The effect of traffic volume on noise of housing and shopping area of Manggala District

N M Kamal¹, Y Jinca² and S Wunas³
¹Department of Infrastructure Planning, Graduate School of Hasanuddin University
²Department of Transportation, Faculty of Engineering, Hasanuddin University
³Department of Spatial Science, Faculty of Engineering, Hasanuddin University

Email: nahlahmustafakamal@yahoo.co.id

Abstract. Pollution includes environmental problems that threaten major cities in Indonesia, especially those originating from motor vehicle emissions and the effect of noise on health. This study aims to determine how the impact of traffic volume with noise by looking at the functional aspects of buildings along the road. This study measured the noise and data collection of traffic volume on the Main street in the neighbourhood between the sub-districts of Manggala, Makassar. Data collection comes from primary data, namely, data from research results and secondary data, library search. The results of the data collection were obtained, namely the volume of vehicles higher on Friday, namely on the road of DR J Leimena, which is 531 units of vehicles, the lowest in the Bukit Baruga housing estate. The more vehicles, the higher the noise level. The results of noise measurements at the research location indicate that in the Bukit Baruga residential area the maximum range is 53 dB, on the LAN 63 dB and the road Dr. J. Leimena - Jalan Antang Raya is around 65 dB, referring to KEP.48/MENLH/11/1996, November 25, 1996. The results of the communication disruption questionnaire are quite disturbing to the community. This study concludes that the noise level prediction model is directly proportional to the volume of traffic and is influenced by factors of road conditions (flat and elevation) and the distance from occupancy to the road.

1. Introduction

The capacity of roads in major cities in Indonesia is considered disproportionate to the growth in the number of vehicles. This issue causes problems on many roads. The overbalanced between road capacity, and traffic volume causes congestion which results in air pollution and noise. Pollution is one of the environmental problems that threaten major cities in Indonesia, especially motor vehicle emissions and the effect of noise on health. According to previous research, [1] revealed that the noise level in the City of Makassar reached 79-81 dB. An increase in the number of motorized vehicles causes an increase in noise levels on the highway, causing inconvenience to road users and the surrounding community, individuals who are exposed to noise every day are at risk of hearing loss [2,3]. Roads with heavy and light vehicles that are quite dense are at risk of producing noise. Residential areas, social activities, including schools, mosques, residences, and hospitals located on both sides of the road are ones that are most affected by the noise.

According to [4], the most common problem in residential constructions and settlements in urban areas is the number of units that considered disproportionate with the population growth rate. The other problems are the quality of buildings that do not meet the liveable standards, lack of aesthetic requirements, and other proper facilities and infrastructures. The deteriorate of environment quality brings about air and noise pollution. The impact of traffic noise causes disorders for some workers such as; giving effects on performance and state of the body’s health and concentration in work, experiencing temporary and permanent deafness so as to cause discomfort anxiety, especially for
workers who have hearing problems and wearing hearing aids that have certain limits and for those who are very sensitive to continuous noise [5].

Based on the above-mentioned reasons, this study aims to find out how the influence of traffic volume and noise by examining the aspects of building functions along the road.

2. Method

2.1. Research design

This research is field research aiming to measure the noise level based on traffic volume, surrounding of the location of the main road with different building functions and plant density, in the Ruang Milik Jalan and Ruang Pengawasan Jalan in the demarcation area. The approach used is a field study for the measurement or calculation of traffic and noise volumes. A qualitative descriptive visual survey will be deployed for the data collection on building function and plant density that is thought to be a noise reduction.

2.2. Research Time and Location

The field research was conducted on certain days in October, November, and December by choosing a time for a relatively high level of traffic density, especially in the morning at 06.00 to 08.00 and afternoon 15.00 to 17.00. The study was conducted on the Main Road at Bukit Baruga Residential Area Jalan Raya Baruga, in the front of LAN, and in Jalan Dr.J. Leimena/Antang Raya. The three locations were chosen based on consideration of differences in building function, road status, traffic volume, and plant density on the side or in the Ruang Milik Jalan.

2.3. Data Collection and Analysis Methods

Data sources are divided into two; primary and secondary data. Primary data for traffic volume was collected manually by an enumerator at a predetermined point, by calculating the exact vehicle's number and recording of noise levels using a Sound Level Meter tool. Secondary data was collected from articles, journals, and library searches related to traffic noise on the highway. The data analysis method was conducted in some stages as follows; (a) Generally describing the location of the study. (b) Calculating the volume and type of vehicle, demarcation of the fence/building, fence height, density and function of the building, road elevation (c) Measuring road traffic noise using a Sound Level Meter for 2 hours at each point of observation in the morning and evening. (d) Analyzing the function of buildings, damping plants (reducing elements and vegetation plants), the distance between fences and plants, and vegetation height in the three study sites.

3. Results

Table 1 explains that the Noise Prediction Model (dB) on the main road, the initial noise, which is influenced by other factors, besides vehicle traffic on the road and varied according to building functions and road elevation differences. The initial noise in the Bukit Baruga Residential is in the range of 20 to 26 dB. On the highway of Baruga ranges from 25 to 38 dB with the mixed function of the land (Residential, Offices, and small/medium business activities) and in the main commercial business/office area, the noise is in 77 dB. The model of the influence of traffic volume and traffic characteristics on the Bukit Baruga Residential main road, the location of the building and commercial mix functions have a correlation coefficient R² = (0.70-0.85). Traffic noise is also affected by distance and noise sources from the road demarcation area. As seen in Table 2, the noise reduction between the roadside and the road border area is (∆y) = 0.0195 (traffic volume) + 3.97, and the noise reduction affected by the road elevation is ∆y = 0.0819 (volume traffic) + 4.71.

| Table 1. Prediction Noise Model (dB) in main road. |
Bukit Baruga Residential Area

| Measuremen t Location | Elevation (1-2 meter) | Commercial (LAN) | Commercial and Commercial (MIX) |
|-----------------------|-----------------------|------------------|-------------------------------|
| Highway roadside      | y1 = 0.2172(x) + 26,2 197 | y1=0.1866(x) + 24,785 8 | y1=0,0388(x) + 31,804 |
|                       |                       | y1=1.889(x)+38, 8534 | y1=0.0003(x) + 76,77 |

Road demarcation (with distance about 5-10 meter from)

| Distance factor (∆y) road demarcation and noise reduction plants (y1-y2) | Elevation effects |
|------------------------------------------------------|------------------|
| ∆y=0.0195(x)+3,966 9                                   | Δyev1=0.0206( x)+1,4339 |
| ∆y=0.0819(x)+4,7133                                   | Δyev2=0.0418( x)+2,1803 |
| ∆y=0.1402(x)+13,713 5                                 | Relatively zero |

Table 2. Traffic noise sensitivity.

| Main Road Location | Level of Sensitivity Roadside | Road Demarcation | Remarks |
|--------------------|-------------------------------|------------------|---------|
| Bukit Baruga Residential |
| a. Flat            | 0.2172                        | 0.1559           | The main road in the Bukit Baruga Residential area is full of housing (100%) and is filled with trees and shrubs. |
| b. Elevation       | 0.2378                        | 0.1977           |         |
| Non-Residential    |
| a. Bukit Baruga Highway, in the front of LAN | 0.0388                | 0.0404           | Bukit Baruga Highways is filled with the residential-office type of buildings and culinary. |
| b. Dr. J. Leimena  | 0.1889                        | 0.0487           | Jalan Dr. Leimena is filled with commercial |

Source: Final results analysis

Table 2, the sensitivity of traffic noise, explains that the noise sensitivity is higher in the outside of the residential area (Jalan Dr. Leimena-Jalan Antang Raya and business/office area) compared to Jalan Raya Baruga. Similarly, the comparison between housing on a flat road and house located on an elevation. The sensitivity ranges from 0.2177 to 0.2378 on flat roads and ranges from 0.1559 to 0.1977 with an altitude of 1 to 2 meters, in the Ruang Milik Jalan in the demarcation area. Based on the results of the questionnaire, it was found that the highest noise level occurred on Dr. J. Leimena/Jalan Antang Raya, second is LAN, and the lowest noise level is found in Bukit Baruga Residential area.
Table 3 shows the traffic characteristics in Bukit Baruga Housing, which is relatively dense (an average of 12 vehicles/minute), on the main road of the Jalan Raya Baruga in front of the LAN, the volume of traffic in the morning ranges from 33 vehicles per minute while in the afternoon the average is 52 vehicles per minute. Traffic volume on the Dr. J. Leimena in the morning and evening ranged from 32 vehicles per minute and 53 vehicles, respectively. The types of traffic vehicles of the majority of motorized vehicles ranged from 58% to 67%, in the main Bukit Baruga Residential area, in the non-residential area (Baruga LAN and Jalan Dr. J. Leimena) it is around 68% to 77% vehicles. The percentage of cars lies between 32% to 41% in the main Bukit Baruga Residential area while in the non-residential area (the Baruga LAN and Jalan Dr. J. Leimena) the range is between 22% - 31% cars, and other vehicles (trucks, benthos, public transportation, bicycles) in three locations ranging from 0% - 1%. In Bukit Baruga, the volume of vehicles was higher on Saturday afternoon i.e., 139 units of vehicles. In the LAN on Friday evening, there were 522 units of vehicles. On the Jalan Dr. Leimena, the highest volume of vehicles was on Friday afternoon with 531 vehicles. The noise measurement results show that in the Bukit Baruga residential area around 53 dB, in the LAN 63 dB and on Dr. J. Leimena-Jalan Antang Raya about 65 dB.

4. Discussion
Roadside areas are built for the safety and comfort of road users, road development, buffer zones, green lanes, service facility construction sites, and protection of natural formations [6]. The condition of the side of the Bukit Baruga Residential road is filled with shady and shrub trees such as; the Ketapang Kencana tree, bushes (green grasses), and hedges (shrubs). Ketapang Kencana tree has a slender form, has stretched and multilevel twigs so that it is suitable to be used as a yard plant and noise reduction. Ketapang Kencana can grow with heights reaching 10-20 m with stems standing tall and neat. This tree also has slim branches that grow straight. Greenline as a form of the urban forest has the function of maintaining the survival of the earth; as a medium that can reduce air pollutants including carbon dioxide (CO₂) that float in the air and produce oxygen (O₂) [7].

According to [8] to avoid the impact of traffic noise and another outdoor crowd could be done with these several alternatives such as; a. Stay away from sources of noise b. Place a barrier wall c. Increase the elevation/height of the building as a recipient of noise sources. Location and distance (position) of the buildings could reduce the noise caused by traffic. The location of the building towards the source of noise may not be directly related, or in other words, the placement of the building front yards affects the noise reception. The yard can be a pretty good reduction of noise for a building by the mechanism of collecting sound energy in the middle of the building [9]. According to [10], noise can be reduced by extending the propagation media, i.e., moving the source of noise away from the receiver. Traffic noise can be reduced by increasing the distance of the building to the cause of the noise, i.e., by doubling the length of the building, it can reduce noise up to 3 dB. Similarly, [11], stated that increasing the distance between the sound source and the receiver would reduce noise by 6 dB.

Noise reduction can also be made by providing a barrier between the sound source with the receiver [1-]. According to [12], the fence can be a barrier wall that has a minimum height of 1.5 m, the distance of the barrier to the receiver is 2-3 m, the distance of the source to the barrier that is 3-4 m will reduce the sound up to 10 dB. In order to reduce noise caused by road traffic, it is necessary to
make noise barriers from bricks, earth mounds modified to dikes or composting plants with a specific density [13].

The condition on the side of the LAN road, which is filled with commercial activities on the left side which are crowded by the community and on the right side there are mango trees, *glodokan* trees, are palms trees, cape trees which are noise reducing plants. There are no noise-reducing plants observed in Jalan Dr. J. Leimana, except trees (mango trees) located in the residential's front yard. Public attention to the importance of green space does not play an active role in maintaining the presence of plants. Plant management systems are still lacking impact on the maintenance of the type of plant vegetation. The lack of comfortability in the green space is due to the absence of facilities itself.

The results of noise measurements at the study site show that the maximum range of noise in the residential area of Bukit Baruga is around 53 dB, in LAN 63 dB and in Jalan Dr. J. Leimena-Jalan Antang Raya around 65 dB. The noise level can be described in several ways. First, the number of vehicles is directly proportional to the noise level. For example, from the graph, the number of vehicles of 62 units has a noise level of 38.4 dB at the position of researchers on the roadside whereas if the number of vehicles is 138 units, the noise level with the same research position is 53.3 dB. Second, the noise level of Bukit Baruga Residential area in the morning starts from highest to lowest: on the side of the road, behind a tree, and behind a fence. For example, with the number of vehicles 72 units, the noise level on the side of the road is 40 dB, while in the road demarcation area is 38.4 dB.

The road geometry is in the research area in front of the LAN, and Dr. J. Leimena is relatively flat height so that the noise level can be directly received by residents in the house. In Bukit Baruga Residential area, the elevation of the road is uneven. So that the source of noise can be reflected and not directly entered the house. The geometric of the road also affects the noise received by residents inside the house.

Wide land will not be confusing in dealing with noise, because there is still a distance that can be maximized to stay away from the sound source. Based on samples from each location: Bukit Baruga residential area, LAN Baruga highway and Jalan Dr. J. Leimena/Jalan Antang Raya towards disturbance and public health; the noise level at the Bukit Baruga Residential area is relatively deficient, while at the location of the Baruga highway in front of the LAN is considered low, and on Jalan Dr. J. Leimena/Antang Raya is very high, especially noise disturbance in the residence. The number of complaints of communication disorders is relatively low in Bukit Baruga Residential area, so it is in LAN. However, on Jalan Dr. Leimena and Jalan Antang Raya is quite high.

The noise effects on public health are physiological disorders such as dizziness, nausea, insomnia, shortness of breath, rapid fatigue, muscle tension, and abdominal pain have not been seen as for now or are relatively low and can hardly be felt by the community in the three study sample locations. While the disruption to psychological factors, discomfort, emotional influence, anger so that people will move to another place, and the effect of noise on productivity is still very low. It does not really affect residents who live in the Bukit Baruga residential area, while those who live on the Baruga highway in front of LAN and on the way Dr. J. Leimena/Jalan Antang Raya already feels disturbed with a low level of disturbance within tolerant limits.

5. Conclusions and Suggestions
Traffic characteristics in Bukit Baruga residential area are relatively dense (an average of 12 vehicles/minute). On the main road in the Baruga Highway in front of LAN and Dr. Leimena’s traffic volume ranges from 32 to 54 vehicles per minute. Most motor vehicles range from 58% to 77%. The percentage of cars between 22% to 41% and other vehicles (trucks, benthos, public transportation, bicycles) range from 0% - 1%. The momentary noise level at 07.00-09.00 in the residential area of Bukit Baruga ranges from 10 to 30 dB, in the non-residential area, the Baruga Front of the LAN ranges from 20 dB to 30 dB and on Dr. J. Leimena ranges from 30 dB to 45 dB. The noise level prediction model is directly proportional to the traffic volume and is influenced by road elevation factors and distance (road border/road space). Noise sensitivity is higher in residential areas. The noise
level is still low, communication disruptions, physiology, and community psychology in residential areas even relatively are low, areas outside of residential where building functions (works, business and social) are already noisy, physiological and psychological disorders are sometimes disrupted, and suggestions from the results of this study for some areas that have exceeded the threshold are suggested to increase green open space. Further research is needed to assess noise following the characteristics of existing settlements in Makassar City.

References
[1] Tenri 2016 Analisis tingkat kebisingan simpang empat bersinyal di jalan veteran utara makassar (Skripsi). Makassar: Universitas Hasanuddin.
[2] Purnami N and Manyakori S P P 2018 Reactive oxygen species levels are high risk worker of noise induced hearing loss in hospitals IOP Conf. Ser. J. Phys. Conf. Ser. 1075
[3] Wicaksono S N, Dewanti L and Purnami N 2018 Correlation between earphone usage and visiting game centre with hearing threshold IOP Conf. Ser. J. Phys. Conf. Ser. 1075
[4] Syahriartato 2013 Pemantauan Pembangunan Kawasan Perumahan dan Pemukiman Pinggiran Kota Makassar. 10 Juni 2018
[5] Doelle L E 1990 Akustik Lingkungan (Jakarta: Erlangga)
[6] Carpenter P L 1975 Plants in the Landscape. (San Fransisco: W.H.Freeman & Co.)
[7] Iwan H 2007 Endometriosis (Jakarta : PT Gramedia Utama)
[8] Sangkertadi 2006 Analisis Rating Green Building Rumah Tinggal di Kota Manado, Perbandingan antara GBCI dan IGBC, Prosiding Seminar Nasional, Universitas Sam Ratulangi, Manado, ISBN: 978-979-15616-5-5.
[9] Egan 2007 Relationship Marketing: Exploring Relational Strategies in Marketing, (England : Pearson Educated Limited)
[10] Fathoni 2010 Organisasi dan Manajemen Sumber Daya Manusia. Jakarta: Rineka Cipta
[11] Koesnigsberger O H, Ingersoll T G, Mayhew A, and Szokolay S V 1975 Manual of Tropical Housing and Building, Part One Climate Design, Longman, London
[12] Mediastika 2005 Akustika Bangunan Prinsip – prinsip dan Penerapannya di Indonesia (Yogyakarta: Penerbit Erlangga)
[13] Frick 2008 Ilmu Fisika Bangunan, (Yogyakarta : Kanisius)