Analysis of noise pollution level in a University campus in South India

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Abstract. Noise comprises those sounds occurring around us that are not part of the environment under consideration. Noise is also a type of pollution and impacts on our health and wellness. The prevalence of noise is increasing in magnitude and severity because of growing population and urbanization. Noise pollution leads to many chronic and socially significant impacts. This study analyzes the level of noise at different points in SRM University. As the University encompasses a hospital also, it is more important to identify the sources of high noise levels and control them. As per Indian standards the desirable noise pollution for educational institutions and hospitals in daytime is 50 dbA. Noise levels were measured with a sound level meter at 19 points within the campus at three different timings (8–10 am, 12–2 pm, and 3–5 pm) over two cycles of measurements. The preliminary results show higher noise levels during morning and evening. Noise during Cycle 2 (latter half of semester) was 20% more compared to that of Cycle 1 (beginning of semester).

1. Introduction
The World Health Organization (WHO) aims to make all peoples attain the highest possible level of health. Health is defined in the WHO Constitution as “[a] state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. By this broad definition that includes well-being, noise impacts can be clubbed as ‘health’ issues [1]. The word "noise" is derived from the Latin word "nausea," which means seasickness or a sensation of discomfort [2]. Noise comprises those sounds occurring around us that are not part of the environment under consideration. It is also a type of pollution and impacts on our health and wellness and the ability to do productive work. Sources of noise pollution include industries, traffic and vehicles, construction and domestic appliances. The effects of noise are both direct and indirect; they affect the health and make our living environment miserable [3–5].

Various measures have been taken and standards evolved by the U.S. Environmental Protection Agency and Indian standards IS: 4954-1968, limiting the noise levels for different types of areas. In order to legally enforce control on noise levels, the Government of India has notified the Noise Pollution (Regulation and Control) Rules 2000, under the Environment (Protection) Act, 1986. Under these rules, ambient air quality standards with respect to noise have been specified for different types of areas. For residential areas, the day time noise should not exceed 55 dB(A) Leq as per these rules.

Universities, colleges, schools, libraries, national laboratories and hospitals come under Silent Zone. It may be mentioned that these are buildings that require on average quiet conditions but are also at the same time noise sources at certain times, for e.g. student movement in universities. In the first
instance, efforts should be made to find a site that is situated in a comparatively quiet environment. At least the site should be away from the noisy roads, rail tracks, aerodromes etc. Where there is no choice, due attention shall need to be paid to the layout of the rooms and facilities. Adequate open space should be left between the building and the roads/noise source. The rooms shall be arranged to be farther away from the noise source, while other unimportant rooms like gymnasium may be laid out closer to it and in a manner to provide a noise shield to the class-rooms and operation theatres.

In this study, the noise level measurements were carried during January–February 2015 and March–April 2015 to assess the noise generated in SRM University campus.

2. Study area

The study area is the University campus covering over 42 blocks. The campus consists of the Faculty of Engineering and Technology, Faculty of Medicine and Health Sciences, Faculty of Science and Humanities and Faculty of Management. It also houses the Medical College Hospital, Research Centre and Hostels. The hospital can accommodate 1200 in-patients. The University has a central library with vast resources and an auditorium that can accommodate over 4,000 people. The study area also covered a few points at a radius of 5 km around the campus, including the railway station (Figure 1).

3. Methodology

A total of 24 sampling collection points was taken in two cycles of readings viz. January–February and March–April, 2015. Three timings were chosen for the study: 8–10 am, 12–2 pm and 3–5 pm, to capture the high noise events of student entry and exit and lunch hour. The sound level meter was used to measure noise level within 24 minutes in a location for taking 1 reading, when noise level was consistent for 5 seconds. Reading was instantaneously tabulated. Five such sample readings were taken in each location. The sound level meter was used in slow response setting, which is ideal for educational institutions, and the instrument was used to record readings in dbA mode.

The values obtained from sound level meter were converted to Leq values. The equivalent continuous noise level (Leq) is the “sound pressure level of a steady sound that has, over a given period, the same energy as a fluctuating sound” under study. It is an average and is measured in dB(A) scale. It can be calculated using the formula [6]

\[
Leq = 10 \log_{10} \left[ \frac{1}{T_M} \int_0^T \left( \frac{P(t)}{P_0} \right)^2 dt \right]
\]  

(1)
Where $Leq$ is the equivalent continuous linear weighted sound pressure level at 20µPa, determined over a measured time interval $T_M$ (s), $P(t)$ is the instantaneous sound pressure of the sound signal, $P_o$ is the reference sound pressure of 20µPa.

Adding $Leq$ values requires taking an anti-log of each value. The addition can be performed as shown [7]:

$$\text{Total} Leq = 10 \log \left( \frac{Leq_1}{10^{10}} + \frac{Leq_2}{10^{10}} + \frac{Leq_3}{10^{10}} + \cdots + \frac{Leq_n}{10^{10}} \right)$$  \hspace{1cm} (2)

4. Results and discussion
This study analysed the noise levels in 24 stations. The equivalent noise level ($L_{eq}$ for 2 hours) across various stations during three different time periods across the two cycles are shown in Figures 2 and 3.

**Figure 2.** $L_{eq}$ vs Station (March–April).

**Figure 3.** $L_{eq}$ vs Station (Jan–Feb).
High noise levels were recorded during morning and evening, corresponding to student entry and exit times. Though the peaks are seen in the sampling locations outside the campus the permissible limit is not maintained in any of the stations. The peak value reaches around 106 dBA. Road traffic and presence of railway station is the reason behind the peak values. Yet, the permissible limit for train noise level is given by IS:4954-1968 as

- Freight trains (900 to 1200 m long) running at 25 to 40 km/h – 90 dB at 6 m, 77 dB at 150 m
- Freight trains (900 to 1200 m long) – 96 dB at 7.5 m running at 65 km/h
- Engine Noise Level – Under all operating conditions, 97–105 dB at 15 m.
- Whistle Noise Level – 110 dB at 15 m.

The problem here is the location of the campus right across both the railway track and NH45, leading to doubling of noise. The advantages of being close to the station and bus stop are offset by the intrusion of noise. The minimum value of 52dBA is noticed in Station 12, which is the auditorium. Even this is above the permissible limit. Lunch hour seems to be a quiet time; probably because the noise shifts to the hostels and canteens (which were not measured). Comparing the two cycles, there is not much difference between starting of the semester and end of the semester, as seen in figures 4–6.

![Figure 4. Comparison of L\textsubscript{eq} (8–10am) in two different cycles.](image)

The noise levels are doubled in just a few locations. The maximum values are also noticed at Potheri, SRM Valliammai Gate and Guduvancherry Railway Station and West inside of Hospitals Zone. In the duration 8–10 am and 3–5 pm (Figures 4 and 6), it is observed that maximum values were recorded in railway stations in Potheri and Guduvancherry due to students (∼3000) arriving to and departing from the campus, respectively. Similar trends were observed by others [5, 8–11]. The noise levels in the stations are only slightly higher than that in the campus in the afternoon, reflecting the lesser number of students in the stations.
Figure 5. Comparison of $L_{eq}(12–2\text{pm})$ in two different cycles.

Figure 6. Comparison of $L_{eq}(2–3\text{ pm})$ in two different cycles.

The $L_{eq}$ for 8 h corresponding to the work day is also consistently above the permissible limit (Figure 7). There is also not much variation between the two cycles.
The advantages of a University campus being near the railway station and/or highway are offset by the level of increase in noise caused by the same. When the University was established, it was a quiet zone with only a few trains plying through the day and the surrounding areas were empty. After 30 years, however, the University itself has grown by leaps and bounds. Residential buildings have mushroomed in Potheri. The stretch of NH45 on which the University lies has also exponentially grown, thereby leading to heavy and constant traffic. The population is increasing every year in the campus. All these are contributing to high noise levels such that the noise levels are higher than the permissible limits always during the day. This has to be brought down if the ill effects of noise pollution are to be prevented. The presence of a hospital within the campus also mandates low noise levels. Some measures to reduce the noise pollution include banning student vehicles within the college premises; planting more trees and sound barriers wherever possible; installing noise-absorbing fixtures in the classrooms; and sensitizing the campus community to the effects of noise pollution.

5. Conclusions
The ill effects of noise pollution are well recorded. The noise levels within and near a University campus were measured and analysed in this study. The advantages of a University campus being near the railway station and/or highway are offset by the level of increase in noise caused by the same, as evidenced in this study. Measures should be taken in such locations to reduce the noise levels so that classrooms will not be subjected to external noise.

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