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Effects of aircraft noise on residents nearby a Malaysian airport

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Abstract. In this study, the effects of aircraft noise on the residents living nearby Sultan Ismail Petra Airport, Kelantan, Malaysia, were investigated. A questionnaire survey involving 60 participants revealed that 46.67% agreed that aircraft noise is a source of disturbance in their daily routine. On-site noise level measurements were carried out over a 2-week period at seven locations (P1–P7) surrounding the airport, where each location represents a different distance from the noise source. The daily average noise levels were within 50–65 dB(A), which exceeded the World Health Organization's recommended maximum indoor noise level and recommended maximum outdoor noise level of 35 and 55 dB(A), respectively. However, the daily average noise levels were lower than permissible exposure limit of 90 dB(A). Based on the results, it can be concluded that exposure to the aircraft noise may affect the quality of life of nearby residents in the long term.

1. Introduction

With the escalating population growth over the years, more and more lands are being developed into cities, which include landed houses, condominiums, low-cost flats, offices, retail stores, restaurants, hotels, motels, medical centers, and transportation facilities (bus and railway stations, and airports). With urbanization, environmental noise becomes a major problem where the people are exposed to various types of noise such as leisure noise (e.g. noise from sporting events, concerts, and night clubs), transportation noise (road, railway, and aircraft noise), impulse noise (noise from guns and firecrackers), noise in the working environment (noise from office machines, telephone ringing, ventilation systems, machines in intensive care units, industrial machinery (lathe machine, punch press, cutting machine, jack hammer, furnace), and other types of noise (wind turbine noise, grass cutting noise, noise from construction and renovation sites [7, 11, 13, 23]. The development of airports and aircraft technologies induced high demand of airplanes activities. Even by improved the quality and the technology of the aircraft system, the level of noise emitted still cannot being controlled to the maximum range of human hearing. This aircraft noise is a noise impact that is generated during multiple stages of flight by any aircraft or its parts. The production of noise may trigger health issues due to this high level of noise.



As defined by the Oxford University Press (2020) noise is ‘a sound, especially one that is loud or unpleasant or that causes disturbance’. According to Cerletti et al. (2020), environmental noise is one of the factors detrimental to public health and guidelines have been developed by the World Health Organization (WHO) to address this issue. Indeed, numerous studies have been carried out to investigate the effects of environmental noise on people’s health with varying results. Some of the common complaints as a result of environmental noise are sleep disturbance with frequent awakenings, difficulties to fall asleep, and sleepiness and fatigue during daytime [7]. Sleep deprivation in turn, impairs the ability to think, understand, concentrate, and make decisions in both schools going children and working adults. Acute exposure to environmental noise can also lead to higher stress levels, annoyance, irritability, as well as speech intelligibility. Prolonged exposure to high levels of noise can also lead to more serious health problems such as tinnitus (sensation of sound even without external sound), hearing loss, hypertension (high blood pressure), ischemic heart disease (condition in which the heart does not receive sufficient blood and oxygen because the arteries are narrowed) as well as psychological health problems (emotional instability, anxiety, and nervousness) [5, 22].

Aircraft noise is no exception, especially to residents living within proximity of an airport and those working in an airport or aircraft hangar. This has been proven in independent studies performed at different parts of the world. Araghi and Yagobhi (2015) investigated the effects of aircraft noise on the physical and mental health of residents living nearby Birjand airport by questionnaire survey. Four domains were assessed: sleep disorders, nervousness, stress and mental illness, and speech intelligibility. The results showed that for residents in Zone 2 (Mehrshahr and Doulat Street, located farther from the airport) suffered from sleep disorders, but they did not suffer nervousness, stress and mental illness, and speech intelligibility. They suggested that both office and residential buildings should be sound insulated to minimize the impact of aircraft noise. In addition, the number of aircraft departures and arrivals should be limited from 10.00 p.m. to 8.00 a.m.

Besides, in Malaysia a study about the community noise at commercial business area was conducted in vicinity of Penang International Airport. Through this assessment, they would like to observe the noise pollution that occur and from this information, it can give idea or guidance for future building or area development for a more viable city in the terms of noise pollution [15].

Bartels, Rooney, and Müller (2018) investigated the effects of aircraft noise on annoyance of 1262 residents living nearby Cologne/Bonn Airport, Germany (which is particularly busy during night time) through telephone survey. The results revealed that the majority of the residents surveyed had high aircraft noise-induced annoyance. Likewise, Gasco, Asensio, and de Arcas (2017) highlighted that aircraft noise-induced annoyance is still high even though efforts have been made by the aviation industry to reduce noise emissions by producing quieter aircraft. Fujiwara, Lawton, and MacKerron (2017) quantified the relationship between aviation (airport location, aircraft noise, and airport activities) and the well-being of the people in and around airports in the United Kingdom. Those in areas with excessive aircraft noise levels had lower happiness and relaxation levels. Nassur et al. (2019), in their study involving 92 residents within vicinity of Paris Charles de Gaulle Airport and Toulouse-Blagnac Airport, France, found that exposure to the maximum sound pressure level during aircraft overflight increased the heart rate of the residents during sleep. Tezel et al. (2019) analysed the noise levels for the residents within proximity of two largest airports in Turkey (Izmir Adnan Menderes Airport and Ankara Esenboga Airport). The noise levels were assessed according to the European Noise Directive as well as annoyance and sleep disturbance indices. Those with acute exposure to excessive noise levels experienced an increase in blood pressure and heart rate, all of which can induce hearing impairment, hypertension, ischemic heart disease, annoyance, and sleep

disturbance.

Ibhadode et al. (2018) assessed the aircraft noise exposure levels of people living/working within proximity of four airports in Nigeria (Ibadan, Benin-City, Warri, and Owerri). Four parameters were evaluated: (1) ambient noise level (ANL), (2) sound pressure level (SPL), (3) aircraft take-off noise level (ATNL), and (4) aircraft landing noise level (ALNL). They performed 120 periodic noise sampling surveys from January to December 2017 at 30 randomly-selected study locations according to the ISO 3891, ISO 1996-1, and ISO 1996-2 standards. The results showed that the SPL, ANL, ATNL, and ALNL were within a range of 103–115 dB(A), 52.3–64.1 dB(A), 69.6–87.7 dB(A), and 66.2–82.7 dB(A), respectively. The values exceeded the maximum noise levels recommended by the WHO: (1) 35 dB(A) (indoor), (2) 55 dB(A) (outdoor), and (3) 90 dB(A) (permissible noise limit for 8-h of exposure). The results revealed that the effects of aircraft noise were most pronounced at the neighborhood of Ibadan Airport, followed by Benin Airport, Owerri Airport, and least of all, Warri Airport. Those living within proximity of Ibadan Airport were at high risk of suffering from headaches, sleep disturbance, noise annoyance, and speech intelligibility in the long term.

A few studies have also been carried out in Malaysia. Ismail et al. (2010) investigated the effects of aircraft noise on the residents living nearby a Malaysian airport, where the noise levels were measured less than 3 km from the airport. The noise levels were measured for 24 h over a 30-day period to determine the following parameters: L_{eq} (equivalent noise level, defined as the noise level with the same energy as the original fluctuating noise for the same period), L_{10} (dominant noise level, defined as the noise level that exceeds 10% of the time during the whole measurement period), L_{90} (background noise level, defined as the noise level that exceeds 90% of the time during the whole measurement period), and L_{max} (maximum sound level). The overall noise level exceeded the Federal Aviation Administration day-night average sound level requirement of 65 dB(A). Most of the peaks in the L_{eq} and L_{10} occurred from 12.00 p.m. to 5.00 p.m., consistent with an aircraft event (aircraft overflight). The results revealed that the aircraft events mostly contributed to the spike in noise levels of more than 65 dB(A), which will likely interfere with communication outside of the building, and lead to fatigue and vocal strain in the long term. However, the airport was not specified.

Abdul Aziz et al. (2017) investigated the noise levels inside a Lockheed C130-H Hercules aircraft hangar of the Royal Malaysian Air Force and the hearing status of the aircraft maintenance crew (63 members) in the No. 20 Squadron, Subang Air Base. They found that the highest noise levels at the center of the hangar were 92.2 and 94.2 dB(A) for daytime and night time, respectively, when all four turboprop engines were started (engines operated at 69.0–75.5% rpm). The noise levels were slightly higher during engine ground run (engines operated at 100.0% rpm), with a value of 95.3 and 97.3 dB(A) for daytime and night time, respectively. Moreover, 41.2% of the maintenance crew suffered from hearing impairment resulting from prolonged exposure to such high noise levels. Even more alarming, because of insufficient resources, only 8.57% of the maintenance crew were supplied with ear defenders. Lack of education regarding occupational noise hazard, arbitrary use of ear defenders, and reluctance to own a personal ear defender despite lack of resources were identified to be factors that led to the hearing impairment.

Recently, the authors [4] evaluated the effects of aircraft noise on 10 workers (comprising ground handling staff, aviation security officers, and general workers) working at the landing area of Sultan Ahmad Shah Airport, Kuantan, Malaysia. Questionnaire survey and noise level measurements were both conducted. The noise levels were measured over a 3-day period around the Boeing 737-800 aircraft with two turbofan engines. The results revealed that the workers were exposed to high levels of noise, which exceeded the permissible exposure limit (100 dB(A) for 2 h of exposure) stipulated by

the Occupational Safety and Health Act. Three workers suffer from hearing problems, and one already received compensation from the Social Security Organization (SOCSO), Malaysia, for hearing loss (ruptured eardrum) due to noise exposure. This indicates that prolonged exposure to high levels of noise can lead to hearing loss.



Figure 1. Sultan Ismail Petra Airport, Kota Bharu, Kelantan.

All of the aforementioned studies indicate the harmful effects of environmental noise, particularly aircraft noise. In Malaysia, there is a lack of awareness concerning the effects of aircraft noise on the physical and mental health of the workers working in an airport or aircraft hangar, as indicated by the authors' previous study [4] and the work of Abdul Aziz et al. (2017), which is a cause for concern. Only one study [16] has been carried out on how aircraft noise affects residents living within proximity of a Malaysian airport, but even then, it cannot be ascertained which airport was the focus of their investigation. With this in mind, this study was conducted to investigate the effects of aircraft noise on the residents living nearby a Malaysian airport, where Sultan Ismail Petra Airport (SIPA), located in Kota Bharu, Kelantan (east coast of Peninsular Malaysia), was chosen as the study location. Kota Bharu is the capital city of the Kelantan state, with an estimated total population of 1.89 million people in 2019 [9]. According to newspaper articles [2, 16], the SIPA would be extended and upgraded to an international airport to accommodate 4 million passengers annually from its current capacity of 1.5 million passengers annually. The expansion and upgradation project are expected to begin in 2020 and complete in 2023. The SIPA served 2.06 million passengers in 2015, which exceeded its current capacity [2], indicating an increasing demand for flight travel. Hence, it can be reasonably assumed that the residents nearby the SIPA will be exposed more frequently to aircraft noise, which will affect their daily routine. For this reason, SIPA was chosen as the study location. This study will shed some light on how aircraft noise affects these residents and from here, some precautionary measures can be proposed for the stakeholders (government policymakers, airport operator, airport construction firms, and residents) to mitigate the effects of aircraft noise.

2. Methodology

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

2.1 Phase 1

Literature survey was first carried out by searching for journal articles, conference papers, Internet articles, newspaper articles, and scholarly books pertaining to aircraft noise published from 2010 to 2020. The literature survey was focused on environmental noise, the types of environmental noise, the effects of environmental noise on public health, aircraft noise, the effects of aircraft noise on residents living nearby airports, and the effects of aircraft noise in Malaysia. The articles were selected based on the criteria for formal meta-analysis [23]: the type of subjects/participants/respondents, the type of exposure, the parameters used to measure the response, and findings. The literature survey was conducted to lay the foundation to investigate the effects of aircraft noise on the residents living nearby the SIPA, Malaysia.

A questionnaire survey was carried out to elicit information on the effects of aircraft noise exposure on the residents living nearby the SIPA. The questionnaire was designed in English and Malay based on the 'Noise Exposure History Interview Questions' [17]. Observations were carried out at residential areas nearby the SIPA, and there were a school, mosque, houses, and stalls. The questionnaire included questions such as how often the participants were exposed to high noise levels and their daily activities that may produce noise, which will negatively affect themselves. The questionnaires were distributed to 60 participants ($n = 60$) at different locations within proximity of the airport. Informed consent was obtained from each participant before the questionnaire survey.

Figure 2 shows the photograph of a participant answering the questionnaire. All of the participants cooperated willingly in the interview and gave their best effort. Most of the villagers or permanent residents living nearby the airport were aware of the aircraft noise, but they were accustomed to the noise in their daily routine. The results of the questionnaire survey were analyzed.



Figure 2. Photograph of a participant during the questionnaire survey and interview session

2.2 Phase 2

Phase 2 was conducted after the results from Phase 1 revealed that aircraft noise had a significant impact on the residents living nearby the SIPA. The noise levels were measured using RS PRO sound level meter (Model: RS-95, RS Components, China) with a resolution of 0.1 dB(A) and accuracy of ± 0.5 dB(A). Phase 2 was conducted over a 2-week period to ensure consistency in the data. The locations selected for noise level measurements were within the range of human hearing.

The noise level measurements were conducted at seven locations (P1–P7), comprising villages, residential areas, a university, and a school, as shown in Figure 3. Each location represents a different distance from the noise source in the airport (i.e. point of aircraft take-off and landing, designated as

CP) to determine the noise levels exposed to those within proximity of the airport. The noise levels were recorded during aircraft take-off and landing. The coordinates of Locations P1–P7 are presented in Table 1.

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

Point	Description	Coordinates	Measured distance from the airport (km)
P1	Kampung Kemumin (village)	6°10'03.4"N, 102°18'41.5"E	2.20
P2	Kampung Pengkalan Chepa (village)	6°10'12.7"N, 102°16'42.1"E	1.64
P3	Kota Bharu (village)	6°10'04.5"N, 102°16'36.2"E	1.82
P4	Kota Bharu (village)	6°09'58.8"N, 102°16'28.7"E	2.20
P5	Taman Kurnia Jaya (residential area)	6°09'41.0"N, 102°18'24.0"E	2.52
P6	Universiti Malaysia Kelantan, Taman Bendahara (university)	6°09'54.2"N, 102°17'01.0"E	0.95
P7	Sekolah Kebangsaan Parang Putting (school)	6°10'04.3"N, 102°18'14.8"E	1.67



Figure 3. Locations selected for noise level measurements at Pengkalan Chepa, Kelantan (Source: Google Maps)

The distance of each location from the airport was measured to assess the differences in the noise level readings. The data also included other on-site environmental factors such as land transport noise; car, lorries, motorcycle, human talking, climate change, construction and others related nature noise. The sound level meter was also placed in different set-ups in relation to the individuals exposed to the noise such as at the school assembly hall (in which student activities were conducted) and residential areas where aircraft noise exposure was prevalent. The methodology adopted in this study is summarized in a flow chart, as shown in Figure 4.

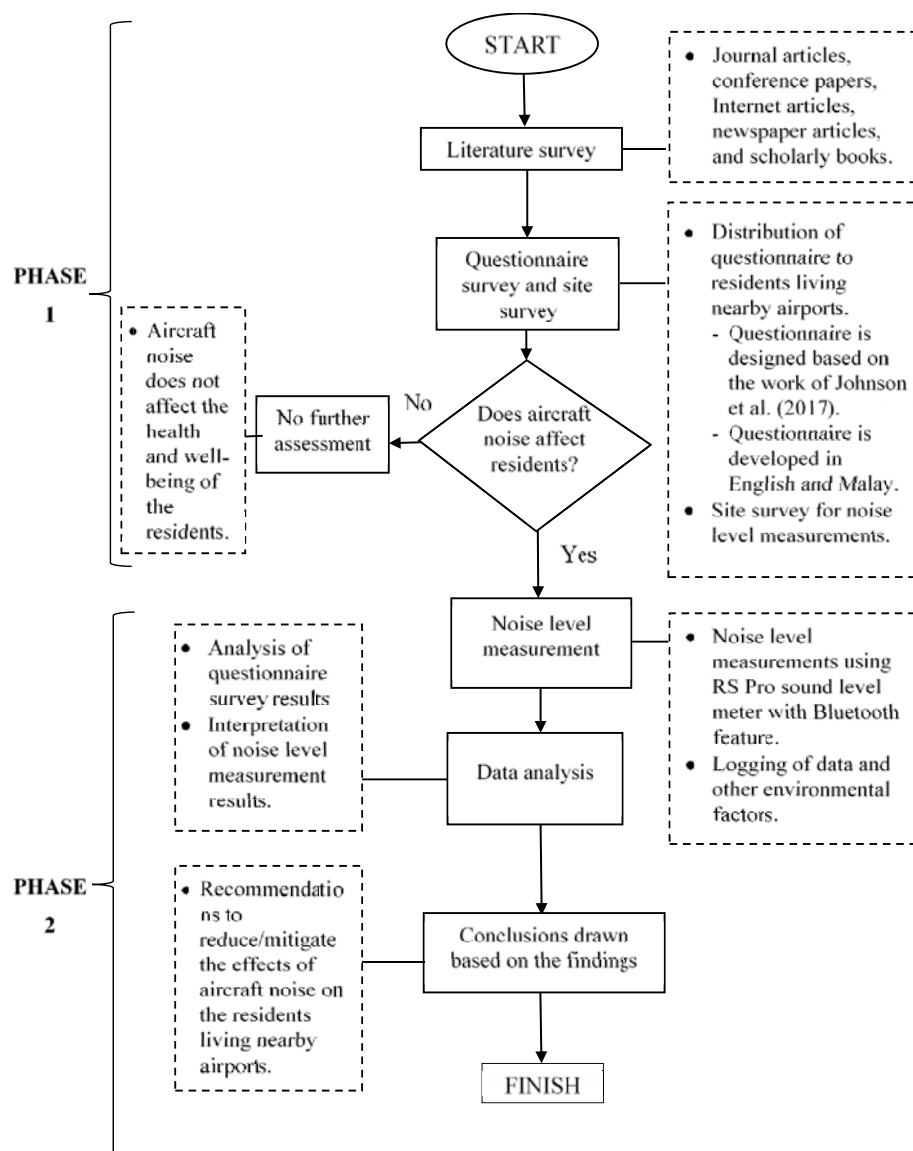


Figure 4. Flow chart of the methodology adopted in this study.

3. Results

3.1 Questionnaire result

Based on the literature survey, it is evident that prolonged exposure to high levels of noise has adverse effects on an individual's physical and mental health, where the most notable effect is the individual's hearing. To obtain the residents' opinions regarding aircraft noise exposure nearby SIPA, a questionnaire survey was carried out with 60 participants ($n = 60$) during the study. From these participants, 28 (46.67%) agreed that aircraft noise exposure causes disturbance to their hearing. The sampling size is deemed sufficient for this study, and nearly 50% of the participants agreed that aircraft noise affected them. The participants were chosen randomly. This number of responses amicable to say that people still concern about the aircraft noise exposure.

Besides, based on the results, some participants were not concerned regarding the aircraft noise because they were accustomed to the noise. Interviews were also conducted with the students at Universiti Malaysia Kelantan, which is located less than 1 km away from the airport, and the results revealed that the students were disturbed by the aircraft noise. The high noise levels emitted by the aircraft may adversely affect the students' psychological health in the long term.

During the questionnaire survey, three (3) teachers from Sekolah Kebangsaan Parang Puting agreed that the aircraft noise causes disturbance to the students. The disturbance usually occurs during the aircraft arrival and departure. The high noise levels emitted by the aircraft cause disturbance to both the students and teachers, and interfere with the teaching and learning process at school. The high noise levels also disrupt the students' concentration and are a source of distraction during classes.

Based on the questionnaire survey, the high noise levels do not only cause disturbance to hearing, but may also lead to other health problems such as annoyance, increased stress levels, sleep disturbance with awakening, and other physical/psychological health problems. These health problems will affect the individuals' quality of life.

3.2 Noise level measurements

The noise levels were recorded at the selected locations (P1–P7) during aircraft take-off and landing over a 2-week period. According to Mr Hasdy Yufaaais, Head of Engineering of Malaysia Airports Holdings Berhad, an average of 29 flight activities were recorded daily. Based on the 2018 airport statistics [19], 24,481 aircraft operations were recorded at the SIPA throughout the year. The number of aircraft operations vary depending on consumer demands and the number of flights, which typically spikes during festive or holiday seasons.

Table 2 shows the noise levels recorded from each location. The data were analyzed based on the minimum, maximum, and average values of noise for each aircraft operation. The noise level measurements at each location were repeated six times to obtain the daily average noise level for each location. The measurements were repeated to ensure that the data were consistent. It shall be noted that the measured noise levels included environmental noise present in the absence of aircraft take-off and landing.

The results are presented in Table 2 with different aircraft landing points. The results were categorized based on the number of noise readings, minimum noise reading, maximum noise reading, average noise reading, distance of the location from the noise source, and daily average noise level.

The last two columns represent the difference between the maximum noise reading recorded and the WHO recommended maximum outdoor noise level (WHO RONL) [55 dB(A)] as well as the corresponding percentage difference.

Based on the percentage difference between the maximum noise reading recorded and the WHO RONL, the percentage increase in noise level was more than 50% for 7 out of 42 measurements. For these measurements, the maximum noise level was within a range of 80–100 dB(A), which is classified as hazardous noise level, and may lead to serious hearing impairment for prolonged exposures. The measured noise level was also influenced by the distance between the location and noise source. For locations with a distance of less than 2 km from the aircraft runway (e.g. P2 and P3), higher noise levels were recorded. Likewise, for locations with a distance of a more than 2 km from the aircraft runway, lower noise levels were recorded, but they still cause disturbance to the residents. The daily average noise level was within a range of 50–65 dB(A).

Table 2. Data obtained from the on-site noise level measurements.

Time (Location)	Noise level readings [dB(A)]			Distance between the location and noise source		Daily average noise level [dB(A)]	Difference between the maximum noise reading and the WHO RONL ^a [dB(A)]	Percentage difference between the maximum noise reading and the WHO RONL ^a [%]
	No.	Min	Max	Average	< 1.5 km from runway			
Day 1 (P1)	1	46.1	69.3	54.4883	√		14.3	26.00
	2	46.0	82.5	59.4150	(2.20 km)		27.5	50.00
	3	45.4	71.2	52.5233			16.2	29.45
Day 2 (P1)	1	43.4	82.2	56.9333	√		27.2	49.45
	2	46.5	72.4	56.3917	(2.20 km)		19.5	35.45
	3	52.4	74.5	59.0717			17.4	31.64
Day 3 (P2)	1	50.5	84.9	57.0650	√		29.9	54.36
	2	51.9	80.4	60.0167	(1.64 km)		31.3	59.91
	3	46.1	86.3	57.1867			25.4	46.18
Day 4 (P2)	1	47.3	80.0	55.3517	√		25.0	45.45
	2	46.8	70.8	58.9717	(1.64 km)		15.8	28.73
	3	45.2	85.6	54.8717			30.6	55.64
Day 5 (P3)	1	45.0	85.8	56.9683	√		30.8	56.00
	2	43.7	85.3	55.9100	(1.82 km)		30.3	55.09
	3	44.8	85.2	55.3650			30.2	54.91
Day 6 (P3)	1	53.3	80.0	65.4567	√		25.0	45.45
	2	53.2	74.2	59.2600			19.2	34.91

3	45.4	79.7	63.2350	(1.82 km)	24.7	44.91
Day 7 (P4)	1	46.3	71.6	54.7883	√	30.18
	2	45.8	69.3	56.9217	(2.00 km)	26.00
	3	42.3	62.0	51.5500	(2.00 km)	12.73
Day 8 (P4)	1	44.3	76.2	58.3500	√	38.55
	2	44.0	73.9	54.8800	(2.00 km)	34.36
	3	44.9	74.9	55.5483	(2.00 km)	36.18
Day 9 (P5)	1	46.0	72.1	56.6450	√	31.09
	2	45.2	81.1	57.6983	(2.52 km)	47.45
	3	44.7	71.2	51.4383	(2.52 km)	29.45
Day 10 (P5)	1	43.8	70.8	52.7350	√	28.73
	2	43.4	75.0	47.7033	(2.52 km)	36.36
	3	44.6	74.0	55.0983	(2.52 km)	34.55
Day 11 (P6)	1	51.9	73.8	56.6700	√	34.18
	2	52.5	77.4	57.6250	(0.95 km)	40.73
	3	53.3	75.7	59.4217	(0.95 km)	37.64
Day 12 (P6)	1	53.6	80.0	61.3783	√	45.45
	2	53.6	68.2	57.2450	(0.95 km)	24.00
	3	53.0	67.3	59.5200	(0.95 km)	22.36
Day 13 (P7)	1	57.2	78.4	64.8100	√	42.54
	2	58.7	74.6	67.1117	(1.67 km)	35.64
	3	57.4	70.2	63.5483	(1.67 km)	27.64
Day 14 (P7)	1	53.9	76.4	60.8183	√	38.91
	2	53.6	74.4	59.6483	(1.67 km)	35.27
	3	53.3	75.6	59.9867	(1.67 km)	37.45

^a WHO RONL: Recommended maximum outdoor noise level by WHO

In general, most of the measured minimum noise levels did not exceed the WHO RONL [55 dB(A)], where the values were within a range of 42–54 dB(A). The lowest and highest minimum noise levels recorded were 42.3 and 58.7 dB(A), respectively. Figure 5 shows the minimum noise levels recorded in this study. The WHO RONL [55 dB(A)] is also included for comparison, as indicated by the red line. The WHO RONL represents the recommended outdoor noise level and it can be seen that most of the minimum noise levels did not exceed this limit. However, three minimum noise levels exceeded the WHO RONL, all of which were recorded at Sekolah Kebangsaan Parang Puting. This is indeed expected because the school is located next to the airport runway, with a distance of 1.67 km away from the point of aircraft take-off and landing.

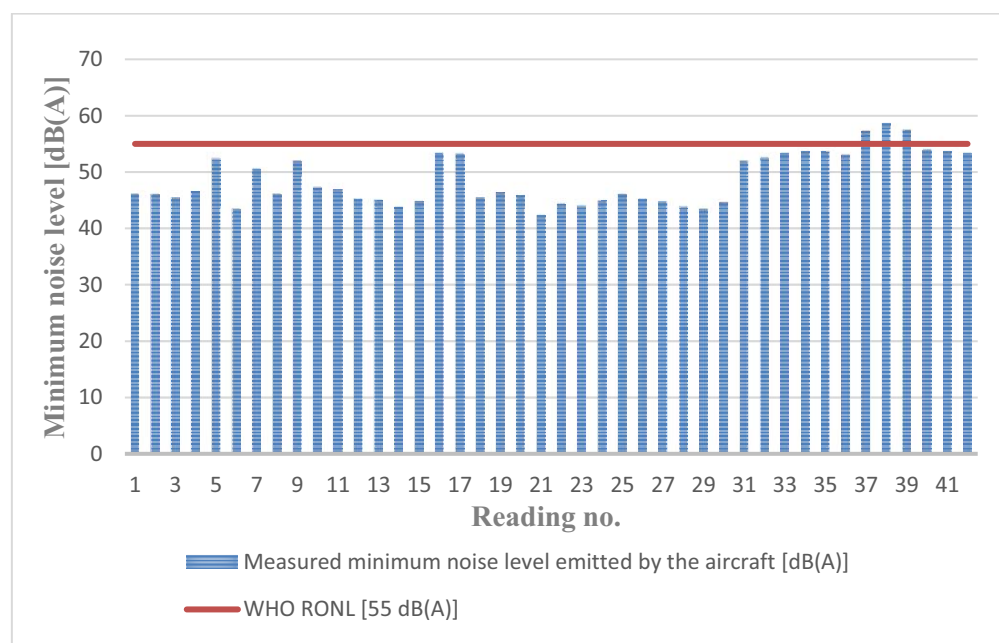


Figure 5. Comparison between the minimum noise levels emitted by the aircraft (measured at P1–P7) and the WHO RONL [55 dB(A)].

During the measurements, the maximum noise levels were recorded when the aircraft approached the sound level meter, which was the nearest point of noise level exposed to human hearing. Such high noise levels occur frequently daily, which leads to annoyance and disturbance to human hearing. In addition, such high noise levels are detrimental for individuals with sensitive hearing such as newborn babies, students, and the elderly. This will affect their mental health.

Figure 6 shows the maximum noise levels emitted by the aircraft measured over a 2-week period. It is evident that all of the maximum noise levels exceeded the WHO RONL [55 dB(A)]. Overall, the maximum noise levels were within a range of 60–90 dB(A). The maximum noise level was highest at P2, with a value of 86.3 dB(A). The measured maximum noise levels vary depending on the type of aircraft taking off and landing at the airport. The lowest maximum noise level was recorded at P4, with a value of 62 dB(A).

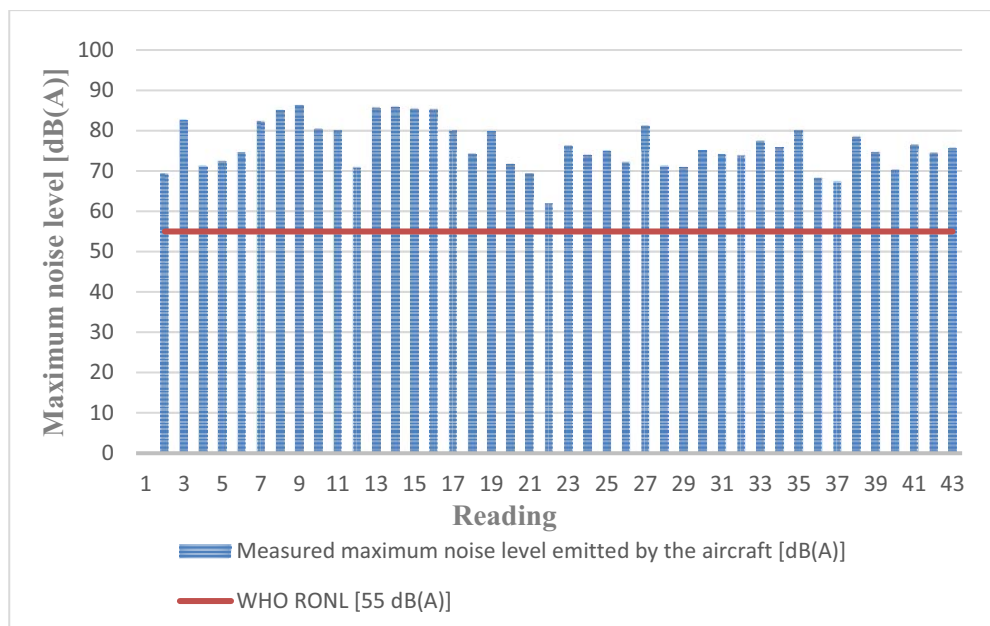


Figure 6. Comparison between the maximum noise levels emitted by the aircraft (measured at P1–P7) and the WHO RONL [55 dB(A)].

Figure 7 shows the comparison between the maximum noise levels emitted by the aircraft measured at P1–P7 and the WHO SRL [90 dB(A)], which is the permissible limit for 8-h of daily noise exposure. In general, the results were positive since the maximum noise levels did not exceed the WHO SRL. Despite this, safety precaution measures are needed to reduce the effects of aircraft noise exposure on those living within vicinity of the airport. However, some individuals seemed to be negligent regarding aircraft noise exposure, which is a concern since this will adversely affect their health and well-being in the long term.

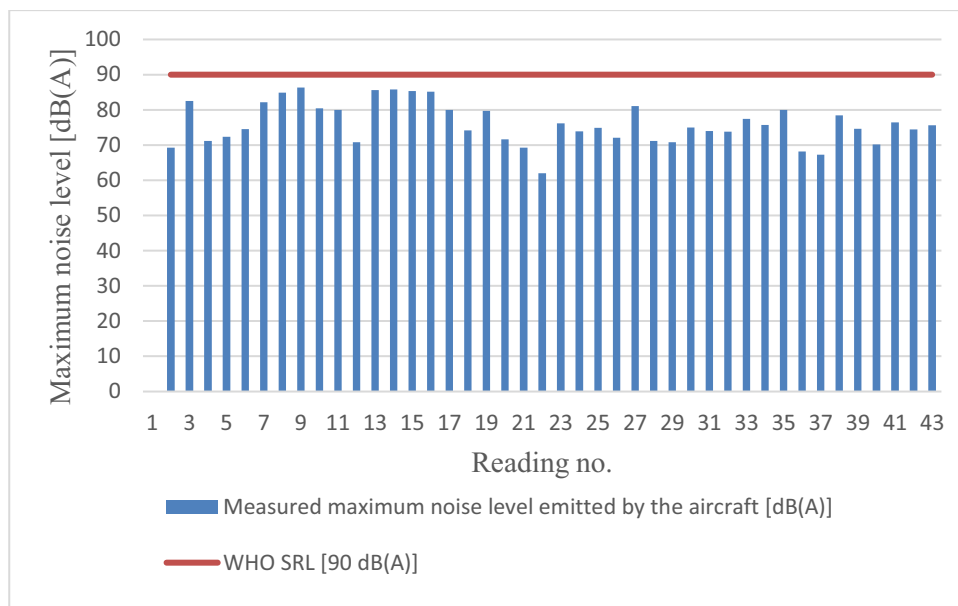


Figure 7. Comparison between the maximum noise levels emitted by the aircraft (measured at P1–P7) and the WHO SRL [90 dB(A)].

Conclusion

The effects of aircraft noise exposure on the residents living nearby Sultan Ismail Petra Airport, Kelantan, Malaysia, have been investigated in this study by questionnaire survey with 60 participants and on-site noise level measurements. Based on the results, it can be concluded that aircraft noise exposure causes disturbance and annoyance to the residents nearby the Sultan Ismail Petra Airport. About 46.67% participants agreed that aircraft noise exposure is a source of disturbance in their daily life. Based on the on-site noise level measurements, the lowest and highest noise levels recorded were 42.3 and 86.3 dB(A), respectively. The daily average noise level was within a range of 50–65 dB(A). The results showed that the measured noise levels exceeded the WHO recommended maximum indoor noise level [35 dB(A)] and recommended outdoor noise level [55 dB(A)]. However, the total noise levels did not exceed 90 dB(A), which is the permissible noise limit for daily 8-h exposure of noise. Based on the results, it is recommended that individuals should be more aware regarding aircraft noise exposure and reduce their time on outdoor activities especially during aircraft take-off and landing. Some of the actions that can be taken are improving the architectural designs and building orientation in relation to the local wind direction. In addition, most developed countries should consider adopting an aero polis concept instead of merely building airports. Finally, the use of anechoic and soundproof wedges as wall-claddings or soundproof material are also recommended.

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