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Noise Measurement on Raya Merr Street, Surabaya

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Abstract---*Noise is an unwanted sound from a business or activity at a certain level and time that can cause disruption to human health and environmental comfort. The noise level is divided into 4 zones, zone A with a range of 35-45 dB, zone B with a range of 45-55 dB, zone C with a range of 50-60 dB, and zone D with a range of 60-70 dB. The noise source is divided into 2, that is static such as a factory or machine, and dynamic like a vehicle. The impact that can be obtained by the listener can be noise adaptation, physiological disorders, psychological disorders, communication disorders and the influence of hearing function. Noise measurement can be done using sound level meter and hand counter. This research was carried out on Raya Merr Street, Surabaya with latitude 7°15'54.24"S and longitude 112°46'57.73"T. The study was held for 10x4 minutes or 4 series with an interval of 10 seconds. From that we get 240 data and can find the sound pressure level of 10% and 90% (SPL_{10} and SPL_{90}) with the data taken is the lower bound data. SPL_{10} is 75.5 and SPL_{90} is 65.5. The calculation results a noise value is 75.5 dB. The number of vehicles on the highway affects the value of noise intensity with a correlation value of 65.51% and inversely proportional. The more number of vehicles, the lower the value of noise intensity.*

Keyword---*Noise, Surabaya, Sound Level Meter, Traffic Noise Index*

I. Introduction

The development of technology, especially vehicles, is growing rapidly along with the increasing productivity of human needs. Various vehicles types have different frequencies produced. Continuous and disturbing sound frequencies occur in large cities where vehicles often pass by. This frequency is called noise.

Noise can cause serious disturbances and affect a person's physiological and psychological conditions, besides being a stressor that can modulate the immune response [1]. Noise is generated when the frequency exceeds the allowable threshold. Noise threshold for humans is 85 dB. Analysis is carried out on the highway because the source of vehicle frequency generated when driving can be measured. Measurements are made by calculating the value of the Traffic Noise Index and the number of vehicles passed during the measurement.

In this study measurements of noise on the highway by measuring the value of traffic noise index using a sound level meter, as well as counting the number of vehicles that drove when the measurement be held. This aims to determine the correlation between the intensity of noise and the number of vehicles

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II. Noise and The Impact of Noises

Noise is a sound that arises and is not desired which is disturbing and decreasing one's hearing power. Sound is defined as a series of waves that propagate from the sound of vibrating sources as a result of changes in density and also air pressure. Another definition of sound is the sensation produced when the longitudinal vibrations of molecules from the outside environment, like compaction and stretching of alternating molecules, vis-a-vis a tympani membrane. The pattern of this movement is described as pressure changes in the tympani membrane, each unit of time is a series of waves and this movement in the environment around us is generally called sound waves. Sound is a change of pressure in the air captured by the eardrum and transmitted to the brain.

In an effort of occupational health and safety, noise is defined as all the unwanted sounds or sounds sourced from the tools of the production process and/or work tools which at a certain level can cause hearing loss [2]. In the health sector, noise is a sound that can reduce hearing, both quantitatively (increasing the hearing threshold) and qualitatively (narrowing of the listening spectrum), relating to the intensity, frequency, and time patterns [3]. Based on Decree of the Minister of Environment Number Kep-Men-48/MEN.LH/11/1996 [4], noise is unwanted noise from a business or activity at a certain level and time that can cause disruption to human health and environmental comfort.

Regulation of the Minister of Health of the Republic of Indonesia Number 718/MENKES/PER/XI/1987 states the distribution of noise levels according to 4 zones:

- Zone A (Noise between 35 dB to 45 dB)

  Zones designated for research, hospitals, health or social care places and others.
- Zone B (Noise between 45 dB to 55 dB)

  Zone designated for housing, education, recreation and others.
- Zone C (Noise between 50 dB to 60 dB)

  Zone designated for offices, shops, trade, markets and others.
- Zone D (Noise between 60 dB to 70 dB).

  Zone designated for industries, factories, train stations, bus terminals and others.

Table 2.1 Noise Threshold Value

Regional Zone / Health Environment	Noise level dB (A)
a. Regional Use	
Trade and Services	55
Office and Trade	70
Green open space	65
Industry	50

Government and public facilities	70
Recreation	60
Special	70
- Airport	60
- Railway station	60
- Seaports	70
- Cultural heritage	70
b. Activity Environment	
Hospital or the like	55
Schools and the like	55
Places of worship or the like	55

The source of noise is based on the character, shape, and location of the sound source. Sources based on their character are divided into two, static noise such as factories, machines, tape, and dynamic noise such as cars, airplanes, ships, etc. Sources based on their shapes are divided into two, such as in the form of dots/circles. Circles are like industrial machines and in the form of lines such as vehicles. While the sound source based on the location of the source is also divided into two, the interior noise that comes from humans and household appliances and machinery, and based on exterior noise location that comes from vehicles both on land, sea, and air.

Noise is classified into two types of large groups, fixed noise and irregular noise. Noise is still differentiated into two, noise with interrupted frequency in the form of pure tones with varying frequencies with the source of equipment, while broad band noise occurs at frequencies that are more varied or not pure tones. Non-permanent noise can be divided into three, such as fluctuating noise that is always changing over a certain period of time, intermittent noise that is intermittent and the magnitude can change such as traffic, and impulsive noise generated by high-intensity sounds that hold the ear in a relatively short time like the sound of explosions and so on.

The impact of noise is classified into various types [5]:

- Noise adaptation
- Physiological disorders

  Disorders can include increased blood pressure, increased pulse, peripheral blood vessel construction especially in the hands and feet, and can cause pallor and sensory disturbances. High intensity noise can cause dizziness/headache.

  - Internal system of the body
  - Hearing threshold

The hearing threshold is the weakest sound that can still be heard. The lower weakest sound level that is heard means the lower threshold of hearing, meaning the better the listener. Noise can affect the hearing threshold value either temporarily (physiological) or permanent (pathophysiological). Hearing loss is temporary when the ear can immediately restore its function after being exposed to noise [6].

- Sleep disorder;

Based on research, it was found that the percentage of a person could wake up from sleep by 5% at a level of sound intensity of 40 dB (A) and increase to 30% at a level of 70 dB (A). At the level of sound intensity of 100 dB (A) to 120 dB (A), almost everyone will wake up from sleep .

- Psychological disorders such as discomfort, lack of concentration, anxiety, fear, emotions
- Communication disorders
- Effects on hearing

One of the factors that influence noise is the volume of the vehicle. Research shows a positive correlation between noise level and disturbance level. Sound generated by traffic is sound with a level of sound that is not constant. The level of noise interference originating from the sound of traffic is influenced by the sound level, the intensity occurs in units of time, and the sound frequency that it produces [7]. The traffic noise index is a number that shows the relationship between the maximum and minimum noise level differences with the interference caused by the loss of traffic. Traffic Noise Index, abbreviated as TNI, is a formula to find the amount of SPL (Sound Pressure Level) of 10% and 90% obtained from the range cumulative distribution and statistics obtained from measurements based on A level [8].

To measure noise is using Sound Level Meter and Hand Counter to calculate the number of vehicles passed by type of vehicle. Sound Level Meter functions to measure noise between 30-130 dB and from a frequency of 20-20,000 Hz. Sound Level Meter consists of a microphone, amplifier, and attenuator circuit and several other devices. Sound Level Meter is equipped with level scale adjustment buttons such as A, B, C, and D. Scale A, for example, is a range of weighting scales that cover low sound frequencies and high sound frequencies that can still be received by normal human ears. Meanwhile scales B, C and D are used for special purposes, such as measuring noise produced by jet engine aircraft.

III. Methods

The research was held on Raya Merr Street, Surabaya with latitude 7°15'54.24 "S and longitude 112°46'57.73" T on August 28, 2017. The tools was used during the measurement are Sound Level Meter, stopwatch, and hand counter. Sound level meter works is by directing the device to the sound source and measuring once every 10 seconds and doing it for 10 minutes. Calculation of the number of vehicles is done by using a hand counter and each vehicle is classified according to its type by category; motorcycles, cars and trucks. Vehicle density is calculated for 10 minutes, and the results of these calculations are recorded for data analysis.

Data analysis of noise is used this following formula:

Table 3. Data Analysis Formula

Formula	Description
$SPL = \frac{f > u}{n} \, x \, 100\%$	SPL: sound pressure level f> u: frequency n: number of vehicles
TNI (dB) = 4 ($SPL_{10} - SPL_{90}$) + $SPL_{90} - 30$	TNI: Traffic Noise Index SPL_{10}: SPL approaches 10% SPL_{90}: SPL approaches 90%

IV. Discussion

Noise measurements on Raya Merr Street Surabaya were carried out at 14.50-16.30 WIB by measuring noise intensity using sound level meter and calculating the number of vehicles in the form of cars, motorcycles and trucks. Data from research results obtained based on observations for 4 series are as follows:

Table 5 Series 1 Data

No	t	p (dB)	No	t	p (dB)
1	0:10	68	31	5:10	70
2	0:20	72	32	5:20	68
3	0:30	72	33	5:30	74
4	0:40	68	34	5:40	70
5	0:50	62	35	5:50	64
6	1:00	68	36	6:00	64
7	1:10	70	37	6:10	62
8	1:20	70	38	6:20	64
9	1:30	68	39	6:30	66
10	1:40	68	40	6:40	70

11	1:50	70	41	6:50	72
12	2:00	70	42	7:00	74
13	2:10	76	43	7:10	70
14	2:20	70	44	7:20	72
15	2:30	70	45	7:30	72
16	2:40	68	46	7:40	70
17	2:50	80	47	7:50	68
18	3:00	72	48	8:00	68
19	3:10	62	49	8:10	64
20	3:20	64	50	8:20	74
21	3:30	64	51	8:30	66
22	3:40	68	52	8:40	64
23	3:50	64	53	8:50	66
24	4:00	70	54	9:00	66
25	4:10	68	55	9:10	64
26	4:20	70	56	9:20	64
27	4:30	68	57	9:30	66
28	4:40	64	58	9:40	68
29	4:50	70	59	9:50	72

30	5:00	68	60	10:00	70

Table 6 Series 2 Data

No	t	p (dB)	No	t	p (dB)
1	0:10	62	31	5:10	70
2	0:20	70	32	5:20	68
3	0:30	64	33	5:30	68
4	0:40	64	34	5:40	66
5	0:50	68	35	5:50	64
6	1:00	72	36	6:00	62
7	1:10	74	37	6:10	64
8	1:20	70	38	6:20	68
9	1:30	70	39	6:30	70
10	1:40	72	40	6:40	80
11	1:50	66	41	6:50	74
12	2:00	70	42	7:00	70
13	2:10	72	43	7:10	72
14	2:20	68	44	7:20	74
15	2:30	64	45	7:30	70

16	2:40	72	46	7:40	76
17	2:50	62	47	7:50	72
18	3:00	70	48	8:00	66
19	3:10	64	49	8:10	70
20	3:20	64	50	8:20	68
21	3:30	66	51	8:30	66
22	3:40	64	52	8:40	70
23	3:50	70	53	8:50	66
24	4:00	72	54	9:00	64
25	4:10	72	55	9:10	64
26	4:20	70	56	9:20	72
27	4:30	72	57	9:30	72
28	4:40	70	58	9:40	70
29	4:50	70	59	9:50	68
30	5:00	72	60	10:00	72

Table 7. Series 3 Data

No	t	p (dB)	No	t	p (dB)
1	0:10	72	31	5:10	66

2	0:20	72	32	5:20	66
3	0:30	68	33	5:30	66
4	0:40	68	34	5:40	68
5	0:50	76	35	5:50	71
6	1:00	64	36	6:00	68
7	1:10	66	37	6:10	69
8	1:20	71	38	6:20	71
9	1:30	70	39	6:30	70
10	1:40	70	40	6:40	72
11	1:50	66	41	6:50	73
12	2:00	69	42	7:00	71
13	2:10	66	43	7:10	68
14	2:20	68	44	7:20	70
15	2:30	66	45	7:30	66
16	2:40	70	46	7:40	62
17	2:50	71	47	7:50	64
18	3:00	71	48	8:00	68
19	3:10	71	49	8:10	63
20	3:20	67	50	8:20	70

21	3:30	71	51	8:30	70
22	3:40	72	52	8:40	70
23	3:50	74	53	8:50	68
24	4:00	72	54	9:00	71
25	4:10	74	55	9:10	72
26	4:20	70	56	9:20	72
27	4:30	72	57	9:30	70
28	4:40	66	58	9:40	70
29	4:50	64	59	9:50	72
30	5:00	64	60	10:00	72

Table 8. Series 4 Data

No	t	p (dB)	No	t	p (dB)
1	0:10	70	31	5:10	70
2	0:20	72	32	5:20	70
3	0:30	75	33	5:30	70
4	0:40	73	34	5:40	72
5	0:50	76	35	5:50	72
6	1:00	76	36	6:00	70
7	1:10	72	37	6:10	68
8	1:20	70	38	6:20	80
9	1:30	68	39	6:30	72
10	1:40	62	40	6:40	72
11	1:50	68	41	6:50	74
12	2:00	66	42	7:00	70
13	2:10	70	43	7:10	70
14	2:20	70	44	7:20	64
15	2:30	70	45	7:30	68
16	2:40	72	46	7:40	70
17	2:50	68	47	7:50	72
18	3:00	72	48	8:00	68

19	3:10	72	49	8:10	70
20	3:20	70	50	8:20	70
21	3:30	78	51	8:30	68
22	3:40	70	52	8:40	68
23	3:50	72	53	8:50	70
24	4:00	70	54	9:00	70
25	4:10	72	55	9:10	78
26	4:20	64	56	9:20	78
27	4:30	68	57	9:30	72
28	4:40	64	58	9:40	74
29	4:50	72	59	9:50	72
30	5:00	70	60	10:00	70

Table 9. Noise Parameter Value for 4 Session

Parameter	1 (dB)	2 (dB)	3 (dB)	4 (dB)
Maximum	80	80	76	80
Minimum	62	62	62	62
Average	68,43	68,70	69,15	70,73

Table 10. Series Overall Data Analysis

Value	Frequency (f) / (%)	Lower Limit (u)	Upper Limit (v)	f> u	f< v	Cumulative %	Midpoint

61-65	38 / 15,83	60,5	65,5	2 40	1 1	100,00	63
66-70	124 / 51,67	65,5	70,5	2 02	7 8	84,17	68
71-75	67 / 27,92	70,5	75,5	7 8	2 02	32,50	73
76-80	11 / 4,58	75,5	80,5	1 1	2 40	4,58	78
Total	240 / 100						

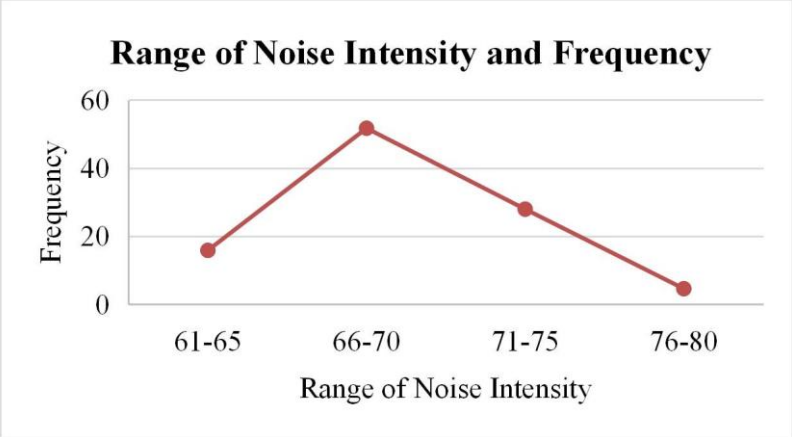

Figure 1. Range of Noise Intensity and Frequency

Decree of the Minister of Environment Number 48 on 1996 states that the noise level that can be tolerated in the school environment and its range is 55 dB. Based on the tables and graphs that have been listed, the highest range of noise intensity is obtained between 60-70 dB with a frequency of 120. This is due to the large number of vehicles passing.

Traffic Noise Index (TNI)

$TNI = 4(SPL_{10} - SPL_{90}) + SPL_{90} - 30$

$= 4(75,5 - 65,5) + 65,5 - 30 = 75$

The study was conducted for 10x4 minutes with an interval of 10 seconds. So that we get 240 data and we can find the sound pressure level of 10% and 90% (SPL_{10} and SPL_{90}) with the data taken is the lower bound data. SPL_{10} is 75.5 and SPL_{90} is 65.5. The calculation results produce a noise value of 75.5 dB. Analysis of the relationship between noise intensity and vehicle density based on vehicle volume calculation shows that vehicle density is directly proportional to noise intensity. The denser the vehicle, then the higher intensity of the noise, but if the number of vehicles is increasing tenuously, then the lower intensity of the noise.

Table 11. Total Vehicles Data by Type

Series	Total Vehicles			
	Motorcycle	Car	Truck	Total
1	520	116	9	645
2	480	180	3	663
3	545	153	11	709
4	629	181	12	822

Table 12. Value of Noise Intensity and Total Vehicles

Parameter	Series of Data			
	1	2	3	4
Noise Intensity	90.5	90.5	75.5	75.5
Total Vehicles	645	663	709	822

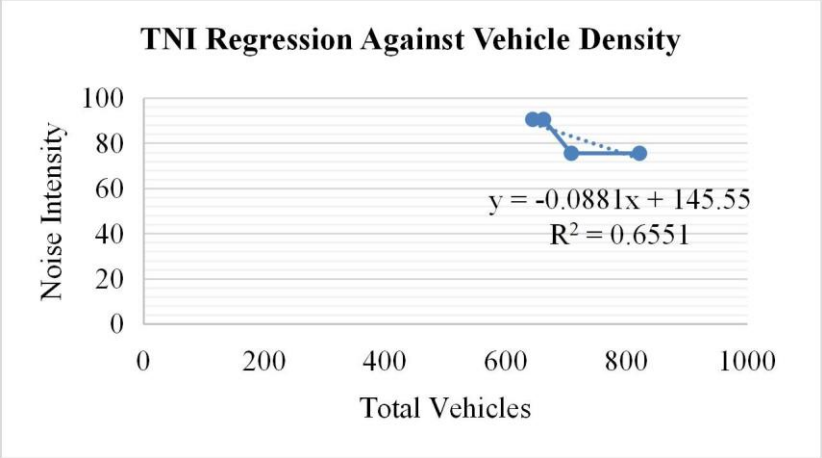

Figure 2. Graph of Noise Intensity Regression Against Vehicle Density

The graph shows that the number of vehicles affects the value of noise intensity of 65.53%, and 34.49% is another unknown factor. Correlation values obtained show negative data indicating the relationship between noise intensity and vehicle density inversely. It means the more number of vehicles, the lower value of the noise intensity. This happens because motorcycles are the aspects that most affect the noise index on the highway. Because the value of noise intensity can be influenced by the way a rider rides his motorcycle. This is also influenced by horns and exhausts of motorcycles which have a loud sound, so when we measured value of noise intensity, a high value can be obtained.

V. Conclusions

Based on the results of research on the measurement of noise on Raya Merr Street Surabaya, the conclusion can be decided is the value of Traffic Noise Index (TNI) obtained during the research in 4 series, which is equal to 75.5 dB. The

number of vehicles on the highway affects the value of noise intensity with a correlation value of 65.51% and inversely proportional. Which means the more number of vehicles, the lower value of noise intensity. This is happened because the horn and exhaust produced by the motorcycle affect the value when noise is measured. 4 Gabriel 3 Heinz 5 Prabu 7 Rosidah 6 Sasongko 8 Subroto 1 Alm 2 Anggraini

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