IMPACT OF ADJACENT CONSTRUCTION ON CLASSROOM ACOUSTIC ENVIRONMENT AND SITE SAFETY AT RUET

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ABSTRACT

Rajshahi University of Engineering & Technology (RUET) has experienced rapid campus construction with potential impacts on classroom acoustic conditions and site safety; this study conducted short-term sound monitoring at ten classrooms-adjacent locations (three replicates each) and a structured safety audit at five construction sites. Results show spatially heterogeneous but elevated noise exposures; the Fluid Mechanics Lab area recorded the highest mean maximum level (70.8 dB) with a peak of 79.3 dB and the highest mean midpoint proxy (63.3 dB), while several academic blocks (Civil, Admin, CSE) clustered around 60–61 dB; the library and Heat Engine Lab were lowest (about 56 dB). Safety audits revealed systemic gaps. PPE use was absent, signage was limited, and entry control and first-aid were inconsistent. Given the proximity of noisy operations to teaching spaces, immediate measures (temporary acoustic hoardings, time-restricted noisy works, improved perimeter control, mandatory PPE, and routine spot monitoring) are recommended, alongside longer-term indoor monitoring to assess cumulative exposure and intervention efficacy.

Keywords: *Construction noise, Classroom acoustic exposure, RUET, Safety audit,*

1. INTRODUCTION

Rajshahi University of Engineering & Technology (RUET) is the only government engineering university in northern Bangladesh and has recently invested in large-scale construction to provide modern, technologized, and spacious classrooms and accommodation for its students (Hasan & Younos, 2020). While these developments aim to improve the campus learning environment, construction activities frequently proceed without comprehensive mitigation measures or consistent enforcement of safety protocols, creating audible disturbances for nearby classrooms and safety risks for passers-by and workers (Mir et al., 2022; Kumar et al., 2023).

Evidence from Bangladesh and comparable settings shows construction and road traffic are dominant contributors to elevated community noise, with measured levels routinely exceeding national and international guidelines and producing negative health outcomes (Rahman et al., 2022; Roy et al., 2023; Kumar et al., 2023). Local studies further report that classroom and school environments often experience particulate and gaseous pollutant burdens alongside high noise, with PM2.5, PM10, and noise frequently above WHO-recommended limits and posing potential health risks to students (Islam et al., 2024; Roy et al., 2023). Occupational and community studies also document respiratory, auditory, and broader health impacts linked to particulate and noise exposures in Bangladesh (Saha et al., 2020; Quader et al., 2024).

In addition to exposure concerns, low levels of safety awareness and inconsistent safety behaviours among university populations and construction sites undermine effective risk reduction (Hasan & Younos, 2020; Mir et al., 2022). Given documented gaps in regulation, monitoring, and mitigation, campus construction can create persistent noise hotspots and exacerbate classroom disturbance and health risks unless targeted controls are implemented (Quader et al., 2024; Kumar et al., 2023).

This study, therefore, quantifies ambient sound levels in classrooms adjacent to active construction zones at RUET, compares measured values with national and international guideline limits, and evaluates the adequacy of on-site safety measures. By situating on-campus measurements within the broader literature on noise sources, health impacts, and management frameworks, the investigation aims to identify pragmatic mitigation and safety-management actions that reduce classroom noise exposure and protect campus populations (Mir et al., 2022; Rahman et al., 2022; Islam et al., 2024).

2. METHODOLOGY

The study was conducted at selected classroom-adjacent locations across the RUET campus (Figure 1). Five building groups/sites were surveyed: Architecture, Civil, Administrative (Admin), Computer Science & Engineering (CSE), Electrical and Electronic Engineering (EEE), plus additional activity locations including the Fluid Mechanics Lab, GCE building, Heat Engine Lab, Library, and Fitting Shop. Fieldwork was performed on 30 October 2025 during the morning period (approx. 09:50–10:30) when construction activity and class-related noise were present.

Measurement posture and position: Each measurement was taken at a representative classroom façade or adjacent outdoor point close to classroom openings, at approximately ear height (≈1.2–1.5 m), and at a fixed distance from the construction or road edge to ensure comparability across sites.

Temporal coverage: Measurements were taken in the same morning session for all sites to reduce diurnal variability.

Purpose: To assess the presence and adequacy of construction-site safety controls that could influence noise exposure and occupant/worker safety.

Checklist items: Safety barrier, warning signage, debris, material storage, controlled entry/exit, first-aid availability, supervisor presence, lighting, and use of PPE (helmet, boots, gloves, jacket, goggles).

Sites audited: Civil building (Site 1), Admin building (Site 2), Mechanical building (Site 3), EEE building (Site 4), and beside-library location (Site 5).

Fig. 1: Study area

Data recording: For each item, inspectors recorded categorical assessments **(e.g., yes/no/moderate/ok/not enough/a few/uncontrolled/controlled) during the same morning visit.** Spatial and temporal patterns: Site-to-site differences were examined to identify hotspots and relate measured levels to proximate noise sources (construction activity, traffic, student activity) and built-form characteristics (classroom orientation, ventilation openings).

3. RESULTS AND DISCUSSIONS

Measurement summary computed as: Mean Max dB **= average of the three recorded Max dB values per location;** Mean Min dB **= average of the three recorded Min dB values per location;** Mean midpoint dB **= mean of (Mean Max dB and Mean Min dB). Values rounded to one decimal** (Table 1).

Table 1: Measurement summary

Location	Mean Max dB	Mean Min dB	Mean midpoint dB
Architecture building	64.0	54.7	59.4
Civil building	67.1	53.9	60.5
Admin building	67.1	54.6	60.8

Location	Mean Max dB	Mean Min dB	Mean midpoint dB
CSE building	67.5	52.6	60.1
EEE building	64.5	51.1	57.8
Fluid mechanics lab	70.8	55.8	63.3
GCE building	67.2	52.3	59.8
Heat Engine Lab	62.6	51.3	56.9
Library	61.2	50.8	56.0
Fitting Shop	66.1	50.9	58.5

Highest **Mean Max dB**: Fluid mechanics lab (70.8 dB). Highest **Mean midpoint dB** (proxy for central exposure): Fluid mechanics lab (63.3 dB), followed by Civil/Admin/CSE areas (~60–61 dB). Lowest **Mean midpoint dB**: Library (56.0 dB) and Heat Engine Lab (56.9 dB). Largest observed single Max value across all sites: 79.3 dB (Fluid mechanics lab observation 3). Smallest observed single Min value across all sites: 48.1 dB (Heat Engine Lab obs 1).

Site 1 — Civil building: Moderate safety barriers; no warning signage; material storage average; entry moderately controlled; first-aid available; supervisor present; lighting OK; PPE (helmets, boots, gloves, goggles) not used; jackets worn by a few. Overall: administrative controls are partially present, but PPE compliance is absent.

Site 2 — Admin building: No safety barrier; no signage; material storage OK; entry uncontrolled; first-aid available; supervisor present; lighting OK; no PPE observed; jackets a few. Overall: weak perimeter control and signage; supervision present, but entry uncontrolled.

Site 3 — Mechanical building: Safety barrier present; no signage; material storage OK; entry controlled; first-aid insufficient; supervisor present; lighting OK; no PPE observed; jackets a few. Overall: better physical controls, but first-aid and PPE are lacking.

Site 4 — EEE building: Safety barrier present; warning signage present; material storage average; entry controlled; first-aid available; supervisor present; lighting OK; no PPE; jackets a few. Overall: relatively better control and signage, but PPE absent.

Site 5 — Beside library: Moderate safety barrier; warning signage present; material storage average; entry moderately controlled; first-aid not available; supervisor present; lighting OK; no PPE; jackets a few. Overall: moderate controls but critical gaps in first-aid and PPE.

Common safety gaps: PPE usage (helmets, boots, gloves, goggles) was uniformly absent across all audited sites. Warning signage was absent at most sites except the EEE building and beside the library. Entry control varied from uncontrolled to controlled; two sites reported uncontrolled or only moderately controlled access. First-aid provision was inconsistent (one site reported "not enough", one site reported "no").

The highest measured noise exposures (Fluid mechanics lab, Civil/Admin/CSE clusters) coincide with sites showing mixed or incomplete safety controls, suggesting concurrent risks to both classroom occupants and workers. Absence of consistent perimeter controls, signage, and PPE increases the potential for both direct injury risk to passersby/workers and uncontrolled noise-generating activities close to classroom openings. Noise hotspots are listed in Table 2.

Table 2: Noise hotspot ranking

Rank	Location	Mean Max dB	Mean midpoint dB	Likely dominant source
1	Fluid mechanics lab	70.8 dB	63.3 dB	Construction / intermittent heavy machinery
2	Civil building	67.1 dB	60.5 dB	Construction activity/traffic
3	Admin building	67.1 dB	60.8 dB	Construction activity/campus traffic

Rank	Location	Mean Max dB	Mean midpoint dB	Likely dominant source
4	CSE building	67.5 dB	60.1 dB	Nearby construction/student activity
5	Fitting Shop	66.1 dB	58.5 dB	Workshop tools/equipment noise
6	GCE building	67.2 dB	59.8 dB	Construction/traffic
7	Architecture building	64.0 dB	59.4 dB	Construction/adjacent activity
8	EEE building	64.5 dB	57.8 dB	Construction/traffic
9	Heat Engine Lab	62.6 dB	56.9 dB	Workshop/test equipment
10	Library	61.2 dB	56.0 dB	Traffic: lower internal noise

The present study documents elevated ambient noise levels at classroom-adjacent locations across the RUET campus and identifies clear hotspots (Fluid Mechanics Lab, Civil/Admin/CSE clusters) where mean maximum and midpoint sound levels approach or exceed recommended community limits. These findings align with broader evidence from Bangladesh and comparable settings that construction and road-traffic sources produce persistent, guideline-exceeding exposures in educational and residential environments (Rahman et al., 2022; Kumar et al., 2023; Quader et al., 2024). The observed peak values (up to ~79 dB) and morning-period variability are consistent with intermittent heavy machinery and vehicular pass-byes reported in on-campus and urban studies, underscoring the episodic yet substantial character of exposure that can interrupt classroom activities and reduce acoustic comfort (Kumar et al., 2023; Mir et al., 2022).

Comparison with school- and classroom-focused studies indicates a compounded risk where noise co-occurs with other indoor pollutants. Islam et al. (2024) reported that school environments in Bangladesh frequently experience simultaneous exceedance of PM2.5/PM10 and high noise levels; our RUET measurements show a similar pattern of localized high-noise microenvironments adjacent to active works and workshops (Fluid Mechanics, Fitting Shop). The concurrence of mechanical and construction noise with academic spaces suggests potential for both acute classroom disturbance (reduced speech intelligibility, concentration loss) and chronic impacts on hearing and well-being if exposures persist during instructional hours (Islam et al., 2024; Roy et al., 2023).

The safety-audit results highlight systemic gaps in on-site mitigation and worker protection (absent PPE, inconsistent signage, variable entry control). These findings echo workplace and community studies from Bangladesh, where inadequate safety culture and enforcement exacerbate exposure and health risks (Hasan & Younos, 2020; Saha et al., 2020). In particular, the near-universal absence of helmets, boots, gloves, and goggles at construction points adjacent to classrooms signals both occupational vulnerability and a higher likelihood of uncontrolled noisy operations occurring close to sensitive receptors. Mir et al.'s (2022) synthesis of construction-noise management advocates integrated assessment and control steps (assessment, prediction, control, monitoring); the observed deficiencies at RUET indicate weak implementation of that framework and point to immediate administrative and engineering priorities.

From a health-risk perspective, the RUET noise profiles resemble those associated with adverse outcomes in population studies. Rahman et al. (2022) and Quader et al. (2024) reported strong associations between elevated urban noise and poorer self-reported health, with traffic and construction featuring as primary sources. Given that many RUET classrooms face uninterrupted exposure during lecture periods, the campus context is likely to produce not only short-term performance decrements but also contribute to cumulative annoyance and stress for students and staff—effects documented in the cited epidemiological work.

Our findings also complement research emphasizing source-proximate and building-envelope controls. Kumar et al. (2023) and Mir et al. (2022) both highlight practical mitigation hoardings, acoustic screens, scheduling, and traffic management as effective first-line measures. The hotspot-specific recommendations offered here (temporary hoardings, acoustic barriers, scheduling noisy operations outside teaching hours, localized enclosures for noisy equipment) are therefore consistent with established best practice and directly address the gaps observed in the safety audit. For sensitive receptors such as the library and lecture theatres, the combined use of administrative scheduling and secondary glazing or sealing is likely to offer meaningful reductions in classroom intrusions without large capital works, as recommended in prior campus-level mapping studies (Kumar et al., 2023).

Limitations of the present work should be considered when extrapolating to health outcomes and policy. Measurements were limited to a single morning session and to outdoor/adjacent façades rather than continuous indoor logging, which constrains estimates of cumulative daily or semester-long exposure and internal classroom attenuation/ amplification effects. Comparable studies that report indoor pollutant co-exposures and health metrics (Islam et al., 2024; Roy et al., 2023) typically employ longer-term monitoring and personal exposure assessment to link exposures to physiological outcomes; future RUET work would benefit from such extended monitoring and from coupling noise data with subjective disturbance surveys and cognitive-performance measures.

Practical implications for campus governance emerge clearly from the synthesis. First, immediate administrative fixes enforcing PPE, signage, controlled entry, and permitted working hours are low-cost steps that address both safety and noise generation near classrooms, consistent with the safety-culture deficits reported by Hasan and Younos (2020). Second, targeted engineering measures (acoustic hoardings, mufflers, enclosures, and sealing of classroom openings) are supported by construction-noise management literature and are likely to achieve rapid reductions in classroom intrusions (Mir et al., 2022; Kumar et al., 2023). Third, instituting a simple monitoring-and-response protocol routine, spot monitoring, a complaints desk, and coordination between academic timetabling and contractors would operationalize the "assessment → control → monitoring" loop emphasized in systematic reviews (Mir et al., 2022).

In conclusion, the RUET campus exhibits spatially heterogeneous but concerning noise exposures at several classroom-adjacent sites, driven primarily by construction, workshop activities, and traffic. These exposures occur alongside institutional safety gaps and mirror patterns reported in Bangladeshi urban and occupational studies, indicating risks to acoustic comfort, learning, and health (Rahman et al., 2022; Quader et al., 2024; Islam et al., 2024; Saha et al., 2020). Implementing a prioritized mix of administrative controls and targeted engineering interventions guided by routine monitoring and strengthened site safety practices would align RUET with established best practices and substantially reduce both noise nuisance and safety hazards for students, staff, and workers.

4. CONCLUSIONS

This rapid assessment found that classroom-adjacent locations at RUET experience spatially heterogeneous but meaningful noise elevations, most pronounced at the Fluid Mechanics Lab and clustered across Civil, Admin, and CSE areas, occurring alongside consistent deficiencies in basic site safety controls (absent PPE, limited signage, variable entry control, and inconsistent first-aid). The combined evidence indicates dual risks to acoustic comfort, learning performance, and worker/bystander safety. Immediate, low-cost actions (temporary acoustic hoardings, rescheduling of high-noise tasks outside teaching hours, controlled site perimeters, visible signage, mandatory PPE, and routine spot monitoring) should be implemented without delay. Medium-term measures (sealing or secondary glazing for sensitive classrooms, localized equipment enclosures, contractor noise clauses) and longer-term actions (continuous indoor/outdoor monitoring, integration of noise-management into procurement/contracts, and periodic safety-culture training) are recommended to reduce exposure, strengthen compliance, and enable evaluation of intervention effectiveness.

DECLARATION OF USE OF AI

No help from AI was utilized in this paper

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