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Evaluation of Traffic Noise Exposure in Old Folks' Homes, Batu Pahat, Johor

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Abstract

Excessive noise exposure can adversely affect the elderly, causing sleep disorders, depression, and stroke. To analyse the noise levels in old folks' homes, this study used a data logging sound level meter to evaluate traffic noise levels of three old folks' homes located along the busy road of Jalan Kluang during peak hours of weekdays and weekends (7.30 am to 9.30 am and 4.30 pm to 6.30 pm). Traffic counts were conducted according to different classes during the first hour of the survey. The study showed that traffic volume did not affect noise levels at Rumah Sejahtera Batu Pahat and Sherun Old Folk Home (BP), but a positive correlation was found at Healthlife Old Folks Home. Noise levels (LAeq(2hrs)) recorded for Rumah Sejahtera Batu Pahat, Sherun Old Folks Homes (BP), and Healthlife Old Folks Homes were 75 dBA, 67 dBA and 70 dBA, respectively. They are all above the recommended values set by the Department of Environment Malaysia (DOE), which is 60 dBA for daytime. The noise levels at nearby buildings, including nursing homes, are likely to be around or exceed the DOE standard. The research is essential as it evaluates the seriousness of traffic noise pollution around the old folks' homes along Jalan Kluang. This study will be helpful for future research and development of built-environment plans.

1. Introduction

Noise pollution is a significant environmental issue in rapidly urbanising areas, primarily caused by traffic, industrial, and residential activities. Traffic noise, especially from highways, is a significant noise source in urban areas [1]. The increasing traffic volume in urban areas has led to prolonged exposure to noisy environments, affecting human peace and quality of life. The WHO stated that noise pollution has adverse effects on health, including interference with speech communication, cardiovascular and metabolic effects, rest and sleep disturbances, annoyance, mental disturbances, and other relevant health outcomes [2].

Older individuals are more vulnerable to noise due to slower brain processing and decreased sensitivity to stimuli that occurs during the ageing process [3]. They are more sensitive to noise and may have trouble concentrating on sounds, as well as increased irritability from surrounding conversations [4]. Prolonged exposure to traffic noise can lead to poor sleep quality, increased stress levels, inflammation, and elevated blood pressure. It may also lead to stroke, death, and other health complications [5]. Thus, the old folks' homes shall comply with recommended noise level standards recognised by local authorities or the World Health Organisation (WHO) for the sake of the residents.

A previous study found a strong correlation between traffic volume and noise levels, with reduced traffic resulting in lower noise levels [6]. Additionally, the type of vehicle, road surface type, vehicle speed, and vehicle stopping on the road all contribute to the noise levels in traffic [7].

Jalan Kluang in Batu Pahat is a busy road with heavy traffic. In view of the importance of quiet environments and necessary environmental control measures, this study was conducted to evaluate the relationship between traffic noise and traffic volume in three old folks' homes near Jalan Kluang, and the traffic noise level was then compared with the noise limit set by the Department of Environment (DOE).

2. Traffic Volume and Traffic Noise

Traffic volume is identified as the most influential factor in traffic noise emission [8]. The studies showed that traffic flow has the highest impact on noise levels than other factors such as engine types, exhaust systems, interaction of tyres and road, road conditions, and weather [9]. Speed also plays an important role in noise transmission. The study shows that noise levels increase with speeds [10]. Moreover, trucks are particularly noisy due to their diesel engines, which operate under higher pressure and have more components that generate noise [11]. Exhaust systems and engines are the primary contributors to a vehicle's overall noise level, followed by the intake system, fan, cooling system, transmission, and, lastly, the tyres [12].

Therefore, analysing the traffic volume along Jalan Kluang is a key step as the three selected old folks' homes are located close to this road. The Yearly Statistics of Transport, provided by the Ministry of Transport Malaysia, mentioned that the average daily traffic (ADT) along the Batu Pahat - Ayer Hitam - Kluang Road exceeded 30,000 from 2012 to 2014 and increased consistently to over 40,000 vehicles from 2015 to 2018. However, the implementation of the Malaysian Movement Control Order (MCO) has led to a significant decline in vehicle counts, from 36,704 vehicles in 2019 to 18,986 vehicles in 2021 [13]. The traffic volume along the route is expected to return to normal in 2022, following the upward trend of recovery post-pandemic.

Several noise assessment studies and surveys conducted near the buildings along Jalan Kluang have shown that the noise levels exceed the recommended noise level standard set by the DOE [14]-[16]. All studies above have stated that the background noise level is strongly associated with traffic volume.

The recommended permissible sound levels, LAeq Day and LAeq Night, for noise-sensitive areas – such as old folks' homes - based on DOE, are 60 dBA and 55 dBA, respectively [17]. In addition, there is no recommended internal noise level or reverberation time according to the latest DOE guidelines. Therefore, only external noise levels were measured and compared with the local standard in this study.

Exposure to noise pollution can lead to various health effects. The short-term health effects of noise exposure on the population include noise-induced sleep disruption, increased daytime sleepiness, and impaired cognitive performance [18]. Long-term exposure to relevant noise levels over time can contribute to an elevated risk of cardiovascular disease, specifically myocardial infarctions (heart attacks). Risk factors for myocardial infarctions, such as hypertension and high cholesterol, are also exacerbated by exposure to traffic noise [19]-[21].

Exposure to noise pollution can lead to short-term health effects, including slower mental processing, sensory changes, and disturbances in sleep architecture, resulting in more time spent in light sleep and less time in deep sleep, particularly among older individuals. This made the elderly tend to be more susceptible to noise pollution. [22]. These disruptions in circadian rhythms increase the risk of sleep disorders, cognitive difficulties, premature death, cancer, metabolic syndrome, cardiovascular dysfunction, immunological dysregulation, hormone issues, mood disorders and increased risk of various health issues [23]. Long-term exposure to traffic noise is associated with a higher risk of dementia, lower sleep efficiency, and increased risk of stroke, especially among the elderly. Adults living in areas with high daytime traffic noise levels were more likely to be hospitalised for stroke, whereas nighttime traffic noise further elevated the stroke risk of the elderly [24].

3. Methodology

This study is structured in a three-step process. Firstly, traffic noise was measured at three old folks' homes from 7:30 am to 9:30 am and from 4:30 pm to 6:30 pm, on two weekdays and two weekends. Second, a traffic count was conducted to determine the traffic volume to different classes near the selected old folks' homes. The correlations between traffic volume and noise level were then established by analysing the collected data using the scatter plot method. Lastly, the data was compared with DOE standards.

3.1 Study Location

Table 1 describes the surroundings of the selected old folks' homes, including their coordinates and addresses, which indicate their locations. The selected old folk's home included Rumah Sejahtera Batu Pahat, Sherun Old Folk Home (BP), and Healthlife Old Folks Home. These old folks' homes are all located next to the main section of Jalan Kluang.

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Table 1 *Selected the old folks' homes*

Details of The Facilities	Surroundings of The Facilities
Rumah Sejahtera Batu Pahat Address: 399, Batu, 4, Jln Kluang, Taman Megah, 83000 Batu Pahat, Johor Coordinates: 1.871074894734835ºN, 102.98412249559716 ºE	 Rumah Sejahtera Batu Pahat [25]
Sherun Old Folk Home & Handicap Centre (BP) Address: 14, Jln Bintang, Taman Koperasi Bahagia, 83000 Batu Pahat, Johor Coordinates: 1.8616743615916154ºN, 102.95146438155223 ºE	 Sherun Old Folk Home & Handicap Centre (BP) [26]
Healthlife Old Folks Home Address: No. 85-4, Jalan Haji Basir, Jalan Kluang, 83000, Batu Pahat, Johor. Coordinates: 1.8490722243605069ºN, 102.93871248241632 ºE	 Healthlife Old Folks Home [27]

3.2 Traffic Noise Measurement

A sound level meter was used to log the noise levels at each measurement location. The measurement was conducted in accordance with the Guidelines for Environment Noise Limits and Control released by DOE [12]. The microphone was mounted at a height of 1.5 m on a tripod and placed at least 1.5 m away from the property boundary of each targeted 1-2 storey house (old folks' homes). The microphone was positioned toward the noise source when conducting the noise survey. 1-second LAeq was logged during each measurement session.

The traffic flow slightly fluctuates but not drastically over each of the two measured hours. Therefore, 30-minute average and 2-hour average LAeq are used for analysis and daily representation in this study.

Table 2 *Vehicle classes*

Class	1	2	3	4
Type of Vehicles	Motorcycles	Cars	Vans and Medium Trucks	Heavy Trucks and Buses

The traffic count, with vehicle classes defined in Table 2, was conducted simultaneously as the noise logging at the roadside of the same old folks' homes. Vehicles in both directions and all lanes were counted every 15 minutes during the first hour of the measurement.

4. Results and Discussions

The measured LAeq values are presented in Table 3. The sound level meter was positioned nearest the main road, 4.50 m away from it, while the field measurement was carried out at Rumah Sejahtera. Therefore, the nearer position of the sound level meter at Rumah Sejahtera recorded a higher LAeq than the other two selected old folks' homes.

Table 3 *Summary of the noise level in the selected old folks' homes*

	Day	$L_{Aeq(2hrs)}$ (dBA)				
		AM Peak	PM Peak	Daily Average	2-Day Average	4-Day Average
Rumah Sejahtera Batu Pahat	Weekday 1	75.85	76.06	76.0		
(4.50 m from Jalan Kluang)	Weekday 2	73.90	76.08	75.1	75.6	
5417 vehicles/ hr (weekday)	Average	75	76			75
4371 vehicles/ hr (weekend)	Weekday 1	74.15	76.03	75.2		
	Weekday 2	74.52	74.60	74.6	74.9	
	Average	74	75			
Sherun Old Folk Home &	Weekday 1	66.80	66.36	66.6	66.2	
Handicap Centre (BP)	Weekday 2	67.10	64.07	65.8		
(10.50 m from Jalan Kluang)	Average	67	66			67
3794 vehicles/ hr (weekday)	Weekday 1	68.40	65.31	67.1	67.4	
3321 vehicles/hr (weekend)	Weekday 2	67.66	67.71	67.7		
	Average	68	67			
Healthlife Old Folks Home	Weekday 1	71.24	68.79	70.2	70.8	
(13.20 m from Jalan Kluang)	Weekday 2	71.93	70.69	71.4		
3098 vehicles/ hr (weekday)	Average	72	70			67
2339 vehicles/ hr (weekend)	Weekday 1	69.82	69.38	69.6	69.8	
	Weekday 2	68.82	70.92	70.0		
	Average	69	70			

The sound level meter was positioned 10.50 m away from the main road of Sherun Old Folk Home & Handicap Centre (BP), whereas the sound level meter was set up 13.20 m away from the main road of Healthlife Old Folks Home. However, Healthlife Old Folks Home recorded a slightly higher sound pressure level than Sherun Old Folk Home & Handicap Centre (BP), even though the placement of the sound level meter was slightly further away from Sherun Old Folk Home & Handicap Centre (BP). Therefore, it is also proven that the location layout of the selected area and the traffic volume play a significant role in determining the noise level as well [28].

Based on Table 3, Rumah Sejahtera Batu Pahat had the highest traffic noise levels, exceeding the DOE's recommended limit by 15 dBA. Sherun Old Folk Home & Handicap Centre (BP) and Healthlife Old Folks Home also surpassed the limit by 7 dBA and 10 dBA, respectively. Therefore, all three old folks' homes failed to meet the DOE's noise standards of 60 dBA during the daytime in noise-sensitive areas.

Linear regressions of traffic noise level (LAeq (30min)) with traffic volume of the three old folks' homes were demonstrated in Fig. 1 to Fig. 3. Fig. 1 and Fig. 2 show that the R2 values obtained at Rumah Sejahtera Batu Pahat and Sherun Old Folk Home & Handicap Centre (BP) are too small (R2 <0.1), which signifies that the traffic volume has no significant effect on the average traffic noise level. Based on Fig. 3, the R2 values at Healthlife Old Folks Home are within the range of 0.1 to 0.3, which signifies a low correlation between traffic and the average traffic noise level.

Additionally, Fig. 4 illustrates a moderate positive correlation ($0.3 < R^2 < 0.5$) between the number of Class 4 vehicles and the average traffic volume at Rumah Sejahtera Batu Pahat. This indicates that a greater number of Class 4 vehicles leads to higher average traffic noise at Rumah Sejahtera Batu Pahat. In contrast, Fig. 5 indicates no association between the number of Class 4 vehicles and traffic noise in Sherun Old Folk Home & Handicap Centre (BP), as the R2 value obtained is less than 0.1. Furthermore, Fig. 6 presents a moderate positive association between the number of Class 4 vehicles and the average traffic noise levels at Healthlife Old Folks Home. The R2

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value for LAeq (30min) versus traffic volume was 0.4846. This indicates that more Class 4 vehicles contributed to higher traffic noise at Healthlife Old Folks Home.

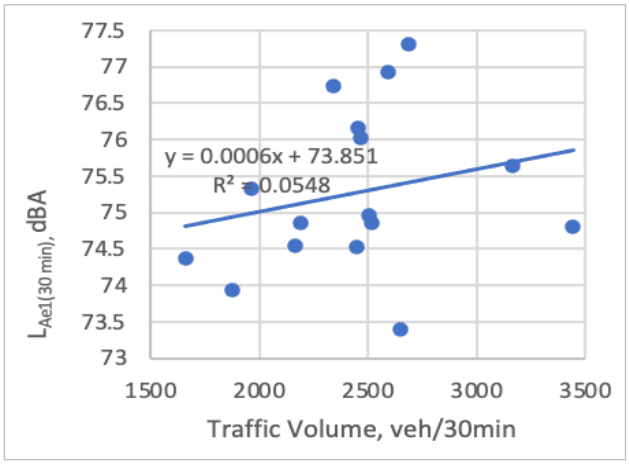

Fig. 1 *Rumah Sejahtera - The correlation between traffic noise level (LAeq (30min)) with traffic volume*

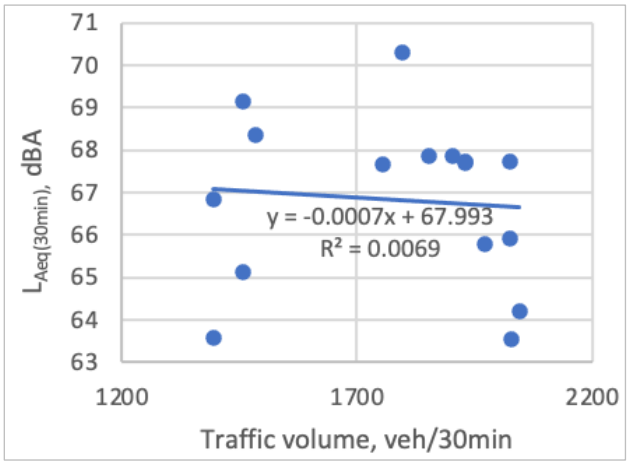

Fig. 2 *Sherun Old Folk Home & Handicap Centre (BP) - The correlation between traffic noise level (LAeq (30min)) with traffic volume*

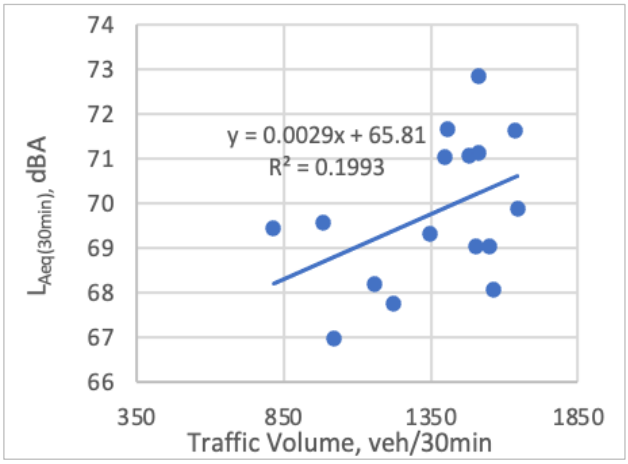

Fig. 3 *Healthlife Old Folks Home - The correlation between traffic noise level (LAeq (30min)) with traffic volume*

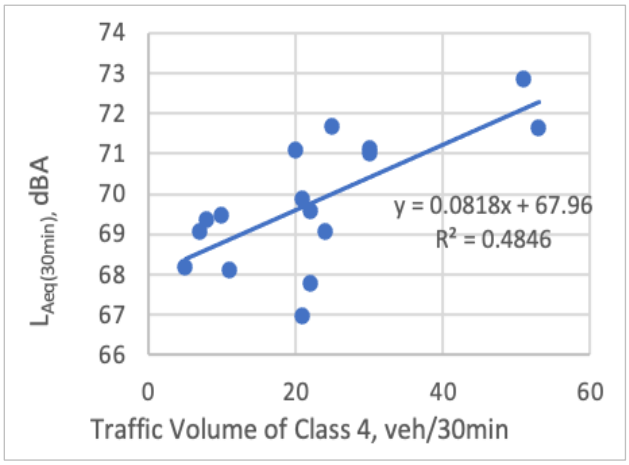

Fig. 4 *Rumah Sejahtera - The correlation between traffic noise level (LAeq (30min)) with number of Class 4 vehicles*

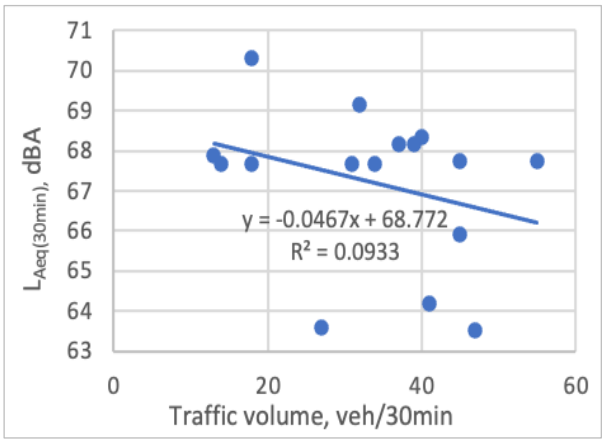

Fig. 5 *Sherun Old Folk Home & Handicap Centre (BP) – The correlation between traffic noise level (LAeq (30min)) with number of Class 4 vehicles*

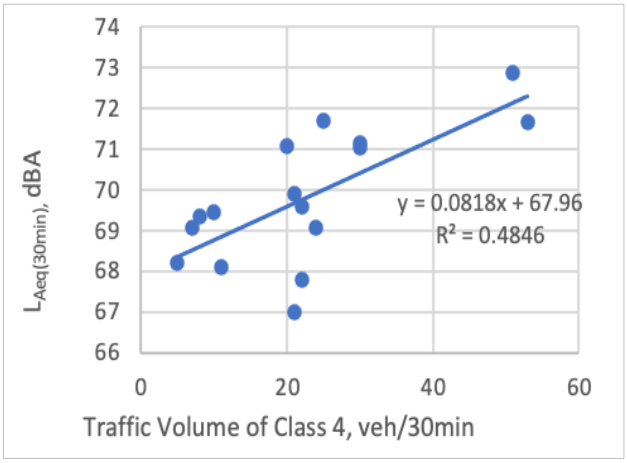

Fig. 6 *Healthlife Old Folks Home - The correlation between traffic noise level (LAeq (30min)) with the number of Class 4 vehicles*

In summary, the analysis indicates that the total traffic volume has no significant impact on the average sound pressure level at Rumah Sejahtera. Other factors, such as vehicle speed, road condition, and road gradient, may also influence traffic noise levels. However, the number of Class 4 vehicles was found to contribute to higher traffic noise at Rumah Sejahtera Batu Pahat. Moreover, an inconsistency was found in the correlation between total

traffic volume and traffic noise level, as well as between traffic noise level and the number of Class 4 vehicles at Sherun Old Folk Home & Handicap Centre (BP). This could be possibly due to the location of the old folks' home, which is near a junction equipped with traffic lights, and is connected to the busy roads of Jalan Kluang and Jalan Tan Swee Hoe. Finally, it was also found that the increase in traffic volume led to an increase in the noise level, and the number of Class 4 vehicles significantly impacted the noise emissions at Healthlife Old Folks Home.

Moreover, the results were found to have similarities with those of a previous study along Jalan Kluang. The noise levels recorded at SK Seri Aman and SK Pintas Jaya during the peak hour, from 7:00 am to 12:00 pm, were 53.50 dB – 80.93 dB and 55.85 dB – 71.23 dB, respectively [14]. In addition, the field test conducted along Jalan Kluang near the school achieved an average LAeq of 79.2 dBA [15], whereas the average noise level at Pantai Puteri Hospital, located on Jalan Kluang, was 75 dBA [16]. All the study locations above have exceeded the recommended noise level standard set by DOE. Thus, more research is needed regarding traffic noise in noise-sensitive areas, traffic volume, and the type of vehicles that pass through Jalan Kluang to raise awareness among communities and relevant authorities.

5. Conclusions

The study revealed high traffic volume along Jalan Kluang, with varying levels at different old folks' homes. The traffic flow at Rumah Sejahtera Batu Pahat recorded an average of 5417 vehicles per hour on weekdays and 4371 vehicles per hour on weekends. Sherun Old Folk Home & Handicap Centre (BP) had an average of 3794 vehicles per hour on weekdays and 3321 vehicles per hour on weekends, while Healthlife Old Folks Home had an average of 3098 vehicles per hour on weekdays and 2339 vehicles per hour on weekends.

The measured average traffic noise levels at the three homes were 75 dBA, 67 dBA, and 70 dBA, respectively, exceeding the DOE standard of 60 dBA for noise-sensitive areas during the daytime. This indicates that Jalan Kluang is a busy road with high traffic volume, and buildings near it are more likely to approach the noise limit set by the DOE.

While the traffic noise at Rumah Sejahtera Batu Pahat was not significantly affected by traffic volume, a positive correlation was observed between the number of Class 4 vehicles and the level of traffic noise. Sherun Old Folk Home & Handicap Centre (BP) shows inconsistent results between total traffic volume and the traffic noise level in LAeq(15min) and LAeq(30min). This is possibly due to traffic interruptions caused by traffic lights at the intersection near the old folks' home. On the other hand, Healthlife Old Folks Home demonstrated a positive relationship between traffic volume and traffic noise level, assuming that other factors, such as traffic composition, speed, and driving patterns, remain unchanged. The number of Class 4 vehicles also had a positive influence on the traffic noise levels in this location.

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Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***Study conception and design:*** *Tong Yean Ghing;* ***Data collection:*** *Liew Jia Yee;* ***Analysis and interpretation of results:*** *Tong Yean Ghing; Noor Dina Md Amin;* ***Draft manuscript preparation:*** *Liew Jia Yee; Tong Yean Ghing; Noor Dina Md Amin. All authors reviewed the results and approved the final version of the manuscript.*

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