

## QUANTITATIVE AND PERSPECTIVE EVALUATION ON THE ENVIRONMENTAL NOISE POLLUTION AND COMMUNITY ANNOYANCE IN THE VICINITY OF A RESIDENTIAL AREA

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**Abstract:** Noise is an unwanted sound that causes dissatisfaction, discomfort, and annoyance at a high level and long exposure. High environmental noise levels lead to annoyance in the residential area of the community. This study aimed to investigate the noise level and community noise annoyance of the residential area in Terengganu. Noise measurements were repetitively taken using a Sound Level Meter (SLM) and the evaluation of  $L_{Aeq}$ ,  $L_{max}$ ,  $L_{min}$ ,  $L_{10}$ , and  $L_{90}$  were measured in Decibel-A (dBA). The community noise annoyance was assessed through the questionnaire surveys and analysed using Statistical Package for Social Sciences (SPSS) version 26 and Microsoft Excel 2019. The  $L_{Aeq}$  during the day and nighttime was 59.3 dBA and 55.9 dBA, respectively. Both  $L_{Aeq}$  have not exceeded the limits set by the Department of Environment (DOE), Malaysia. Most respondents did not feel annoyed by the noise (76.9%), which was the outcome of the questionnaire surveys. The noise assessment could provide useful information to maintain a healthy resident environment.

Keywords: Noise pollution, residential, annoyance, survey, Malaysia.

### Introduction

Noise is known as an unwanted or undesirable sound (Leung *et al.*, 2017), disrupting the surrounding environment (Isa *et al.*, 2018). In Malaysia, two types of noise were noted: Environmental and occupational. Both are under different stakeholders in Malaysia, as the Department of Environmental (DOE) is responsible for environmental noise (Ismail *et al.*, 2015). Meanwhile, the occupational noise is under the Department of Occupational Safety and Health (DOSH) (Mansor *et al.*, 2020). Notably, environmental noise can lead to annoyance in the community (Segaran, 2020), such as noise from traffic, railways, and construction or renovation (Ma *et al.*, 2018).

Occupational noise comes from noise exposure in the workplace, which can affect

workers. Accordingly, road traffic noise is a major source of environmental noise for continuous sound, as well as railway and aircraft noise, which are more disruptive and louder compared to traffic noise (Seidler *et al.*, 2017). In the Vietnamese population, the higher road traffic noise levels ranging from 5 to 10 dB are more tolerable than aircraft noise. Although compared to European and North American, the Vietnamese expressed significant annoyance with aircraft noise (Gjestland *et al.*, 2015). According to Okokon *et al.* (2015), four out of five Finnish adults mentioned they were subjected to traffic noise in their residential area, highlighting that it is a concern even in less densely populated, quieter communities. In Montreal, most of the population reported

greater annoyance towards traffic noise than aircraft noise, followed by train noise, with percentage values of 20.1%, 13.0%, and 6.1%, respectively. This is due to the distance of the transportation noise sources to the population (Ragetti *et al.*, 2015).

Noise annoyance is the health effect of exposure to environmental noise (Gong *et al.*, 2022). The maximum  $L_{eq}$  for daytime and nighttime are 55 dB and 40 dB, respectively, to avoid noise annoyance and sleep disturbance in the community (Berglund *et al.*, 1999). According to Seidler *et al.* (2017), exposure to road traffic and aircraft noise with noise levels exceeding 70 dB and 50 dB to 54 dB, respectively, can lead to depression. Interestingly, some people have a high level of noise acceptance and are not influenced or annoyed by the noise (Isa *et al.*, 2018).

This could be due to various factors such as their upbringing, personality traits, or even habitual exposure to noisy environments (Oeding *et al.*, 2022). These factors contribute to a natural resilience to noise in some individuals, enabling them to remain focused, calm, and unbothered even in situations where others might find the noise overwhelming. Furthermore, this resilience allows them to navigate noisy environments without significantly impacting their well-being. Note that noise annoyance can disrupt daily activities and rest and cause emotional expressions such as anger, depression, anxiety, stress, and tiredness, which can also change the individual's behaviour (Ragetti *et al.*, 2015).

Environmental noise is an unwanted sound, primarily made by humans, that can lead to adverse health effects. This mainly includes vehicle noise, neighbourhood noise, and noise from social activities (Sung *et al.*, 2017). Many previous studies have proven that the major source of environmental noise is transportation noise, especially traffic and road noise. According to Belojevic *et al.* (2016), the noise source affecting the community was about 80%, which comes from the road traffic noise in their population. Meanwhile, Ma *et al.* (2018) noted

that the significant sources of noise pollution in Beijing are road traffic and construction or renovation. In contrast, a small proportion of noise comes from the neighbourhood or the community itself in South Africa. Notably, neighbourhood noise was higher than traffic road noise in terms of noise sensitivity and noise annoyance in their population (Sieber *et al.*, 2018).

Environmental noise can cause sleep disturbance and affect daytime activities or performances (Basner & McGuire, 2018). In addition, noise pollution can cause many effects such as hearing loss, mental illness, lack of performance, psychological and physiological, and annoyance towards people (Berglund *et al.*, 1999). According to Bouzid *et al.* (2020), noise coming from heavy transport was reported to significantly contribute to noise annoyance, with a percentage of 60% of respondents. This is compared to motorcycles, with a percentage of 46% of respondents. In Shah Alam, Malaysia, there were two intersections, A and B, and respondents agreed that both intersections lead to annoyance caused by traffic noise, with percentages of 81.6% and 40%, respectively (Isa *et al.*, 2018).

In line with the rising population and developing country, Malaysia has many conveniences located near the main road or roadsides, especially in residential areas. This contributes to the increased noise level and leads to annoyance among the people. According to Isa *et al.* (2018), the residential area in Shah Alam is mostly located near roads that people can access easily. As the population increases, the transportation systems also increase, causing traffic road noise and annoyance towards the nearby community. For example, a high number of cars, motorcycles, or vans usage can lead to a high traffic noise level (Napi *et al.*, 2021). Additionally, the noise level may be influenced by time and location, especially in residential areas.

In Malaysia, the traffic noise level is commonly higher at two peak hours: Morning and evening on weekdays. This is due to

standard working and school hours, as most people travel to and from work or school at these two peak hours in the residential area (Abdullah *et al.*, 2021). Nowadays, many countries have undergone the development phase and need to achieve Sustainable Development Goals (SDGs). Despite that, some negative impacts such as pollution, affect the goals that need to be considered. Thus, addressing noise pollution is crucial as it protects public health, boosts mental well-being, promotes sustainable development, and enhances overall quality of life. Moreover, it is key to fostering healthier, more livable communities and advancing global objectives like SDG 3 (Good Health and Well-being) and SDG 11 (Sustainable Cities and Communities).

Reducing noise pollution is not merely about lowering noise levels but creating environments where individuals can thrive physically, mentally, and socially. According to Segaran *et al.* (2020), noise in Malaysia needs to be studied in order to mitigate and reduce the traffic noise problem. It also aims to achieve the goals of the development county in 2020. In China, environmental pollution, especially noise pollution, has increased due to many car owners and rapid urbanisation (Ma *et al.*, 2018).

## Materials and Methods

The residential area for this study was in Tok Jembal, Terengganu (5.3954°N, 103.0965°E). The study area was selected due to the distance of the residential area from the main roads, as the main sources of environmental noise pollution came from the road traffic, which was located at 178.02 m from the main road. Correspondingly, a study on the impact of noise exposure in a residential area was conducted, dividing the area into two categories. The first category included homes located 50 m to 100 m away from the main roads, while the second category consisted of homes situated directly on the main roads. The noise levels in these two groups were then compared with the established noise pollution standards (Ali *et al.*, 2021). Note that the noise level measurement was conducted according to the Guidelines for Environmental Noise Limits

and Control 2019 by the DOE (2019).

The noise level measurement was monitored using a Sound Level Meter (SLM) and the most suitable for the noise level monitoring was Class 1 standard SL4033SD, which meets IEC 61672 (Abdullah *et al.*, 2019). The microphone of the SLM on the tripod stand was placed at a height of 1.5 m above the ground and at a 70-degree angle. Meanwhile, the wind speed was measured using the Kanomax Climomaster. If the wind speed measurement exceeds 5 m/s, the noise level is invalid. Two samplings were set in the daytime from 7:00 a.m. to 10:00 p.m. and nighttime from 10:00 p.m. to 7:00 a.m. The data were obtained at 1-hour time intervals continuously over 24-hour day-night cycles. Accordingly, the noise level measurement data was collected three days on weekdays and three days on weekends.

$L_{Aeq}$  was calculated using Equation 1, and the value was expressed in Decibel-A (dBA) unit:

$$L_{Aeq} = 10 \log \sum_{i=t}^{i=n} (10)^{L_i/10} (t_i), \quad (1)$$

where

$n$  = the total number of samples taken

$L_i$  = the noise level in dBA of the  $i$ th samples

$t_i$  = fraction of total sample time

$L_{min}$  is the minimum or the lowest sound level and  $L_{max}$  is the maximum or the highest sound level.  $L_{10}$  is defined as traffic noise and  $L_{90}$  can be defined as background or ambient noise level.

The noise annoyance towards the community was evaluated by conducting questionnaire surveys for the community or the residents in the study area. The questionnaire utilised in this research was made available in both English and Malay to accommodate participants who are fluent in either language. The questionnaire's content was adapted from the work of de Paiva Vianna *et al.* (2015), ensuring that the questions were relevant and applicable to the study's objectives. Accordingly, the surveys were administered to the residents in the study areas. At the same time, the noise level was measured. The questionnaire survey

data were computed in Statistical Package for Social Science (SPSS) software version 26. The respondents in this study were selected from 26 people in the residential area.

**Results and Discussion**

The trends of noise levels on weekdays and weekends in the study area are displayed in Figure 1. The  $L_{max}$  for day and night revealed that the noise level was higher on weekdays (65.3 dBA) compared to on the weekends (64.9 dBA). However, there was no statistically significant difference ( $p > 0.05$ ) in the study area. The noise level,  $L_{Aeq}$ ,  $L_{min}$ ,  $L_{max}$ ,  $L_{10}$ , and  $L_{90}$  for each day on weekdays and weekends at day and nighttime were illustrated in Figure 2.

The maximum noise level,  $L_{max}$ , was higher on weekday 2 with a value of 65.3 dBA compared to the other days during the daytime. The noise level for each day on weekdays and weekends during nighttime is depicted in Figure 2 (b). It revealed that the maximum noise level,  $L_{max}$  was higher on weekend 3 with a value of 64.9 dBA compared to the other days during nighttime. In particular, traffic noise was the main source of the high maximum noise level, followed by the daily activities of the residents and shops located in the study area. According to Segaran *et al.* (2020), the  $L_{AFmax}$  is based on the

study area near shop lots, playgrounds, or other public utility areas. Simultaneously, some of it originates from residents' vehicles, contributing to the high maximum noise level such as vehicle speed, honking, big engines, and other modifications of vehicles. The motorcycles also contribute to noise pollution in the residential area, disturbing nearby residents. Notably, the noise from motorcycles was reported to be the main contributor to the high maximum noise level,  $L_{max}$ , and the high noise level from the motorcycles could affect people nearby.

In addition, the convenience provided near the study areas such as restaurants, shops, and institutions and accessibility of public transport and roadways also contribute to the increased human population in the study areas. This includes increasing the number of vehicles that can cause high traffic noise in the residential area. As the population of Shah Alam grows, so will the number of vehicles caused by the many facilities provided. This comprises higher institutional centres, restaurants, marketplaces, retail malls, decent roadways and connections, recreational parks, good access to public transportation, and hospitals. These are among the key attractions that draw people to the residential area nearby and result in the traffic noise pollution in Shah Alam (Isa *et al.*, 2018).

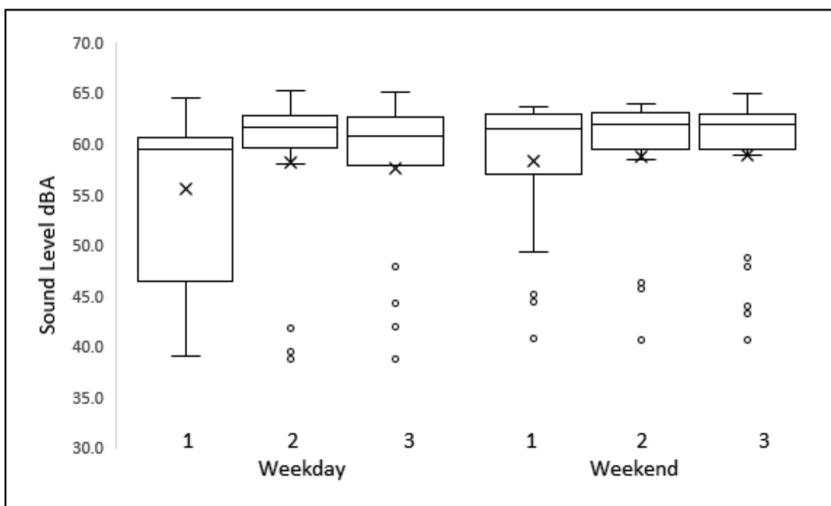


Figure 1: Trend of noise level

Moreover, the road near the residential area was the main road connected to the city centre and the university nearby, which contributed to more vehicles on the road that resulted from noise pollution in the residential area. The main road, Mohammed Al Qasim and the University of Technology that connects to the city centre, Bab Al Sharqi, contributed to the high noise level in the residential area with the lowest noise level, 68 dB in the daytime (Mesrop *et al.*, 2020). The high noise level could also be due to the driver's attitude on the road in the residential area, such as when using the emergency brake, speeding up, and honking. The noise levels in the study area were within 60 and 75 dBA during morning and evening peak hours (Sulaiman *et al.*, 2018).

Traffic flow could also contribute to traffic noise pollution in residential areas. The noise level from the free flow of traffic could be higher than the heavy flow of traffic based on factors such as friction of tires, exhaust, acceleration, and others (Esin & Afahakan, 2017). Moreover, the traffic noise,  $L_{10}$  was higher on weekday 3 in the daytime with a value of 64.1 dBA and higher on weekends with a value of 63.2 dBA during nighttime compared to the other days on both. In essence, using the main roads increases the number of vehicles, contributing to the high traffic noise level. This is especially true during the daytime, as the road near the study area was one of the main roads located near schools and other institutions.

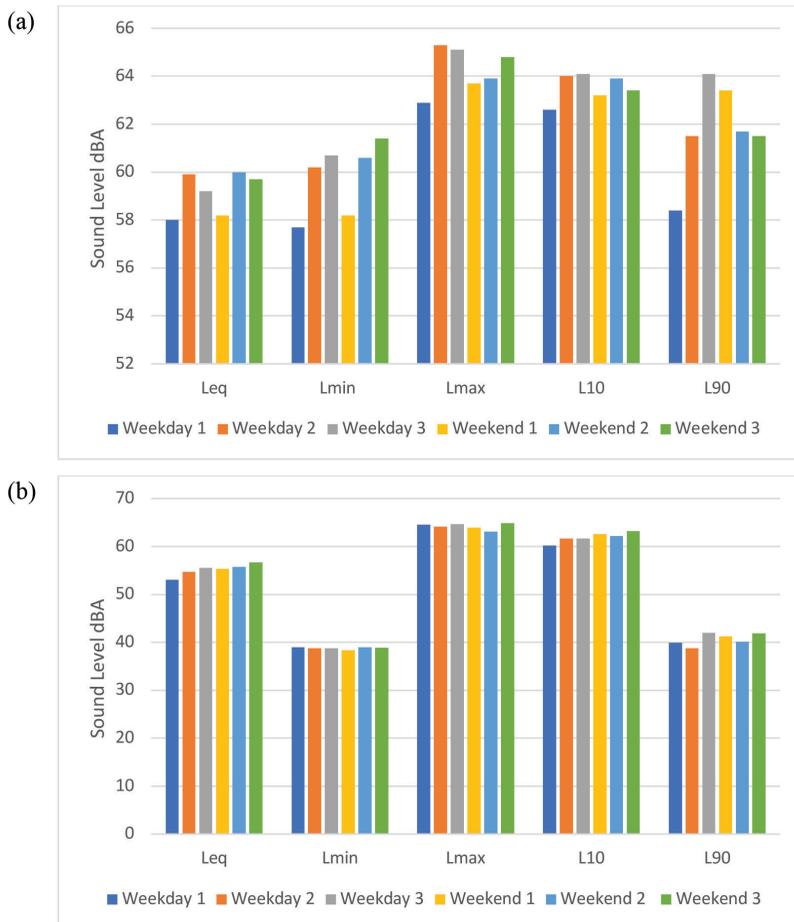


Figure 2: Noise level indices (a) daytime, (b) nighttime

According to Isa *et al.* (2018), traffic noise level and traffic volume are higher at intersection B based on the usage of the roads for the parents to send and pick up their kids to and from school. Furthermore, students also travel back to the institution nearby, as the roads are near the expressway, institutions, and commercialised areas. The speed of the vehicles can also be one of the sources of the traffic noise level increase in the study area. According to Segaran *et al.* (2019), speeds were the primary contributor to the traffic noise level at Kampung Istana and SK Bukit Soga. In addition, the high number of vehicles and average speed could increase the noise level in those areas.

The compliance of noise level  $L_{Aeq}$  of the study area was displayed in Figure 3 (a) and 3 (b) for weekdays and weekends during the day and nighttime, separately. The equivalent noise level,  $L_{Aeq}$ , on weekdays and weekends during the daytime still complied with the Guidelines for Environmental Noise Limit and Control (2019) provided by the DOE. The values for both  $L_{Aeq}$ , which were 59.0 and 59.3 dBA, illustrated in Figure 3 (a), are still under the permissible limit of the  $L_{Aeq}$  set by DOE with a value of 60 dBA for daytime (7:00 a.m. to 10:00 p.m.) at residential areas. However, the noise level still needs to be measured to ensure it does not exceed the permissible limit of the guidelines set by DOE. A previous study suggests that the noise level resulted from two stations, L3 and L5, located at Jalan Kluang, Batu Pahat resulted at 57.1 dBA, respectively, and it exceeded the guidelines set by DOE (2019) with a value of 55 dBA for residential areas (Segaran *et al.*, 2020).

The equivalent noise level,  $L_{Aeq}$ , on weekdays and weekends during the nighttime were displayed in Figure 3 (b) with values of 54.4 dBA and 55.9 dBA, respectively. The  $L_{Aeq}$  on weekends (55.9 dBA) exceeds the prescribed limit of the  $L_{Aeq}$  set by DOE with a value of 55 dBA for nighttime (10:00 p.m. to 7:00 a.m.) in the residential area. However, the noise level is still accepted if it has not exceeded 2 dBA, which is the noise limit of the guidelines set by DOE. This is due to the fact that some people

still use the road. However, they are not as busy in the daytime as they are not using it at school, institution, or workplace. On the other hand, the noise level of Klang Valley exceeded the permissible noise limit ( $L_{Aeq}$ ) during nighttime. This causes the residents nearby to experience a high noise level at that time and mostly, it comes from the speed of the vehicles on the road (Nor *et al.*, 2019). Moreover, some other factors can contribute to the increasing noise level such as vehicles entering and exiting the intersection of the residential area, the emergency, or a quick break. According to Isa *et al.* (2018), fewer vehicles enter and exit the intersection in the afternoon compared to the morning and evening, resulting in lower noise levels.

Additionally, vehicles at this intersection tend to slow down or stop while at another intersection, drivers are more likely to speed up. The noise level in the residential area was higher than the standards, 60 dB and the lowest noise level was 68 dB during the daytime recorded between two intersections: Bridge Alghadeer (Mohammad Alkasem) and Albab Alsharqi (Mesrop *et al.*, 2020). The equivalent noise level,  $L_{eq}$  of Desa Tun Razak and Taman Sentul Utama was recorded to exceed the standard limits set by DOE during day and nighttime with values of 75.7 dBA, 73.4 dBA, 68.6 dBA, and 64.2 dBA, respectively, that comes from vehicles on the road nearby (Segaran *et al.*, 2020). Another report suggests that the  $L_{Aeq}$  for Sites 1 and Sites 2 was 45 dBA. Site 3 was 48 dBA, which is still under the limits set by DOE and World Health Organization (WHO). Note that 55 dBA resulted in the traffic noise not being the main source of noise pollution in the study area (Sulaiman *et al.*, 2018).

In this study, community annoyance was analysed through questionnaire surveys among the study area residents, Taman Maidam. This survey was to determine whether environmental noise, especially traffic noise, can cause disturbance or annoyance to them. 26 residents were selected as respondents. There were 13 questions in the questionnaire that were mostly based on a nominal scale where the answers

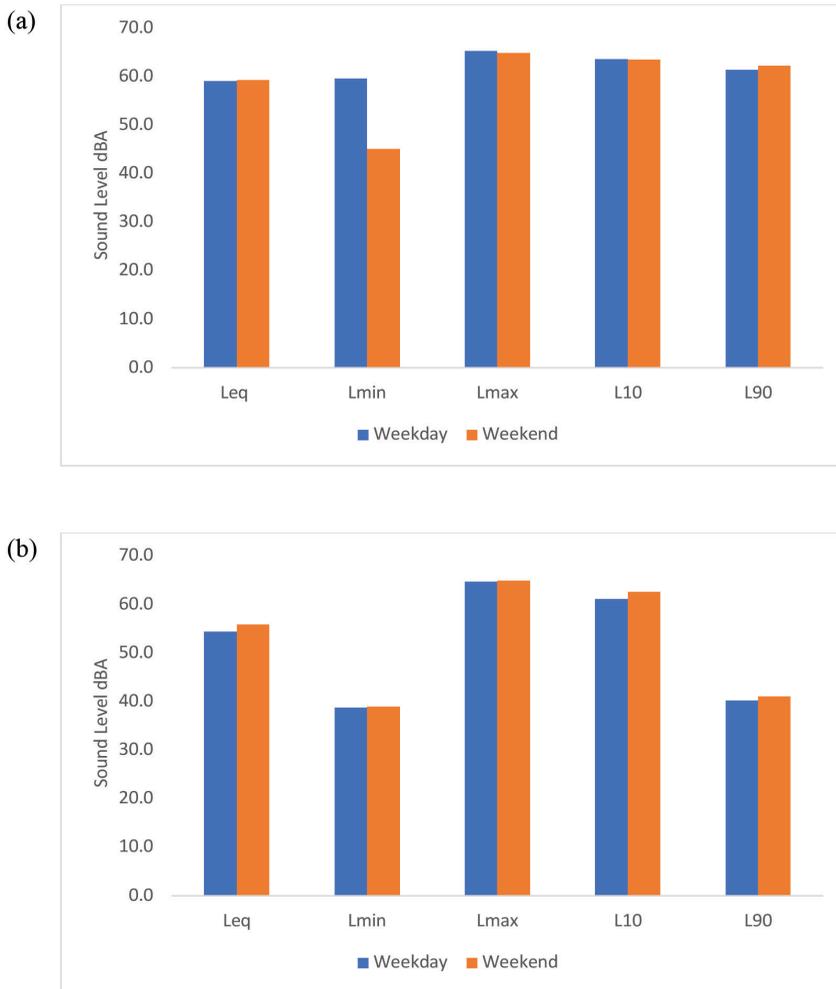


Figure 3: Average noise level indices (a) daytime, (b) nighttime

were “Yes”, “No”, and “Do Not Know”. Some only need to be answered based on their experiences and understandings. The results from the respondents presented the percentage of respondents who answered the question, as displayed in Figure 4. The age respondents were mostly 40 years old and above, with a percentage of 38.5% ( $n = 10$ ), compared to the 18 to 25 years old and 26 to 39 years old, with a percentage of 26.9% ( $n = 7$ ) and 34.6% ( $n = 9$ ), respectively. Next, the respondents’ gender was the same for the males and females, with 50% ( $n = 13$ ).

In this study, most of the respondents have knowledge about noise pollution, with a percentage of 69.2% ( $n = 18$ ), only some of them did not know about noise pollution, 30.8% ( $n = 8$ ), as illustrated in Figure 4 (a). The residents of the respondents in this study area mostly live in this residential area for five years and above as for 5 years, 10 years, 15 years, 16 years, and 20 years with percentages higher than 11.5% ( $n = 3$ ), 19.2% ( $n = 5$ ), and 7.7% ( $n = 2$ ), respectively. Some lived below five years, with a percentage of 3.8% ( $n = 1$ ). The noise pollution in the residential area of

the respondents was diagnosed as there was none of the problem related to noise pollution as the respondents mostly answered “No” with a percentage of 65.4% ( $n = 17$ ) than “Yes” and “Do Not Know” with a percentage value 19.2% ( $n = 5$ ) and 15.4% ( $n = 4$ ), respectively [Figure 4 (b)].

As for the noise annoyance towards daily activities or life among the respondents, mostly answered “No”, with a percentage value of 76.9% ( $n = 20$ ), and some of them answered “Yes” with 23.1% ( $n = 6$ ) that the noise causes annoyance towards their daily basis [Figure 4 (c)]. As most respondents lived in the study areas for five years or more, the residents can already tolerate the noise pollution in their residential areas. Most of the respondents chose the sources of the noise coming from the parks (65%), highways (31.7%), and aircraft (23.3%). In contrast, 65% of the respondents could tolerate the noise from parks, only 20% considered it a minor noise annoyance (de Paiva Vianna *et al.*, 2015). On the scale of the degree of annoyance level from 1 to 10, the respondents mostly gave two out of 10 scales with 30.8% ( $n = 8$ ), and some of them gave one and three out of 10 with 23.1% ( $n = 6$ ), respectively. Next, the main questions of this survey were the major sources of noise pollution in the respondents’ area and 100% ( $n = 26$ ) answered that vehicles were the major sources of noise pollution in their area.

The primary noise sources come from transportation, especially vehicles, and the increasing number of vehicles due to the country’s development, either in urban or rural areas (Mutalib *et al.*, 2018). The respondents chose the sources of the noise in the study area to originate from their own house and roadway noise, with 60% and 48.3%, respectively (de Paiva Vianna *et al.*, 2015).

The observation towards the increase of the traffic flow in recent times among respondents take “No” as their answer with 53.8% ( $n = 14$ ) and “Yes” and “Do Not Know” with 26.9% ( $n = 7$ ) and 19.2% ( $n = 5$ ), respectively [Figure 4 (d)]. Moreover, the respondents mostly answered “No”, with 88.5% ( $n = 23$ ) for the question about

the report of a complaint about a neighbourhood being too noisy. Conversely, there was quite a number of “Yes” as their answers, with 11.5% ( $n = 3$ ) [Figure 4 (e)]. Most of the respondents did not have any knowledge or were unaware that there are rules and regulations related to noise, as most of them answered “Do Not Know” with 50% ( $n = 13$ ). Some of them answered “Yes” and “No” with 30.8% ( $n = 8$ ) and 19.2% ( $n = 5$ ), respectively [Figure 4 (f)]. At the peak time of the day, the respondents experienced noise pollution mostly at 7:00 a.m. and 5:00 p.m., with 26.9% ( $n = 7$ ).

As for the nighttime, the respondents who experienced noise pollution mostly answered 10:00 p.m. with 7.7% ( $n = 2$ ). Most respondents choose these hours since the roads near their residential areas are busy with vehicles. At 7:00 a.m., people commute to work and universities, and parents send their kids to school, while at 5:00 p.m., most people tend to return home from work and university. According to Nor *et al.* (2019), the peak time of higher noise levels in the study area was recorded during the morning and evening, busy hours for people working at offices and business people opening their shops. This is especially true from 2:00 p.m. to 3:00 p.m., the high noise level caused by the high number of vehicles on the road coming from people returning from their workplace. At the same time, the number of vehicles was predicted to be higher during the morning from 07:30 a.m. until 08:30 a.m. as people commute to work and send their kids to school. This includes the afternoon from 12:30 p.m. until 1:30 p.m. since it is lunch hour for office workers and parents to pick up their kids from school. Lastly, during the evening, from 5:00 p.m. until 6:00 p.m., people return from work to their own homes (Isa *et al.*, 2018). With regard to the consultation and conversation with the neighbours about the noise pollution that can affect the community, the majority of them responded “No”, with 96.5% ( $n = 25$ ) [Figure 4 (g)].

Lastly, regarding the effect of noise pollution, the respondents provided “Headache”, “Stress”, “Insomnia”, and “No Disturbance”

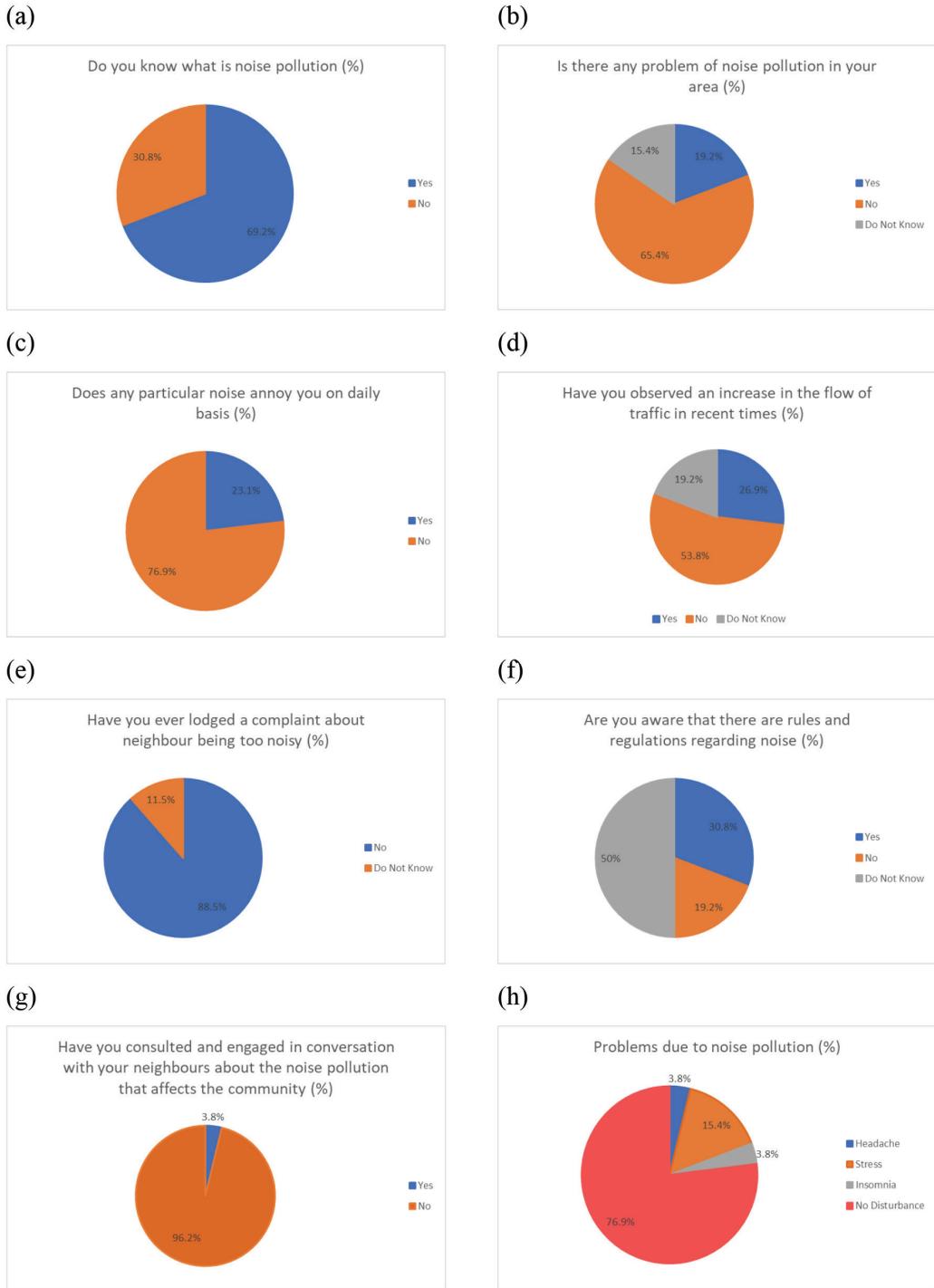


Figure 4: Community annoyance

as their answers, with 3.8% ( $n = 1$ ) for the “Headache” and “Stress”, 15.4% ( $n = 4$ ), and 76.9% ( $n = 20$ ), respectively [Figure 4 (h)]. According to de Paiva Vianna *et al.* (2015), the majority of the respondents, with a percentage of 53.3%, considered their house a silent area since they could already tolerate the noise and had lived there for a long time. However, the majority of complaints among the community were that environmental noise at their residents disturbs their daily life and rest time and contributes to stress and lack of sleep quality or insomnia, especially from traffic noise in the study area (Paiva *et al.*, 2019).

### Conclusions

In conclusion, the noise level during the daytime is higher compared to the nighttime. This is due to the number of vehicles on the roads to the facilities nearby, as the residential area is located near the schools, universities, and workplaces. The major source of the noise in this study area is road traffic. Accordingly, 100% of residents agreed that the noise mostly comes from vehicles. However, 76.9% declared no noise disturbance in the study areas. This proved that the residents could already tolerate the noise as they had lived in the residential area for an extended time. In particular, some had already lived for 10 years, 16 years, and 25 years.

As the noise level did not surpass the standard limits set by DOE and the community was not annoyed or disturbed by the environmental noise around them, it can be concluded that there were no issues regarding noise pollution and community noise annoyance in this study area. For effective noise management, continuous monitoring of noise levels is recommended to ensure they remain within acceptable limits, particularly considering ongoing urban development. Additionally, fostering community engagement by encouraging feedback on noise-related issues will facilitate promptly addressing any emerging concerns. Therefore, future research should also explore the long-term effects of road traffic noise on residents’ health and quality of life.

This is alongside comparative studies in other residential areas with varying characteristics to comprehensively understand the broader implications of noise pollution.

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### Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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