicles that use road sections are increasing day by day, this causes problems in the transportation sector, one of which is the problem of noise pollution (noise) caused by traffic flows to the surrounding environment, one of which is the school area, hospital. Noise is unwanted sound, in general noise is closely related to disturbance. Noise is everywhere and distraction is one of the most common reactions to noise. Traffic noise is the dominant source of environmental noise in urban areas. Sources of noise associated with transportation are those from private cars, passenger cars, motorcycles, buses, trucks and heavy vehicles (Syaiful S, Sri WM, 2019; Syaiful S, et.al, 2022; Syaiful S, et.al, 2022; Syaiful S, Wahid N, 2020) Each vehicle produces noise, but the source and amount of noise varies greatly depending on the type of vehicle. Noise in urban areas with heavy traffic is not a new problem anymore, but an old problem that needs to be solved together (Aslan H and Kocaman H, 2018; Astarita V, et.al, 2018). Health services are not only influenced by internal factors, but also by external factors, namely the condition of the surrounding environment. Noise is a disturbing thing in the process of health services, at a prolonged intensity and at a certain level it can be harmful to health (Cicilia K, et al, 2019; Hana K and Juang A, 2019).

The purpose of this study was to obtain how much noise level caused by the volume of motorized traffic on the road in front of SMA Taruna Terpadu Boash Salabenda, Bogor district. The limitation of the research in making this final project is limited to the object of research on the

source of noise generated by motorized vehicles, both private vehicles, public transportation and freight transportation on the road in front of SMA Taruna Terpadu Boash Salabenda, Bogor Regency. The noise disturbance studied and observed is limited to noise source level disturbances which are not disturbances of air pollution levels or waste pollution. The sample used is the road users in front of the Boash Salabenda SMA Taruna Terpadu, Bogor Regency, namely, the staff from the Taruna Terpadu Boash Salabenda high school and people who pass in front of the SMA Taruna Terpadu Boash Salabenda, Bogor Regency. The sample studied can represent daily activities carried out at 06.00 - 18.00 WIB. Days that represent each hospital activity for four days, namely Monday, Wednesday, Thursday and Saturday, which means the day that represents each activity.

In research on noise in schools, the most important influence is the sound of public transport vehicles stopping in front of the school gate. This stop will result in congestion, the form of traffic jam is the gathering of motorized vehicles, causing noise. This sound will affect the hearing of the students. So that special research is needed so that public transportation and student pick-up transportation do not stop carelessly. It should also be noted that public transport stops are far from the school entrance gate (Syaiful S, Andana R, 2021; Syaiful S et.al, 2022; Syaiful S, Irbah AF, 2021; Syaiful S et.al, 2021; Syaiful S et.al, 2022).

Traffic flow

Traffic flow in general is a traffic condition that has an influence in terms of the volume and volume of traffic itself (Anonymous, 1997).

Free flow volume in real condition

The volume of free current in real conditions is shown in the equation (1).

FV = (FVo + FVw) x FFsf x FFVcs …………………………………………………………(1)

With:

FV   : actual basic free current volume (LV), [Km/hour];

Fvo   : basic free flow volume (LV), [Km/hour];

FVw   : effective traffic width adjustment [Km/hour];

FFVcs   : city size adjustment factor;

FFVsf   : side resistance adjustment factor.

Capacity

The capacity value is shown in the equation (2).

C = CO x F cw x FCsp x FCsp x FCcs…………………………………….………………….(2)

With:

C   : capacity [pcu/hour];

CO   : basic capacity for certain conditions [pcu/hour];

Fcw   : traffic lane width adjustment factor;

FCsp   : direction separator adjustment factor;

FCsf   : side resistance adjustment factor;

FCcs   : city size adjustment factor

Road performance level

 The level of road performance is shown in the equation (3).

$$\dfrac{Q}{C}$$

$$DS = \text{———} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots..(3)$$

With :

DS   : degree of saturation,

Q   : traffic flow capacity,

C   : capacity.

Passenger Car Equivalent

The passenger car equivalent (EMP) for each type of vehicle depends on the type of road and the total traffic flow expressed in 1 hour. All SMP values for different vehicles are based on the EMP coefficient, to determine the equivalent of a passenger car, it is shown in table 1, and the determination of the frequency of events is shown in table 2.

Table 1. Determining passenger car equivalence (EMP)

Road type = one-way street and divided road	Traffic flow per lane (vehicles/hour)	EMP	
		HV	MC
Two lanes one way (2/1)	0	1,3	0,40
Four divided lanes (4/2D)	>1050	1,2	0,25
Three lanes one way (3/1)	0	1,3	0,40
Six divided lanes (6/2 D)	>1100	1,2	0,25

(Anonymous, 1997)

Table 2. Determination of incident frequency

Types of Adverse Events	Symbol	Weight Factor
Pedestrian	PED	0,5
Parking, vehicle stop	PCV	1,0
Vehicles in+out	EEV	0,7
Slow vehicle	SMV	0,4

(Anonymous, 1997)

Road capacity/actual capacity

Actual capacity is defined as the maximum current through a point on the road that can be maintained per hour under certain conditions. The capacity value is observed through data collection in the field whenever possible, because the location has a flow approaching the capacity of the road segment a little (as seen from the capacity along the road), the capacity is also estimated from the analysis of light traffic conditions. The total capacity is the product of the basic capacity (Co) for certain conditions (ideal) and the correlation factors (F) taking into account the effect on capacity, the capacity is expressed in passenger car units (pcu). The basic equation for determining the capacity shown in equation (4) is:

$$C = Co \times FCw \times FCsp \times FCsf \times FCcs \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots....(4)$$

With :

C   : actual capacity [pcu/hour];

Co   : basic (ideal) capacity for certain ideal conditions [pcu/hour];

FCw   : adjustment factor for capacity;

FCsp   : adjustment factor for current-splitting capacity;

FCsf   : adjustment factor for 2 shoulder side drag capacity;

FCcs   : adjustment factor for city size capacity.

The adjustment factor is obtained from the table if the actual condition is the same as a certain base case (ideal), then all the adjustment factors are 1.0 and the capacity is the same as the basic capacity (Co), the FCw capacity adjustment is shown in table 3 and the FCsp capacity adjustment factor is shown in the table 4.

Table 3. Co base capacity for urban roads

Road type	Basic capacity (SMP/Hour)	Notes
Four lanes split or one way street	1659	Per lane
Four undivided lanes	1500	Per lane
Two undivided lanes	2900	
		Total two-way

(Anonymous, 1997)

Table 4. Adjustment of FCw capacity for the effect of traffic lane width for urban roads

Road type		Effective traffic lane width(Wc) (M)	FCw
Four lanes split or one way street	Per lane	3,00	0,92
		3,25	0,96
		3,50	1,00
		3,75	1,04
		4,00	1,08
Four undivided lanes	Per lane	3,00	0,91
		3,25	0,95
		3,50	1,00
		3,75	1,05
		4,00	1,34
Two undivided lanes	Per lane	5	0,56
		6	0,87
		7	1,00
		8	1,14
		9	1,25
		10	1,29
		11	1.34

(Anonymous, 1997)

Table 5. Capacity adjustment factor for direction separator (FCsp)

Directional separator SP %-%		50-50	60-40	70-30	80-20	90-10	100-0
FCsp	Two lane 2/2	1,00	0,94	0,88	0,82	0,76	0,70
	Four lanes 4/2	1,00	0,97	0,94	0,91	0,88	0,85

Degree of Saturation

The degree of saturation (Ds) is the ratio of the current to the capacity used so that the main factor in determining the level of performance and road segments, the value of the degree of saturation also indicates whether the segment of the road has capacity problems or not. The degree of saturation on a certain road is calculated by equation (5) as follows:

$$DS = \frac{Q.\,smp}{C} \quad\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(5)$$

With:

Ds   : degree of saturation [pcu/hour];
Q   : traffic flow;
C   : actual capacity [pcu/hour].

The actual total current (Q.smp) is calculated by the formula:

$$Q.smp = Qvehicle \times Fsmp \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(6)$$

Noise

Noise is an unwanted sound from a business or activity at a certain level and time that can cause disturbances to human health and environmental comfort (Anoim, 1996). Based on the nature and spectrum of sound, noise is divided into:

1. Continuous noise with a wide frequency spectrum, this noise is relatively constant within the limits of approximately 5 dBA for a period of 0.5 seconds consecutively.

2. Continuous noise with a narrow frequency spectrum, this noise is also relatively constant, but only has a certain frequency (at a frequency of 500, 1000, and 4000 Hz) such as secular chainsaws, gas valves.

3. Intermittent noise, this noise does not occur continuously, but there is a period of relative calm, for example traffic noise, noise at the airport.

4. Impulsive noise. This type of noise has a change in sound pressure exceeding 40 dB in a very precise time and usually shocks the hearing, eg gunshots, explosions of firecrackers, cannons.

5. Repeated impulsive noise. This noise is the same as impulsive noise, only here it occurs repeatedly, for example a forging machine.

6. The types of environmental noise can be shown in table 6, while the effects of noise are shown in table 7.

Table 6. Types of environmental noise

Definition	Description
Noise amount	All the noise in all places at a certain time anyway.
Specific noise	Noise between amounts of noise that can be clearly distinguished for acoustic reasons. Often the source of the noise can be identified.
Residual noise	The noise that remains after the elimination of all specific noise from the amount of noise in a certain place at a certain time.
Background noise	All other noise when focusing on a particular noise.

(Anonymous, 1996)

Table 7. Effects of noise

Type		Description
Physical consequences	Hearing loss	Temporary threshold change due to noise.
		Permanent threshold change due to noise
Physical consequences	Physiological consequences	Increased discomfort or stress, increased blood pressure, headache, ringing sound.
		Annoyance, confusion.
Psychological consequences	Emotional disturbance	

(Anonymous, 1997)

These limits of noise levels for some areas or environments can be shown in table 8.

Table 8. Noise level limits

Health area/environment designation	Noise level (dB$_A$)
1. Area allocation	
a. Housing and settlement	55
b.Trade and services	70
c.Office and trade	65
d.Green open space	50
e.Industry	70
f. Government and public facilities	60
g.Recreation	70
2. Activity environment	
a. Hospital or the like	55
b. School or the like	55
c. Places of worship or the like	55

(Anonymous, 1996)

Data analysis

Observational data in this study is the observation data on the level of noise on a straight road with regional characteristics. The assumption taken is that the increase in the noise level (Y) is a dependent variable and is influenced by several independent variables, namely:

X1 is the first independent variable/motorcycle volume (SPM)

X2 is the second independent variable/volume of private car (MP)

X3 is the third independent variable/volume of public transportation (AU)

X4 is the fourth independent variable/volume of freight transport (AB)

Based on the data above, the linear regression model approach is obtained, namely: Y = a0 + a1.X1 + a2.X2 + a3.X3 + a4.X4 + ……….an.Xn. Where ao, a1, a2, a3 and a4 are coefficients determined based on research data.

Research Place

The place and location of this research is in front of SMA Taruna Terpadu Boash Salabenda, namely the Bogor-Parung highway, including the National road.
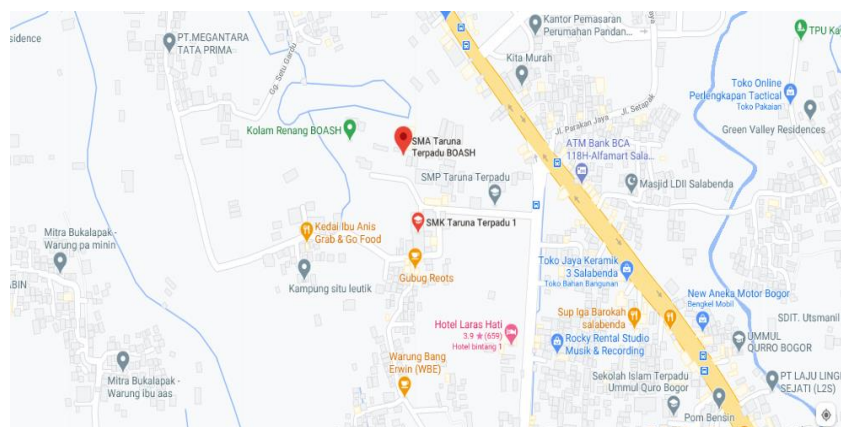

Figure 1. Research site map

Figure 2. The location is in front of the SMA Taruna Terpadu Boash Salabenda

Ingredient

The material used in this study is in the form of data forms to retrieve traffic data for motorcycles, private cars, public transportation and freight transport as well as noise data taken from the measurement results of the Sound Level Meter (SLM) noise instrument used.

Tool

The main and supporting equipment used in this study are as follows:

1) Sound Level Meter (SLM), as the main tool for calculating noise that occurs at a certain place and time. The SLM used has fruit, which include:

a) SLM 1, SLM Manual Krisbow brand, type KW06-291,

b) SLM 2, SLM Manual brand Krisbow, type KW06-291, and

c) SLM 3, SLM Outo brand Extech, type HD600.

2) Roll Meter, as a tool to measure the distance between the SLM point and the road and school wall buildings.

3) Digital camera, to document all processes in the ongoing research.

4) Tally or manual counting tool, as a tool to count the number of vehicles passing on the highway.

5) Laptop, as a tool in data collection and processing data obtained from the field during the research.

6) Stationery and note-taking officers in the field, to assist in recording everything obtained during data collection in the field.

RESEARCH METHODS

The research method is presented in the form of a flow chart in figure 3 below.
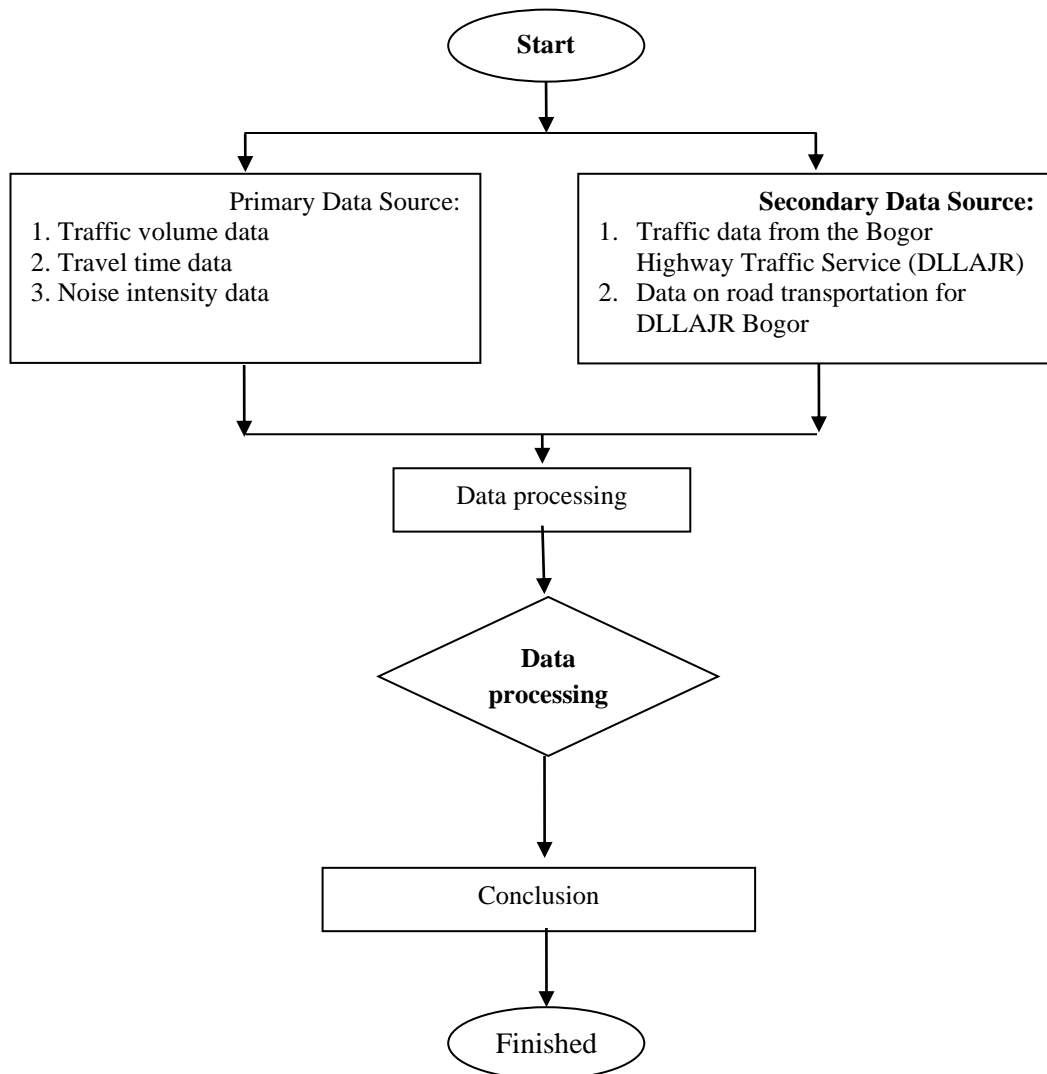
Figure 3. Research flow chart

RESULTS AND DISCUSSION
Traffic data results

This traffic data is obtained from the calculation of the Passenger Car Equivalence (EMP). The use of this calculation is intended to make it easy for traffic analysis to be carried out by passenger car unit factors (SMP) for each motor vehicle according to the Indonesian Road Capacity Manual (MKJI 1997), for urban roads as follows:

1) Heavy Vehicle (HV) = 1.30
2) Light Vehicle (LV) = 1.00
3) Motorcycle (MC) = 0.40
4) Non-motorized vehicles = 1.00

In practice, the grouping is divided into two groups, namely motorcycles and light vehicles, where motorcycles (MC) have a value of 0.40 and light vehicles (private cars, public transportation and freight transport) with an EMP of 1.00.

Volume Processing Results on Monday 10 May 2021

Based on the volume calculation guide from the Highways Department of the Ministry of Public Works of the Republic of Indonesia, data collection using volume uses the following formula: Volume of motorcycles number of motorized vehicles / length of time survey

Number of two-way motorcycles	$= 298 + 144 = 442$
Time needed	$= 06.00 – 06.15$
	$= 15$ minutes ($15/60$) = (0.25) hours
Example calculation:	
Is known :	
Number of vehicles (n)	$= 442$ vehicles
so	
Volume (Q=n/t) Q	$= 442/0.25$
	$= 1768.00$ vehicles/hour

Discussion of Noise caused by Motor Vehicles

From the results of data processing using SPSS 22 and selecting the existing data, it is obtained as attached. However, to show that the recommended data below are data on the volume of motorcycles, private cars, public transport cars and freight cars.

Correlation Test

Correlation testing is used to find the relationship between two or more independent variables which are jointly associated with the dependent variable, so that the contribution of the independent variable which is the object of research is known to the dependent variable.

Table 9. Interpretation of r value

No	r	Interpretation of Value r
1	0	Uncorrelated
2	0,01 – 0,20	Very low
3	0,21 – 0,40	Low
4	0,41 – 0,60	Slightly low
5	0,61 – 0,80	High enough
6	0,81 – 0,99	Tall
7	1	Very high

Hypothesis

Ha = There is a significant effect between the volume of motorcycles, the volume of passenger cars, the volume of public transport and the volume of goods transport with noise

Ho = There is no significant effect between the volume of motorcycles, the volume of passenger cars, the volume of public transport and the volume of goods transport with noise

$= 5.00\%$

Statistical Data Analysis Monday May 10, 2021
Discussion using a distance of 0.00m with SLM 1

The results of data processing using SPSS 22 obtained the noise level (y) with the volume of motorcycles (SPM/x1), the volume of private transport cars (MAP/x2), the volume of public transport cars (MAU/x3) and the volume of goods transport cars (MAB/ x4) based on the 95% confidence level. The following is the result of the equation representing the condition of the distance of 0.00m using SLM 1: $y = 87.634 + 9.136E\text{-}6x_1 - 0.010x_2 - 0.002x_3 + 0.006x_4$.

Discussion with a distance of 4.00m using SLM 2

The noise level (y) with the volume of motorcycles (SPM/x1), the volume of private transport cars (MAP/x2), the volume of public transport cars (MAU/x3) and the volume of freight cars (MAB/x4) based on a 95% confidence level. The following is the result of the equation that represents the 4.00m distance condition using SLM 2, namely: $y = 66.954 + 0.003x_1 - 0.002x_2 - 0.008x_3 + 9.056E5x_4$.

Discussion with a distance of 20.50m using SLM 3

The noise level (y) with the volume of motorcycles (SPM/x1), the volume of private transport cars (MAP/x2), the volume of public transport cars (MAU/x3) and the volume of freight cars (MAB/x4) based on a 95% confidence level. The following is the result of the equation that represents the 20.50m distance condition using SLM 3: $y = 54.61 + 0.002x_1 - 0.002x_2 + 0.002x_3 + 0.004x_4$.

Analysis of Statistical Data for Wednesday, May 12, 2021
Discussion using a distance of 0.00m with SLM 1

The results of data processing using SPSS 22 obtained the noise level (y) with the volume of motorcycles (SPM/x1), the volume of private transport cars (MAP/x2), the volume of public transport cars (MAU/x3) and the volume of goods transport cars (MAB/ x4) based on the 95% confidence level. The following is the result of the equation representing the condition of the distance of 0.00m using SLM 1: $y = 83.837 + 0.004x_1 + 0.009x_2 - 0.019x_3 - 0.019x_4$.

Discussion with a distance of 4.00m using SLM 2

The noise level (y) with the volume of motorcycles (SPM/x1), the volume of private transport cars (MAP/x2), the volume of public transport cars (MAU/x3) and the volume of freight cars (MAB/x4) based on a 95% confidence level. The following is the result of the equation representing the condition of the 4.00m distance using SLM 2: $y = 57.22 - 0.012x_1 - 0.021x_2 - 0.022x_3 - 0.014x_4$.

Discussion with a distance of 20.50m using SLM 3

The noise level (y) with the volume of motorcycles (SPM/x1), the volume of private transport cars (MAP/x2) and the volume of freight cars (MAB/x4) based on a 95% confidence level. The following is the result of the equation representing the 20.50m distance condition using SLM 3: $y = 60.139 + 0.001x_1 + 0.002x_2 + 0.001x_4$.

Statistical Data Analysis Thursday, May 13, 2021

Discussion using a distance of 0.00m with SLM 1

The results of data processing using SPSS 22 obtained the noise level (y) with the volume of private transport cars (MAP/x2), the volume of public transport cars (MAU/x3) and the volume of freight cars (MAB/x4) based on a 95% confidence level. The following is the result of the equation representing the condition of the distance of 0.00m using SLM 1: $y = 78.397 + 0.006x_2 + 0.008x_3 + 0.013x_4$.

Discussion with a distance of 4.00m using SLM 2

The noise level (y) with the volume of motorcycles (SPM/X1), the volume of private transport cars (MAP/x2), the volume of freight cars (MAB/x4) based on a 95% confidence level. The following is the result of the equation that represents the 4.00m distance condition using SLM 2: $y = 68.542 - 0.002x_1 + 0.010x_2 + 0.023x_4$.

Discussion with a distance of 20.50m using SLM 3

The noise level (y) with the volume of private transport cars (MAP/x2), the volume of public transport cars (MAU/x3) and the volume of freight cars (MAB/x4) based on a 95% confidence level. The following is the result of the equation that represents the condition of a distance of 20.50m using SLM 3 is: $y = 62.031 + 0.002x_2 - 0.002x_3 + 0.020x_4$.

Statistical Data Analysis Saturday 15th May 2021
Discussion using a distance of 0.00m with SLM 1

The results of data processing using SPSS 22 obtained the noise level (y) with the volume of motorcycles (SPM/x1), the volume of private transport cars (MAP/x2), the volume of public transport cars (MAU/x3) and the volume of goods transport cars (MAB/ x4) based on the 95% confidence level. Here are presented the results of the equation representing the condition of the distance of 0.00m using SLM 1 are: $Y = 76.342 + 0.002x1 + 0.006x2 - 0.005x3 - 0.005x4$.

Discussion with a distance of 4.00m using SLM 2

The noise level (y) with the volume of motorcycles (SPM/x1), the volume of private transport cars (MAP/x2), the volume of public transport cars (MAU/x3) and the volume of freight cars (MAB/x4) based on a 95% confidence level. The following is the result of the equation that represents the 4.00m distance condition using SLM 2: $y = 66.325 + 0.001x1 + 0.007x2 - 0.002x3 - 0.005x4$.

Discussion with a distance of 20.50m using SLM 3

The noise level (y) with the volume of motorcycles (SPM/x1), the volume of private transport cars (MAP/x2) and the volume of freight cars (MAB/x4) based on a 95% confidence level. The following is the result of the equation representing the condition of the distance of 20.50m using SLM 3: $y = 58.204 + 0.003x1 - 0.001x2 - 0.017x4$.

CONCLUSION

Based on the above discussion that the increase in the volume of motorcycles, private transport cars, public transport cars and goods transport cars to the noise generated, the following results are obtained. The volume of motorcycles, private transport cars, public transport cars and freight transport cars has a significant effect on noise, from all analysis calculations, the largest equation is obtained on the first day of the study, the third point (Sound Level Meter 3) a distance of 20.50m, with the equation, $y = 54.61 + 0.002x1 - 0.002x2 + 0.002x3 + 0.004x4$. The volume of motorcycles, private cars, freight cars also has a significant effect on noise, which is the second largest equation obtained on the second day of the study at the second point on (Sound Level Meter 2) with a distance of 4.00m. The contribution of the equation is, $y = 57.22 - 0.012x1 - 0.021x2 - 0.022x3 - 0.014x4$.

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