Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 3
Open Access

Determining The Indoor/Outdoor Environment Noise Pollution For A University (Education) Campus

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Cite this paper as: Huda M. Selman, Ghassan Abukhanafer, Ali. M. Al-Musawy, Mohsen Karrabi,(2024) Determining The Indoor/Outdoor Environment Noise Pollution For A University (Education) Campus. *Frontiers in Health Informatics*, 13 (3), 9678-9688

Abstract
Noise pollution is one of the general and vital environmental pollutants that can cause an assortment of serious health hazards in our daily life, such as, hearing impairment, cardiovascular problems, depression, and the like. For the well-being of the society and public health, places such as hospitals, educational institutes, and recreational areas such as parks should be made noise-free. Educational institutions, like university campuses, are areas that are highly sensitive to noise pollution; therefore, special care needs to be taken in this regard. The objective of this article is to examine the noise pollution level at the Ferdowsi University of Mashhad campus, which is ignored, despite its developmental process. Accordingly, a digital sound level meter GM1351 was used, with a range of 30–130 decibels (dB). Noise measurements were collected in twenty locations (indoor and outdoor) within the campus during working hours (8.00 am–8.00 pm). The Excel program was applied to calculate some indices such as, noise climate, equivalent continuous noise level, and noise pollution level. The results indicate that the average noise levels (L_{eq}) for the indoor and outdoor sites were 54.11 and 62.33 dB, respectively. It can be concluded that the university campus is not free from noise pollution and authorities should take serious steps to create a quiet environment for healthy scientific and research activities. A map has also been generated to show the noise levels across the campus, which can be a valuable tool to plan new construction phases within the university.

Keywords: *Noise indicator, noise level map, noise pollution, university campus*

Introduction

Noise pollution (NoP) is one of the general and significant environmental issues in large cities, which have an adverse effect on human health, environment, and quality of life. According to the literature, seventy sources of noise were considered as major causes of annoyance in big cities[1,8]. The pie chart shows different causes along with their % of pollution (Fig.1). The deleterious effects of noise on human soundness and development have been underestimated for a relatively long time. Apart from the discomfort and irritation caused by NoP, it can cause permanent disability depending upon its intensity, duration, and frequency[2]. Van Kempen *et al.*, (2006) and Stansfeld and Crombie (2011) found a direct association between exposure to environmental noise and hypertension and ischemic heart sickness [3,4]Exposure to acute noise influences the body`s compensatory mechanism to stress causes increased blood pressure and vasoconstriction, contributes to heart attack, leads to learning disabilities, tinnitus, and affects the human physiological functions temporarily or permanently[5,9].

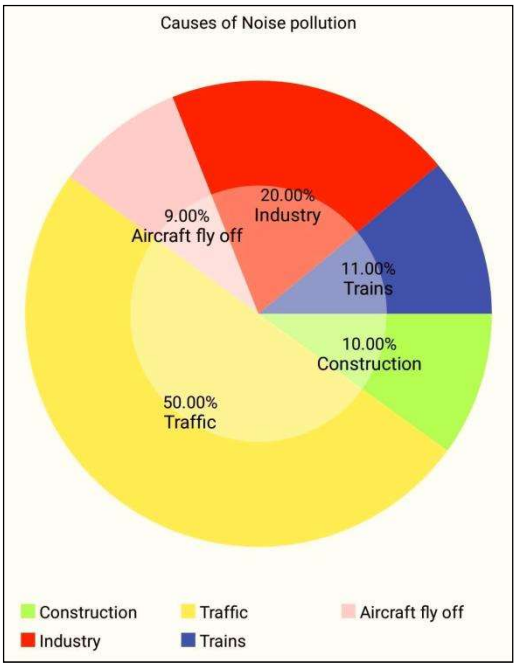

Fig. 1: Causes of noise pollution

People's hearing usually decreases by various factors such as occasional infections in the interior ear and naturally old sound receptors. Deafness is the initial problem being faced in newly industrialized cities, as these cities ignore the issue of noise level management during their developmental process . [1, 2].

Ferdowsi University of Mashhad In recent years, educational facilities and research infrastructures have been developing at the Ferdowsi University of Mashhad , Iran, whereas, they are ignoring the noise management on the campus. Noise pollution has a negative result on the academic performance and the concentration of the students and staff, because of the physiological manifestations such as headaches, irritability, nervousness, and fatigue, leading to decreased work efficiency. Focusing on this neglected problem and origin of hearing loss is the purpose of this study, which may be defined depending on the subsequent factors measuring the level of indoor/outdoor noise pollution at the FUM campus

Materials and Methods

Study Area

The Ferdowsi University of Mashhad the largest academic institute of eastern Iran, was chosen as the study area for noise pollution,. This comprises 10 faculties, 25000capita, and an area of approximately 3km^2. Of late, the university has had an admission of national and international students for different courses at graduate, post-graduate, and doctoral levels that include a broad range of activities. Population growth leads to noise intensification in indoor locations. In different schools and different sample sites, indoor and outdoor locations were taken for investigating NoP (see Table1).

Table 1 Indoor and Outdoor locations

Indoor	Code	Outdoor	Code
Agriculture / Horticulture college	A	North Main Entrance N.M.E	a
Agriculture/ Agronomy and Plant Breeding college	B	East Main Entrance E.M.E	b
Central Building	C	West Main Entrance W.M.E	c
Faculty of Architecture, Urbanism and Islamic art	D	South Main Entrance S.M.E	d
Faculty of Engineering	E	East Main Road E.M.R	e
Faculty of Mathematical Sciences	F	East Main Road- Residential E.M.R-Res	f
Faculty of Science	G	West Main Road W.M.R	g
Faculty of Pharmacy	H	Square of Science SOS	h
Faculty of Administration and Economic Sciences	I		
Faculty of Natural Sources and Environment	J		
Faculty of Sport Science and Physical Education	K		
Central library	L		

Data Collection

The NoP level was measured using the Digital Sound Level Meter (GM1351, Taiwan) in a weighting network, in such a manner that for each sample location, noise measurements were carried out continuously for fifty days, with six monitoring periods per day. The selected schedule during the daytime was followed as; 8.00–10.00 a.m., 10.00–12.00 a.m., 12.00–14.00 p.m., 14.00–16.00 p.m., 16.00–18.00 p.m., and 18.00–20.00 p.m. The study schedule of FUM was also observed, and it was recorded that the last lecture offered in campus was at 18.00 p.m. This was included in the sixth period of monitoring. The measurement was carried out every

20 minutes (six records during two hours), and a 4-minute recording was necessary to ensure the measurement stability.

The sound level meter was placed at a height of 1.5 meters above ground level. The data collected from each location (Indoor and Outdoor) was processed by statistical analysis. Figure2 shows the twelve indoor and eight outdoor sample locations/zones selected for the noise pollution study around the Ferdowsi University campus. Moreover, the corridors were considered as effective areas to measure noise pollution, in order to calculate the surface portion per capita and the number of students and staff (professors and employees) for each indoor zone was considered.

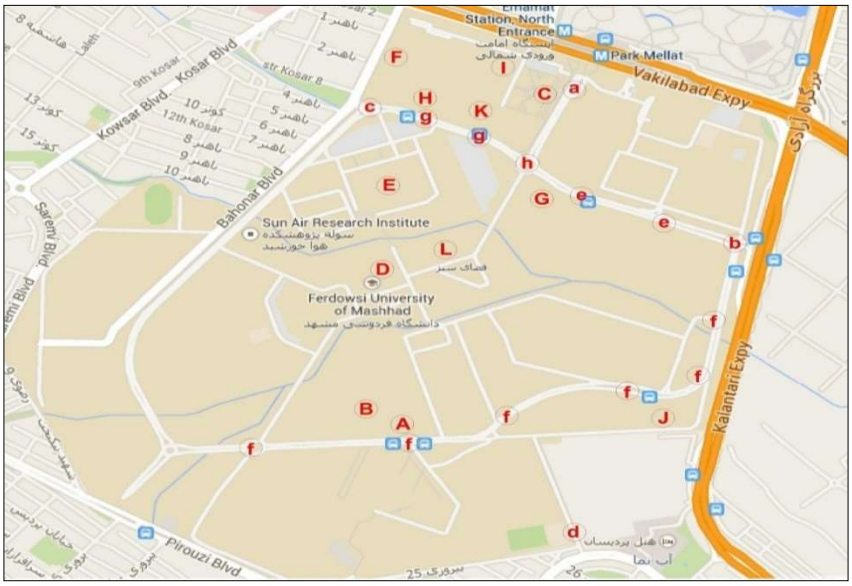

Figure 2. Indoor and outdoor sampling sites.

Statistical Method Description

A digital sound level meter (GM1351 Taiwan) was used, with a range of 30–130 decibels (dB). Noise measurements were collected in twenty locations (indoor and outdoor) within the campus during working hours (8.00 am–8.00 pm). The Excel program was applied to calculate some indices such as, noise climate, equivalent continuous noise level, and noise pollution level.

Noise Pollution Indices

Indices of different NoP were calculated exploitation Gaussian percentile, to find the levels of sound pollution. Different percentile values such as L_{10}, L_{50}, and L_{90} were obtained from the sample records. Noise Climate (NC), Equivalent Noise Level (L_{eq}), and Noise Pollution Level (L_{np}) were assessed by depending on the L_{10}, L_{50}, and L_{90} parameters[10-12]. These indices were calculated by applying the following equations

$$NC = L_{10} - L_{90} \quad (1)$$

$$L_{eq} = L_{50} + \left(\frac{NC^2}{60} \right) \quad (2)$$

$$L_{np} = L_{eq} + NC \quad (3)$$

Where: NC represents the Noise Climate, L_{10} has a level of sound that is more than 10 percent of the Peak Noise Level, L_{50} has a level of sound that is more than 50 percent of the Mean Sound Level, L_{90} has a level of sound that is more than 90 percent of the Residual Noise Level; L_{eq} is the Equivalent noise level and L_{np} is the Noise Pollution Level.

Results

The aim of this article is to measure the levels of NoP at the Ferdowsi University Campus of Mashhad and analyze the methods of mitigating them. The existing noise pollution level has also been evaluated, to be compared with the campus planning criteria, to investigate on how to improve the solutions. Sound levels have been calculated at strategic areas within the campus during working hours, from 8:00 am to 8:00 pm, and compared with the levels calculated by WHO .

Educational buildings (faculties), the central (administrative) building, and library were considered as indoor sites, whereas, the roads, gates, and intersections were selected as outdoor areas. The measurement period conducted in this study was for 50 days in a period between October and November 2022. The sound of aircraft passing over the University was excluded. The data collection period was selected considering (*i*) the presence of students and staff and (*ii*) similar time interval for all locations. The collected data was finally inserted into the Excel program to calculate the maximum, minimum, and average noise level indices for all indoor and outdoor locations.

Indoor Locations

The equivalent average noise level (L_{eq}) of indoor locations for different time intervals is depicted in Figure 2, which indicates that the Faculty of Engineering was the noisiest place (L_{eq}= 60.08 dB) among all indoor sites. The reason for this noise may be due to the engineering workshops and a greater number of students compared to the other faculties on the campus, but the most significant factor was the lowest surface portion per capita. In contrast, the most quiet indoor site was the central library **(**L_{eq}= 44.82 dB), which could be due to the modern construction plan that had the voice isolation system and highest surface portion per capita (Figure 3a).

All average noise level indices were calculated including L_{10}, L_{90}, L_{50}, NC, L_{eq}, L_{np}, L_{max}, L_{min} for indoor sites, as shown in Table 2. The noise pollution level, L_{np}, takes into account both the noise climate (NC) and L_{eq} indices, giving an idea of noise pollution, with noise level fluctuations. It is considered as the best indicator of physiological and psychological impact of noise. The maximum observed L_{np} was 62.18 dB, in the Faculty of Engineering, while it was minimum, 45.77 dB, in the Central Library (see Table 3). The daily average ambient noise levels (L_{eq}) in dB versus the surface portion, as well as, the hourly average noise level for all indoor sites are shown in Figure 3. As it can be observed the maximum noise level was found to be at 8–10 a.m. and the minimum was recorded at 18–20 p.m. All the indoor locations on the campus of the Ferdowsi University of Mashhad are considered to be noisy sites, as they exceed the WHO standards, .

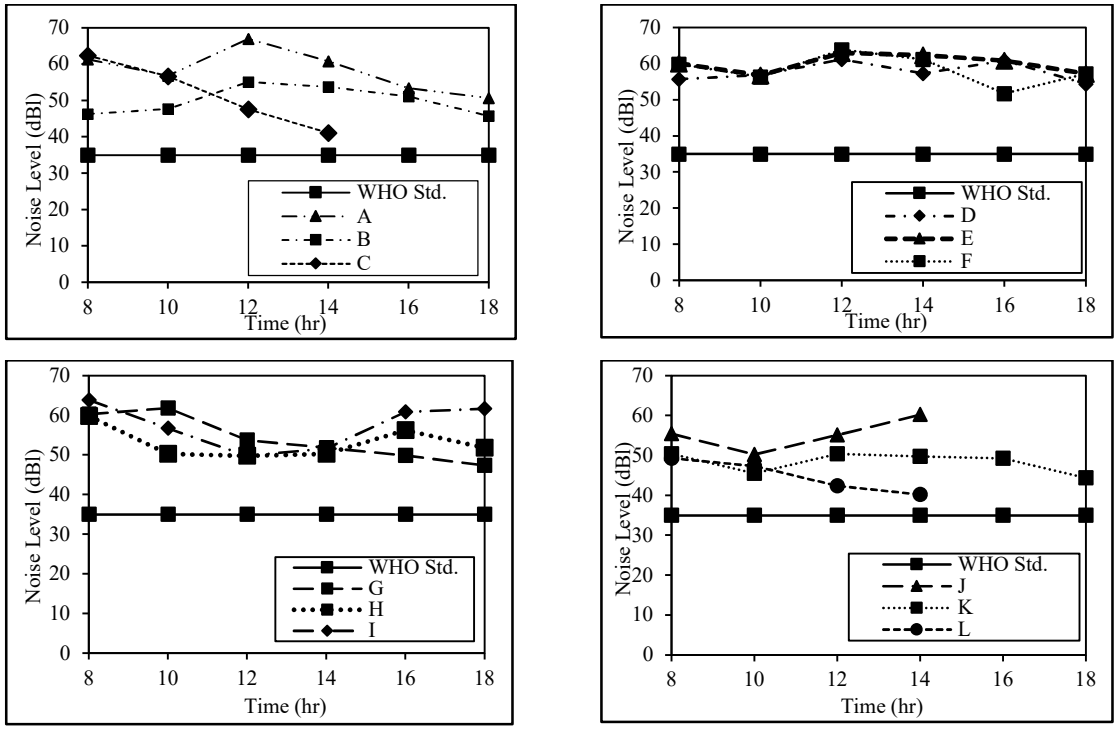

Figure3. The equivalent continuous average noise level (L_{eq}) of indoor locations

Table 2 Daily average noise level indices (dB) for all indoor zones.

Location	av. L_{10}	av. L_{90}	av. L_{50}	av. NC	av. L_{eq}	av. L_{np}	av. L_{max}	av. L_{min}
A	59.58	57.17	58.21	2.41	58.32	60.74	59.93	56.85
B	51.13	48.89	49.83	2.25	49.93	52.17	51.74	48.73
C	52.77	51.32	51.87	1.45	51.92	53.63	53.10	15.13
D	58.83	56.26	57.63	2.57	57.75	60.32	59.15	56.03
E	60.95	58.85	59.98	2.10	60.08	62.18	61.13	58.60
F	59.20	57.13	58.34	1.96	58.41	60.37	59.29	56.98
G	54.82	53.14	54.09	1.68	54.14	55.82	55.00	52.98
H	54.26	52.43	52.94	1.83	53.04	54.86	55.22	52.73
I	58.07	55.94	57.34	2.12	57.42	59.54	58.28	55.83
J	55.81	54.78	55.23	1.03	55.25	56.28	55.94	54.70
K	48.93	47.94	48.27	0.99	48.29	49.28	49.03	47.87
L	45.24	44.29	44.80	0.95	44.82	45.77	45.28	44.00

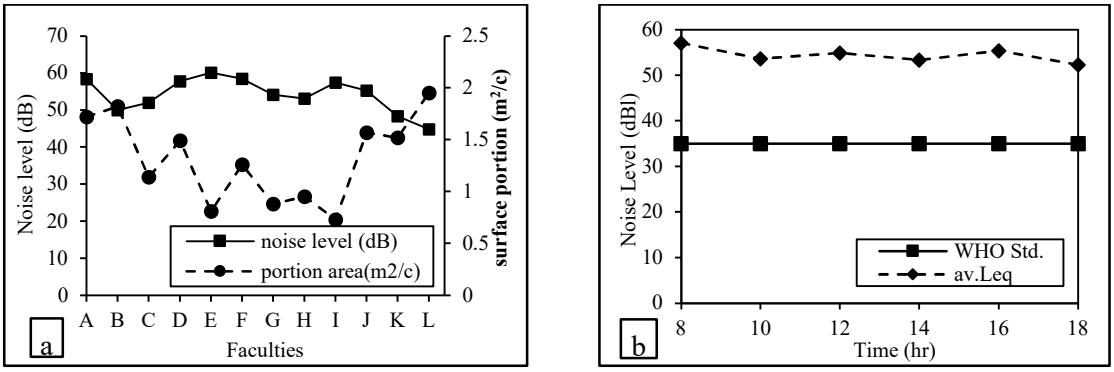

Figure 4. a) The daily average ambient noise levels versus surface portion; b) the hourly average noise level for all indoor sites

Outdoor Locations

Figure 5shows the average L_{eq} observed for outdoor sites during the measurement period. The maximum L_{eq} (68.41 dB) was found at the east main entrance because of its proximity to the Shahid Kalantari highway, which had high traffic at the gate. The minimum L_{eq} (59.23 dB) was observed at the south gate due to its distance from the main road and low traffic. All average noise level indices calculated in this study for outdoor locations are displayed in Table 3. The daily average noise levels (L_{eq}) for every outdoor location and the hourly average noise level for outdoor locations are presented in Figure 6. The results show that the maximum noise level was measured at 8–10 a.m. in the morning and the minimum was pointed out at 6–8 p.m. in the evening, similar to indoor sites. As it can be noticed in this figure, the equivalent average noise level is always greater than the WHO limit (55 dB). Figure 7 illustrates a noise map (by ArcMap 10.3.1 software and Google Maps) of the University campus with respect to the mean values found from the six measurement times based on indoor and outdoor location codes (Table 1 and Figure2)

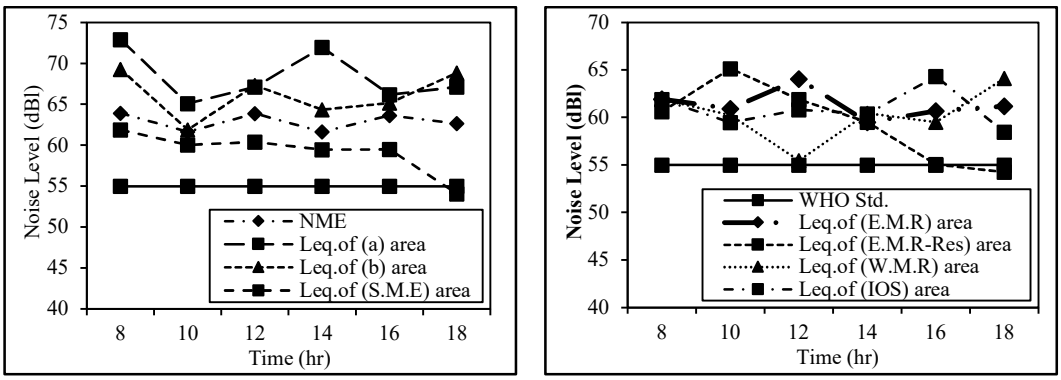

Figure5. The equivalent continuous average noise level (L_{eq}) of outdoor sites.

Table 3 Average noise levels indices in dB for all outdoor zones.

Indices	av. L_{10}	av. L_{90}	av. L_{50}	av. NC	av. L_{eq}	av. L_{np}	av. L_{max}	av. L_{min}
a	63.62	61.58	62.83	2.03	62.90	64.94	63.75	61.28
b	70.20	65.72	67.96	4.48	68.41	72.89	70.49	64.77

c	67.07	64.63	66.03	2.44	66.14	68.59	67.44	64.43
d	59.74	58.53	59.20	1.21	59.23	60.44	59.81	58.32
e	61.84	60.61	61.36	1.23	61.39	62.62	62.00	60.43
f	60.18	58.63	59.37	1.55	59.41	60.96	60.47	58.48
g	60.92	59.56	60.42	1.36	60.28	61.64	61.05	59.37
h	61.53	60.05	60.86	1.48	60.90	62.37	61.67	59.80

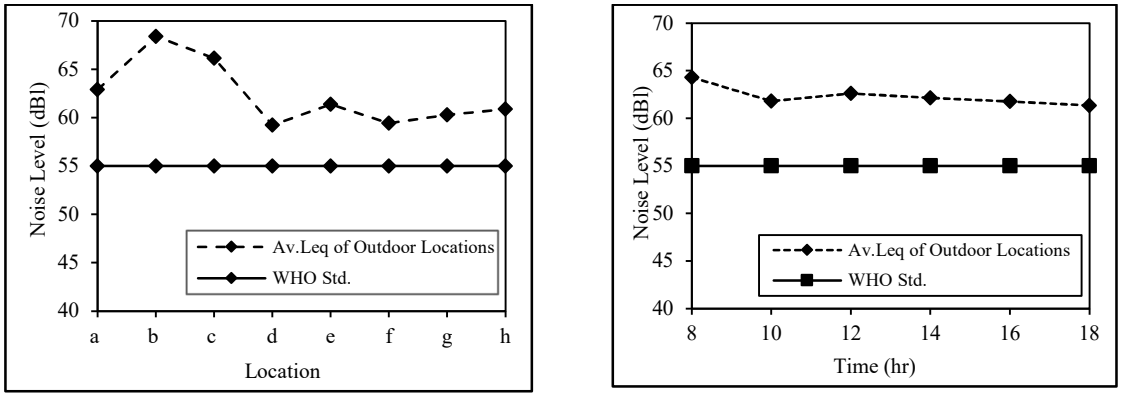

Figure 6. The hourly average noise level for all outdoor locations.

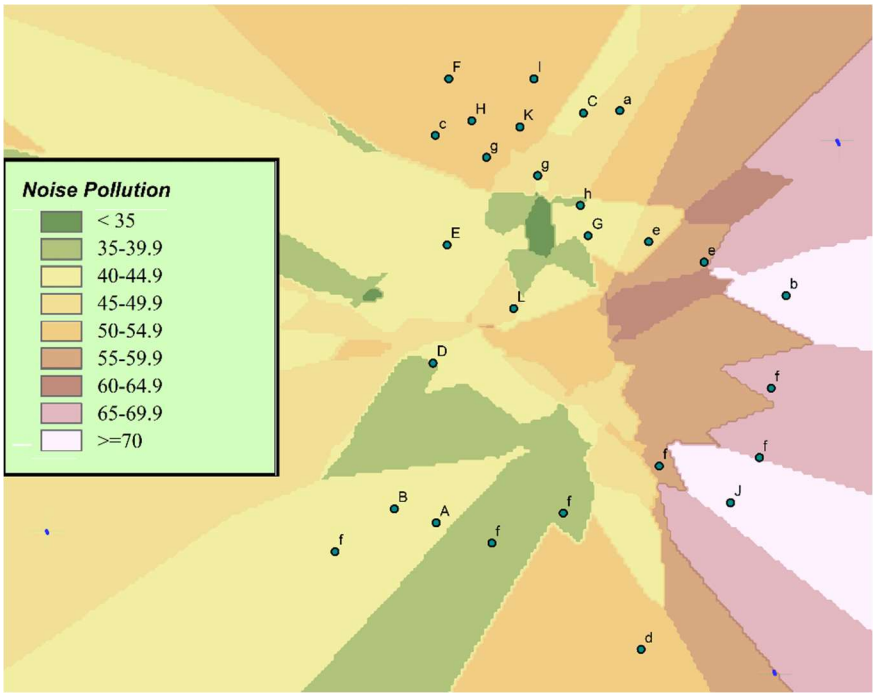

Figure 7. Noise map in the campus of the Ferdowsi University of Mashhad

Discussion

The reason for the noise in Indoor sites ((educational buildings (faculties), the central (administrative) building, and the library)) may be due to the engineering workshops and a greater number of students compared to the other faculties on the campus, but the most significant factor was the lowest surface portion per capita. In contrast, the quietest indoor site was the central library (Leq= 44.82 dB), which could be due to the modern construction plan that had the voice isolation system and highest surface portion per capita (Figure 3a), while the reason for the noise outdoor (the roads, gates, and intersections) was proximity to the Shahid Kalantari highway, which had high traffic at the gate. Eventually, as an educational hub in Mashhad, L_{eq} for indoor and outdoor Ferdowsi University of Mashhad zones were recorded as 54.11 dB and 62.33dB, respectively, which were compared with those of the Ataturk University (AU) in Erzurum, Turkey, campus of the Polytechnic Center of the Federal University of Paraná (PC-FUP), Brazil and Gauhati University (GU) Campus, India.

Mean noise levels at AU, Turkey, in the morning, noon, and evening were reported as 62.65, 62.51, and 62.95 dB, respectively. Results of the study presented that the average noise level was 62.70 dB, more than 55 dB, which was the allowed average value (WHO, L_{eq} = 55 dB) [3]. Similar results were reported on PC-FUP, Brazil where the 58 points was evaluated and it was found that the noise level exceeded the 55 dB standard limit [4]. At GC, India in 2013, the mean equivalent sound pressure level (M_{eq}PL) in the morning was recorded as 61.2 dB, which was again above the prescribed noise limits. M_{eq} PL in the mid-day and evening were found to be 60 dB and 60.6 dB, respectively [5].

Therefore, all institutions and universities must reduce and control noise pollution in both indoor and outdoor locations, which is now considered a major health concern, but is being ignored by many academic institutes. Some strategies, such as adjusting the surface portion by developing new buildings, developing regulations for construction, considering advanced traffic management, effective road maintenance, and using materials for pavements that make less noise, are measures that can be adapted to meet the global healthy threshold and make every educational and scientific institute free from noise pollution.

Conclusions

In this study, significant noise pollution was observed on the campus of the Ferdowsi University of Mashhad through monitoring L_{eq} (equivalent continuous average noise level) at different indoor and outdoor zones which were calculated as 54.11 and 62.33 dB, respectively. As mentioned earlier, the L_{eq} was more than the threshold clarified by WHO . There could be several reasons for the excess noise in the campuses, which could be, (*i*) The admission of students had increased recently, (*ii*) the proximity of some buildings to the main roads and highways (*iii*) the lack of furniture inside the buildings, (*iv*) the absence of signs to prevent noise pollution, (*v*) traditional construction planning (no sound proof) (*vi*) the presence of heating equipment in some colleges containing noise generating fans, and (*vi*i) the existence of bus stations and speed breakers near the buildings that generate noise pollution on the part of drivers. Noise pollution has a negative result on the academic performance and the concentration of the students and staff, because of the physiological manifestations such as headaches, irritability, nervousness, and fatigue, leading to decreased work efficiency. Therefore, it is the duty of all institutions and universities to reduce and control noise pollution in both the indoor and outdoor locations, which is now considered as a major health concern, but is being ignored by many academic institutes. Some strategies, such as, adjusting the surface portion by developing new buildings, developing regulations for construction, considering advanced traffic management, effective road maintenance, and using materials for pavements that make less noise, are measures that can be adopted to meet the global healthy threshold and make every educational and scientific institute free from noise pollution. there are no Competing Interests

Author contribution:
All authors have accepted responsibility for the entire content of this manuscript and consented to its submission

to the journal, reviewed all the results and approved the final version of the manuscript.
Huda M. Selman, Ghassan Abukhnafer and Ali. M. Al-musawy: Conceptualization, Methodology, Writing - original draft preparation.
Mohsen Karrabi: Supervision, Reviewing and editing, Data curation. also linguistically and scientifically corrected.

References

1. Gheibi M, Karrabi M, Latifi P, Fathollahi-Fard AM. Evaluation of traffic noise pollution using geographic information system and descriptive statistical method: a case study in Mashhad, Iran. Environmental Science and Pollution Research. 2022:1-14.
2. Igan MD, Pinheiro M. Credit growth and bank soundness: fast and furious?: International Monetary Fund; 2011.
3. Clark C, Martin R, Van Kempen E, Alfred T, Head J, Davies HW, et al. Exposure-effect relations between aircraft and road traffic noise exposure at school and reading comprehension: the RANCH project. American journal of epidemiology. 2006;163(1):27-37.
4. Stansfeld S, Crombie R. Cardiovascular effects of environmental noise: research in the United Kingdom. Noise and health. 2011;13(52):229.
5. Sørensen PM, Haddock A, Guarino E, Jaakkola K, McMullen C, Jensen FH, et al. Anthropogenic noise impairs cooperation in bottlenose dolphins. Current Biology. 2023.
6. Czupich M, Łapińska J, Bartoš V. Environmental Sustainability Assessment of the European Union's Capital Cities. International Journal of Environmental Research and Public Health. 2022;19(7):4327.
7. González DM, Morillas JMB, Rey-Gozalo G. Effects of noise on pedestrians in urban environments where road traffic is the main source of sound. Science of the total environment. 2023;857:159406.
8. Ibili F, Adanu EK, Adams CA, Andam-Akorful SA, Turay SS, Ajayi SA. Traffic noise models and noise guidelines: A review. Noise & Vibration Worldwide. 2022;53(1-2):65-79.
9. Organization WH. World report on hearing: World Health Organization; 2021.
10. Selman HM. Investigation of Noise Levels Within Al-Muthanna University in Al-Muthanna Province/ Iraq. AL-MUTHANNA JOURNAL OF ENGINEERING ANDTECHNOLOGY (MJET). 2015.
11. Titu AM, Boroiu AA, Mihailescu S, Pop AB, Boroiu A. Assessment of Road Noise Pollution in Urban Residential Areas—A Case Study in Piteşti, Romania. Applied Sciences. 2022;12(8):4053.
12. Sahu A, Pradhan M, Mohanty C, Pradhan P. Assessment of traffic noise pollution in Burla town, India; an inclusive annoyance study. Sound Vib. 2020;54(1):27-42.
13. Ozer S, Zengin M, Yilmaz H. Determination of the Noise Pollution on University (Education) Campuses: a Case study of Ataturk University. Ekoloji Dergisi. 2014;23(90).
14. Zannin PHT, Engel MS, Fiedler PEK, Bunn F. Characterization of environmental noise based on noise measurements, noise mapping and interviews: A case study at a university campus in Brazil. Cities. 2013;31:317-27.
15. Phukan B, Kalita K. An experimental study of noise pollution in Gauhati University campus, Guwahati, Assam, India. International journal of environmental sciences. 2013;3(5):1776-84.
16. Czupich M, Łapińska J, Bartoš V. Environmental Sustainability Assessment of the European Union's Capital Cities. International Journal of Environmental Research and Public Health. 2022;19(7):4327.
17. González DM, Morillas JMB, Rey-Gozalo G. Effects of noise on pedestrians in urban environments where road traffic is the main source of sound. Science of the total environment. 2023;857:159406.
18. Ozer S, Zengin M, Yilmaz H. Determination of the Noise Pollution on University (Education) Campuses: a Case study of Ataturk University. Ekoloji Dergisi. 2014;23(90).

19. Zannin PHT, Engel MS, Fiedler PEK, Bunn F. Characterization of environmental noise based on noise measurements, noise mapping and interviews: A case study at a university campus in Brazil. Cities. 2013;31:317-27.
20. Phukan B, Kalita K. An experimental study of noise pollution in Gauhati University campus, Guwahati, Assam, India. International journal of environmental sciences. 2013;3(5):1776-84.