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A PRELIMINARY STUDY OF ENVIRONMENTAL NOISE IN PUBLIC UNIVERSITY

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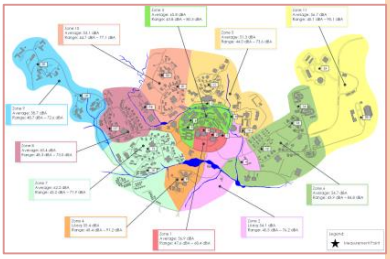
Graphical abstract



Abstract

Environmental noise problems have increased every year and have brought negative effects to the neighbouring communities. Educational areas, such as university, college and school, are the places for learning and gaining knowledge. However, students feel stressed and annoyed when they are exposed to noisy environments. The main objective of this research is to investigate the current environmental noise problem in Universiti Teknologi Malaysia (UTM). It is a preliminary study of environmental noise problem and a total of 24 measurement locations were selected based on the working zones in UTM. Each location was measured in an hour during the working period. About 95.8 percent of the measurement results exceeded the permissible limit of the guideline by the Department of Environment (DOE). Besides, the UTM noise zones have been established by referring to the measurement results. The findings of this study could assist the UTM management in deciding the noise abatement strategy. Also, the noise zones could be disseminated to the public in order to increase the public awareness towards the environmental noise problems in UTM.

Keywords: Environmental noise, noise pollution, noise zones, noise source, university

1.0 INTRODUCTION

Noise pollution has become a global burden that has caused many environmental issues to human and wildlife [1-2]. Environmental noise normally includes noises from traffic, construction, industry, business and entertainment activities. Exposure to excessive noise could bring harmful effects to the human auditory system, which has caused noise-induced hearing loss (NIHL) in [3-4]. The NIHL is incurable as no treatment or medicine can regrow the damaged hair cells on the cochlea in the inner ears. Similarly, it could cause tinnitus to a person who is excessive exposed to noise. The symptom of tinnitus is continuous ringing in the ears. It could also induce an emotional distress to sufferers, including anxiety and mental distress [5]. Previous studies have discussed the effects of noise to humans, where the noise could disrupt human health and activities in daily living, such as sleep disturbance, stress, annoyance, deficits in cognitive abilities, reducing performance, physical health problems and speech interruption [6-9]. Other studies revealed that young adults would elevate their ambulatory blood pressure if they are exposed to high levels of environmental noise; especially in young females who are more susceptible

to environmental noise exposure than young males [10-11].

Noise pollution could bring adverse effects to the wildlife. A review on the impacts of environmental noise to the wildlife had been carried out by Kight and Swaddle [12]. This article established a conceptual framework for this issue, where environmental noise could affect the neighbouring animals through their biological, behavioural, ecological, genetic and cellular processes. Noise pollution has influenced animal communication and behaviour, especially to the aquatic, avian and mammal communities [13-15]. For example, the avian communities are the most common wildlife that can be seen in urban areas. Many comprehensive evidences have shown that environmental noise greatly disturbed their communication system, which could directly affect breeding process, nesting locations, nestling begging calls and behaviour [16-19]. Thus, it is significant to study environmental noise, including the impacts of noise to the adjacent environment and communities.

Zannin found that about 93.3 percent measurement points for the environmental noises exceeded the permissible limit of urban areas (65 dBA) and 40.3 percent of total measurement points were measured with extremely high values [20]. By looking at environmental noise problems in university, a study conducted noise measurement at two campuses in India. It was found that the noise levels at two campuses exceeded the permissible limits and disturbed the surrounding communities [21]. Jaff and Hossieni found that most of the studied areas in university were above 70 dBA, which could seriously affect the concentration of students [22]. A case study from a university in Brazil showed that approximately 90 percent of the measurement points were over the permissible limits of educational areas (55 dBA) recommended by the World Health Organization [23]. Another investigation concluded that the noisiest area in university is the business centers with an average noise level of 87 dBA [24].

In order to cope with environmental noise problems, Oyedepo proposed some recommendations of noise mitigation planning, including the technical, planning, behavioural and educational solutions [25]. It could minimize environmental noise pollution through the control of noise source, noise transmission path and the receiver of noise [26]. Advanced traffic system could also reduce the noise level, such as transforming the road profiles, using porous material for road, restricting the traffic, as well as constructing the noise barrier. A study proved that the reduction of fifty percent on traffic flow could reduce about 3 dBA of the environmental noise level [27]. The dissemination of noise information to the public could also increase the noise awareness by knowing the adverse effects to their health and daily life. Therefore, environmental noise should be always monitored and controlled, especially in schools, colleges and universities so that the students will not be disturbed by the environmental noise and hence save them from noise problems.

This article discusses a preliminary study of environmental noise in a public university. Universiti Teknologi Malaysia (UTM) was selected in this study. The main objective of study is to determine the environmental noise levels at different working zones in UTM. This study can be used to identify the impacts of daily noise to the environment and the community in UTM. In addition, it develops the noise zones for UTM by using the results from the environmental noise measurement, where it could be used to increase public awareness and help the management to decide further environmental noise monitoring. Finally, the following sections reveal the study background, research methodology and the findings of study.

2.0 BACKGROUND OF UNIVERSITI TEKNOLOGI MALAYSIA

UTM was established in 1972. The main campus of UTM is located at the state of Johor in Southern Malaysia. It is categorized as a research university with 25,172 students in the year 2014. It is a well-known university in Malaysia and has trained many professional engineers every year. More than ten colleges are located in two areas, namely the inner ring and the outer ring, which could roughly accommodate 14,774 students in one academic session [28]. The inner ring includes faculties as well as management, administration, financial business areas and so forth. UTM also provides bus service for their students in the inner and outer rings. The bus service operates based on the schedule from UTM management.

The noises in UTM are emitted by vehicles, buses, daily maintenance, landscaping works, laboratory equipment, as well as the noises from heating, ventilation and air-conditioning (HVAC) system. Daily working areas for landscaping works, such as leaf blowing, drain clearing and grass cutting works, were divided based on the working zones from the UTM Office of Asset and Development (OAD). Table 1 shows the eleven working zones in the UTM campus. Each working zone encompasses different areas. UTM management appoints the contractors to handle the maintenance and landscaping works at each working zone, which means only one contractor will be in charge of one working zone. In fact, many efforts have been done by the UTM management to monitor environmental noise. Students' vehicles and leaf blowers are restricted to access only some roads in the working zone 1 and 3 during the working period. Most of these areas are faculties and the management strived to minimize the noises as to avoid the disruption of noise to the students and staffs.

Table 1 Working Zones in Universiti Teknologi Malaysia

Working Zone	Area
1	Business area, Office of Student Affairs Alumni (HEMA), library, halls and mosque.
2	Equine park and primary school.
3	Faculty of built environment (FAB), faculty of civil engineering (FKA), faculty of mechanical engineering (FKM), faculty of science, faculty of education and center for the information and communication technology (CICT).
4	School of graduate studies (SPS).
5	Faculty of electrical engineering (FKE) and Faculty of chemical engineering (FKK).
6	Kolej Tuanku Canselor (KTC), Kolej Perdana (KP), college 9 (K9) and college 10 (K10).
7	Kolej Tun Fatimah (KTF) and Kolej Rahman Putra (KRP).
8	Kolej Tun Razak (KTR) and Kolej Tun Hussein Onn (KTHO).
9	Kolej Datin Sri Endon (KDSE) and Kolej Dato' Onn Jaafar (KDOJ).
10	Kolej Tun Dr. Ismail (KTDI) and college 11 (K11).
11	UTM stadium and cluster area.

3.0 RESEARCH METHODOLOGY

3.1 Framework of Study

A new framework of study has been established in order to achieve the objectives of the study on the environmental noise in UTM. Initially, it is important to identify the current environmental noise problem and study the daily working process in UTM. The noise problem is generally contributed by the maintenance and landscaping works, as well as the daily traffic noise in the campus. Indeed, the working zones, divided by the OAD, are the best reference for this study to make the decision on the measurement locations. The environmental noise measurement of this study will cover all working zones inside the UTM campus. At least one measurement point was carried out in each working zone. Still, the noise measurement was conducted in an hour during the working period in order to achieve the objectives of this study. During the measurement process, it is important to identify the main noise sources contributing the unwanted noise to the environment. The noise data was recorded and analysed in the next process. The noise data includes the equivalent continuous sound pressure level (LAeq), noise peak level (Lpeak), maximum and minimum noise levels (Lmax and Lmin), noise level exceeded for 10% of the time (L10), noise level exceeded for 50% of the time (L50) and noise level exceeded for 90% of the time (L90). The Department of Environment (DOE) guideline has stated that the permissible noise level should not exceed 50 dBA for the noise sensitive areas, low density residential, institutional and worship areas [29]. Thus, this value was used to compare to the measurement results to check whether the results are over or under the permissible limits. However, the results of this study were assumed as being continuous along the working day due to the short measurement period of this study. After analysing the noise data, the result was used to plot the noise zones on the map of the UTM campus. The noise zones reveal the equivalent continuous sound pressure levels and the range of noise levels for each working zone. It discusses the results and proposes further action for a noise mitigation plan. Lastly, it concludes the environmental noise circumstances in UTM campus.

3.2 Environmental Noise Measurement

In this sub-section, the noise measurement planning, method and equipment discuss in detail. Based on the UTM working zones, there are about eleven working zones inside the UTM campus. A total of twenty-four measurement locations have been decided to measure the environmental noise to denote the noise level in that particular zone. The decisions of measurement locations were based on the considerations of sensitive and residential areas. Besides, the measurement was taken using the sound level meter Pulsar Model 33 Type 1. This equipment conforms to the standard of International Electrotechnical Commission (IEC), including the IEC 61672-1-2003 [30]. Furthermore, device calibration has also been conducted during the start and finish of the measurement in order to ensure the measurement was carried out in the proper way. The measurement time for each location was one hour during the working day. The data of sound level meter was recorded in A-weighting frequency network and the height of sound level meter was 1.5 meter. The LAeq was the result after carried out one hour measurement at that particular selected point and it will be used to check with the permissible limit from DOE guideline.

4.0 ANALYSIS AND RESULT

After collecting the noise data from 24 selected measurement points, the results were analysed as shown in Table 2. The noise sources were observed during conducting the measurements. There are three main types of noise sources emitting high noise level to the environment, which are vehicles, grass cutter and leaf blower. The vehicles included the cars, buses, trucks and motorcycles. Three types of noise sources could be seen in nine working zones, except working zones 1 and 3. This is because leaf blowers are not allowed to operate in these areas. For working zone 1, three measurement points were carried out. The highest LAeq (62.3 dBA) was found at point 2. This point was located at the center of library, UTM main hall, praying and business areas. The noise was generally generated

by human daily activities, but less traffic flow. In working zone 3, there were about four measurement points. Point 5 recorded 73.3 dBA as the highest LAeq compared to other points. Figure 1 shows the noise chart for this point. The main noise source was the buses, which were fetching students to the center of UTM from all residential colleges. The residential colleges were bound in working zones 6 to 10. Point 15 in the working zone 7 was the highest LAeq (71.9 dBA) and point 12 in the working zone 6 was the lowest LAeq (49.1 dBA) among the measurement points in these five working zones. The noise chart of point 12 is shown in Figure 2. There is only one measurement point that is under the DOE permissible limit. In other words, about 95.8 percent of the measurement points were over the permissible limit.

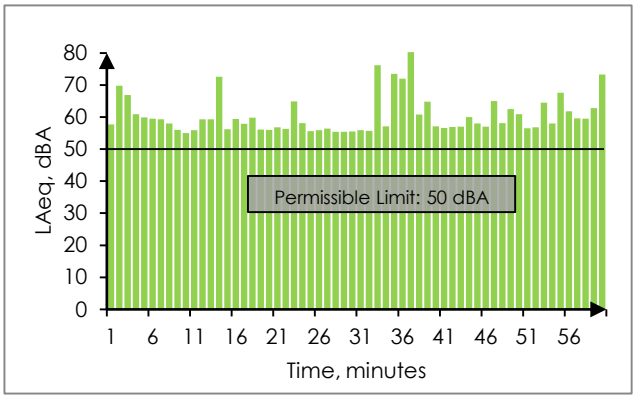


Figure 1 Equivalent Continuous Sound Pressure Level at Point 5 in the Working Zone 3

The environmental noise zones of UTM were plotted based on the measurement results as shown in Figure 3. The scale of the UTM map was one to five thousands millimeter and the buildings are filled with grey colours as an indication of its location. Eleven working zones are filled with different colours to show its boundary area. The legend of star symbol represents the location of the measurement point. The LAeq and the range of noise levels are labeled in the rectangular boxes with different colours in order to designate the noise circumstances in that particular working zone. Some working zones have few measurement points, thus the LAeq was obtained by averaging the noise levels. Also, the range of noise was referred to the highest and lowest levels of these few points.

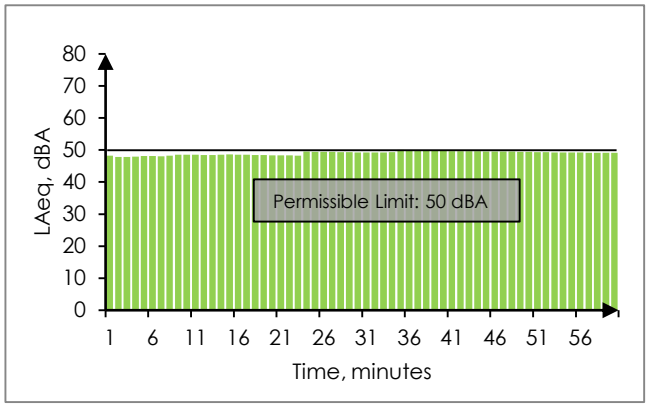


Figure 2 Equivalent Continuous Sound Pressure Level at Point 12 in the Working Zone 6

5.0 DISCUSSION

Based on the results, 95.8 percent of measurement points exceeded 50 dBA permissible limits. It is important to study the variation noise levels at the measurement points. Indeed, high environmental noise levels could bring adverse effects to the communities in UTM. Working zones 1 and 3 exceeded the permissible limits, where most of the faculties and offices were located. UTM staffs and students will be disturbed by the noise. A noisy environment could distract them from focusing on daily tasks and reduce their performance level [9]. It was found that the current monitoring strategy was ineffective in these two zones, even though some of the roads were restricted to be accessed only by students' vehicles. Effective mitigation plan, especially the restriction of staffs' vehicles and the number of shifts for buses to access these areas can be prepared. The environmental noise level could be reduced by controlling the volume of traffic [27].

A majority of measurement points in working zones from 6 to 10 also exceeded the permissible limit, where the residential colleges are located. The main noise sources were the leaf blower and the grass cutter. The workers need to use these machines every day with a daily working period of 8 hours. Noisy environments could affect the students' daily life in these areas. Students are unable to focus on their studies in a noisy environment. They will feel stressed and annoyed when continuously exposed to environmental noise [7, 31]. Thus, a new action plan is required to minimize the environmental noise in residential areas. The contractors are encouraged to use low-noise machines in their daily works. Definitely, the best solutions of noise abatement are well-organized operation and maintenance of the machineries, retrofit application and new design for low noise emission machineries [32]. Alternatively, the protection on affected areas could also erect the noise barriers and conduct more measurement in certain areas to study the noise sources; as a consequence, the noise mitigation plan can effectively reduce the environmental noise [9].

Besides, the environmental noise would bring negative impacts to the animals as discussed in the

previous section. In UTM, there are both domestic and non-domestic animals. Domestic animals include horses, deer, sheep, ducks and chickens. For wild animals, there are birds, monkeys, cats, fishes, wild boars, squirrels and monitor lizards. Those animals are sensitive to the daily environmental noise because their habitats are near to the noise sources. It is important to provide noise protection planning to the neighbouring animals in order to prevent the noise from interrupting their habitats and biophysical processes [33].

In this study, it was observed that many landscape workers did not wear hearing protective equipment, such as earmuffs and earplugs, during the working period. The leaf blower and grass cutter emitted high level of noise to the environment. Surely, the workers are evidently exposed to high risk of hearing loss as they were carrying the machines during the landscaping works. This is supported by the previous research, where the grass cutting workers had hearing impairment problems because they did not wear hearing protectors during work [34]. Therefore, the supervisors need to ensure that workers wear the hearing protectors regularly in all working zones. Lastly, the UTM noise zones have been established and the features of this map were discussed in previous section. The noise zones could be used to assist the UTM management in monitoring the current environmental noise problems. It could be used as information for making decisions on noise abatement strategies. Previous study revealed that the provision of noise zone could enhance the effectiveness of noise monitoring [35]. It could also increase the awareness of noise and the adoption of preventive action by disseminating information to the public, especially to the students.

Table 2 Results of Environmental Noise Measurement at 24 Selected Measurement Points

MP[a]	Z[b]	L_{Aeq}, dBA	L_{peak}, dBA	L_{max}, dBA	L_{min}, dBA	L_{10}, dBA	L_{50}, dBA	L_{90}, dBA	PL[c]	NS[d]
1	1	57.9	88.8	65.1	57.9	64.8	61.5	52.4	O[e]	V[g], GC[h]
2	1	62.3	80.3	63.5	51.7	62.5	58.4	54.2	O[e]	V[g], GC[h]
3	1	50.4	80.1	68.4	47.6	65.1	58.7	52.3	O[e]	V[g], GC[h]
4	2	54.1	99.3	76.2	45.5	59.0	50.8	47.1	O[e]	V[g], GC[h], B[i]
5	3	73.3	98.9	80.3	55.0	65.8	61.3	56.8	O[e]	V[g], GC[h]
6	3	60.4	80.7	69.3	53.8	64.9	56.6	51.4	O[e]	V[g], GC[h]
7	3	69.9	84.3	70.2	57.7	67.6	58.3	50.5	O[e]	V[g], GC[h]
8	3	55.5	98.2	79.6	43.8	60.7	51.8	46..4	O[e]	V[g], GC[h]
9	4	55.4	102.4	91.2	45.4	60.1	51.1	47.1	O[e]	V[g], GC[h], B[i]
10	5	50.9	90.3	72.4	46.3	54.1	48.9	47.4	O[e]	V[g], GC[h], B[i]
11	5	51.6	90.5	73.6	44.0	56.9	45.1	44.4	O[e]	V[g], GC[h], B[i]
12	6	49.1	111.1	84.8	45.5	49.3	47.3	46.4	U[f]	V[g], GC[h], B[i]
13	6	55.7	92.8	79.6	44.9	61.3	52.0	47.0	O[e]	V[g], GC[h], B[i]
14	6	59.3	98.2	79.6	43.9	57.2	46.8	45.8	O[e]	V[g], GC[h], B[i]
15	7	71.9	84.8	71.9	44.8	65.2	51.5	44.0	O[e]	V[g], GC[h], B[i]
16	7	52.5	81.8	70.1	43.2	58.1	47.9	43.0	O[e]	V[g], GC[h], B[i]
17	8	60.1	82.7	70.2	48.3	64.4	52.7	44.9	O[e]	V[g], GC[h], B[i]
18	8	60.7	85.7	73.0	52.2	66.3	54.6	44.8	O[e]	V[g], GC[h], B[i]
19	9	59.1	81.0	72.6	48.7	67.1	56.9	47.4	O[e]	V[g], GC[h], B[i]
20	9	58.2	84.8	58.9	56.3	58.0	57.6	52.4	O[e]	V[g], GC[h], B[i]
21	10	54.5	85.2	72.3	49.7	59.9	53.7	50.5	O[e]	V[g], GC[h], B[i]
22	10	51.7	92.6	77.1	44.7	56.7	47.4	45.4	O[e]	V[g], GC[h], B[i]
23	11	62.9	104.7	90.1	40.1	56.5	44.3	41.7	O[e]	V[g], GC[h], B[i]
24	11	50.5	93.7	78.3	40.2	45.4	42.6	41.4	O[e]	V[g], GC[h], B[i]

[a]Measurement point. [b]Zone. [c]Permissible limit. [d]Noise source. [e]Over permissible limit. [f]Under permissible limit. [g]Vehicle. [h]Grass cutter. [i]Leaf blower.

6.0 CONCLUSION

In conclusion, most of the measurement points exceeded the permissible limit. High environmental noise could influence the daily activities of the neighbouring communities. Preventive action is needed to be carried out in order to provide a sustainable environment with low noise. The noise zones are important to increase the public's awareness on noise. In addition, the followings are the recommendations for future noise monitoring in UTM campus:

1. Environmental noise measurement should be frequently conducted at the noisy areas, so it could update the latest information to the public.
2. Personal noise exposure measurement and audiometric test should be conducted on the workers for the investigation of occupational noise exposure problems in UTM.
3. Traffic noise measurement should be conducted at the entrances of UTM campus because heavy traffic flows during the working period.
4. Further study on the room acoustic at the lecture halls and classrooms in UTM in order to determine the impacts of environmental noise to the students during the lecturing period.

5. A survey should be conducted on the students in order to study the awareness and perception of students towards the noise in their university.

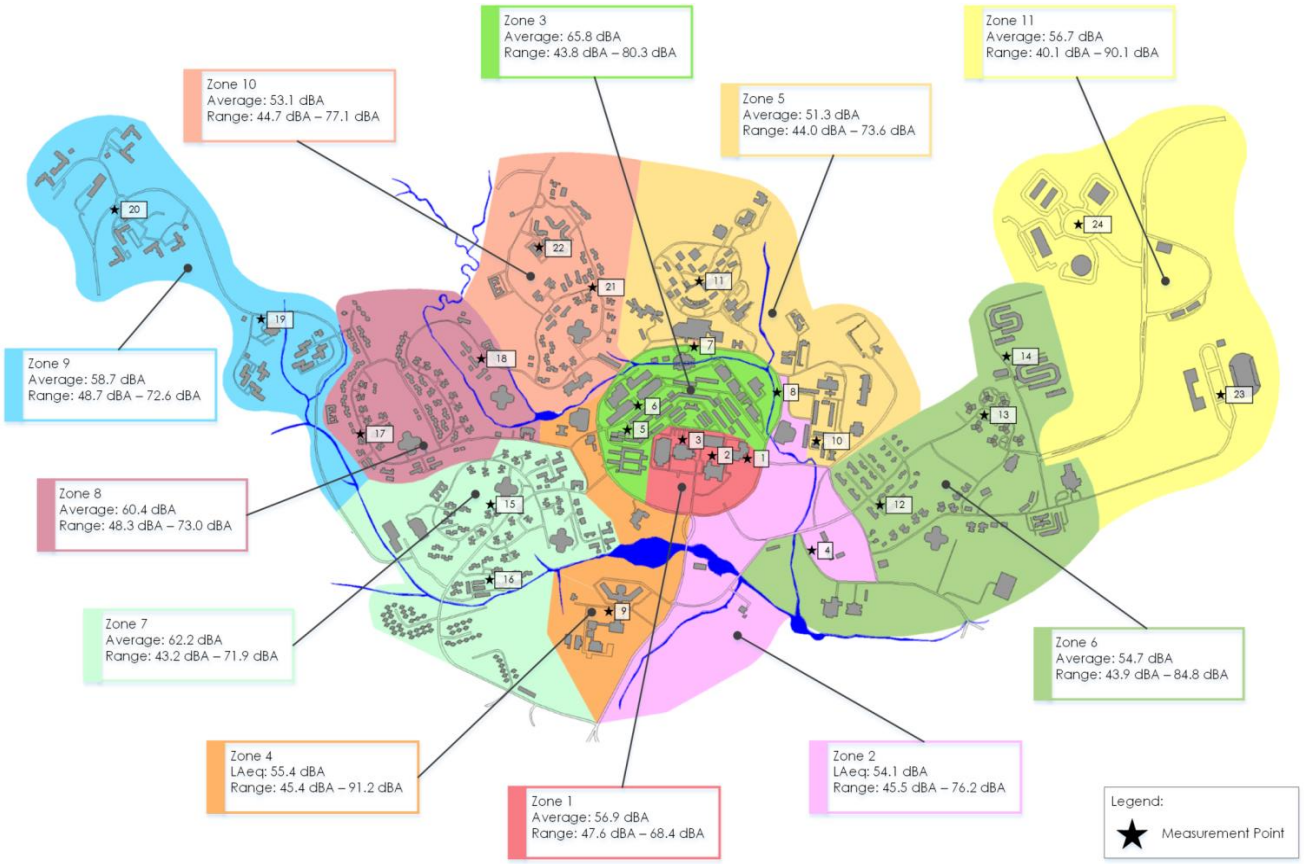


Figure 3 Noise Zones of Universiti Teknologi Malaysia

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