Influence of Traffic Performance Againsts the Noise of the Vehicles in Medan

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Abstract. This research is motivated to analyze the noise level of the vehicles due to high volume of traffic on the streets of K.L. Yos Sudarso, Letda Sudjono and Gatot Subroto Medan, Indonesia. Mathematical model was applied that states the relationship between noise level with the volume of vehicle and analyzes the average noise due to vehicle traffic. The data was analyzed using the method of direct reading and recording every measurement in 2 hours 10 minutes. The results shows, the highest level of vehicle noise on Gatot Subroto street is of 76.2 decibels with the number of vehicles passing by was 7.214 unit passenger cars/hour for passenger transport and 1,647 unit passenger cars/hour for transport of good occurred in the morning. However, these influences can increase when the volume of traffic is crowded on a way then the noise level would exceeds a threshold range of 70 decibels caused by the toot who is tuned to preempt, when the traffic lights don’t work, the sound of the exhaust, tire friction with a paved road at the time of braking and so on. So, this region is a zone D for industrial environment, factories, train stations and bus terminals. Noise level ranges from 60-70 decibels.

Keywords: Traffic performance, vehicle noise

1. The first section in your paper

High intensity of passing vehicles in city highways certainly has environmental impact along the road being passed. Those vehicles cause noises, such as the sound of engine coming out of the exhaust, the horn sound as well as other noises caused by the activities of other engines. Long term traffic noises will cause nuisance and disturb the surrounding environment. According to the Decree of the Minister of Environment Number 48 of 1996 concerning the Noise Level Standards stated that noise is unwanted sound coming from business or activity in certain level and time which can cause health problem for human and environmental problem, specifically at 60-70 dB.

Buchari classifies the noise interference into two categories, which are the auditory effects including hearing impairment and non-auditory effects including communication problem as well as decreasing working spirit due to exhaustion and stress. Based on the research done by Djalante, the acceptable level of noise for human’s health depends on how long and how intense the noise is exposed. Considering the important role of the traffic and public transport which affect the livelihood of many people, the development of transportation infrastructure and transport facilities should be arranged and developed in an integrated system.
Based on the statement above, a research regarding the level of highways noise in Medan on secondary arterial roads, roads which connect the primary to the secondary area such as the ones at K. L Yos Sudarso Street’s, Letda Sudjono Street’s and also at Gatot Subroto Street’s – Kampung Lalang should be conducted to find out whether the noise level occurred is still tolerable or has exceeded the threshold that an activity of installing road dividers which aims to reduce the negative effects of the noise should be done just as those applied in the United Kingdom based on the book published by the Department of Transport.

2. Theoretical Framework

2.1. Traffic performance on roads
In evaluating the urban traffic problems, it is necessary to review them based on the functional classification and the network systems of existing road sections. The urban traffic functions are divided into arterial, collector and local roads, while the network systems consist of primary and secondary roads. According to Tamin, the urban traffic problems generally occur only on main road, which are the arterial and collector roads based on the classification mentioned. The volume of traffic on main roads is commonly high. On the other side, traffic equation does not exist and is local due to generally low volume of traffic and access to the surrounding is high on local road. The performance of urban traffic can be assessed using the following parameter:

2.1.1. On roads: V/C (Volume Capacity ratio), speed, and traffic density.
2.1.2. On intersections: delays and residual capacity.
2.1.3. If available, the data of traffic accident can also become the consideration in evaluating the Effectiveness of urban traffic system.

Basically, ears are always responsive to a very wide range of sound pressure although its pressure is very small. The weakest sound has a maximum of 1000 Hz of pressure variation for amplitude of the same displacement with pressure amplitude of about 9-10 cm, that if is viewed from this variation then the human ears are very sensitive organs. The findings of research conducted by the Noise Abatement Commission in New York show noise levels of different sound sources, which can be seen in Table 1.

| Sound Source or Description | Intensity (dB) |
|-----------------------------|----------------|
| Pain tolerance              | 120            |
| Nail mounting tool (rivet)  | 95             |
| Elevated train              | 90             |
| Roadway                     | 70             |
| General conversation        | 65             |
| Smooth car                  | 50             |
| Regular radio sound at home | 40             |
| Whisper                     | 20             |
| Hissing leaves              | 20             |
| Hearing threshold           | 0              |

Now, sound waves are viewed as they are; the spherical waves. If the sound source emits sound waves then the energy will evenly distributed throughout all directions forming a ball which moves further away from the source of the sound with enlarging radius. Then, by those who receive the sound waves (listeners), the sound power energy is absorbed, specifically the power per unit area. This power per unit is called as sound intensity I (energy of time per unit area). This sound energy will become smaller when it avoids the sound source with ratio 1/r² of its energy source where r is the distance between the listener and sound source.
Thus, it can be formulated with the Press 2.5 that sound intensity is:

\[
I = \frac{P_{\text{average}}}{\text{Surface area of sphere}} = \frac{P_{\text{average}}}{4\pi r^2}
\]

(2.5)
in which:
\(I\) = sound intensity
\(P\) = wave receiver (human ears)
\(\pi = 3.14\)
\(r\) = distance between the listener and the sound source

2.2 Noise

Noise is derived from the word ‘noisy’ which means any sound which distracts, disturbs or are harmful to daily activities. Noisy is generally defined as unwanted sound and can also cause the environmental pollution. The Minister of Environment Decree describes noise as unwanted sound coming from businesses or activities on certain level and time which can cause health problem and environmental discomfort. The influencing factors include the pattern of intensity, frequency and generation. Noise itself is usually considered as unwanted sound. Sound occurs when the human ear listens at small pressures that rise and fall in the air which is caused by the vibrations from solid objects. Noise can be described in various terms from three variables, which are the amplitude, frequency and time pattern.

Noise has criteria in which the lowest noise level is set in certain rooms based on their main functions. If the noise criteria of a room have been discovered, then ways to reduce the noise can be found. The noise reduction is by lowering the sound power received to reduce the level of noise produced.

Classifies noise into several types, which are: Continuous noise with wide frequency spectrum (wide band noise), Continuous noise with narrow frequency spectrum (narrow band noise). For example, circular saw, gas valve, and etc. Intermittent noise. For example, traffic, airplanes sound in airports, and etc. Impact or impulsive noise, such as the gunfire or cannon and explosion, and Repeating impulsive noise, such as forging machine in the company.

Minister of Health Regulations Number 718 of 1987 concerning the noise in health, is divided into four zones, which are:

2.2.1 Zone A is zones for schools, hospitals, health or social care. The noise intensity is around 35-45 dB
2.2.2 Zone B is for residences, schools and recreation spots. The noise intensity is around 45-55 dB
2.2.3 Zone C is for offices, shops, commerce, and markets with noise intensity around 50-60 dB
2.2.4 Zone D is for industrial areas, factories, train stations and bus terminals with intensity level around 60-70 dB

There are basically three types of noise sources; noise point source, noise field source and noise line source. Noise caused by the urban traffic is included as noise line source. According to Prasetio, noise sources can be derived from:

a. Interior noise, which is noise source coming from human, household appliances or building machines.
b. Outdoor noise, which is noise source coming from the traffic, transportation, industries, mechanic tools seen in the building, building sites, roadwork, sport activities and others which occur outside the room or building.
2.3 Noise Measuring Instrument

Sound Level Meter is a tool which is used to measure how big is the noise produced by workers or in a place which its noise level should be measured. This tool is used to measure the intensity level between 30-130 dB(A) and from frequency of 20-20,000 Hz. The specifications of Sound Level Meter are as follows:

- **2.3.1** Measurement ranging from 26 dB (A)
- **2.3.2** Function notes up to 99 notes
- **2.3.3** 6 adjusted ranges of measurement
- **2.3.4** Dimension of 264 x 68 x 27 mm
- **2.3.5** Weighs 260 gram

Thus, the function and application of Sound Level Meter are as follows:

1. **Function**: Sound Level Meter is used to measure noise between 30-130 dB in decibel unit from frequency between 20-20,000 Hz.

2. **Application**: The application of Sound Level Meter is usually applied in factories to analyze the noise level of tools in those factories. For example, in fertilizer factory, tools that are potential in causing noise such as the turbines, compressors, condensers, drum pumps and etc.

   Generally, the SLM & Noise Dosimeter are directed to the sound source, at ear level, in order to capture the noise created. For the purpose of measuring the noise in a work room, recording is carried out in a full work shift with several times of recording from SLM. Ways to use it are as follows:

   a. **Tools preparation**:
      1) Place the battery in its tray
      2) Press power button
      3) Check the line sign on the monitor to know whether the battery is in good or bad condition

   b. **Measurement**:
      1) Press Max button in order to reach maximum point
      2) Then, move the Selecter to the line dB in order to measure the noise. Observation for 1-2 minutes with around 6 recordings is done in each location of measurement. The results in form of numbers are shown in the monitor.
      3) Next, press the Hold button to hold.
      4) Note down the measurement result and count the noise average.

   Based on the Minister of Environment Decree Number 48 of 1996, there are two ways of measuring noise. First; a simple way by using Sound Level Meter which generally measures the sound pressure dB (A) for 10 minutes on each measurement. The recording is done in every 5 seconds. Second; a direct way by using Integrating Sound Level Meter which facilitates the L\text{TMS} measurement with recording in every 5 seconds in 10 minutes of measurement.

2.4 Traffic Noise

The increasing development of transportation on highways certainly has impact towards the environment along the busy roads with means of transportations. This phenomenon creates new problem in transportation. An example of serious transportation problems is the sound pollution (noise) which is caused by the traffic on the surrounding. The impact which can be seen directly is in schools located in the city with a traffic-intensive urban area. Road traffic is the main source of noise which is considered disturbing to most people. Noise often occurs on roads where most of the society’s activities happen, such as the schools, mosques and offices. Road traffic noise is considered very disturbing yet cannot be denied. One of the noise sources on traffic is motor vehicle, including the two-wheeled, three-wheeled and four-wheeled vehicles. The noise sources include the sound of honking horn when vehicles want to overtake each other and also when the traffic light is not working, the sound of vehicle exhaust due to excessive pedal pressure, friction of the tire with paved roads during braking, and etc.
3. Research Method
This field research was conducted from 20th February to 12th March 2017 to calculate traffic volume, in which every Fridays of each week was the measurement day due to more congested traffic volume. The research was located in three secondary arterial roads in Medan, which are: K.L. Yos Sudarso Glugur Street’s, Letda Sudjono Street’s and Gatot Subroto Street’s.

Those streets were considered quite effective in this research due to high traffic volume, inadequate road width with fairly dense conditions. The population of the research was passing vehicles on these three roads which later were examined for six hours. Samples being taken were vehicles passing at 7 to 9 am, 12 am to 2 pm, and 5 to 7 pm. Vehicles on urban roads are categorized into two categories based on the Indonesian Highway Capacity Manual – HV represents the freight vehicles and MC for passenger transport vehicles and are calculated based on the passenger car equivalent (PCE). In this research, the data collection includes primary data and secondary data, which are:

1. Primary Data
   a) Road Traffic Data Survey
      The data was collected through direct survey and observation. Through direct data collection, data including the traffic volume and noise measurement result were collected. The traffic volume data was collected by using Classified Traffic Counting Survey method, where each passing vehicles on the examined road was recorded for the whole day based on the classification and also based on the rush hour of each research location. Vehicle classifications including the passenger transport vehicles (MC) such as motorized tricycles, private cars, public transportations/ taxis, micro buses (L-300), buses, motorcycle and bicycles/tricycles/carts, while the freight vehicles (HV) are the pick-up cars, two-axle truck (four-wheeled), two-axle trucks (six-wheeled), three-axle trucks, four-axle trucks and trailers.

   b) Noise Intensity Data
      The noise intensity measurement was conducted on 24th February, 3rd March and 7th March 2017. The collection of traffic noise data was assisted by the team from Medan Occupational Safety and Health in the work program to complete this final project. The traffic noise intensity was measured in three days on the same locations, which were Jalan K.L. Yos Sudarso, Jalan Letda Sudjono, and Jalan Gatot Subroto. The measurement was done at the same time which was during rush hours in which every two rush hours was divided into ten minutes of measurement and one effective day was chosen on each location. The method used in measuring noise intensity was by using direct reading method – by noting down the result obtained from Sound Level Meter tool. Then, it was analyzed to calculate the average by using Microsoft Office Excel 2007.

4. Result and Discussion
Based on the results of measurements calculated at Jalan Yos Sudarso in the morning, the maximum noise intensity value was obtained in the third ten minutes, that is at 7.20-7.30 am at 75.8 dB, the minimum value of the measurement was 74.1 dB between 8.40 - 8.50 am and the average value of noise at Location 1 is 75 dB with number of vehicles passing in the morning was 758 SMP/hour of freight transport while passenger transportations were 4.170 SMP/hour. For measurements during daytime (12 am to 2 pm), maximum noise intensity value was obtained at 1 to 1.10 pm at 73.8 dB, the minimum noise intensity value was at 1.50 to 2 pm at 71.2 dB, and the average value at Location 1 at daytime was 72.5 dB with the number of vehicles passing by during the day as many as 3.954 SMP/hour of passenger transports and freight transports totaling 1.075 SMP/hour. Based on average results in three locations above, showed that traffic performance had the potential to increase the noise.

      The maximum noise intensity value obtained on measurement in the afternoon is at 5 to 5.10 pm was 76.9 dB, the minimum intensity value occurred at 6 to 6.20 pm at 75.5 dB, and the average value of the total was 76.1 dB with the number of vehicles passing were 5.591 SMP/hour of passenger transports while freight transportation only amounted to 798 SMP/hour. At Location 2, the maximum noise intensity value was obtained at 7.10 to 7.20 am at 76.4 dB, the minimum noise value was obtained at 8.40 to 8.50 pm at 71.2 dB, and the average value was 74 dB with the number of vehicles...
passing on this road was 4.576 SMP/hour of passenger transportations and 1.268 SMP/hour of freight transportations.

The maximum noise intensity value obtained at 12 am to 12.10 pm was 73.8 dB while the minimum noise intensity value obtained was 71.7 dB which occurred at 12.20 to 12.30 pm, and the average value for noise intensity during daytime was 72.85 dB with number of vehicles crossing in the afternoon were 3.814 SMP/hour of passenger vehicles and 1.398 SMP/hour of freight transports.

The maximum noise intensity value obtained for the measurement in the afternoon was 76.4 dB during the same time at 5.30 to 5.40 pm and 6.40 to 6.50 pm, the minimum noise intensity value was at 6.10 to 6.20pm at 74.3 dB, and the average noise value was at 75.2 dB with number of vehicles passing by were 5.444 SMP/hour of passenger transportations and 1.746 SMP/hour of freight transports.

At Location 3, the maximum noise intensity value obtained for the measurement in the morning was 77.6 dB and was obtained at 7 to 7.10 am, the minimum noise intensity value was at 8.20 to 8.30 am at 75.5 dB, and the average value was at 76.2 dB with number of vehicles passing by were 1.647 SMP/hour of freight transports and 7.214 SMP/hours of passenger transportations.

The maximum noise intensity value obtained for measurements during daytime was 73.8 dB at 1.10 to 1.20 pm, the minimum noise intensity value was obtained at 1.40 to 1.50 pm at 71.5 dB, and the average value obtained was 72.6 dB with number of vehicles passing by were 1.888 SMP/hour of freight transports and 3.911 SMP/hour of passenger transportations.

The maximum noise intensity value obtained from the measurement in the afternoon was 76.5 dB at 5 to 5.10 pm, the minimum noise intensity value was obtained at 6.50 to 7 pm at 75.9 dB, and the average noise value obtained was 75.9 dB with number of vehicles passing by were 2.343 SMP/hour of freight transports and 6.524 SMP/hour of passenger transportations.

There was a difference in the level of noise produced among Jalan Yos Sudarso, Jalan Letda Sudjono and Jalan Gatot Subroto road at each measurement time. It can be seen on Figure 4.10 which shows the findings on Location I at Jalan K. L. Yos Sudarso.

![K.L. Yos Sudarso's Street](image)

**Figure 1:** Leq relationship chart with the measurement time for three data retrieval times at Jalan Yos Sudarso

The results of measurement on the second location (at Jalan Letda Sudjono) during the time of measurement are shown in Figure 1.
Figure 2: Leq relationship chart with the measurement time for three data retrieval times at Jalan Letda Sudjono

Results on Location 3 at Jalan Gatot Subroto can be seen on Figure 3

Figure 3: Leq relationship chart with the measurement time for three data retrieval times at Jalan Gatot Subroto

There was a difference in the average level of traffic noise between Jalan K.L.Yos Sudarso with Jalan Letda Sudjono and Jalan Gatot Subroto for the Leq noise intensity. This can be seen in Table 3 and Figure 4.

Table 2: Average Leq noise intensity of the vehicles at three research locations.

| Time         | Average Leq at Jalan K. L. YosSudarso | Average Leq at JalanLetdaSudjono | Average Leq at JalanGatotSubroto |
|--------------|--------------------------------------|----------------------------------|----------------------------------|
| 07.00-09.00  | 75 dB                                 | 74 dB                            | 76.2 dB                          |
| 12.00-14.00  | 72.5 dB                               | 72.85 dB                         | 72.6 dB                          |
| 17.00-19.00  | 76.1 dB                               | 75.2 dB                          | 75.9 dB                          |
Based on Figure 4, the comparison of Leq average vehicle noise intensity at the three road sections studied shows that the highest value of measurement in the morning was at Jalan Gatot Subroto-Kampung Lalang with a total of 76.2 dB and total vehicles were 8.861 SMP/hour. This condition occurred in the morning due to the similar time of going to work, office, and to go to school and Jalan Gatot Subroto is also the main road between Medan and Binjai, Medan and Aceh, and also other cities.

Based on the research that has been carried out at the three secondary arterial roads, namely at Jalan K.L. Yos Sudarso, Jalan Letda Sudjono and Jalan Gatot Subroto-Kampung Lalang, it can be seen that the traffic volume passing at Jalan Gatot Subroto in the morning was the highest with vehicles passing by were 1.674 SMP/hour of freight transports and 7.214 SMP/hour of passenger transportations, which also resulted congestion and noise levels produced by motorized vehicles.

As being mentioned previously, the sources of noise were coming from vehicles which most of them were from machines, the frictions among the vehicles with the road and air, the type of engine, the type of cooling fan of the vehicle, different parts of exhaust system and the type of the vehicles. It commonly occurred on road contact noise which exceeded the engine noise at the speed of more than 60 km/hour. The traffic noise was included as the criteria of line noise; it was caused by the sound of vehicles passing by the roads as well as the increasing congestion of traffic on those roads. Besides those factors, there were also parameter of the vehicles themselves including the composition of the vehicles, the nature of the drivers, and the stability/instability of the motorized traffic.

The parameter of roads being passed by was the physical condition of the roads, such as the shape of the road, the slope of the road, curvature, road bends, different road surfaces and the width of the road that motorized vehicles pass through. Therefore, based on the division of noise zones/territories by the Minister of Health Number 718 of 1987 in Setiawan, this zone was in zone D namely the industrial environment, factories, railway stations, bus terminals and traffic.

5. Conclusion And Suggestion

Conclusio

Based on the research that has been conducted, the average value for the level of traffic noise on the road: K.L. Yos Sudarso Street’s was at 76.1 dB, Letda Sudjono Street was at 75.2 dB, and Gatot Subroto Street’s was at 76.2 dB.

The impact or effect caused by motor vehicle noise were:
5.1. Inadequate road conditions such as the number of potholes, the uneven asphalt layer during fillings, the lack of width of road due to street vendors selling around the road and insufficient parking.

5.2. Thus, the narrowness of a road segment is very influential on traffic congestion, especially on vehicles passing in and out of each intersection without anyone managing the vehicle.

5.3. The impact of vehicle noise on human can be in the form of disruption of nerves which can cause impairment or even more severe damage. For example, hearing loss - a change that occurs at the level of hearing which results in difficulties in living a normal life. Hearing loss usually occurs while understanding a conversation. Noise can also cause weakness during listening, communication disorders, sleep disturbances, causes of heart effects or blood veins and psychophysiological effects, decreasing physical performance, and can cause irritation responses and changes in social behavior.

5.4. The impact also occurs on flora and fauna. For example, large volume of vehicles on the road can cause the leaves of the plant to be hollow and withered, contaminated by vehicle pollution. Livestock will become sick if human eat plants that contain and are contaminated with fluorine.

**Suggestion**

The suggestions that can be conveyed from the results and discussion obtained from this study are:

a. Efforts to minimize or at least to not increase the noise level should be made since it can affect the health and environment.

b. Traffic facilities should be fixed, such as the maintenance of road conditions, road widening and the restriction of street vendors who are still selling around the road body.

c. On the other side, ideas of road blocking, road transfer, vehicles engine maintenance, tree planting around the road or the use of personal protective equipment in order to not disrupt health or to avoid long-term danger should be proposed.

**References**

[1] Buchari.2007, *Kebisingan Industri dan Program Hearing Conservation Program*, (http://Library.us.ac.id). Bandung.

[2] Djalante, S. 2010, *Analisis Tingkat Kebisingan di Jalan Raya Yang Menggunakan Alat Pemberi Isyarat Lalu Lintas (APIL) (Studi Kasus: Simpang Ade Swalayan).* Jurnal SMARTek. Vol. 8 No. 4. November 2010: 280-300. Bandung.

[3] Hidayati, N. 2007, *Pengaruh Arus Lalu Lintas terhadap Kebisingan.* Skripsi. Universitas Muhammadiyah Surakarta. Surakarta.

[4] Ikrorn., Ikhwan., Nurzannah. 2005,*Pengaruh Kebisingan Lalu Lintas Jalan terhadap Gangguan Kesehatan Psikologi Anak SDN Cipinang Muara Kecamatan Jatinegara Kota Jakarta Timur. Makara, Kesehatan.* VOL. 11, NO. 1, Juni 2007: 32-37. Jakarta.

[5] Ishaq.2007,*Tarf Intensitas Bunyi Fisika.* Kesehatan Pendengaran. Semarang.

[6] Leksono. (2009) *Gambaran Kebisingan di Area Kerja Shop C – D Unit Usaha Jembatan PT. Bukaka Teknik Utama.* Skripsi. Universitas Indonesia.

[7] Keputusan Menteri Lingkungan Hidup Nomor 45 Tahun. 1997,tentang Indeks Standar Pencemar Udara. Jakarta.

[8] Menteri Negara Lingkungan Hidup. 1996, *Baku Tingkat Kebisingan, Surat Keputusan Menteri Negara Lingkungan Hidup Nomor: Kep-48/MENLH/1996/25 November 1996*, Jakarta.

[9] Manual Kapasitas Jalan Indonesia (MKJI). 1887, Jakarta: Direktorat Jendral Bina Marga. Departemen Pekerjaan Umum.

[10] Prasetio, L. 1985, *Akustik Lingkungan.* Institut Teknologi Sepuluh Nopember Surabaya. Penerbit Erlangga. Jakarta.
[11] Satwiko, P. 2005, *Fisika Bangunan 1 (edisi 2)*. Penerbit ANDI. Yogyakarta.

[12] Suroto, W. 2010, Dampak Kebisingan Lalu Lintas Terhadap Pemukiman Kota. (Kasus Kota Surakarta). *Jurnal of Rulan and Development*. Volume 1, No. 1 Februari 2010. Yogyakarta.

[13] Tamin, O. Z. 2000, *Perencanaan dan Pemodelan Transportasi*. ITB. Bandung.

[14] Umiati, S. 2011, *Pengaruh Tata Hijau Terhadap Tingkat Kebisingan Pada Perumahan Jalan Ratulangi Makassar. Teknika 2*. Makassar

[15] Zeamansky. 1999, *Fisika Untuk Universitas 1 (Mekanika, Panas, dan Bunyi)*. Penerbit Trimitra Mandiri. Jakarta.