ORIGINAL ARTICLE

Effects of Environmental Noise Pollution Towards School Children

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ABSTRACT

Introduction: Noise, in particular, environmental noise is the undesirable sound produced by urbanization and industrialization process affecting human health such as hypertension, hearing loss, and sleep disturbances. We conducted a study analyzing noise pollution status and students' and teachers' perceptions of noise pollution at primary schools. **Methods:** The noise level is monitored during daytime (0700-2200 hours), simultaneously the questionnaires were distributed to students and teachers for subjective evaluation. **Results:** The evaluated equivalent noise level (LAeq) was 61.7 to 69.4 dBA on the school day and 62.2 to 62.3 dBA on the non-school day. For both school and non-school days, the Lmax is higher at schools located in the industrial area (77.0 dBA) rather than schools located in the residential area (74.5 dBA). Students agreed that the classroom was noisy (95%) and outside classroom noise that was heard by students is bell (43%), followed by traffic noise (26%). Additionally, the majority of teachers for both schools responded that road traffic (11.59%) is the source of outside school noise and most interference noise during the classes was produced by students (13.04%). **Conclusion:** Findings of this study are beneficial for policymakers and stakeholders in sense of noise pollution management at schools.

Keywords: Environmental noise, Perception, Noise pollution, School, Road traffic

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INTRODUCTION

A high level of unwanted sound is considered as noise (1). In Malaysia, noise is divided into two broad categories: environmental and occupational noise. Environmental noise is related to noise annoyance and community noise (2, 3), while occupational noise is related to noise-exposed from the working environment (4, 5). The responsible stakeholders for environmental and occupational noise are the Malaysian Department of Environment (DOE), Ministry of Water and Environment and Malaysian Department of Occupational Safety and Health (DOSH), Ministry of Human Resource, respectively. Environmental noise pollution is often being neglected as it cannot be seen and taste but has detrimental effects on human beings. Environmental noise pollution in Malaysia is faced where the receptors are located near the roadside, including the schools (6, 7). The low performance of students is closely related to the high noise level (8, 9). It is more worsen when the schools are located near the roadside (10-12). High noise level is proven in affecting human health (13), including child memory (14). The dissemination of knowledge in education sector such as school faced the interference of noise pollution. School children are in the stage of developing their hearing mechanisms, thus exposure to high noise will inhibit the concentration in the classroom. Pupils are distracted by high noise levels which reducing their attention in the classroom (15), and distraction during the learning process (16). 57% of pupils agreed that high noise levels obstructed the

learning process in the classroom (17). The problems of noise pollution at schools are varied at different land use; urban, industrial, and residential. The assessment of noise pollution is needed to investigate the status of noise and its effects on school children.

In Malaysia, several studies on noise pollution had been conducted. (18) notified the noise levels at Johor Bharu's school building is highest during the afternoon and lowest during the morning with 75.17 dBA and 48.23 dBA, respectively. In Terengganu, (7) clarified that noise during non-school day (64.7 - 68.4 dBA) was higher as compared to the school day (63.7- 66.4 dBA). They added that motor vehicle has a positive relationship with noise level (r = 0.392). Conversely, there is a negative relationship between noise and traffic (R^2 = 0.0162) as proven by (2). There might be other factors influence noise level. Apart from motor vehicles, the train is susceptibly contributing to the high noise level. According to (19), the train arrival increases noise to the maximum level of 90 - 100 dBA. In the residential vicinity, the noise level was found 70 – 75 dBA, and L_{Aeq} was 65.5 - 70.0 dBA. It was found that the daytime noise (68.20 - 72.11 dBA) is higher than nighttime noise (67.71 - 68.43 dBA) (3). This finding is supported by a study by (2), which found the L_{Aeq} at the residential area is 67.3 - 70.0 dBA and 70.0 - 74.5 dBA of the noise level in Johor (20). (21) and (22) found that 61% and 20 - 50% of the public felt noisy in a residential area, respectively. L_{Aeq} was found higher during the weekday (51.0 - 63.5 dBA) as compared to the weekend (53.1 - 66.4 dBA). In institutional area, cars (r = 0.708) contribute to higher noise, followed by motorcycle (r = 0.639) (23). Another study shows that the morning peak shows the highest noise level (60 – 71 dBA) both during weekday and weekend as compared to midnight (34 dBA) in Johor Bharu (24). The highest noise level during morning peak is further supported by (2) with 51.3 - 57.1 dBA in Batu Pahat, Johor.

In line with the Sustainable Development Goal (SDG-11) on sustainable cities and communities, there is a need for investigating the noise pollution in Malaysia, specifically in primary school as they are the future leader. They need a conducive and comfortable environment to learn, moreover, their internal organs are still in the developing process. The motivation and concentration during the learning process in school were also evaluated in this study. By that, we received the information on perception towards noise pollution. Policymakers and planners will benefit from this study as they can use the findings for future planning, especially for a suitable and sustainable sitting position of the intended constructed educational centers.

MATERIALS AND METHODS

Study areas and sampling campaign

The local plan of Kuala Terengganu and Kuala Nerus is used for the site selection and classification of land use (residential and industrial) (25). Two primary schools involved are Sekolah Kebangsaan Tok Jembal (SKTJ) (S1) and Sekolah Kebangsaan Gong Badak (SKGB) (S2) (Table I). Sound Level Meter (SLM) was used in the monitoring campaign for noise. The noise level was received by the microphone and displayed measurement values in decibels on SLM. SLM was placed on a tripod stand at 1.5 m from the ground (26). Measurement of wind speed is important to ensure the validity of noise level. The wind speed is measured by using Kanomax Climomaster. The collected data are invalid if the wind speed at the sampling point exceeded 5 m/s. Location of sampling points is measured using Global Positioning System (GPS). Lastly, measuring tape was used to measure the length between repetitive points. Measurement was made at three points near the main road side, representing the main exposure of students towards noise pollution. The distance between the three points are ±10 meters and the length of the school boundary from the roadside was 3.5 meters. The schematic representation during data collection is shown in Figure 1. The sampling was conducted from 0700 hours to 2200 hours (daytime) which is 15 hours per day (26). The sampling was performed for 3 days on the school day and 3 days on the non-school day for each study area. This is because the number of vehicles that generate noise might vary between the school day and non-school day. The time interval for monitoring the noise level at each point is 15 minutes.

Table I : Location of study areas. Two study areas are located at SK Tok Jembal, which is considered a residential area, and SK Gong Badak, which is considered an industrial area

Site	Location	Classification	Coordinate
S1	Sekolah Kebangsaan Tok Jembal	Residential	Lat: 05 21'149 Long: 103 5'50.67
S2	Sekolah Kebangsaan Gong Badak	Industrial	Lat: 05 23'49.64 Long: 103 4'25.97

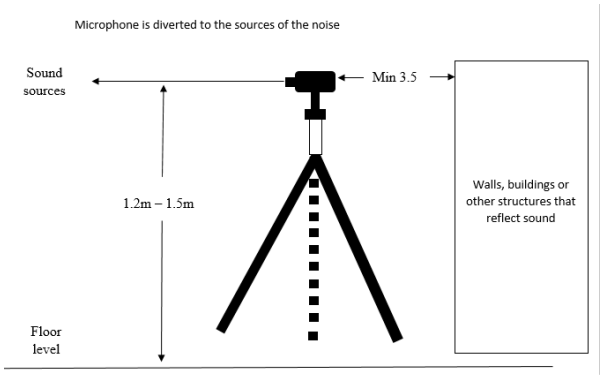

Figure 1: Schematic representation during noise levels sampling. Sound Level Meter (SLM) is used for noise monitoring campaign. The noise level was received by the microphone and displayed measurement values in decibels on SLM. SLM was placed on a tripod stand at 1.5 m from the ground

Data analysis

Equivalent noise level (L_{Aeq}) was calculated using Equation (1) which is expressed in dB(A) unit.

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

Where,

n = the total number of samples taken

L_i = the noise level in dB(A) of the ith sample

t_i = fraction of total sample time

The environmental noise level is considered as complies if L_{Aeq} value does not exceed the existing guideline for maximum permissible sound level for boundary noise. Lmax is the maximum sound level and Lmin is the minimum sound level. L_{10} and L_{90} are known as traffic and background noise, respectively. Both L_{10} and L_{90} are evaluated via percentile analysis.

The information on noise perspectives by students and teachers were acquired via questionnaire. Questionnaires for students and teachers were embedded in Appendix 1 and Appendix 2, respectively. The survey was carried out simultaneously with the measurement of noise (classes near the roadside), each site exposures to some kind of sources of noise, and representing all measured noise levels. This survey targeting students and teachers in study areas. Nominal (Yes and No) and ordinal scales (Scale of 1-4) were used for students and teachers, respectively. The questionnaire analysis of relative (%) and absolute (n) frequencies were evaluated via Statistical Packages for Social Sciences (SPSS) version 25.

RESULTS

Fig. 2A and Fig. 2B show noise level monitoring results at different land use on school and non-school days, respectively. The range of L_{Aeq} during school and non-school days received by the receptors within the vicinity of school areas are (50.4 to 77.0) dBA and (50.4 to 72.3) dBA, respectively. Maximum noise levels (Lmax) are higher at industrial area with 77dBA, compared at the residential area with 74.5dBA. The exposure of noise pollution is higher during school day as shown in Fig. 2A and 2B. It is in line with cumulative number of traffic volume which increases the sound level. The number of motor vehicles during the school day in the industrial area was 4718 units with L_{Aeq} of 69.2 dBA and for the same day in the residential area, the traffic volume was 4031 units with L_{Aeq} of 61.7 dBA. In this study, the number of motor vehicles from class N, O, and T that pass through S1 was higher compared to S2 (Fig. 2C). This is because the uses of motor vehicles from class N, O, and T were commonly used in the industrial area for the carriage of goods. Fig. 3A and Fig. 3B depict the exceedances of noise levels with the standard limit. Comparing with the Planning Guidelines for Environmental Noise Limit and Control provided by (26), L_{Aeq} (minimum found as 61.7dBA) were exceeded the limit set due to the increment of traffic volume at study areas. The results are in line with the findings evaluated by (7), where the L_{Aeq} at residential area is lower than industrial area, but both areas exceeding the standard. School area is considered as one of the sensitive areas, thus the standard limit of L_{Aeq} gazette by (26) is 55.0dBA (daytime).

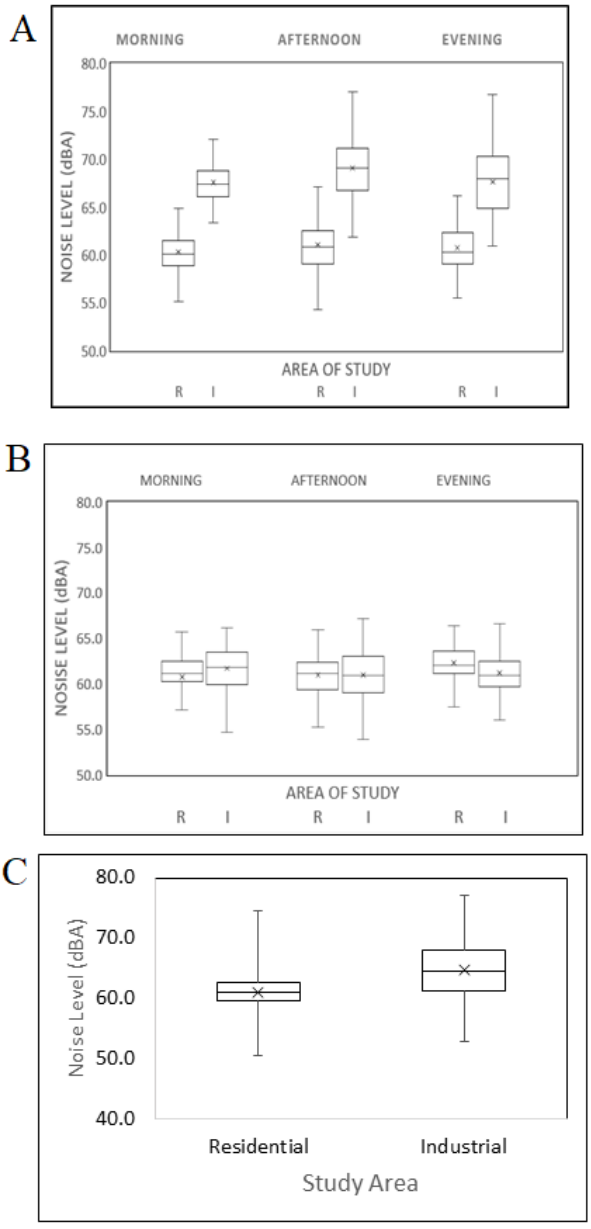

Fig 2: Trend of the noise level. The trend of noise level is higher during the weekday at the industrial area during the three peak hours (A). The trend of noise level is slightly similar during the weekend at both study areas during the three peak hours (B). The trend of noise level is higher in the industrial area compared to the residential area (C).

In this study, students' perspectives from the questionnaire survey were analyzed to determine which activities produced a high level of noise and also to determine either environmental noise at their school gives a significant impact during the learning process.

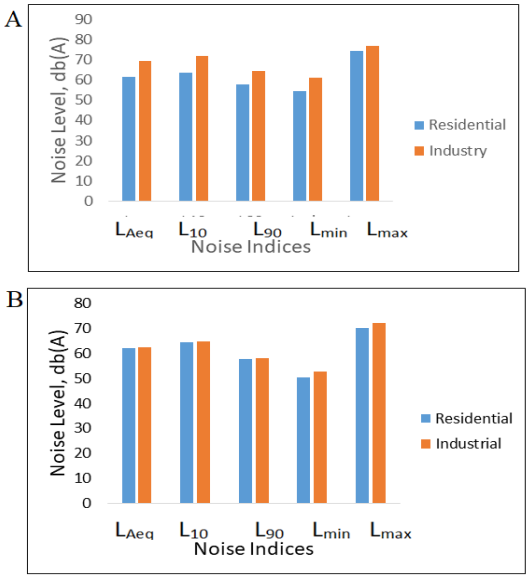

Fig 3: Noise indices at study areas during weekdays and weekends. Noise indices composed of L_{Aeq}, L_{10}, L_{90}, Lmin, and L_{max} during the weekday (A). Noise indices composed of L_{Aeq}, L_{10}, L_{90}, L_{min}, and L_{max} during the weekend (B).

A total of 96 students were selected as respondents students in year 6 (12 years old) and their classes are near the roadside. Questions given to the students were based on a nominal scale where the answer was "Yes" or "No" only. A total number of 8 questions were given to evaluate their perspective towards environmental noise. Results from the respondents were shown by calculating the percentage number of respondents towards the questions given in Fig. 4A-4D. Thus, from Fig. 4A it is clearly showing that 95% (n=91) of the students considered the classroom to be noisy. Only 5% (n=5) of students have the opposite opinion towards this question. Regarding the perceived sources of noise from the outside classroom, it was questioned which outside noise that heard the most in their classroom. Unfortunately, mostly students were disturbed by bell sound (43%, n=41). However, traffic noise was also ranked in the second place with 26% (n=25) followed by people on the street 18% (n=17) and lastly horn, sirens, and alarm 14% (n=13). Fig. 4B shows that traffic noise is one of the sources that highly contributed toward students while they were in the learning process at school. During knowledge delivery, noise affects when the teacher is explaining (51% (n=49)). 23% (n=22) of students said it was during when they did exercise or test. Besides, there was a slightly decreasing percentage for an answer when they were doing a reading which is 20% (n=19). 6% (n=6) (Fig. 4C) felt they did not affected by noise. To conclude overall student's perception of environmental noise at their school, Fig. 4D shows that more than half of students 51% (n=49) responded that noise produces outside school affects their studies. Besides students, teachers' perspectives were also analyzed to determine either the noise produce from the environment gives significant impacts on the teaching process from their views. A total of 69 teachers from

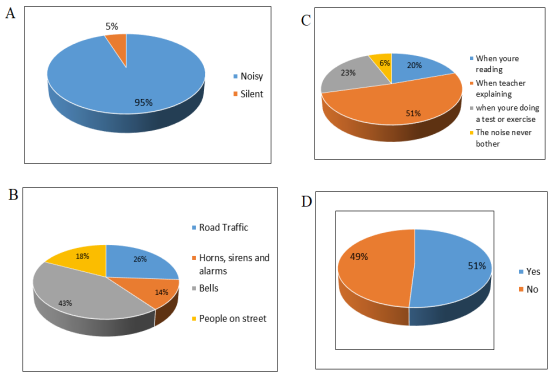

Fig 4: Student perspectives. 95% of students agreed the environment is noisy (A). 26% agreed noise comes from traffic (B). 6% of students said they are not bothered by the noise (C). 51% said the noise comes from the outside of the school (D).

both schools were selected in this survey questionnaire. Questions given to the teachers were using the ordinal scale from 1 to 4 represent "Any", "Little", "Some" and "A lot of", respectively. Results from the respondents were shown by calculating the percentage number of respondents towards the questions given. The average of teachers' age involved in this study is between 31 to 57. The ability of outside noise and types of noise obstruct knowledge delivery process were discussed. Road traffic noise (11.59%, n=8) affects "a lot of" obstruction in class, the neighborhood with 4.35% (n=3), people on the street with 4.35% (n=3) and horns, sirens, and alarm with 1.45% (n=1). Our main aim is to assess the influence of road traffic noise towards teaching and learning obstruction. But, teachers agreed that the road traffic noise disturb only "a little" (55.05%, n=38) compared to "a lot" (11.59%, n=8) as shown in Table II. Later, students in the classroom itself caused "a lot of" obstruction with 13.04% (n=9), other classroom noise with 4.35% (n=3), and outside school noise with 2.90% (n=3). Since there is no playground around the classroom areas, there were no teachers who responded that playground noise caused interference of noise during the classes. Sources from the equipment to support teaching also not be ranked as a lot of noise disturbance during the classes.

DISCUSSION

Heavy trucks are mainly the contributing factor for the increment of noise level as 192 units of lorries and 10 units of trailers are passing by the study areas during monitoring campaign. Furthermore, the discrepancy on the types of traffic volume number of different classes are influencing the noise level variation. Classes are including the Class N for transport minor stuffs like small lorry, Class O for transport heavy and large items including semi-trailers and Class T for agricultural activities like the tractor. According to (27), there are many heavy sources in heavy trucks, promoting the high

Table II Teachers' Perspective Evaluation

Annoyance of different sources of outside school noise	None		Little		Some		A lot of	
	n	%	n	%	n	%	n	%
Road Traffic	16	23.19	38	55.07	7	10.14	8	11.59
Horns, Sirens and Alarm	15	21.74	37	53.62	16	23.19	1	1.45
Workshop/ Industries	37	53.62	28	40.58	4	5.80	0	0.00
Works	22	31.88	40	57.97	7	10.14	0	0.00
Neighbourhood	42	60.87	21	30.43	3	4.35	3	4.35
People on street	39	56.52	23	33.33	4	5.80	3	4.35
Interference of noise during classes	**None**		**Little**		**Some**		**A lot of**	
	n	%	n	%	n	%	n	%
Students noise	3	4.35	34	49.28	23	33.33	9	13.04
Equipment noise to support teaching	24	34.78	35	50.72	10	14.49	0	0.00
Other classroom noise	7	10.14	29	42.03	29	42.03	3	4.35
Playground noise	29	42.03	31	44.93	9	13.04	0	0.00
Outside school noise	21	30.43	41	59.42	5	7.25	2	2.90

noise level and behavior as compared to automobiles. Sound is radiated by the tire, for the most part from the area near the tire or road contact patch. The sound radiated from the tire or road contact is reflected on various occasions between the street surface and the tire track before it propagates further to the receiver (28). The noise level was higher during the school day due to the number of drivers parked and stopped their vehicles along the sidewalks and shoulders of the roads to fetch their children at the same period hour at the school causing considerable traffic congestion (29). Noise generated from the gearbox of the vehicle by the vibration transmitted via the gear, shaft, and bearing to the housing (30) also contributed to the higher noise level. Motor vehicle is not solely influence the noise level at study areas, there are other factors induce high noise level. High noise level at the industrial area might cause by the road humps. The braking and accelerating before and after reaching road hump induce high noise level. These mechanisms influence noise level around the vicinity of monitoring campaign (31). In residential area, there is an influence of yellow strips. The interaction of tire and yellow strips increase noise level (7). Instead of slowing down the motor vehicle, public tends to increases their speed, thus induce the noise pollution. Noise, when the teachers are explaining, is one of the factors that influence the knowledge delivery process. Clear communication among students and teachers are important during the development process of students in school so as they can increase the capability to clearly hear what the teachers are going to explain (15). Students noted that the noise produce outside school affects their studies, this might affect the learning and give adverse impacts on students such as dizziness, emotional feeling, uncomfortable feeling, and poor communication (32).

CONCLUSION

In conclusion, the environmental noise at residential and industrial areas are significantly different, which residential area has lower noise as compared to the industrial area. We received a subjective view from students affected with noise pollution, inopportunely only 26% felt affected by road traffic noise, while mostly were disturbed by bell sound. Unfortunately, the LAeq at study areas exceeded the limit set by the Malaysian Department of Environment. Thus, several mitigations can be taken to reduce the exposure of environmental noise such as relocate the students to another class that has potentially received lower noise compared to the class near the roadside, planting trees that can absorb noise and therefore can reduce the noise level received by the students and the conceivable noise reduction on existing roads including building a soundproof between the road and school.

ACKNOWLEDGEMENT

This research was funded by the Fundamental Research Grant Scheme for Research Acculturation of Early Career Researchers by the Malaysian Ministry of Education (RACER/1/2019/TK10/UMT//1) and Research and Management Center, University Malaysia Terengganu. We also would like to thanks the Air Quality and Noise Laboratory, University Malaysia Terengganu for the provision of instrumentations for the data collection.

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