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ASSESSING ENVIRONMENTAL NOISE POLLUTION AROUND PUBLIC HOSPITALS IN SELANGOR, MALAYSIA: IMPLICATIONS FOR URBAN PLANNING

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Abstract

Environmental noise is a major concern, particularly in the vicinity of hospitals, which are designated as sensitive areas. There are many complaints about the outside noise, which makes their time in the hospital uncomfortable. Numerous factors, such as expanding urbanisation, industrial activity, traffic, and building, contribute to environmental noise pollution. To avoid having a significant negative effect on users, it is crucial to investigate the sources and measure the level of environmental noise. To date, no data has been recorded on environmental noise around public hospitals in Malaysia. The aim of this study is to assess the current environmental noise pollution surrounding selected hospitals and explore potential improvements that contribute to future urban planning. This study integrates a field measurement at three public hospitals in the Klang Valley (Hospital Shah Alam, Hospital Tengku Ampuan Rahimah and Hospital Sungai Buloh), employing quantitative data collection via a sound level meter with a data logger to identify the various environmental noise sources surrounding public hospitals in the Klang Valley. The findings indicate that in one case study, the average readings failed to meet the DOE standard, categorising it as environmental noise pollution. Considering the results obtained, all three case studies' environments require significant improvements that can be addressed through strategic urban planning, such as enforcing zoning regulations that restrict noise-emitting activities in the surrounding areas.

Keywords: Environmental noise, noise pollution, urban planning, public hospital, field measuremen

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INTRODUCTION

Environmental pollution encompasses various forms, including a significant concern: environmental noise. Noise is by definition, "worthless sound" or "noise that is undesirable to the receiver" (Wallis et al., 2019). Most of the noise pollution comes from the outside of the building. Due to the concentration of people, businesses, and activities like transportation, it is higher in cities. The World Health Organisation claims that long exposure to noise levels above 70 dB (A) has a serious negative impact on human health and can cause a variety of irreversible health issues, including hearing impairment. Those who live nearby may find this noise stressful. Noise pollution usually interferes with human activities and the balance and comfort of life, especially in hospital areas (Bhatia, 2014).

Hospital systems have been under increasing pressure to improve performance. Almost all the infrastructure and human resources in this healthcare sector are provided by the government, making it one of the largest in Malaysia's services department. Doctors, nurses, pharmacists, dentists, and other allied healthcare workers are employed and deployed by the Minister of Health to various healthcare facilities across the country, ranging from rural clinics to district hospitals to tertiary specialist hospitals (Quek, 2013). Compared to other public or commercial structures, hospitals present a unique and complex set of challenges. In Malaysia, both public and commercial primary health care services are available (World Health Organization, 2013). Given the complexities and unique challenges that hospitals face, it is crucial to consider various environmental factors that can impact patient care and overall well-being. One such factor is noise pollution, which has become an increasingly recognised health risk over time. An unwelcome sound is referred to as environmental noise, and it is a pollutant in the environment that needs to be controlled.

Continuous noise that exceeds certain thresholds can have detrimental health effects (Hashim Lim et al., 2023). Hospitals are regarded as noise-sensitive structures due to the presence of hospitalised patients and the activities that occur within them (Montes-González et al., 2019). Noise can originate both internally and externally in hospital environments. According to Jue and Nathan-Roberts (2019), most of the noise that disturbs patients is produced by personnel and machines. Meanwhile, environmental noise pollution can be attributed to transportation, industrial sites, and various other sources. Significant efforts have been made to eliminate traffic pollution at its origin. Despite the fact that vehicles are significantly quieter now than they were ten years ago, the effect of this improvement has been negated, and the level of annoyance has continued to rise due to the rise in traffic volume (Fahmi et al., 2023). The development of quieter automobiles may have provided a temporary solution to the problem, but it has not been completely resolved (Vos & Beek, 2019). According to the

findings of these investigations, noise exposure affects a variety of physiological processes. It is crucial to measure environmental noise to prevent severe consequences for users. However, there has been no research on environmental noise near the hospitals in Selangor. Therefore, this study aims to assess the current environmental noise pollution surrounding selected hospitals and explore potential improvements that contribute to future urban planning.

Table 1: Noise Level Standard by WHO and Selected Countries

	Noise level, Leq dBA	
Noise Level Limit	**Daytime**	**Night-time**
WHO	55	45
Malaysia (**DOE** Low Density)	55	50
Germany (Noise level guidelines)	45	35
Australia (Recommended outdoor background noise level)	45	35
Japan (Environmental quality standards)	45	35
Korea (Environmental quality goal)	50	45
Philippines (Environmental quality noise standards)	50	40
Iran		
(Residential area)	55	45
(Commercial area)	65	55
(Industrial area)	75	65

Source: Segaran et.al, (2020)

Table 2: Second Schedule, Recommended Permissible Sound Level (LAeq) by Receiving Land Use for Existing Built-Up Areas

Receiving Land Use Category	**LAeq Day**	**LAeq Night**
Low Density Residential, Noise Sensitive Receptors, Institutional (School, Hospital, Worship)	60 dBA	55 dBA
Suburban and Urban Residential, Mixed Development	65 dBA	60 dBA
Commercial business zone	70 dBA	65 dBA
Industrial zones	75 dBA	75 dBA

Source: DOE (2019)

Components of Environmental Noise Measurement

Measuring environmental noise levels is critical for determining where noise problems exist. This section describes the components that are included in the environmental measurement in this study.

Instrument: Sound Level Meter with Data Logger

Sound level meters serve as indispensable tools for quantifying diverse forms of noise pollution, encompassing industrial, environmental, mining, and aircraft noise assessments. According to the Department of Environment (DOE) guidelines from 2019, handheld deployment of sound level meters facilitates immediate spot readings, while prolonged monitoring necessitates their installation on tripods. Enhancing measurement accuracy, an extension cable coupled with a pre-amplifier allows the microphone to be positioned at elevated distances from the sound level meter body. However, the standard microphones accompanying general-purpose sound level meters lack water-resistant properties, rendering them unsuitable for prolonged outdoor use due to their vulnerability to humidity-induced drift. For sustained all-weather monitoring, specialised microphones are recommended (DOE, 2019).

Duration: Short-Term Sampling

Continuous sampling of instantaneous sound pressure levels over a specified duration constitutes an essential method for short-term noise measurement, aiding in the identification of noise sources and their impact on local communities (Svantek, 2024). Typically, measurements conducted for shorter durations, such as 30 minutes or an hour at specific times of the day, offer valuable insights into prevailing noise levels. However, these assessments, when not extended throughout the full day and night, provide only an approximate indication of typical noise levels, contingent upon minimal temporal fluctuations. It is imperative to acknowledge that despite their utility, LAeq values derived from such short-term measurements inherently encompass uncertainties and inherent inaccuracies, as highlighted by the Department of Environment (DOE, 2019). These inevitable limitations necessitate cautious interpretation of the acquired data, acknowledging the potential variability and imprecision inherent in the estimations of environmental noise levels.

Introduction to Hospital in Malaysia

Malaysia has the best healthcare system in the world and some of the hospitals have the lowest medical fees for treatment. Malaysian public health services are administered centrally by the Ministry of Health through its central, state, and district offices (World Health Organization, 2013).

Categories of Hospital

Public hospitals in Malaysia are divided into five categories, which are small district hospitals, larger district hospitals with resident specialists, state-level general hospitals with resident specialists, national hospitals, and specialist

hospitals or institutions. The primary role of public hospitals in the system is to provide secondary care to the population (World Health Organization, 2013).

Type of Healthcare Facilities and Services

This frequently includes the option of selecting the sort of health care facility to use. Healthcare facilities and services are primarily classified as Primary, Secondary, Tertiary, and Quaternary healthcare. Table 3 shows the different forms of healthcare being delivered between secondary and tertiary services.

Table 3: Second Schedule, Recommended Permissible Sound Level (LAeq) by Receiving Land Use for Existing Built-Up Areas

	Secondary	**Tertiary**
Function & Responsibility	Specialist treatment: Provide specific expert care	Hospitalization treatment: Care for hospitalized patients
Healthcare Services	Treat specific systems of the body; specific disease/ condition.	● Requires highly specialized equipment and expertise ● Complex treatments and procedures
Care Providers	● Cardiologists - heart ● Endocrinologists - hormone systems, diabetes, thyroid ● Oncologists- cancers	Advanced diagnostic centres, specialized intensive care units and modern medical facilities

Source: Malaysia Secondary Healthcare Ecosystem –27 Advisory (n.d.)

Source of Environmental Noise around the Hospital

Environmental noise near hospitals, as explained by Helmi et al. (2021), occurs from diverse external factors, including road traffic, construction activities, and residential and commercial zones. This pervasive noise, prevalent in densely populated areas, is intrinsically linked to the forces of industrialisation, transportation, and ongoing urbanisation (Magiera & Solecka, 2021). Within hospital premises, Wallis et al. (2019) identify internal sources contributing to environmental noise, encompassing equipment, pager alerts, staff conversations, and interactions among patients. Jue and Nathan-Roberts (2019) concur with this assessment, underscoring that a substantial proportion of disruptive noise experienced by patients originates from both healthcare staff and operational machinery. Table 4 presents a comprehensive literature review-derived list of potential sources of environmental noise surrounding public hospitals in Selangor. This list provides an understanding of the complex nature of noise in healthcare settings.

Table 4: Possible Sources of Environmental Noise around Public Hospital in Selangor

Variables	Jue & Nathan-Roberts (2019)	Helmi et al. (2021)	De Vos & Van Beek (2019)	Magiera & Solecka (2021)	Frequency
Traffic Noise	/	/	/	/	4
Construction Activity	/	/	/	/	4
Residential		/		/	2
Commercial			/	/	2

Sources: Authors (2024)

RESEARCH METHODOLOGY

This study adopts a quantitative approach, employing field measurements conducted as case studies across three public hospital buildings in Selangor. Specifically focusing on a state-level general hospital and two district hospitals renowned for their secondary and tertiary care services, the selection criteria for these case studies were thoroughly tailored to suit the study's objectives. Each case study represents distinct environmental noise sources, as depicted in Figures 1, 2, and 3, allowing for a comprehensive analysis of varied noise origins.

To ensure methodological consistency, sound level meters (SLMs) were strategically positioned on tripods, situating the microphone at an elevation ranging from 1.2 to 1.5 meters above the ground. The measurement sites were carefully chosen within a 500-meter radius of the case studies, maintaining a minimum distance of 3.5 meters from any walls, buildings, or sound-absorbing structures. Prior to data collection, SLMs were calibrated to record noise levels during the day, using the "A-weighted" scale and "fast" time response settings, adhering to standardised measurement protocols. This thorough technique is intended to collect and analyse the environmental noise levels unique to each case study, demonstrating differences due to various noise sources within hospital grounds.

Figure 1: Environmental Noise Source Points around Hospital Shah Alam
Source: Authors (2024)

Figure 2: Environmental Noise Source Points around Hospital Tengku Ampuan Rahimah
Source: Authors (2024)

Figure 3: Environmental Noise Source Points around Hospital Sungai Buloh
Source: Authors (2024)

The noise level was measured during each hospital's visiting hours, which are approximately 12:30 p.m. to 2:00 p.m. and 4:30 p.m. to 7:30 p.m., with a 15-minute interval between each reading as shown in the following Table 5. During the field measurement, the noise level is measured three times to obtain a noise average, thereby increasing the accuracy of the data collected as shown in Table 6. This data analysis provides highly beneficial data for identifying noise sources and areas that are likely to be exposed to harmful noise levels.

Table 5: Details of Data Collection

Location	Visiting Time	Date	Environmental Noise Source	Remarks
Hospital Shah Alam	12.30 p.m – 2.00 p.m. 4.30 p.m. – 7.00 p.m.	11/4/23	Residential Jalan Iridium 7/35	SA1
		12/4/23	Commercial Area Seksyen 7	SA2
		5/5/23	Klinik Kesihatan	SA3
		8/5/23	Traffic Noise	SA4
Hospital Tengku Ampuan Rahimah	12.30 p.m – 2.00 p.m. 4.30 p.m. – 7.30 p.m.	6/5/23	LRT3 Construction Site	AR1
		7/5/23	Taman Petaling Indah	AR2
		10/5/23	Traffic Noise	AR3

Location	Visiting Time	Date	Environmental Noise Source	Remarks
Hospital Sungai Buloh	12.30 p.m – 2.00 p.m.	12/5/23	Construction Site	SB1
	4.30 p.m. – 7.00 p.m.	17/5/23	Danau Seri Apartment	SB2
		20/5/23	Traffic Noise	SB3

Source: Authors (2024)

Table 6: Sample of Measured Data over the Field Measurement Period at Hospital Shah Alam

	Reading (dB)				
Time	**R1**	**R2**	**R3**	**Average (dBA)**	**Remarks**
12:45	56.0	55.0	55.8	55.6	
13:00	61.9	57.9	58.7	59.5	
13:15	59.7	55.0	55.8	56.8	
13:30	62.3	60.6	59.8	**60.9**	
13:45	62.1	58.9	57.0	59.3	
14:00	64.9	65.0	61.7	**63.9**	Car horn
16:45	64.8	62.4	65.4	**64.2**	Motorbike
17:00	56.2	54.5	54.6	55.1	
17:15	52.5	53.7	51.0	52.4	
17:30	61.9	60.9	63.6	**62.1**	Lorry
17.45	60.0	63.0	61.5	**61.5**	Bus
18:00	54.5	54.0	54.8	54.4	
18:15	74.7	72.0	70.3	**72.3**	Ambulance siren
18:30	56.7	57.9	59.6	58.1	
18.45	58.4	56.7	56.4	57.2	
19:00	58.3	54.7	57.8	56.9	
Average: 64.9					

Source: Authors (2024)

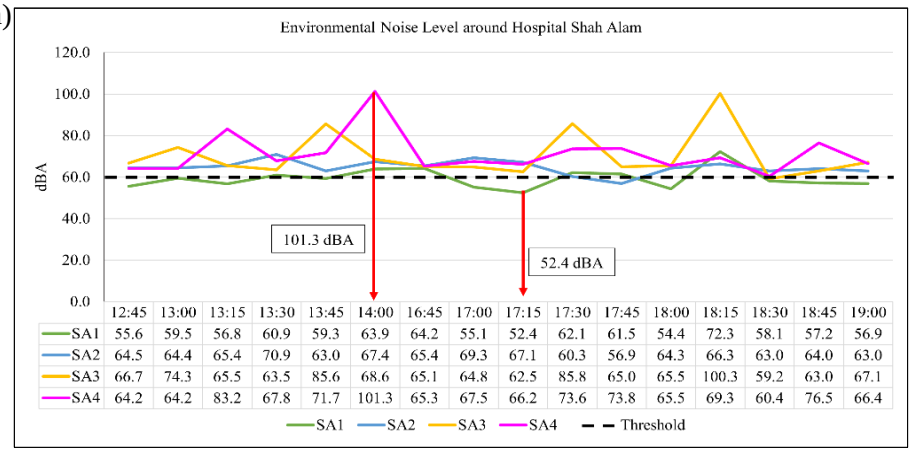
This study adopts a descriptive analysis methodology to interpret, illustrate, and summarise field-measured data points, aiming to distinguish frequent patterns aligning with all significant data collected. Employing sound level meters for data collection, the gathered information is graphically represented to establish cases where environmental noise levels surpass the thresholds established by DOE. Through this analytical approach, the study aims to assess the current environmental noise pollution surrounding selected hospitals that contribute to environmental noise pollution, facilitating a detailed analysis and discussion based on the collected information from the field measurements conducted.

RESULT AND DISCUSSION

This section shows the result of the noise measurement level taken during the field measurements in line graph form. The data collection process revealed various sources of environmental noise around the hospitals. In the following

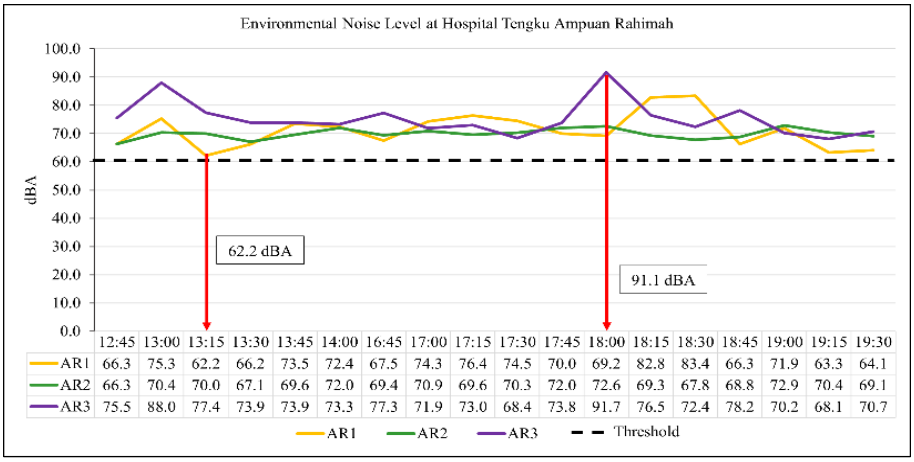
figures, each line denotes the different source points while the dotted line represents the threshold for the hospital environment, which is 60 dBA as stated in the Second Schedule since hospitals are noise-sensitive structures, it is important to look up at the guideline by DOE to ensure patient satisfaction while staying in hospitals. From that graph line, it can be clearly seen the highest and lowest values of environmental noise around the hospital in each case study.

a)



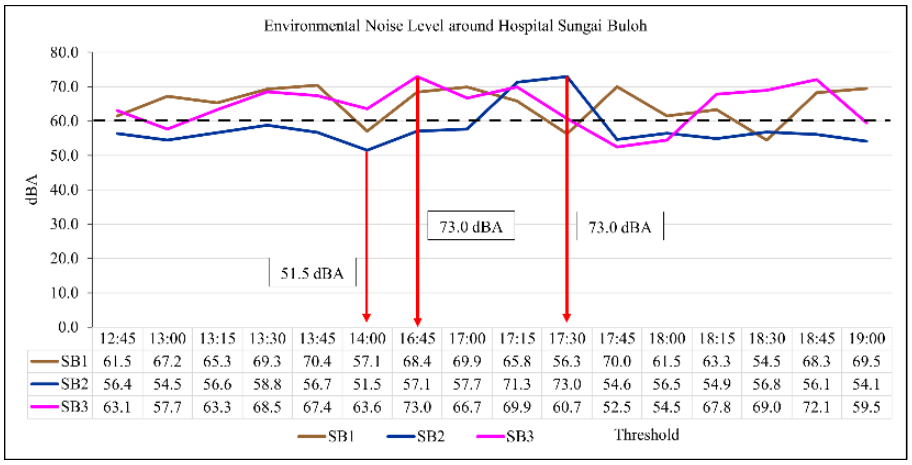
	12:45	13:00	13:15	13:30	13:45	14:00	16:45	17:00	17:15	17:30	17:45	18:00	18:15	18:30	18:45	19:00
SA1	55.6	59.5	56.8	60.9	59.3	63.9	64.2	55.1	52.4	62.1	61.5	54.4	72.3	58.1	57.2	56.9
SA2	64.5	64.4	65.4	70.9	63.0	67.4	65.4	69.3	67.1	60.3	56.9	64.3	66.3	63.0	64.0	63.0
SA3	66.7	74.3	65.5	63.5	85.6	68.6	65.1	64.8	62.5	85.8	65.0	65.5	100.3	59.2	63.0	67.1
SA4	64.2	64.2	83.2	67.8	71.7	101.3	65.3	67.5	66.2	73.6	73.8	65.5	69.3	60.4	76.5	66.4

b)



	12:45	13:00	13:15	13:30	13:45	14:00	16:45	17:00	17:15	17:30	17:45	18:00	18:15	18:30	18:45	19:00	19:15	19:30
AR1	66.3	75.3	62.2	66.2	73.5	72.4	67.5	74.3	76.4	74.5	70.0	69.2	82.8	83.4	66.3	71.9	63.3	64.1
AR2	66.3	70.4	70.0	67.1	69.6	72.0	69.4	70.9	69.6	70.3	72.0	72.6	69.3	67.8	68.8	72.9	70.4	69.1
AR3	75.5	88.0	77.4	73.9	73.9	73.3	77.3	71.9	73.0	68.4	73.8	91.7	76.5	72.4	78.2	70.2	68.1	70.7

c)



	12:45	13:00	13:15	13:30	13:45	14:00	16:45	17:00	17:15	17:30	17:45	18:00	18:15	18:30	18:45	19:00
SB1	61.5	67.2	65.3	69.3	70.4	57.1	68.4	69.9	65.8	56.3	70.0	61.5	63.3	54.5	68.3	69.5
SB2	56.4	54.5	56.6	58.8	56.7	51.5	57.1	57.7	71.3	73.0	54.6	56.5	54.9	56.8	56.1	54.1
SB3	63.1	57.7	63.3	68.5	67.4	63.6	73.0	66.7	69.9	60.7	52.5	54.5	67.8	69.0	72.1	59.5

Figure 4: Result obtain during the field measurement case study; a) Hospital Shah Alam, b) Hospital Tengku Ampuan Rahimah, and c) Hospital Sungai Buloh
Source: Authors (2024)

Beginning with observations near Hospital Shah Alam (a), at 14:00 there is the highest environmental noise level with 101.3 dBA. This peak noise level was primarily attributable to ambulance sirens and horns, highlighting their significant impact on the acoustic environment. This aligns with residents' perceptions that vehicle and construction activities are major noise contributors in Seksyen 7, Shah Alam (Abdullah et al., 2024). Notably, this increase in noise coincided with the end of the lunch break and visiting hours, which contributed to traffic congestion and increased noise emissions along the main road. At 17:15, SA1 recorded the lowest noise level in the residential area, measuring 52.4 dBA, which may be attributed to decreased activity near the residential area. Only the residential area at Jalan Iridium 7/35 (SA1), which measured 59.9 dBA, was able to maintain noise levels below the threshold limit. However, the noise levels in the other monitored areas, SA2, SA3, and SA4, exceeded the DOE threshold, registering at 64.9 dBA, 70.2 dBA, and 71.1 dBA, respectively

Moving on to the findings concerning Hospital Tengku Ampuan Rahimah (b), AR3 recorded the maximum noise level of 91.7 dBA at 18:00. Again, ambulance sirens emerged as the predominant source, which was exacerbated by the peak traffic hour and the presence of numerous traffic signals, which impeded the ambulances' ability to move quickly. This congestion resulted in a prolonged siren duration of approximately one minute, which exacerbated noise propagation in the vicinity. At 13:15, AR1, which was situated on a construction site, registered the lowest noise level at 62.2 decibels. This decibel reduction coincided with the temporary cessation of construction activities during

lunchtime. Upon assessment for adherence to the DOE noise threshold, it became evident that all examined sources in the vicinity of Hospital Tengku Ampuan Rahimah, namely AR1, AR2, and AR3, exceeded the designated threshold, with respective measurements of 71.1 dBA, 69.9 dBA, and 75.2 dBA.

SB2 and SB3 exhibited the maximum noise levels at Hospital Sungai Buloh (c) at 17:30 and 16:45, respectively, registering 73.0 dBA. At 14:00, however, SB2 exhibited the lowest noise level, measuring 51.4 dBA. The hospital's location, adjacent to a highway exit and outfitted with multiple main gates, appears to have contributed to effective traffic management, resulting in traffic that is consistently manageable even during peak hours. Only SB2, which measured 57.9 dBA, remained compliant with the DOE's noise limits. SB1 and SB3 measured 65.5 dBA and 64.6 dBA, respectively, which were marginally above and below the threshold. Collectively, these findings highlight the complex relationship between sources and their temporal variations in influencing the acoustic environment around these healthcare institutions, with implications for both patient well-being and urban planning strategies.

Since hospitals are noise-sensitive structures, it is important to look up the guidelines set by DOE to ensure patient satisfaction while staying in hospitals. To further analyse whether the case study exceeds the threshold is categorised as environmental noise pollution, Table 7 shows the data summary of the environmental noise level for every point of source around the case study.

Table 7: Data Summary of Environmental Noise Level for Every Point of Sources around the Case Study

			Noise Level (dBA)		
No	**Case Study**	**Location**	**Minimum**	**Maximum**	**Average**
1	Hospital Shah Alam	SA1	52.4	72.3	59.4
		SA2	56.9	70.9	64.9
		SA3	59.2	100.3	70.2
		SA4	60.4	101.3	71.1
2	Hospital Tengku Ampuan Rahimah	AR1	62.2	83.4	71.1
		AR2	66.3	72.9	69.9
		AR3	70.7	91.1	75.2
3	Hospital Sungai Buloh	SB1	54.5	70.4	65.5
		SB2	51.5	73.0	57.9
		SB3	54.5	73.0	64.6

Source: Authors (2024)

The data summary reveals that only two specific points, SA1 and SB2, managed to meet the DOE standard of less than 60 dBA, recording levels of 59.4 dBA and 57.9 dBA, respectively. Notably, these points, both situated in residential areas, shared a common source of environmental noise. These residential areas were equipped with security guards at their main road entrances,

requiring a residential card for access. A contrasting scenario was observed in AR2, another residential area, which registered a higher noise reading of 69.9 dBA due to the absence of security guards at its main access road. Additionally, AR2's proximity to the hospital's rear gate, a popular parking spot, contributed to its noise level. This phenomenon stemmed from inadequate parking provisions within the hospital premises, as supported by Ariffin (2022), who highlighted insufficient parking spaces in hospital blueprints. Consequently, visitors had to park some distance away, occasionally on roadside stretches.

The most substantial recorded environmental noise was at AR3, marked by a reading of 75.2 dBA, classifying it as a form of environmental noise pollution. This noise stemmed from traffic on the main road adjacent to Hospital Tengku Ampuan Rahimah. The consistent congestion on this road compounded noise levels, particularly during peak visiting hours, coinciding with lunch and the day's end. Over the course of the measurement period, the hospital's ambulance made around 33 trips, often navigating through traffic lights, leading to unavoidable delays. This pattern extended to SA4, where noise levels reached 71.1 dBA around Hospital Shah Alam. The drivers' tendency to inappropriately honk their horns after traffic lights turned green, in violation of the Noise Pollution (Regulation and Control) Rules (2000), played a role in this issue. These rules stipulate that within 100 meters of hospitals, educational institutions, and courts, horn use should be limited to situations involving imminent danger. Drivers should refrain from prolonged and frequent horn usage, particularly within designated silent zones.

In summation, the case study focusing on Hospital Tengku Ampuan Rahimah, denoted as (b), experienced the highest environmental noise levels. These noise levels emanated from three distinct sources, collectively contributing to the notable noise pollution around the hospital premises.

CONCLUSION

This study has been able to assess the current environmental noise pollution surrounding selected public hospitals in Selangor. The field measurement case study was drawn to a conclusion from the analysed data. The data collection phase identifies different sources of environmental noise around the hospital premises. These noise source points were meticulously monitored and analysed, with some recorded noise levels surpassing the prescribed 60 dBA limit. Overall, the data analysis indicated that most of the source points around the hospitals exceeded the recommended threshold for environmental noise, emphasising the need for measures to mitigate noise levels.

Aiming to recommend an approach to reducing environmental noise around public hospitals, the authors extended the study, recommending some strategies that can be used to improve the hospitals' surroundings, such as enforcing zoning

regulations that restrict noise-emitting activities in the surrounding areas. This approach could include planning green spaces, quieter streets, silence zones, and placing noise-sensitive facilities like hospitals in areas away from major highways or industrial zones. Apart from that, dedicated ambulance lanes or rerouting traffic away from the hospital zone would help minimise traffic congestion and reduce noise levels. Lastly, there is potential for urban planners to collaborate with local governments to increase public awareness about noise pollution regulations. Future research could expand to evaluate the effectiveness of various noise reduction methods, including zoning regulations and sound-absorbing materials, in different hospital environments.

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