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Noise standards and the impact of noise on teaching and learning activities

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KEYWORDS

Noise Standards
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ABSTRACT

This study investigates noise pollution, a significant environmental and public health concern. It provides a comprehensive overview of noise standards in Vietnam, the United States, and Japan, comparing permissible levels across various environments including specific areas, residential zones, and workplaces. The comparative analysis reveals substantial variations, with Japan imposing the strictest regulations, particularly noted in special areas and workplaces. The document then examines the far-reaching impacts of noise, detailing its effects on general health, including nervous system, cardiovascular issues, sleep disorders, and hearing loss. Crucially, it explores the specific impacts on teaching and learning activities, highlighting impairments to cognitive performance, creation of communication barriers, and adverse health effects on both students and lecturers. A practical measurements study was conducted by students under supervisor of lecturer, at Lecture Hall A2, in University of Transport and Communications. Actual noises levels were collected by students during class and break times, and these measurements frequently exceeded both Vietnamese and United States standards, particularly when influenced by external sources like the metro and traffic. Based on these findings, the research proposes a range of technical and management solutions aimed at mitigating noise pollution in educational settings, such as installing soundproof materials and adjusting operational schedules.

1. A Comparative Analysis of National Noise Standards: Vietnam, the United States, and Japan

Noise pollution represents a significant environmental and public health challenge in contemporary society, necessitating regulatory measures to define permissible noise levels in various environments. Different countries have established specific noise standards aimed at minimizing harmful effects and protecting public health and welfare. This section provides an overview and comparative analysis of noise standards in Vietnam, the United States, and Japan, highlighting key differences across specific areas, residential zones, and workplaces.

In Vietnam's Noise Standards, noise standards are regulated at two primary levels for different environments. The National Technical Regulation on Noise (QCVN 26:2010/BTNMT) defines limits for:

- *Specific areas:* These include locations within the fence of medical facilities, schools, kindergartens, churches, pagodas, and other areas with special regulations.
- *Communal areas:* This category covers apartment complexes, individual houses, hotels, administrative agencies, etc. Additionally, Vietnam has regulations for occupational noise exposure under the National Technical Regulation on Noise - Permissible Exposure Levels of Noise in the Workplace (QCVN 24:2016/BYT). This standard specifies permissible exposure levels based on duration, with an allowable exposure level not exceeding 85 dB for 8 hours. The maximum sound pressure level always during operation must not exceed 115 dB.

Table 1. Vietnam's Noise Standards [1].

TT	Area	06:00 a.m. to 09:00 p.m.	09:00 p.m. to 06:00 a.m. (next day)
1	Specific areas	55 dB	45 dB
2	Communal areas	70 dB	55 dB

Table 2. Permissible limits of sound pressure level according to exposure time [2].

Noise exposure time	Permissible limit of equivalent sound pressure level (LAeq) - dBA
8 hours	85
4 hours	88
2 hours	91
1 hour	94
30 minutes	97
15 minutes	100
7 minutes	103
3 minutes	106
2 minutes	109
1 minutes	112
30 seconds	115

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United States' Noise Standards Noise are regulated at different levels by various agencies, most notably for occupational and environmental noise.

- *Occupational Noise Standards (OSHA):* The Occupational Safety and Health Administration (OSHA) primarily regulates workplace noise to protect workers from hearing damage. Protection is required when sound levels exceed limits presented in Table 3, measured on the A scale of a standard sound level meter at slow response (Fig 1).
- *Environmental Noise Standards (EPA):* The U.S. Environmental Protection Agency (EPA) provides recommendations for noise levels requisite to protect public health and welfare with an adequate margin of safety. Specific provisions exist for schools, hospitals, and churches, where noise levels should not exceed the standards for the assigned noise zone or unreasonably interfere with their use.
- *Vehicle Noise:* While the document notes no clear regulations on noise limits for moving vehicles in areas, the US does have noise emission standards for motorcycles. Exhaust systems for federally regulated street motorcycles from 1986 onwards must not cause the motorcycle to produce noise emissions exceeding 80dB.

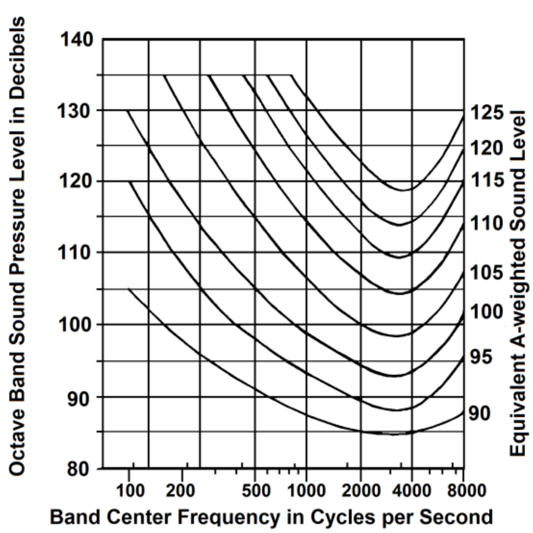

Fig 1. The A scale of a standard sound level meter at slow response [3].

Table 3. Permissible Noise Exposures [3].

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
11/2	102
1	105
1/2	110
¼ or less	115

Table 4. Summary of noise levels identified as requisite to project public health and welfare with an adequate margin of safety [4].

Effect	Level	Area
Hearing Loss	L_{eq} = <70 dB	All areas
Outdoor activity interference and annoyance	L_{dn} = < 55 dB	Outdoors in residential areas and farms and other outdoor areas where people spend widenly varying amounts of time and other places in which quitet is a basis for use
	$L_{eq(24)}$ = < 55 dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	L_{dn} = < 45 dB	Indoor residential areas
	$L_{eq(24)}$ = < 45 dB	Other indoor areas with human activiies such as schools, etc.

Japan's Noise Standards Japan maintains notably strict noise standards, which are set as environmental quality standards.

- *Environmental Quality Standards:* These standards vary based on area type and time category (Table 5). Daytime is from 6:00 a.m. to 10:00 p.m., and nighttime is from 10:00 p.m. to 6:00 a.m.

. Area type AA (areas where quietness is specially required, e.g., convalescent facilities)

. Area type A (areas used exclusively for residences)

. Area type B (areas used mainly for residences)

. Area type C (areas used for commerce, industry, and residences)

. Areas Facing Roads: Specific standards apply to areas facing roads (for Area A facing roads with two or more lanes and for the space adjacent to a road carrying arterial traffic, Table 6&7). Standards for indoor noise, transmitted from outside, can be applied for residences whose windows are usually closed on the sides most affected by noise (45 dB or less daytime, 40 dB or less nighttime).

- *Motor Vehicle Noise:* request limits for motor vehicle noise also vary by area and time. (Table 8)

Table 5. Environmental Quality Standards in Japan [5].

Type of area	Standard value	
	Daytime	Nighttime
AA	50 dB or less	40 dB or less
A and B	55 dB or less	45 dB or less
C	60 dB or less	50 dB or less

Table 6. Noise standard for areas facing roads [5].

Areas	Standard value	
	Daytime	Nighttime
Area category	60 dB or less	55 dB or less
Area A facing roads with two or more lanes	65 dB or less	60 dB or less

Table 7. Noise standard for the space adjacent to a road carrying arterial traffic [5].

Standard values	
Daytime	Nighttime
70 dB or less	65 dB or less

A comparison of the noise standards reveals significant differences between Vietnam, the United States, and Japan. Japan enforces the strictest noise pollution regulations in all categories, maintaining lower decibel limits to safeguard public health. (Table 9)

Table 8. Request Limits for Motor Vehicle Noise [6].

Time / Area	Daytime	Morning Evening	Nighttime
Areas bordering on a single-lane road in Area I	55 dB	50 dB	45 dB
Areas bordering on a single-lane road in Area II	60 dB	55 dB	50 dB
Areas bordering on a two-lanes road in Area I & II	70 dB	65 dB	55 dB
Areas bordering on a more-than-two-lanes road in Area I & II	75 dB	70 dB	60 dB
Areas bordering on a single-lane road in Area III & IV	70 dB	65 dB	60 dB
Areas bordering on a two-lanes road in Area III & IV	75 dB	70 dB	65 dB
Areas bordering on a more-than-two-lane road in Area III & IV	80 dB	75 dB	65 dB

Table 9. Comparison table of standards between countries.

Area	US		Japan		Vietnam	
	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime
1- Specific areas			50 dB	40 dB	55 dB	45 dB
Outdoor activity	55 dB	50 dB				
Indoor activity	55 dB	45 dB				
2- Residence area, hotels… etc.			55 dB	45 dB	70 dB	55 dB
Outdoor activity	55 dB	50 dB				
Indoor activity	55 dB	45 dB				
3- Workplace (commerce, industries)	85 dB		60 dB	50 dB	85 dB	

2. Assessment of Noise Pollution Status at Lecture Hall A2

This section details a specific case study focusing on noise pollution at Lecture Hall A2 within a university setting, aiming to measure current noise conditions and evaluate them against relevant regulatory benchmarks.

To identify and quantify the noise, at Lecture Hall A2, a systematic measurement process was undertaken as described in the source. The assessment utilized noise measuring equipment designed to measure the intensity of noise levels, assess, and manage noise pollution, monitor workplace safety, and identify sources of excessive noise.

The noise measurement steps involved dividing participants into two distinct groups: one group positioned inside building A2 and another group located on the street. Each group was equipped with a noise measuring device. The measurements were conducted at two distinct times: during class time and during break time. The process was timed, notably starting the measurement signal when the metro was operating, suggesting a focus on identifying the impact of specific transient noise sources. The overall purpose of this measurement was comprehensive: to collect noise levels across different days of the week (specifically Monday, Thursday, and Sunday), to understand the difference between daytime and nighttime noise levels, to compare levels between break time and class time, and crucially, to evaluate the impact of the metro.

The collected data provided specific insights into noise levels under different conditions at Lecture Hall A2 and its surroundings. Figures 2, 3, 4, 5, and 6 visually represent some of these findings.

During class time in Hall A2: The measurements showed notable variations influenced by the metro's presence. When the metro was not present, the noise level in Lecture Hall A2 was reported to exceed the Vietnamese standard by 9.1%. Interestingly, on weekdays and weekends without the metro, the noise level was found to be 5.4% less than the standard. However, when the metro appeared, the actual noise level significantly exceeded the Vietnamese standard by about 33.6%. This led to the conclusion that the metro is a main cause of noise during class time.

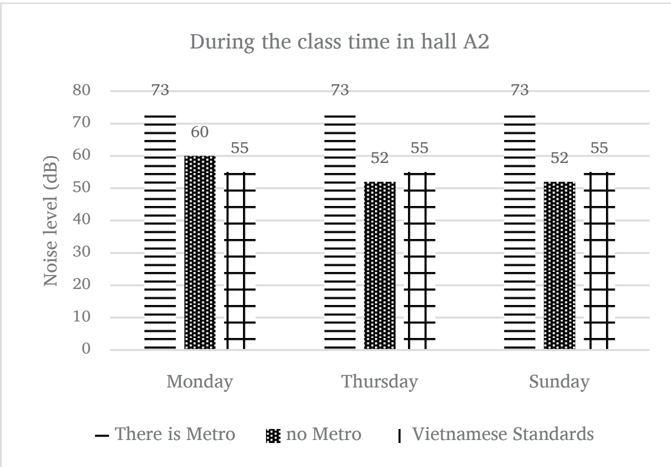

Fig 2. During the class time in hall A2.

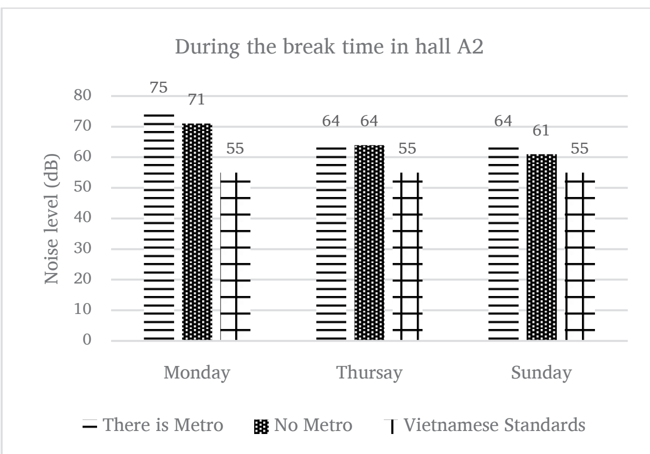

Fig 3. During the break time in hall A2.

During break time in Hall A2: The source indicates that before the metro's influence, the noise level was slightly higher, sometimes exceeding the standard by about 29.1%. When the metro was present, the exceedance was around 36.4% on Monday. On other measured days, the noise level with and without the metro was noted as being almost the same during break time. This suggests that during break time, noise originates not only from the metro but also from other activities such as student talking and outdoor activities of students. (Fig.3).

Noise level on the street: Measurements on the street, shown in Fig4, were primarily affected by traffic rather than the metro. The source explains that when vehicles accumulate at a red light and then move simultaneously when the light changes to green, this causes a significant amount of noise. On Sunday, noted as a holiday, the street noise decreased due to a reduction in vehicles.

At night: the indoor noise level in Lecture Hall A2 decreased significantly compared to daytime. However, when compared to the US standards (at night), the indoor noise level still exceeded the standard by 33.0% when the metro was present and 17.8% when the metro was absent.

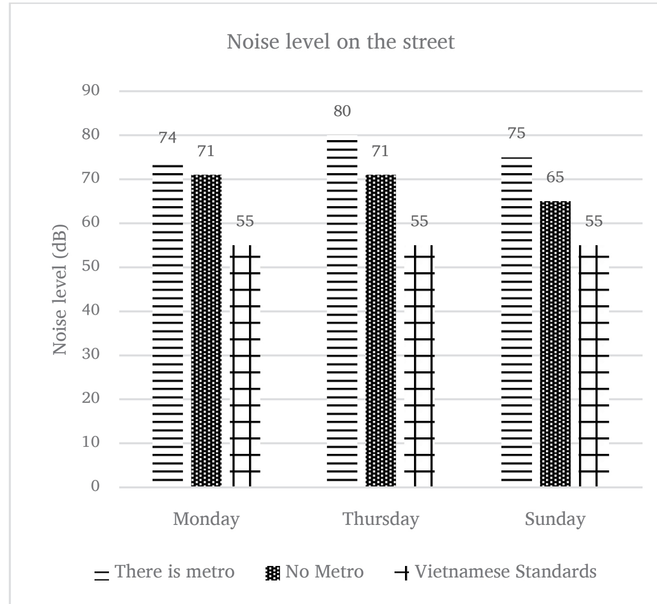

Fig 4. Noise level on the street.

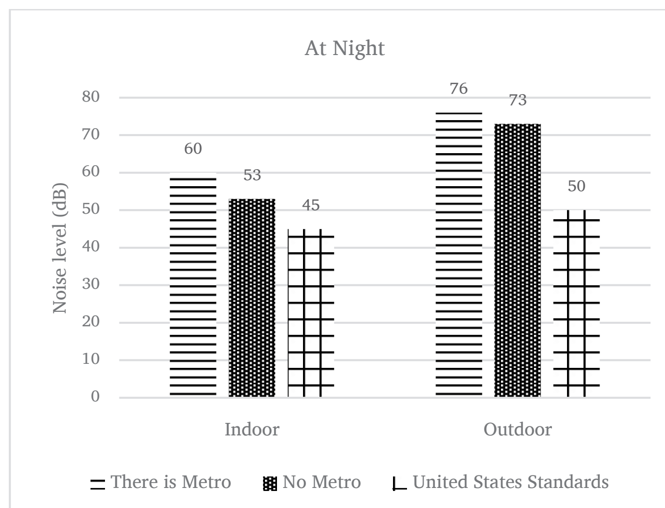

Fig 5. Noise level on the street at night.

Outdoor noise sources: The assessment also summarized the impact of the metro and other vehicles when outdoors, as shown in Fig 6. The difference in noise levels outdoors was not significantly different whether the metro was present or not. This implies that the noise caused by vehicles is equivalent to the noise from the metro, largely attributed to the accumulation and simultaneous movement of vehicles at intersections.

Although the noise level has exceeded the standards of Vietnam as well as the world, in fact we do not need to build noise-proof walls because the impact of the Metro train is only about 5-7 minutes, so the allowable standard is up to 103dB, while the impact of other vehicles is only about 2-3 minutes, the allowable standard is up to 106-109dB [2].

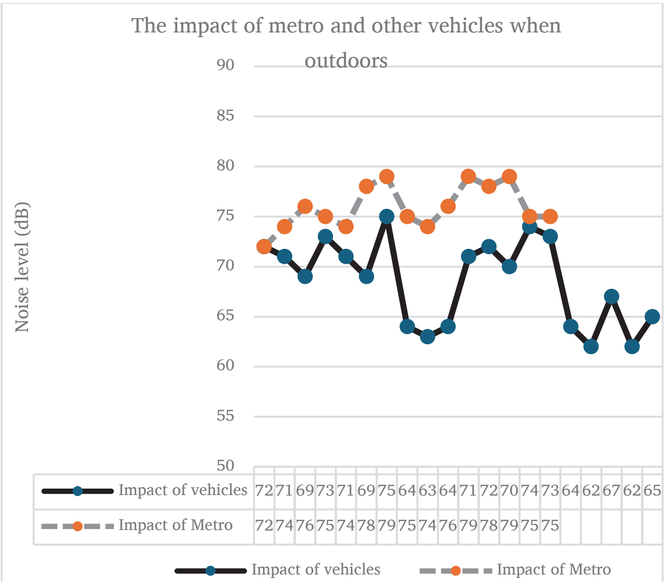

Fig 6. The impact of metro and other vehicles when outdoors.

3. Conclusion

Drawing upon the comprehensive information presented in this study, it is evident that noise pollution represents a significant environmental and health challenge in modern society, with far-reaching negative impacts. Our investigation delved into the landscape of noise standards across Vietnam, the United States, and Japan, explored the documented influences of noise on human health and, particularly, on teaching and learning activities, and presented a case study evaluating actual noise levels at Lecture Hall A2.

The comparative analysis of national noise standards revealed notable variations, underscoring different approaches to managing this ubiquitous pollutant. Japan was identified as enforcing the most stringent noise control measures across special areas, residential zones, and workplaces, with significantly lower permissible decibel limits compared to the United States and Vietnam. Conversely, Vietnam exhibited the most lenient policies, particularly in residential and workplace environments, suggesting a potentially higher tolerance for noise exposure among its population. While vehicle noise emission standards exist, the enforcement levels and specific area regulations differ, with the US and Japan having clearer requirements in certain contexts compared to the absence of clear regulations for vehicles passing through different areas in the U.S. and Vietnam.

In educational settings, specifically university teaching and learning activities, noise acts as a significant barrier. It impairs cognitive performance by causing distraction and reducing the ability to encode and recall information, negatively affecting memory. Noise creates communication barriers, hindering effective interaction between lecturers and students, limiting collaborative activities, and potentially contributing to a negative classroom atmosphere. Furthermore, constant exposure to noise leads to fatigue, discomfort, and can impose long-term health effects on both students and lecturers, forcing them to speak louder and increasing stress levels.

The case study at Lecture Hall A2 provided empirical data on actual noise levels. The measurements indicated that noise levels in the hall often exceeded Vietnamese standards, particularly when the Metro was present, although other sources like student activities also contributed during break times. Measurements on the street showed that traffic is a significant noise source, comparable in impact to the Metro, especially during peak times when vehicles accumulate at intersections. Even at night, indoor noise, while decreased, still exceeded some US standards, and outdoor levels remained high due to persistent transportation. While acknowledging that noise from transient sources like the Metro might have higher permissible exposure limits based on duration, the consistent exceedance of standards highlights a clear noise pollution issue in this specific educational environment.

Addressing the identified noise challenges requires a multi-faceted approach. Proposed solutions range from technical interventions such as installing soundproof glass doors, using sound-absorbing materials within the classroom, and building soundproof barriers or planting trees along railway tracks, to management and organizational strategies. These latter strategies could involve working with railway authorities to adjust train schedules or speeds near schools and re-planning classroom layouts to locate sensitive activities in quieter areas.

In conclusion, this study reinforces the critical need to address noise pollution, particularly in environments sensitive to concentration and communication, such as educational institutions. The findings highlight that despite existing standards, actual noise levels frequently exceed these limits, impacting both health and learning outcomes. Future research should focus on implementing and evaluating the effectiveness of proposed solutions in real-world settings and further investigating the long-term psycho-social effects of noise exposure in academic environments. Policies must be strengthened and enforced to ensure quieter, healthier, and more conducive spaces for teaching and learning.

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