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RESEARCH ARTICLE

Noise Analysis Caused by Vehicle Speed in front of RS PMI BOGOR

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Abstract

Bogor has a role as the supporting area of Jakarta and Cianjur, Jakarta and Sukabumi, therefore, the main streets of Bogor are always crowded with vehicles. This causes noise so the road users and the people in the area are annoyed by the noise.

This research took place in front of RS PMI Bogor. The data processing uses SPSS program version 17.00 and PSPP program. The result of data processing, it is acquired the highest value of R*square* is 69,54% and the formula, y = 51,649 + 0,263x1 + 0,531x2 + 0,442x3 + 0,634x4. From this formula, there is a significant influence between the speed of the motorcycle, private cars, public cars and freight cars. It means there is an influence of the motorcycle speed, private cars speed, public car speed and freight car about 69,54 % toward noise. Based on the correlation table, the influence is quite enough on SLM 3 with the distance of 13,42 m from the side of the road. If there is no increasing speed of the motorcycle speed, private cars speed, public car speed and freight car, then the level of noise will be 51,649 dB_A. This level of noise is still below the standard of the Ministry of Environment of Indonesia about 55 dB_A which means it is below the limit of noise level.

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Introduction:-

Transportation develops fast from year to year by the technology development. Nowadays, transportation holds important role in human life. Roads are the main facilities in supporting smooth traffic (Highway Capacity Manual, 2000; Nurul Hidayati, 2004; Suwardjoko P Warpani, 2002). With the increasing of the number of vehicles, the number of streets should be added. However, the broadening and addition new roads is only 0,10 % every year (Bappeda Kota Bogor, 2015). Geographically, Bogor is strategically located is near Jakarta, the capital city of Indonesia. The road networking system is not evenly spread, still centered in the city center. To decrease the crowded traffic on the main roads, additional access is needed on the outer ring of the city center and shortcuts (RTRW Kota Bogor, 2011-2031; Susantoro, 2011; Tamim, 2000). Bogor has the role as the supporting city of Jakarta and Cianjur, and also Jakarta and Sukabumi. Therefore, the role causes the main roads in Bogor are always crowded with vehicles (White book Bogor, 2010).

The patients of the hospital will also be annoyed by the passing by vehicles in front of the hospital. Because of that, the distance arrangement between the hospital and the street must be arranged well for the comfort of the patients of the hospital patients. Technical requirements of the hospital building should suit its function, comfort and easiness in giving service and protection and also safety to all people including the handicappers, children and the elderly to create comfort for the public facility users (Legislation about the hospital of Indonesia, 2009). The hospital (RS) PMI BOGOR includes in it so it needs the reconsideration between the sidewalks, trees in front of RS PMI Bogor to the noise of the vehicles. The environment factor that is caused by the transportation activity, generally related with noise, air pollution, pedestrian delay, traffic accident, stress on the driver and public health (Doni J. Widiantono, 2014; Leonard Franita, 2014). Noise defines as unexpected sound for example the one that hampers the voice, sound of music or that causes pain or that hampers the lifestyle (Buchari, 2007). There are two environment quality standards of noise that are the allowed maximum limit (60 dB_A) and the expected maximum limit (45 dB_A) (Jakarta

Governor Decree, 2001). The exceeded noise can bring some bad effects like annoyed feeling, speech problem, sleep disorder, and mentally stress, headache and lack of concentration (Zaen, 2012). Generally, the higher vehicle speed will cause higher noise and the harder road surface will also make higher noise. (Timbul P.M. Panjaitan et al, 2011).

The Study Formula:-

The study in this research is how high the noise caused by the vehicles and its influence to traffic speed.

Study Objective:-

The objective of this study is to get the influence of traffic speed to noise caused by the vehicles and compared the acquired value with the noise limit standard.

Literature Review:-

Speed:-

Speed is a magnitude that shows distance of the vehicle divided by the travelling time (Silvia Sukirman, 2000).

Noise:-

Noise is unexpected sound caused by the activity in a certain time and level that can cause problem in human health and environment comfort. (Ministry of Environment of Indonesia, 1996).

Based on the characters and sound spectrum, noise can be divided by:

1) Continuous noise with the wide frequency spectrum, this noise is still relatively in the limit less than 5 dB_A in 0.5 second in a row.
2) Continuous noise with a narrow frequency spectrum, this noise is relatively steady; however it only has certain frequency (in frequency of 500, 1000, and 4000 Hz) such as secular saw, gas valve.
3) Intermittent noise. This noise does not happen continuously, but there is a relatively quiet period, such as traffic sound, airport noise
4) Impulsive noise. This noise has a change in sound pressure more than 40 dB_A in a speed of time and usually shocks the hearing, such as gunshot, bomb.
5) Repeated Impulsive noise. Similar to impulsive noise but it happens repeatedly such as forging machine (Buchari, 2007).

The factors that influence the hearing disorder are caused by the noise intensity. Noise intensity is important in the hearing disorder. The higher noise intensity, the higher risk of hearing disorder that can happen. The tolerable maximum noise intensity is below 85 dB_A, if it is more than 85 dB_A, the effect happens will depend on how long the influence is. Therefore, the government set up the maximum noise standard of 85 dB_A with working hour of 8 hours each day or 40 hours a week. Duration and the exposure period.

In the noise intensity of 85 dB_A, the exposure period will affect the hearing disorder. The longer exposure period will give higher risk in deafness. To avoid the hearing disorder in the workers that work in working place with the noise intensity above 85 dB_A, the duration of the exposure must be limited daily according to the noise intensity. Exposure duration allowed by the OSHA (Occupational Safety and Health Administration) can be seen on the table below:

Exposure Duration Each Day based on the Noise Intensity

Noise Intensity (dB_A)	Working hour (hour).
90	8
92	6
95	4
97	3
100	2
102	1,5
105	1
110	0,5
115	0,25

(Faradella's. 2009).
In deciding the limit of noise for each study zone, below is RS PMI Bogor that is included in health purpose environment.

Table 1. Noise Level Limit

Designation area / Health environment	Noise Level (dBA)
1. Designation Area	
a. Housing and residential	55
b. Trades and services	70
c. Offices and trades	65
d. Green opened area	50
e. Industry	70
f. Government and public facilities	60
g. Recreation	70
2. Activity Scope	
a. Hospitals and suchlike	55
b. Schools and suchlike	55
c. Praying houses and suchlike	55

Source: Kementerian Negara Lingkungan Hidup RI (1996).

The relationship of noise and distance is the further distance of the noise source, the lower noise produced with the distance of 60,00 m noise level about 59,560 dB_A that is injection function y=70,90 – 0,189x (Syaiful, 2005; Linasari P Bangun *et al*, 2009).

Data Analysis:-

In the data sampling the process is additional noise level (y) that is the limited variable and influenced by some unlimited variables that are:
x1 is the first unlimited variable/motorcycle speed (Spm)
x2 is the second unlimited variable/private car speed (Map)
x3 is the third unlimited variable/public car speed (Mau)
x4 is the fourth unlimited variable/freight car speed (Mab)
Based on the data above, the linear regression model approach is achieved that is y = ao +a1.x1 + a2.x2 + a3.x3 + a4.x4
where ao, a1, a2, a3 and a4 is a coefficient assigned based on the study result data (Duwi Priyatno, 2013).

Correlation Test:-

Correlation test is used to look for the relation between two unlimited variables or more that are related with the limited variable so the amount of unlimited variable contribution that becomes the study object on the limited one will be known.

Table 2. Interpretation of r value

No	r	Interpretation of r value
1	0	Not correlate
2	0,01 – 0,20	Very low
3	0,21 – 0,40	Low
4	0,41 – 0,60	Quite low
5	0,61 – 0,80	High enough
6	0,81 – 0,99	High
7	1	Very high

Source: Duwi Priyatno (2013).

Hypotheses:-

H_a = There is a significant between motorcycle speed, private car speed, public car speed and freight car speed with the noise level.

H_o = There is no significant influence between motorcycle speed, private car speed, public car speed and freight car speed with noise level.

α = 5,00%

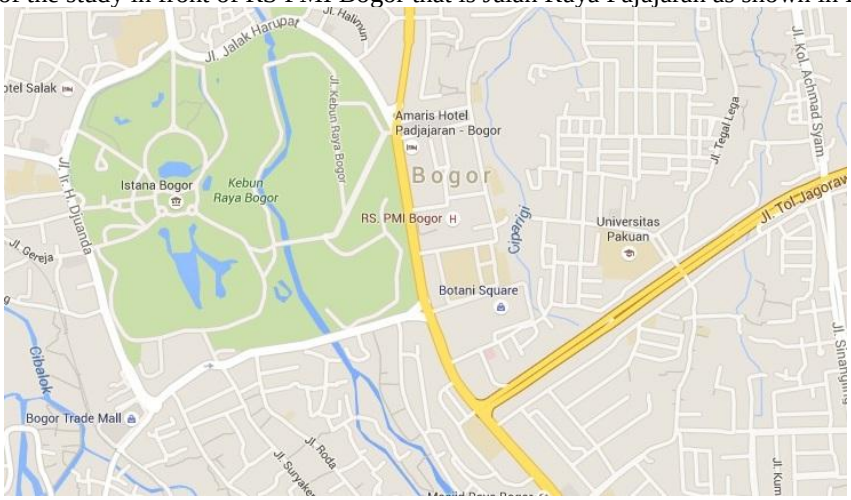
Study Mechanism, Material and Study Equipment:-

Study Time:-

Field data sampling time was done for two days, Monday January 26, 2015 and Saturday January 31, 2015.

Study Location:-

Location of the study in front of RS PMI Bogor that is Jalan Raya Pajajaran as shown in Figure 1.



Source: http//: www.google map kota Bogor (2015).

Figure 1. Location of the Study in front of RS PMI Bogor:-

Situation traffic of the study in front of RS PMI Bogor that is Jalan Raya Pajajaran as shown in Figure 2.

Source: Research location (2015)

Figure 2. Situation traffic front of RS PMI Bogor

Study Material:-

Material used in this study is a data form to get traffic data of motorcycles, private cars, public cars and freight cars as well as noise data taken from the measurement result of noise tool Sound Level Meter (SLM) used.

Study Equipment:-

Main equipment and supporting equipment used in this study is:

1) Sound Level Meter (SLM), as the main tool to measure the noise level happened in a certain time and place. There are some kinds of SLM used such as:
a) SLM 1, SLM Manual Krisbow brand, type KW06-291,
b) SLM 2, SLM Manual Krisbow brand, type KW06-291, and
c) SLM 3, SLM Auto Extech brand, type HD600.
2) Meter roller, as the tool that measure the distance between the located spot of SLM with the road side and walls of the hospital (RS PMI Bogor).
3) Digital Camera, to record all the study process for 12 hours for every time the data taken.
4) Tally, as the assistant tool to calculate the number of vehicles passing by the hospital (RS PMI Bogor).
5) Laptop, as a tool to connect the data from SLM Auto Extech brand, type HD600 and process data gained on the field when the study is being held.
6) Stationery and a person whose job is recording the data in written form, assisting in writing the number of vehicles in the data sampling manually.

Field Data Sampling:-

Traffic result data calculated is data per 15 minutes for 12 hours in a day and the data sampling done for two days on Monday January 26, 2015 and Saturday January 31, 2015. Data is taken from 6 AM to 6 PM.

Speed Processing Result

Based on the guide of speed counting (Department of Public Works General Directorate of Bina Marga, MKJI, 1997), that data sampling on speed uses the formula as follow:

Known the number of motorcycle

V = d/t or distance divided by time

The distance suggested is 75,00 m.

One of the speed counting used in this study is

Known :

Study observation distance is 75,00 m and

Time (t) = 5,25 seconds

Distance (r) = 75,00 m

Number of vehicle (s) = 326 vehicles

Value :

$$\text{Speed (v)} = \frac{75{,}00/1000}{5{,}25/3600}$$

$$= \mathbf{51{,}43\ km/hour}$$

Noise Study Caused by Vehicles

From the data processing result using SPSS version 17,00 (Duwi Priyatno, 2013) and accurate data choice done and recommended data shown, the data are motorcycle speed data, private car speed data, public car speed data and freight car speed data.

Monday, January 26, 2015:-

Statistical Data Analysis for speed with the distance of 0,00 m on SLM 1:-

Data processing result using SPSS version 17,00 noise level (y) achieved with the motorcycle speed (Spm/x1), private car speed (Map/x2), public car speed (Mau/x3) and freight car speed (Mab/x4) based on the level of trust 95% is : $y = 87{,}764 + 0{,}032x1 + 0{,}153x2 + 0{,}124x3 + 0{,}420x4$.

1) Test Criterion

Test result model summary has value R^2 = 0.481 which means that x1, x2, x3 and x4 influence about 48,10 % toward y.

Test result *anova* has value $F\text{-}_{count}$ = 0.911 with the probability value of (sig) = 0.414. From the data input it is gained the value of $F\text{-}_{Table}$ = 3.29 so $F\text{-}_{Count} < F\text{-}_{Table}$, so H_a is denied and H_o is granted.

Test result coefficients, motorcycle speed, private car speed, public car speed and freight car speed has constant value (a) = 87,764, (b) = 0.032, (c) = 0,153, (d) = 0,124, (e) = 0,420 and the value of $t\text{-}_{Count}$ = 6,763 and the value of (sig) = 0.000, from the data achieved the value of $t\text{-}_{Table}$ = 2.017, so $t\text{-}_{Count} > t\text{-}_{Table}$, then H_a is granted while H_o is denied.

2) Hypotheses Decision

From the test statistical result above, it can be concluded that the hypothesis about the influence of vehicle speed to noise is significant.

Statistical Data Analysis for speed with the distance of 3,00 m on SLM 2:-

Noise level (y) the motorcycle speed (Spm/x1), private car speed (Map/x2), public car speed (Mau/x3) and freight car speed (Mab/x4) based on trust level of 95%. It is presented the result of equation of the distance about 3,00 m uses SLM 2 that is : y = 71,765 + 0,012x1 + 0,211x2 + 0,321x3 + 0,442x4. Test result *coefficients*, motorcycle speed, private car speed, public car speed and freight car speed has constant value of (a) = 71,765, (b) = 0.012, (c) = 0,211, (d) = 0,321, (e) = 0,442.

Statistical Data Analysis for speed with the distance of 13,42 m on SLM 3:-

Noise level (y) the motorcycle speed (Spm/x1), private car speed (Map/x2), public car speed (Mau/x3) and freight car speed (Mab/x4) based on trust level of 95%. It is presented the result of equation of the distance about 13,42 m (the farthest distance from the wall of the hospital building) using SLM 3 is : y = 52,426 + 0,001x1 + 0,322x2 + 0,112x3 + 0,662x4.

1) Test Criterion

Test result model summary has value of R_{Square} = 0.5932 which means x1, x2, x3 and x4 influences about 59,32 % toward y.

Test result *anova* has value $F\text{-}_{Count}$ = 0.912 with probability value (sig) = 0.412. From the data input, it has $F\text{-}_{Table}$ = 3.29 so $F\text{-}_{Count} < F\text{-}_{Table}$, so H_a is denied and H_o is granted.

Test result coefficients, motorcycle speed, private car speed, public car speed and freight car speed has constant value (a) = 52,426, (b) = 0.001, (c) = 0,322, (d) = 0,112, (e) = 0,662.

2) Hypothesis Decision

From the result of test statistic above, it can be concluded that hypothesis about the influence of vehicle speed to the noise is significant.

Saturday, January 31, 2015.:-

Statistical Data Analysis for speed with the distance of 0,00 m on SLM 1:-

Data processing using SPSS version 17,00 achieved noise level (y) with motorcycle speed (Spm/x1), private car speed (Map/x2), public car speed (Mau/x3) and freight car speed (Mab/x4) based on trust level of 95% is : y = 89,322 + 0,027x1 + 0,632x2 + 0,410x3 + 0,032x4. Test result coefficients, motorcycle speed, private car speed, public car speed and freight car speed has constant value of (a) = 89,322, (b) = 0.027, (c) = 0,632, (d) = 0,410, (e) = 0,032.

Statistical Data Analysis for speed with the distance of 3,00 m on SLM 2:-

Data with the noise level (y), with motorcycle speed (Spm/x1), private car speed (Map/x2), public car speed (Mau/x3) and freight car speed (Mab/x4) based on trust level of 95%. Below is the equation result representing distance condition of 3,00 m by using SLM 2 is : y = 63,321 + 0,034x1 + 0,144x2 + 0,156x3 + 0,425x4. Test result coefficients, motorcycle speed, private car speed, public car speed and freight car speed has constant value of (a) = 63,321, (b) = 0.034, (c) = 0,144, (d) = 0,156, (e) = 0,425.

Statistical Data Analysis for speed with the distance of 13,42 m on SLM 3:-

Testing with noise level (y), with motorcycle speed (Spm/x1), private car speed (Map/x2), public car speed (Mau/x3) and freight car speed (Mab/x4) based on trust level of 95% has equation result representing the distance of 13,42 m by using SLM 3 is : y = 51,649 + 0,263x1 + 0,531x2 + 0,442x3 + 0,634x4.

1) Test Criterion

Test result model summary has the value of R^2 = 0.6954 that means x1, x2, x3 and x4 influences about 69,54 % to y.

Test result *anova* has value of $F\text{-}_{Count}$ = 0.913 with the probability value (sig) = 0.413. the data input $F\text{-}_{Table}$= 3.29 so $F\text{-}_{Count} < F\text{-}_{Table}$, then H_a is denied and H_o is granted.

Test result coefficients, motorcycle speed, private car speed, public car speed and freight car speed has constant value of (a) = 51,649, (b) = 0.263, (c) = 0,531, (d) = 0,442, (e) = 0,634.

2) Hypothesis Decision

From the result of test statistic above, it can be concluded that hypothesis about the influence of vehicle speed to the noise has a strong and significant relation.

Conclusion:-

Referring to the result and the discussion above that there is an increasing in the motorcycle speed, increasing in private car speed, increasing in public car speed, and increasing in freight car speed to the noise level caused. This result is achieved on SLM 3 on Monday and SLM 3 on Saturday which is:

1) Motorcycle speed, private car speed, public car speed and freight car speed have Quite low (Duwi Priyatno, 2013) to noise level. From all of the analysis calculation, it has an equation recommended in this study that is on the third spot (Sound Level Meter 3), with contribution of 59,32% and it has calculation of y = 52,426 + 0,001x1 + 0,322x2 + 0,112x3 + 0,662x4. It means that if there is no increasing in speed of the motorcycle, private car, public car and freight car, then noise level on SLM 3 is about 52,426 dB_A. If there is an additional on number on each transportation media, there is a speed increasing about 1,097 km/hour.

2) Calculation of Motorcycle speed, private car speed, public car speed and freight car speed has High enough influence (Duwi Priyatno, 2013) toward the noise and it has the best equation in the second day research on the spot (Sound Level Meter 3) with the contribution of 69,54% and the equation is y = 51,649 + 0,263x1 + 0,531x2 + 0,442x3 + 0,634x4. It means that if there is no increasing in speed in all means of transportation above, the noise level is about 51,649 dB_A. So for the speed increasing on motorcycle speed, private car speed, public car speed and freight car speed there is a speed increasing about 1,870 km/hour.

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