Assessment of traffic noise pollution at residential and school areas in Jeli, Kelantan

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Abstract. The development of roads interconnects communities and has become important for economic and social development. Higher traffic noise level is often reflected by the increase in the number of vehicles. This paper discussed the relationship between noise level and vehicle density in the study area. The aim of this study was to assess the traffic noise pollution occurring in the residential and school areas in Jeli, Kelantan. The traffic noise measurement was collected using a sound level meter for three consecutive months (July, August and September 2023). The traffic volume was recorded by traffic surveying. The assessments were carried out from 8.00 a.m – 8.00 p.m. The recorded noise levels were compared with the permissible limit (Malaysian noise limit). The highest noise level recorded was 85.9 dBA, well over the permissible limit of 60 dBA by DOE. This was due to the high number of vehicles passing by the road in the study area and the highest number of vehicles recorded was 4976 during sampling time in July at Kg Gemang. Overall, the traffic noise assessments for this study were beyond the standard limit set by DOE during daytime. This considerably high noise could lead to other health effects for the residents.

1 Introduction

Noise has long been underestimated as a hazard capable of causing a variety of short-term and long-term health problems. It gradually poses a potential threat to one's physical and psychological health, thereby affecting overall well-being [1]. The disturbance caused by noise pollution hampers people's daily activities, with the general threshold for tolerable noise being around 80 dB for normal individuals [2]. Transportation related noise pollution comes in different forms such as road, aviation, maritime and train noise. Specifically, traffic noise refers to offensive sounds produced by vehicles on public roads. Vehicle engines, exhaust systems, aerodynamic friction, interactions between vehicles and the road system are all factors that generated this type of noise [3].

Small towns and villages had fewer noise pollution issues. However, noise becomes more of a nuisance to small towns inhabitants when there are roads, railroad tracks or major roadways near their living areas that will eventually cause excessive noise [4]. The vehicular flow on highways that mostly generate traffic noise including vehicle density, road type and

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surface, vehicle speed, gradient, intersections, percentage of lorries on the road and building deflection are all elements that influence noise emission from vehicles [5].

The aim of this paper was to assess the traffic noise pollution occurring in the residential and school areas in Jeli, Kelantan as well as to discuss the contribution factor to the problem, which was the vehicle density in the study area. When dealing with traffic noise, another factor that can be considered is poor town planning. This causes serious traffic noise issues where residential properties, facilities such as schools, hospitals, religious places and other community structures are often built in close proximity to the major roads without proper soundproofing or buffer zones [6]. These buildings could reflect, absorb and transmit sounds. However, the rate of all the reflection, absorption and transmission is also depending on other factors such as building materials and structures.

2 Methodology

In this study, we included two main components, which were (1) traffic noise level measurement and (2) traffic counts. The detailed descriptions for both components are described in the following section.

2.1 Study areas

The locations included in this study were Kg. Gemang (05° 45. 072" N and 101° 51. 724" E) and Maktab Rendah Sains Mara (MRSM) Jeli (05° 44. 964" N and 101° 51. 703" E), whereby both locations were selected based on their sensitivity areas category. In addition, these locations are in the area where daily traffic volume is high due to the straight and flat roadways. The main roadway connecting these two locations is the East-West Highway, which stretches for about 215 km between Jeli, Kelantan and Gerik, Perak.

2.2 Noise level measurement

A sound level meter (TENMARS TM102) was used in order to record the noise produced by the traffic in this study. This device ranges from 80 – 130 dB with A and C weightage. The device was erected with a pole and placed on the side of the road (**Fig. 1.**). It is very important to note that the position of the microphone was mounted at least 1.2 m above ground and the distance from any reflective surface other than the ground was at least 3.5 m [8]. No obstruction should be placed within the area of the device installation to reduce errors. The measurements were taken during 8.00 a.m – 8.00 p.m and the average noise pollution was represented in decibel unit dBA. The monitoring must be done during good weather conditions and during working days.

The noise data were recorded and then analysed to get the equivalent continuous noise level (L_{eq}), percentile of noise exceedance as well as maximum and minimum level for the respective period in the study. The physical attribute of noise and the people's response to it can be predicted using traffic noise index (TNI). This TNI has good relativity in response to the public and by using this, we can evaluate the annoyance mass traffic can cause to the public. A threshold of 74 dBA is established as the limit for surpassing acceptable noise limits for TNI. To determine the traffic noise index (TNI) and noise pollution level (NPL), the following formulas were used to calculate both TNI and NPL.

$$TNI = 4\,(L_{10} - L_{90}) + (L_{90} - 30) \quad (1)$$

$$NPL = L_{eq} + (L_{10} - L_{90}) \quad (2)$$

Fig. 1. The position of sound level meter at the study areas

2.3 Traffic count

The traffic volume refers to the overall quantity of vehicles passing through a specific location within an hour. It is determined by counting the number of vehicles passing through a fixed point on the road. The truck traffic mix ratio, expressed as a percentage, represents the proportion of heavy trucks and buses in relation to the total traffic. A rise in this ratio leads to an elevation in the noise level. The traffic volumes in the respected areas in this study were recorded using manual traffic counting method, which recorded the data in tally sheets. The traffics were divided into types of vehicles according to types of vehicles such as cars, motorcycles, lorries (light, medium and heavy), vans, buses and ambulance (**Table 1**).

Table 1. Types of vehicles and their weight/ engine power

Types of vehicle	**Weight/ Engine power**
Cars	Below 1300 cc
	1301 cc -1600 cc
	1601cc -2000 cc
Motorcycle	Below 150 cc
	151 cc – 200 cc
Light lorries	1 tons – 2 tons
Medium lorries	3 – 20 tons
Heavy lorries	21 tons and over

2.4 Noise measurement parameter

The noise levels were determined through the utilization of percentile noise indices: L_{10}, L_{50}, and L_{90}. L_{10} represents the noise level experienced during 10% of the measuring period, while L_{50} and L_{90} correspond to the noise levels encountered during 50% and 90% of the measuring period, respectively. The term L_{90} refers to the background noise level when there are no nearby sources of noise present. Equations (3) to (6) were used to calculate L_{10}, L_{50} and L_{90}:

$$L_{eq} = L_{10} + 0.018\,(L_{10} - L_{90})^2 \quad (3)$$

$$L_{10} = 61 + 8.4\log(Q) + 0.15P - 11.5\log(d) \quad (4)$$

$$L_{50} = 44.8 + 10.8\log(Q) + 0.12P - 9.6\log(d) \quad (5)$$

$$L_{90} = 39.1 + 10.5\log(Q) + 0.06P - 9.3\log(d) \quad (6)$$

**Q indicates total vehicle, P represents the percentages of heavy vehicles and d represents the distance between the noise sources to the receivers.

3 Results and Discussions

The L_{eq} for each of the sampling sites are shown in **Fig. 2.** and **Fig. 3**. According to the Department of Environment (DOE) Malaysia, the recommended limit for noise exposure is 60 dBA for daytime and 55 dBA for nighttime [7].

The study was done according to various time variations throughout the day. It can be derived from the graph that the highest noise recorded was 85.9 dBA at Kg. Gemang. This high noise was recorded during mid-day and at lunch break time. However, the minimum noise recorded was still under the limit set by DOE, which was 44.6 dBA. For study site 2, which was MRSM Jeli, the highest recorded noise was 83 dBA and this too was recorded at mid-day time. The traffic volume was relatively high during this time of the day compared to mornings and late evenings. The highest volume of vehicles recorded during this study was 1903, at noon near Kg, Gemang, while the lowest vehicle volume recorded was 305 at late evening near MRSM Jeli. This showed that vehicular transportation was really the factor contributing to the high noise level at both study sites.

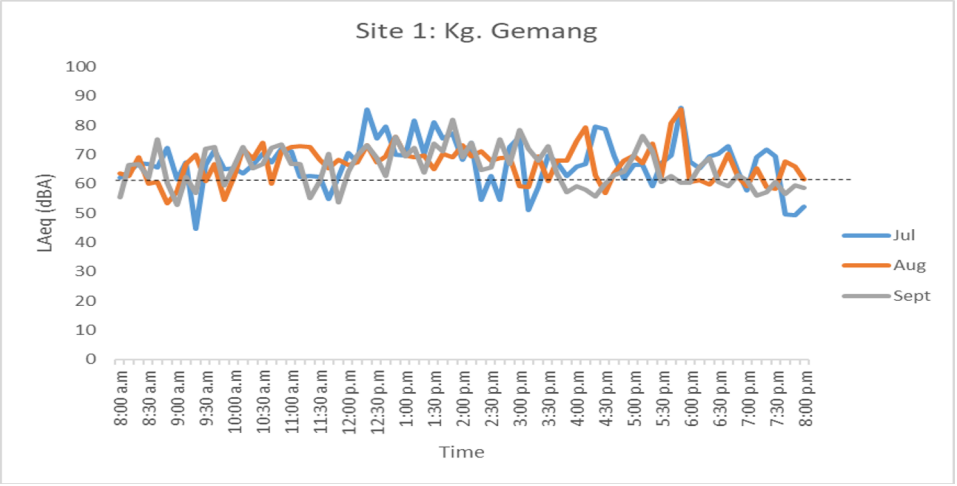

Fig. 2. Average noise level dBA at sampling location Site 1 with the limit set by Department of Environment (DOE) at 60 dBA in dotted line.

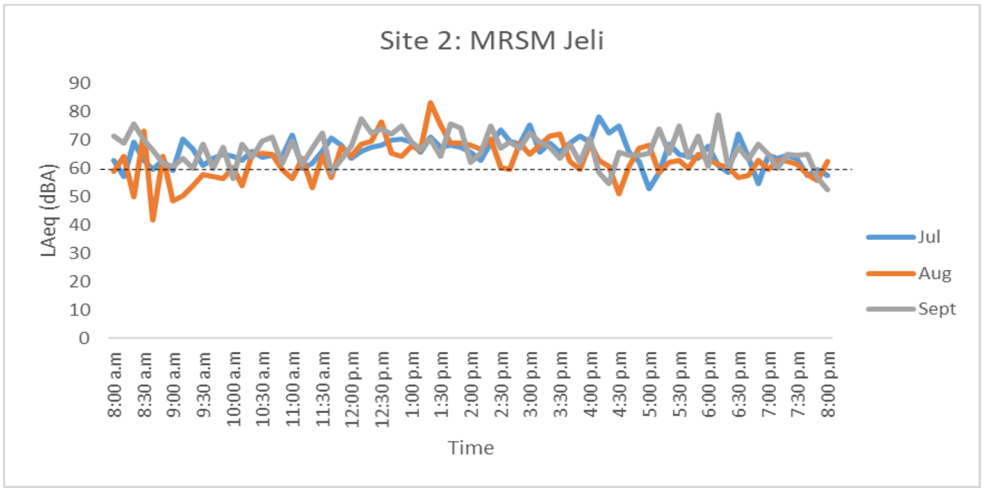

Fig. 3. Average noise level dBA at sampling location Site 2 with the limit set by Department of Environment (DOE) at 60 dBA in dotted line.

Table 2. shows the number of traffic recorded at both study sites. The highest number of traffic recorded during this study was 4976 during data recording time in July, which was recorded at Kg. Gemang in July. The highway that crosses both study sites is well known to have fairly heavy traffic travelling from other towns such as Tanah Merah and Machang to Jeli. The increase in population at study sites due to the development of a few higher educational institutes caused the increase in traffic volumes. It is apparent that people travel through the highway at the study sites by using personal vehicles rather than using public transportation, due to the fact that the public transportation in the area is not effective. Fluctuations in the recorded sound level, as detected by a sound level meter, can occur due to several factors. These include changes in wind direction relative to the noise source, the varying proximity of road traffic and vehicular noise to the measurement meter, and the presence of other sources of noise that contribute to an unstable acoustic environment.

Table 2. Traffic volume (Q) and Truck-Traffic ratio (P) at both study sites

Sites		8.00-11.00 a.m		12.00-2.00 p.m		3.00-5.00 p.m		6.00-8.00 p.m	
		Q	P(%)	Q	P(%)	Q	P(%)	Q	P(%)
Kg. Gemang	Jul	1371	3.7	1903	5.5	1301	9.4	401	12.2
	Aug	690	3.5	718	9.9	776	5.5	399	9.8
	Sept	1317	3.3	804	7.3	1374	2.6	308	7.5
MRSM Jeli	Jul	789	4.8	1209	5.4	1522	3.1	484	5.8
	Aug	557	3.1	913	4.3	1120	4.1	305	6.9
	Sept	498	5.4	979	6.3	680	1.5	454	4.4

All the TNI levels computed during this study exceeded the permissible level of 74 dbA (**Table 3.**). The accepted permissible level for TNI and NPL were 74 dBA and 88 dbA respectively [8]. This shows that the noise recorded in the study areas somehow will negatively affect the residents' health. For example, residents can experience hearing loss when they are exposed to noise for a long period of time [9].

Table 3. TNI and NPL values at both study sites

Sites		8.00-11.00 a.m		12.00-2.00 p.m		3.00-5.00 p.m		6.00-8.00 p.m	
		TNI	NPL	TNI	NPL	TNI	NPL	TNI	NPL
Kg. Gemang	**Jul**	104.9	81.2	93.3	85.1	94.5	81.1	94.6	81.5
	Aug	104.1	80.4	94.2	84.9	92.4	82.0	93.6	81.7
	Sept	104.6	81.2	93.2	82.8	91.7	80.0	92.4	78.4
MRSM Jeli	**Jul**	104.8	79.9	92.8	81.7	92.0	83.3	92.1	77.5
	Aug	103.7	74.5	92.1	81.2	92.2	79.0	92.2	76.8
	Sept	104.6	82.5	93.0	84.1	90.6	80.5	91.5	80.5

Noise pollution from vehicles has various effects on humans, including physical, physiological, psychological, and communication-related impacts. For example, as observed in India, urban residents face health risks due to the improper use of traffic horns and the extensive use of loudspeakers during religious and social celebrations [10]. It is furthermore proved by various studies that there is correlation between the increasing incidence of health issues and noise pollution.

There is evidence that exposure to noise can trigger the production of harmful chemicals and contribute to the spread of viral diseases [11]. It was also found that ambient noise has detrimental effects on human health, specifically by heightening stress levels and exacerbating stress-related conditions such as high blood pressure, cardiovascular disease, peptic ulcers, and migraine headaches [2].

The startling effect of noise on individuals can lead to changes in heart rate and muscle contraction, resulting in an increase in blood pressure, respiration, heart rate, and other physiological responses. The force exerted by blood against the walls of arteries as it is pumped out of the heart influences blood pressure. Higher blood pressure makes it more challenging for the heart to effectively circulate blood [12]. It is also anticipated that low concentration, fatigue, doubts, confidence loss, irritability, misunderstandings, low work ability and others are the variety of psychological, physical and behavioural issues as a result of noise pollution, derived from vehicles [13].

4 Conclusion

The noise level recorded and measured at both sites during the study period exceeded the maximum permissible level set by Malaysian DOE, which is 60 dB (A) at day time and 55 dB (A) at night time. The surrounding community especially, will be affected by traffic noise pollution throughout their daily life. In conclusion, the highway in the study sites has a lot of traffic especially during peak hours such as midday and late evenings. This, in the long run, can negatively affect the residents. We suggest that monitoring should be done periodically to avoid serious health effects to the residents. Programmes that involve the public should also be conducted to educate the nearby residence on the health effects as a result of prolonged noise exposure. As for the traffic management, responsible authorities should apply suitable noise abatement procedures and apply sustainable traffic management to overcome the problems.

References

1. Jamir, L., Nongkynrih, B., & Gupta, S.K. Community noise pollution in urban India: Need for public health action. Indian Community Med. **39**. 8-12. (2014).
2. Purwaningsih, N. M. S., Affan Alli, M. S., Shams, O.U., Ghani, J. M., Ayyaturai, S., Sailan, A. T., & Mohd Sinon, S. H. Analysis of noise pollution : A case study of Malaysia's University, International Dental and Medical Research, 333. (2018).
3. Subramani, T., Kavitha, M. & Sivaraj, K. Modelling of traffic noise pollution. International Journal of Engineering Research and Application, **2**. 3, 3182. (2012).
4. Singh, N. & Davar, S. C. Noise pollution-sources, effects and control. Journal of Human Ecology. **16(3)**. 181-187. (2004).
5. Aziz, S. Q., Lulusi, F. A.., Ramli, N. A., Aziz, H. A., Mojiri, A., & Umar, M. Assessment of traffic noise pollution in Bukit Mertajam, Malaysia and Erbil City, Iraq. Caspian Journal of Applied Science Research. **1(3)**. 1-11. (2012).
6. Nadaraja, B., Wei, Y. X., & Abdullah, R. Green and calm : Modelling the relationships between noise propagation and spatial patterns of urban structure and green covers. Urban Forestry & Urban Greening. **24**. 195-211. (2017).
7. Department of Environment Malaysia (DOE). Guidelines for Environmental Noise Limits and Control. (2017).
8. Segaran, V. C., Tong, Y. G., Abas, N. H., David Daniel, B., Nagapan, S. & Kelundapyan, R. Traffic noise assessment among residential environments in Batu Pahat, Johore, Malaysia. IOP Conference Series : Materials Science and Engineering. **713**. (2020).
9. Hsu, T., Ryherd, E., Wage, K. & Ackerman, J. Noise pollution in hospitals : Impacts to patients. Clinical, JCOM Journal Review. **19**. 7. (2012).
10. Ritovskka, G., Djorgjev, D. & Jordanova, N. Psychosocial effects of community noise : Cross sectional study of school children in the urban center of Skopje, Macedonia. Croatian Medical Journal. **45(4)**. 473-476. (2004).
11. Onwuka, E. C. Oil extraction, environmental degradation and poverty in the Niger Delta region of Nigeria : A viewpoint. International Journal of Environmental Studies. **62(6)**. 655-62. (2005).
12. Mohd Isa, I. I., Mohd Zaki, Z. Z. & Kassim, J. Traffic noise pollution in residential areas. International Journal of Engineering & Technology. **253**. (2018).
13. Basner, M., Babisch, W., Davis, A., Brink, M., Clark C., Janssen, S. & Stansfeld, S. Auditory and non-auditory effects of noise on health. Lancet (London, England). **383**(9925). 1325-1332. (2014).