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The Impact of Aircraft Noise on Residents Residing in the Vicinity of Subang Airport

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ABSTRACT

Noise pollution is a prevalent issue in Malaysia, and this investigation focuses on Subang Airport to assess its impact on nearby communities and explore potential mitigation strategies. Given its proximity to densely populated areas, residents express significant apprehension about the noise generated by the airport. The research methodology involves an in-depth examination of aviation noise literatures, the utilization of noise monitoring equipment (sound level meter) for data collection and an analysis of community questionnaires to gauge public perceptions of noise effects. On-site measurements were conducted at seven locations (P1-P7) around the airport, representing varying distances from the noise source over a two-week period. The daily average noise levels range from 40-65 dB(A), which exceed the WHO's recommended maximum indoor noise level of 35 dB(A) and the suggested maximum noise level for outdoor environments of 55 dB(A). Nevertheless, these averages remain below the permissible exposure limit of 90 dB(A). The study's significance is further assessed through questionnaire analysis, utilizing Statistical Package for the Social Sciences (SPSS) version 28. Of the 193 respondents (71.7%), the majority identify aircraft noise as a significant source of disruption, with 36.4% attributing major annoyance to traffic noise, 25.7% to industrial noise, and 9.7% to construction-related noise. Respondents collectively emphasize the importance of raising awareness about noise pollution dangers within society and underscore the government's role in mitigating noise pollution.

Keywords: Airport area, aircraft noise, noise pollution, sound level meter, SPSS analysis

INTRODUCTION

Noise pollution, often referred to as unwanted or harmful sound, has emerged as a significant global environmental concern impacting both urban and rural areas (Cerletti et al. 2020). As per the World Health Organization (WHO) definition, noise pollution encompasses excessive, displeasing, or disruptive noise that interferes with normal activities (WHO 2019). Transportation-related noise pollution, especially, poses a substantial threat to public health and well-being, encompassing noise generated by various modes of transportation such as road traffic, railways, and aircraft. In urban settings, transportation-related noise pollution constitutes a primary contributor to overall noise pollution levels, with road traffic (20%) and aircraft operations being major sources (Moroe & Mabaso 2022; Hahad et al. 2024).

Extensive research has been conducted worldwide to understand the impacts of aircraft noise on communities and to propose mitigation measures to address these issues. In Malaysia, noise pollution is particularly pronounced in areas surrounding airports, where aircraft noise levels often exceed acceptable thresholds. Sultan Abdul Aziz Shah Airport (Subang Airport) in Subang Jaya, Selangor, Malaysia, is one such location. It serves general aviation, corporate and executive jets, and military training purposes and is situated in close proximity to both commercial and residential areas. A study by Azmi et al. (2019) highlighted that noise levels near Subang Airport surpassed recommended limits, raising concerns among residents regarding adverse health and quality of life effects. The association between aircraft noise and cardiovascular illness has been extensively explored in the literature, with various studies demonstrating a correlation between aircraft noise exposure and increased risks of cardiovascular diseases such as hypertension, myocardial infarction, and stroke (Munzel et al. 2018; Van & Babisch 2012). Mechanisms underlying this association include stress response activation and disruption of sleep patterns, leading to physiological changes contributing to cardiovascular morbidity and mortality.

Studies such as those by Basner et al. (2014), Van Kempen et al. (2018), and Floud et al. (2015) have investigated the effects of aircraft noise on sleep disturbance, cardiovascular health outcomes, annoyance levels, and mental health outcomes among residents living near airports in Germany, the Netherlands, and the United Kingdom, respectively. These studies utilized various methodologies, including field studies, health assessments, and longitudinal surveys, to evaluate the impacts of aircraft noise and propose mitigation measures such as noise insulation and nighttime flight restrictions.

Despite these efforts, previous studies have not adequately measured the combined impact of aviation, traffic, industrial, and construction noise on residents' health. To address the problem of noise pollution effectively, it is crucial to understand how these multiple noise sources affect communities near the airport. Engagement with local residents provides valuable insights that can enhance current efforts to mitigate noise pollution and improve outcomes. Addressing noise pollution is essential for achieving developmental goals, improving environmental conditions, and safeguarding human health. Furthermore, research in this area contributes to a broader understanding of noise pollution globally and raises awareness of its often-overlooked hazards. The objectives of the present study are to quantify the noise levels from various sources and assess their combined impact on residents' health near Subang Airport. Additionally, the collected noise data will be compared to the Guidelines for Environmental Noise Limits and Control (DOE 2019) to assess the severity of the pollution.

METHODOLOGY

The methodology adopted in this study consisted of two phases (Phase 1 and Phase 2), described in the following sub-sections.

PHASE 1: NOISE LEVEL MEASUREMENT

Phase 1 of the study commenced with the assessment of noise levels in various areas surrounding Subang Airport. A HABOTEST sound level meter (Model: HT622B, China) with a resolution of 0.1 dB(A) and accuracy of 1.5 dB(A) was employed for this purpose. The study conducted three daily noise level data collection sessions—morning, afternoon, and evening (during aircraft take-off and landing)—over a period of fourteen days at seven locations near the airport. Each location was monitored for noise levels over two consecutive days, ensuring robust data collection. Careful attention was given to avoid factors like adverse weather conditions during data collection to maintain the accuracy of noise level measurements. The selected measurement areas were within the audible range for human perception.

As depicted in Figure 1, noise level measurements were conducted at seven locations (P1–P7), encompassing villages, residential zones, and commercial districts. These locations were chosen to assess the noise exposure of individuals residing near the airport. Each site represented a distinct distance from the noise source at the airport, known as CP (the point of aircraft take-off and landing). Noise levels were recorded during aircraft take-off and landing activities, and Table 1 presents the coordinates for sites P1–P7. To evaluate the variations in the noise level data, the distances between each location and the airport were measured. Other on-site environmental factors that were included in the data were the noise levels caused by vehicles, lorries, motorcycles, people conversing, construction, climate change, and other natural noises. The selection of seven measurement locations for noise level assessments around Subang Airport is justified by the need for a comprehensive and accurate analysis of noise pollution impacts. By including both residential and industrial areas within a 3 km radius, the study captures the diverse effects on different environments and communities. Points at various distances from the airport allow for the examination of noise attenuation and dispersion patterns, providing insights into how noise levels decrease with distance. This variation helps assess the noise exposure experienced by residents and workers, identifying zones most affected by aircraft operations.

FIGURE 1. Study points selected for noise level measurement
Source: Google earth pro (2023)

TABLE 1. Description of the points chosen for noise level measurements

Point	Description	Coordinates	Measured distance from the airport (km)
P1	Pekan Subang	3° 8’12.43”N 101°32’24.74”E	1.04
P2	Kampung Bunga Raya	3° 8’47.05”N 101°32’8.07”E	1.04
P3	Kampung Landasan	3° 8’49.80”N 101°32’29.36”E	1.57
P4	Kampung Melayu Subang	3° 9’2.99”N 101°32’0.65”E	2.85
P5	Taman Perindustrian Saujana Indah	3° 6’32.60”N 101°33’33.55”E	2.50
P6	Jalan Lapangan Terbang Subang Lama	3° 8’32.27”N 101°32’44.23”E	0.65
P7	Taman Subang Perdana	3° 9’9.54”N 101°32’24.68”E	2.32

It is necessary to compute the L_{Aeq} of the noise level by making use of equation (1) where n is the total number of sample taken, Li is the noise level in dB(A) of ith sample and ti is fraction of total sample time. A-weighted equivalent continuous sound level is measured in decibels, and L_{Aeq} is the abbreviation for that term (dB).

$$L_{Aeq} = 10 \text{ Log}10 \sum_{k=0}^{n} \{(10^{\frac{Li}{10}}) \cdot t_i\} \quad (1) \qquad (1)$$

The L_{Aeq} of the study areas was compared to the Guidelines for Environmental Noise Limits and Control provided by the Department of Environment, Ministry Of Natural Resources And Environmental Sustainability, Malaysia (DOE 2019), Malaysia as shown in Table 2.

TABLE 2. Recommended permissible sound level, L_{Aeq} (DOE 2019)

Receiving land Use Category	L_{Aeq} Day 7.00am-10.00pm	L_{Aeq} Night 10.00 pm-7.00 am
Low density residential, Noise Sensitive Receptors, Institutional (school, hospital, worship)	60 dBA	55 dBA
Suburban an urban residential, mixed development	65 dBA	60 dBA
Commercial Business zones	70 dBA	65 dBA
Industrial zones	75 dBA	75 dBA

PHASE 2: QUESTIONNAIRE SURVEY

In phase 2, to gather data on the impacts of aircraft noise exposure on the locals living close to the Subang Airport region, a questionnaire survey was conducted. The questionnaire asked about the participants' everyday activities that might cause noise that might be detrimental to them and how frequently they were exposed to loud environments. The surveys were given out to 282 individuals (n = 282) at various airport-related venues (total population of study area is 23,834) as mentioned in Table 3.

The survey questionnaire comprises three sections: A, B, and C. Section A focuses on demographic information of respondents. Section B is further divided into three parts, all centered around respondents' awareness of noise pollution. The first part assesses residents' exposure to noise, the second delves into their perceptions of noise pollution, and the final part examines its impact of noise pollution to residents. Section C is split into two parts: coping mechanisms and suggestions for mitigating noise pollution in the Subang Airport area.

TABLE 3. Summary of the questionnaire for the residents

Sections	Related Question
A	Section A consists of the respondent's background information which include gender, race, age group, and employment status.
B	Section B is divided into three sections which involve the level of awareness of noise pollution. The first section is about the level of noise exposure. The second section is about the perception of noise. Finally, the third section is about the effects of noise pollution.
C	Section C is divided into two segments. The first segment is about the coping mechanism. The second segment is about suggestions for improvement.

ANALYSIS OF QUESTIONNAIRE

Statistical Package for the Social Sciences (SPSS) version 29.2.0(20) was used for analysis of the questionnaires. Descriptive analysis was used to analyse the demographic of respondents in Section A, whereas reliability test or Cronbach's alpha was used to test the questions that contain Likert Scale in the questionnaire in Section B and C. As shown in As per Table 4, the Cronbach's Alpha value for the Likert scale reliability statistics is recorded at 0.760, indicating a high level of reliability. This suggests that the Likert Scale utilized in the questionnaire for this study is deemed suitable. The robustness of the research questions is thereby affirmed in effectively attaining the study's objectives.

TABLE 4. Reliability Statistics for Subang Airport Area

Cronbach's Alpha[a]	Cronbach's Alpha Based on Standardized Items[a]	N of Items
0.760	0.762	2

RESULTS AND DISCUSSION

NOISE LEVEL

Noise levels were monitored at designated locations (P1–P7) during aircraft take-off and landing over a span of two weeks. According to live air traffic tracker data from Flight

Radar 24 (https://www.flightradar24.com/3.14,101.69/6), an average of 57 flight activities were observed daily. Referring to airport statistics from 2019, Subang Airport documented 80,606 aircraft operations throughout the year. The frequency of aircraft operations varies, influenced by consumer demand and flight volumes, particularly during festive or holiday periods.

Figures 2 and 3 illustrate the noise level readings collected at seven locations, with three measurements recorded each day, both before and during flight activities. These readings reflect the varying noise level thresholds permitted for different zones. For instance, points 2, 3, and 4 have a permissible limit of 60 dBA while points 7 and 6 allow for 65 dBA and 70 dBA respectively. Points 1 and 5, on the other hand, adhere to a permissible limit of 75 dBA

Table 5 to 7 provides a contrast between the noise levels observed in the study area and the permissible limits set by the Department of Environment. Upon comparison with the noise permissible limits delineated in Table 4, it is evident that the measured noise levels exceed the established thresholds for each zone type. The most notable disparities between the noise permissible limits and the recorded noise levels were observed at Taman Subang Perdana (P7), Kampung Bunga Raya (P2), Kampung Landasan (P3), and Kampung Melayu Subang (P4).

Certain locations exceeded noise thresholds due to their proximity to the flight path and lack of barriers affecting noise propagation. Thresholds varied by zone type (industrial, low-density residential, noise-sensitive receptors, institutional, or commercial), and those closer to the flight path or without noise barriers experienced higher noise levels.

Although wind speeds were not measured during the study, the noise levels were recorded over two weeks at various locations. This approach resulted in no significant differences in the noise level data, suggesting that the impact of environmental conditions was minimal or uniformly distributed across the measurement period and locations, thus not significantly influencing the overall findings.

TABLE 5. Comparison between L_{Aeq} for low density residents to permissible L_{Aeq}

Zone Type	Location					
Low Density Residential, Noise Sensitive Receptors, Institutional, Permissible L_{Aeq}	Kampung Bunga Raya (P2)		Kampung Landasan (P3)		Kampung Melayu Subang (P4)	
	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
60 dB (A)	72.70 dBA	78.18 dBA		74.68 dBA		79.20 dBA

TABLE 6. Comparison between L_{Aeq} Suburban and Urban Residential, Mixed Development and Commercial Business Zones to permissible L_{Aeq}

Zone Type	Location	
Suburban and Urban Residential,Mixed Development, Permissible L_{Aeq}	Taman Subang Perdana (P7)	
65 dBA	Day 13	Day 14
	83.62 dBA	80.61 dBA
Commercial Business Zones, Permissible L_{Aeq}	Jalan Lapangan Terbang Subang Lama (P6)	
70 dBA	Day 11	Day 12
	75.85 dBA	77.67 dBA

TABLE 7. Comparison between L_{Aeq} for Industrial Zones to permissible L_{Aeq}

Zone Type	Location			
Industrial Zones, Permissible L_{Aeq}	Pekan Subang (P1)		Taman Perindustrian Saujana Indah (P5)	
75 dBA	Day 1	Day 2	Day 9	Day 10
	80.96 dBA	80.07 dBA	80.72 dBA	78.09 dBA

RESIDENT'S VIEW ON NOISE POLLUTION WITHIN THE VICINITY OF SUBANG AIRPORT

Throughout the study period, a survey questionnaire involving 282 participants (n = 282) was administered to gather the perspectives of residents on the issue of aircraft noise exposure in the vicinity of Subang Airport. A descriptive test was utilised to analyse the enormous number of total responses. As can be observed in Table 8, the mean gender of respondents at Subang Airport area was 1.62 (SD = 0.487). The mean age was 3.09 (SD = 0.916) and the mean race was 2.46 (SD = 0.947).

TABLE 8. Descriptive Statistic

		Gender	Race	Age
N	Valid	282	282	282
	Missing	0	0	0
Mean		1.62	2.46	3.09
Median		2.00	3.00	3.00
Mode		2	3	3

SOURCES OF NOISE

Based on Figure 4, aircraft noise was identified as a significant disruption by 193 respondents (71.7%), making it the predominant concern. Communities residing near airports bear the brunt of incessant aircraft engine noise, disturbing the peace in both urban and suburban environments. Additionally, 98 respondents (36.4%) cited traffic noise as a major annoyance, which was also highlighted in the survey. The constant horn of cars, trucks, and motorcycles on roads affects everyday life, especially in densely populated urban areas. Another 69 respondents (25.7%) mentioned industries as a notable source of noise pollution, while 26 respondents (9.7%) attributed construction activities as the cause of noise pollution.

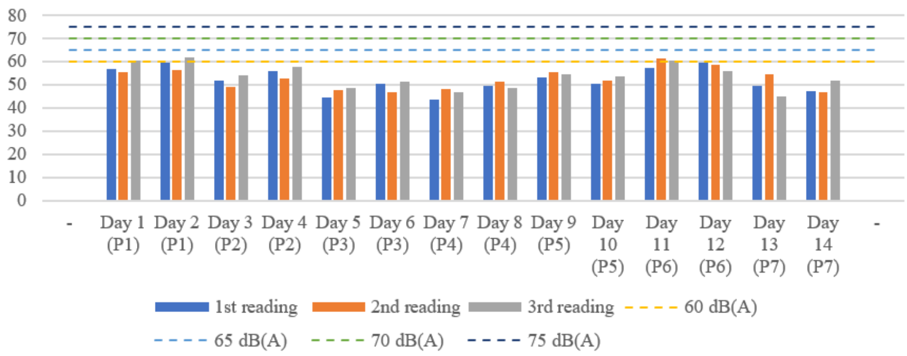

FIGURE 2. Noise level reading before flight activity

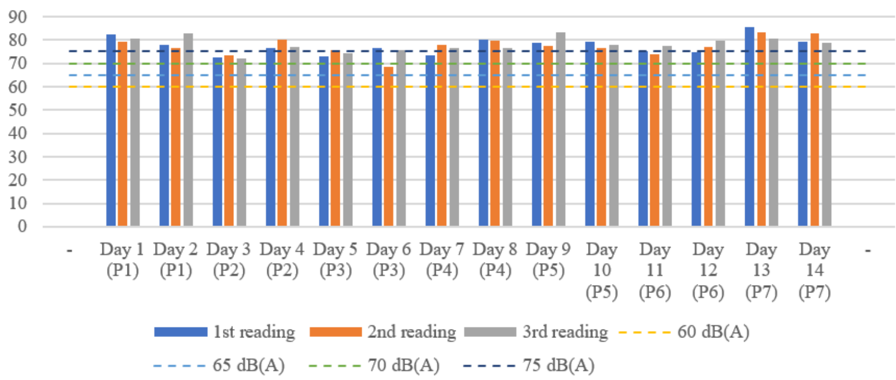

FIGURE 3. Noise level reading during flight activity

EXPOSURE TO NOISE POLLUTION

As depicted in Figure 5, the morning emerged as the time of day with the highest number of respondents reporting noise pollution, with 129 respondents (48.5%) noting this occurrence. This finding aligns with the typical hustle and bustle associated with morning rush hours in urban areas, characterized by heightened traffic and increased human activity. Surprisingly, only 101 respondents (38%) reported encountering noise pollution in the afternoon, despite daytime activities being more prevalent. This contrast may suggest either a relative lull in noise pollution during the afternoon or a different perception of noise during this time compared to the morning.

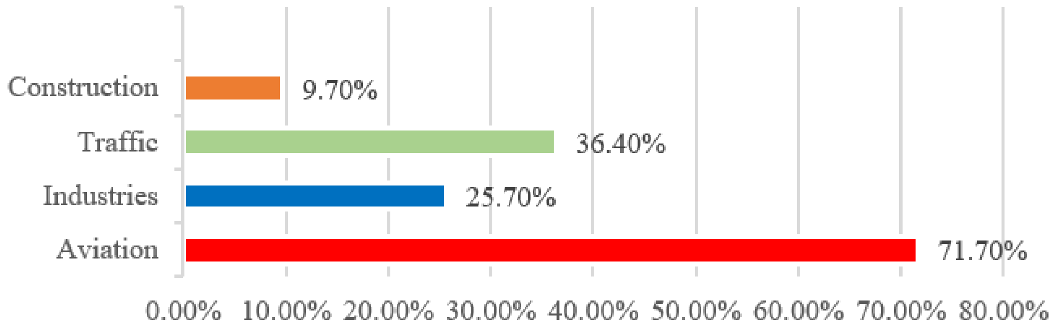

FIGURE 4. Sources of Noise

Evenings emerged as the period when noise pollution was most pronounced, according to 105 respondents (39.5%). This aligns with factors contributing to elevated noise levels such as the conclusion of the workday, intensified traffic, and recreational activities. Conversely, during what is conventionally perceived as a peaceful night, 93 respondents (35%) acknowledged the presence of noise pollution.

EFFECT OF NOISE POLLUTION

According to Figure 6, the respondents reached a consensus that noise pollution increases stress levels, with 33.5% in agreement. High levels of continuous noise have been shown to influence hormones such as noradrenaline, adrenaline, and cortisol. Additionally, 19.6% of the community reported experiencing headaches when exposed to noise pollution. Furthermore, 33.5% of individuals admitted to having difficulty sleeping when exposed to noise pollution, leading to a reduction in sleep duration with continued exposure. While it is recommended that individuals aim for 7–9 hours of sleep each night, preferences for sleeping and waking times vary among individuals (Johnson, 2020). Moreover, 13.5% of respondents reported experiencing other effects from noise pollution, such as difficulty staying focused and insomnia. The presence of noise in their surroundings disrupts their performance in their usual daily routines.

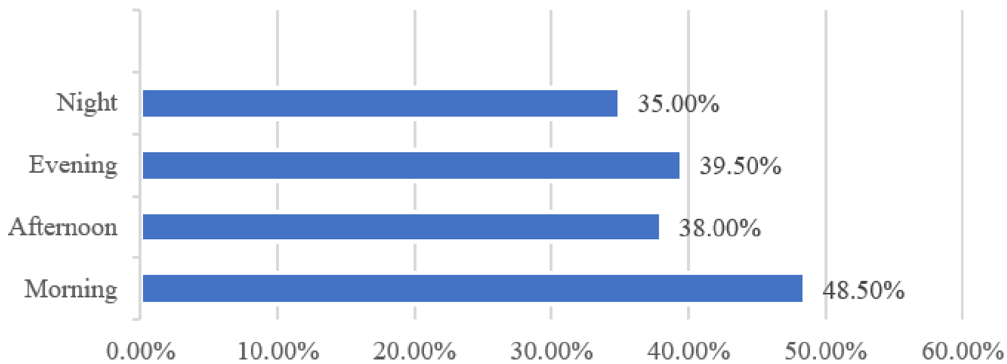

FIGURE 5. Time exposure to noise pollution

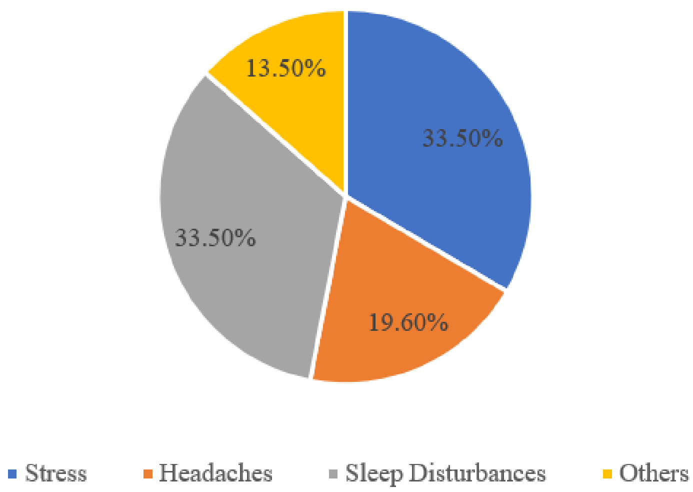

FIGURE 6. The effect of Noise Pollution

AGE AND THE HEALTH ISSUE

According to Table 8, out of 282 respondents, 128 fell within the age range of 19 to 40 years old. The findings indicate that a majority of respondents in this age group experienced stress (46 respondents) and sleep disturbances (43 respondents). The remaining respondents in this age group reported experiencing headaches and other health issues such as temporary hearing loss, insomnia, and difficulty focusing.

A total of 28 survey participants classified in the age group below 18 years old. The majority of them reported experiencing stress (11 respondents), while the remaining respondents cited other health issues such as headaches, sleep disturbances, and other health effects. For respondents aged over 61 years old, their responses varied, including experiences of stress, headaches, sleep disturbances, and other health effects. Only one respondent in this age group reported no disturbances. Majority of respondents who were between the ages of 41 to 60 years old felt that noise pollution has caused them to suffer a variety of side effects including headaches, sleep disturbances and stress specifically when they stay at Subang Airport area. This demonstrates that an individual's sensitivity to the negative impacts of noise pollution increases with advancing age.

TABLE 8. Age and Health Issue Crosstabulation

		Health Issue					
		Headaches	Others	Sleep Disturbances	Stress		Total
Age	<18		6	4	7	11	28
	>61		4	5	7	6	23
	19 - 40		25	14	43	46	128
	41- 60		20	15	37	31	103
Total			55	38	94	94	282
Percentage and totals are based on respondents							
Dichotomy group tabulated at value 1.							

NOISE POLLUTION MITIGATION MEASURES

Among the evaluated initiatives (refer to Figure 7), innovation and research emerged as significant, as noted by 57 respondents (20.2%). This cohort advocates for the exploration of novel methods and technological advancements aimed at mitigating noise pollution. Examples include the development of advanced noise-cancelling techniques or quieter airplane engines, both of which could substantially contribute to noise reduction through research-backed solutions.

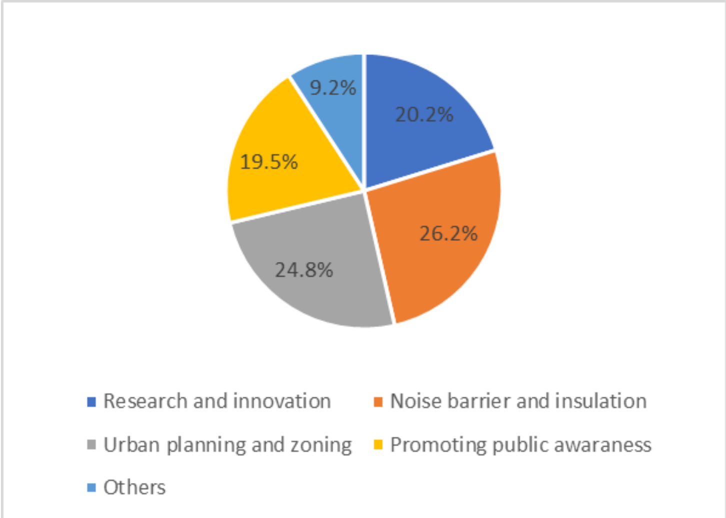

FIGURE 7. Noise Pollution mitigation measures

A considerable plurality of 74 respondents (26.24%) expressed support for insulation and noise barriers as practical measures against noise pollution. This inclination underscores the community's endorsement of structural barriers and soundproofing materials to mitigate the adverse effects of airport noise on nearby residences and businesses. Zoning and urban planning were identified as priorities by 70 respondents (24.82%). This group recognizes the importance of land use regulations and spatial arrangements in noise pollution reduction. Efficient urban planning strategies, such as implementing buffer zones and building regulations, can help minimize airport-related noise exposure in sensitive areas.

Fifty-five respondents (19.50%) scored the critical need to raise public awareness. This group emphasizes the significance of educating the community about the impacts of noise pollution and advocating for responsible actions to limit noise emissions, fostering a communal effort towards mitigation. Moreover, 26 respondents (9.22%) contributed unique approaches or alternative perspectives not included in the provided list. Despite the diversity and divergence of these responses, they underscore the necessity of exploring a wide array of viable solutions tailored to the specific circumstances of Subang Airport.

CONCLUSION

The study evaluated noise levels from Subang Airport and their impact on the nearby community, finding that these levels exceeded acceptable environmental guidelines. A survey of 282 participants revealed widespread awareness and experience of noise pollution, particularly near Subang Airport compared to other areas. The community emphasized the importance of increasing awareness about noise pollution and called for significant government actions, including specific strategies like retrofitting homes with double-glazed windows or implementing curfews on night flights. These measures were suggested based on the study's findings to potentially mitigate noise impacts effectively. Additionally, there was a strong consensus on the need for stricter flight regulations, investment in quieter aircraft technologies, and collaborative efforts between government and the community to achieve a balanced approach addressing both economic and environmental concerns related to aircraft activities near Subang Airport

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DECLARATION OF COMPETING INTEREST

None.

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