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Users' Perception of Acoustic Quality in Lecture Theatres at Ladoke Akintola University of Technology, Ogbomoso, Nigeria

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Abstract- The study assesses acoustic design features and users' perception of acoustic conditions in selected lecture theatres at Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria, with emphasis on their implications for speech intelligibility, acoustic comfort, and effective teaching and learning. The aim is to identify the acoustic design features available in the selected lecture theatres and assess the factors influencing users' perception of acoustic conditions. The study adopted a mixed-method approach involving field observation and questionnaire survey. Seven lecture theatres were purposively selected from twelve identified lecture theatres, with a combined capacity of 6,200 seats. A sample size of 376 respondents was obtained using the Slovin formula and proportionately distributed across the selected lecture theatres, while incidental sampling was used for questionnaire administration. Data were analysed using descriptive statistics and Mean Weighted Values (MWV). Findings reveal that active acoustic facilities were better provided than passive acoustic treatments. Public Address systems recorded the highest rating (MWV = 3.71), followed by microphone systems (3.56) and loudspeaker distribution (3.50), while acoustic door seals (2.00), sound-absorbing floors (2.05), acoustic wall panels (2.23), and window treatments (2.27) recorded the lowest ratings. External traffic noise was identified as the most influential factor affecting users' acoustic perception (MWV = 4.09), followed by the quality of acoustic design (4.03) and generator or mechanical noise (3.97). The findings highlight the need for a balanced integration of active and passive acoustic strategies, particularly improved sound insulation, sound-absorbing materials, and noise control measures, to enhance acoustic comfort, speech intelligibility, and teaching and learning in university lecture theatres.

Keywords: Acoustic Quality, Lecture Theatres, Acoustic Design, User Perception, Sound Insulation, LAUTECH, Nigeria

I. INTRODUCTION

Acoustic quality is an important component of the built environment because it influences speech intelligibility, communication, concentration, comfort, and overall user experience within learning spaces (Kang, 2020; Ayinla *et al.*, 2023). In educational environments, effective acoustic conditions are particularly important because teaching and learning depend largely on the ability of students to clearly hear and understand spoken information. Poor acoustic conditions characterised by excessive reverberation, background noise, sound reflections, and inadequate speech clarity can impair students' concentration and comprehension while increasing lecturers' vocal effort and fatigue (Kang & Schulte-Fortkamp, 2016; Garai *et al.*, 2020; Toftum *et al.*, 2021; Minelli *et al.*, 2022). Consequently, acoustic quality should be considered an essential aspect of architectural design for effective and comfortable learning environments.

Lecture theatres present particular acoustic challenges because they accommodate relatively large numbers of users and typically have greater room volumes, tiered seating arrangements, hard interior surfaces, and extensive dependence on public address and audiovisual systems. These characteristics can influence sound distribution, reverberation, and speech intelligibility within the space (Rindel, 2022; García *et al.*, 2023). Appropriate acoustic design features, including sound-absorbing materials, suitable ceiling and wall treatments, effective room geometry, acoustically appropriate openings, and efficient public address systems, are therefore required to support satisfactory acoustic performance (Everest & Pohlmann, 2015; Kang, 2020; Zannin & Marcon, 2021). International acoustic guidelines similarly emphasise the importance of controlling reverberation and background noise to achieve acceptable speech communication in educational spaces (ISO 3382-1, 2009; ANSI S12.60, 2010; IEC 60268-16, 2020).

Despite these established principles, inadequate acoustic conditions remain a concern in many educational facilities in Nigeria. Studies have reported excessive reverberation, intrusive external noise, inappropriate use of reflective finishes, inadequate sound absorption, and poor sound distribution in university learning spaces (Amasuomo & Ntibi, 2018; Ajala & Adeniran, 2021; Odeleye & Olatunji, 2022; Adewale & Oyelami, 2023). Such conditions can negatively affect users' ability to hear lectures and may reduce acoustic comfort and learning effectiveness. While considerable attention has been given to measurable acoustic parameters, users' experiences provide an equally important dimension for understanding the functional performance of lecture theatres.

Furthermore, acoustic design features such as ceiling configuration, wall finishes, doors, windows, seating materials, public address systems, and sound-absorbing treatments can determine how sound is generated, reflected, absorbed, and distributed within lecture theatres. However, there remains limited empirical documentation of the presence and condition of these features in university lecture theatres in Nigeria, particularly within Ladoke Akintola University of Technology (LAUTECH), Ogbomoso. Existing studies have largely focused on individual acoustic parameters or general acoustic performance, with less emphasis on systematically documenting the acoustic design features available in lecture theatres and understanding how users perceive their condition and performance (Adekalu & Alibaba, 2018; Ajala & Adeniran, 2021; Ayinla *et al.*, 2023). Therefore, this study focuses on the acoustic design characteristics of selected lecture theatres at Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Specifically, the study identifies the acoustic design features present in the selected lecture theatres and assesses users' perception of their condition and performance. The findings are expected to provide empirical evidence that can support improved acoustic design and management of lecture theatres in Nigerian higher institutions.

Study Area: Ladoke Akintola University of Technology (LAUTECH)

Ladoke Akintola University of Technology (LAUTECH), established in 1990, is a public university located in Ogbomoso, Oyo State, Nigeria. The university is situated within the tropical savanna climate zone, characterised by distinct wet and dry seasons, relatively high temperatures, and annual rainfall exceeding 1,000 mm. These environmental conditions, together with the physical characteristics of buildings, can influence the indoor environmental conditions of learning spaces, including acoustic quality.

The university comprises several faculties and a large student population served by lecture theatres of varying capacities, ages, spatial configurations, construction materials, finishes, and acoustic features. The variation in the physical characteristics of these lecture theatres provides a suitable context for assessing the presence and condition of acoustic design features and users' perceptions of their performance. The study therefore focuses on selected lecture theatres within LAUTECH as representative learning spaces for evaluating acoustic quality from the users' perspective.

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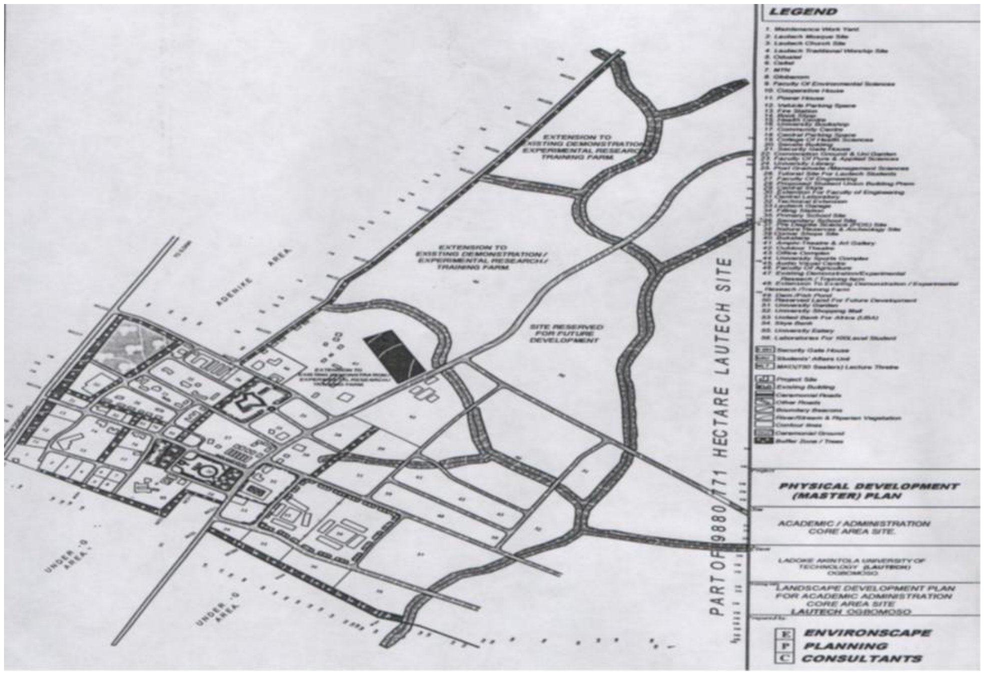

Figure 1.0: Master Plan of LAUTECH.
Source: Physical Planning Unit, LAUTECH (2026)

II. LITERATURE REVIEW

Acoustics is an essential aspect of educational facility design because it influences speech intelligibility, concentration, communication, and learning effectiveness. Poor acoustic conditions, such as excessive reverberation, background noise, and inadequate speech clarity, can increase listening effort and reduce students' comprehension (Mealings *et al.*, 2023; Lindawati *et al.*, 2024). Lecture theatres require particular acoustic attention because their large volumes, high occupancy, tiered seating, and extensive use of hard surfaces can affect sound distribution and speech intelligibility (Rindel, 2022; García *et al.*, 2023).

Acoustic quality is influenced by architectural configuration, materials, finishes, and sound reinforcement systems. Features such as sound-absorbing ceilings and walls, acoustic panels, appropriate openings, upholstered seating, diffusers, and public address systems can reduce unwanted reflections and improve sound distribution (Elkhateeb, 2017; Pereira *et al.*, 2021; Zhang & Liu, 2024). Room geometry and seating arrangement also contribute to acoustic performance, indicating that effective acoustic quality depends on the combined performance of several design features.

Acoustic environments can be evaluated through objective measurements and users' perceptions. Parameters such as reverberation time, background noise, and Speech Transmission Index are commonly used to assess acoustic performance, with standards such as ISO 3382-1 and ANSI/ASA S12.60 providing recommended criteria for educational spaces (ISO 3382-1, 2009; ANSI/ASA, 2010). However, physical measurements alone may not fully reflect users' experiences of speech clarity, noise disturbance, and acoustic comfort. Consequently, users' perception provides an important complementary measure of the functional performance of acoustic design features (Arvidsson *et al.*, 2021; Mealings *et al.*, 2023).

In Nigerian universities, studies have reported excessive reverberation, intrusive noise, reflective finishes, inadequate sound absorption, and poor acoustic treatment in learning spaces (Ayinla *et al.*, 2023; Ajala & Adeniran, 2021). Despite these concerns, limited studies have systematically documented acoustic design features and assessed how users perceive their condition and performance, particularly in LAUTECH lecture theatres. This study

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therefore identifies the acoustic design features present in selected LAUTECH lecture theatres and assesses users' perception of their condition and performance.

III. RESEARCH METHODOLOGY

The study adopted a mixed-method approach combining field observation and questionnaire survey to assess acoustic design features and users' perception of their condition and performance in selected lecture theatres at Ladoke Akintola University of Technology (LAUTECH), Ogbomoso. Relevant literature, acoustic standards, and institutional records were also consulted.

A reconnaissance survey identified twelve (12) lecture theatres, from which seven (7) were purposively selected based on differences in capacity, spatial configuration, and physical characteristics. The selected theatres comprised 250 LT, MKO LT, FAG LT, FPASS LT, SIFAX LT, MGS LT, and FET LT, with a combined capacity of 6,200 seats. Using the Slovin formula at a 5% margin of error, a sample size of 376 users was obtained and proportionately distributed across the selected theatres. Incidental sampling was used to select available users during data collection.
A structured observation checklist was used to document acoustic features, including room configuration, ceiling and wall finishes, floor finishes, openings, seating materials, sound-absorbing elements, and public address systems. A structured questionnaire using a five-point Likert scale was administered to assess users' perception of speech clarity, audibility, background noise, sound distribution, reverberation, and overall acoustic comfort.

Observation data were analysed using descriptive content analysis, while questionnaire responses were analysed using SPSS. Frequencies, percentages, mean scores, and standard deviations were used to summarise responses, while Mean Weighted Values (MWV) were used to rank the perceived condition and performance of the acoustic design features.

IV. FINDINGS AND DISCUSSION

Acoustic Design Features Present in Selected Lecture Theatres
An assessment of the acoustic design features present in the selected lecture theatres at Ladoke Akintola University of Technology is presented in Table 4.1. The findings indicate that active sound reinforcement features were the most prominent. Public Address (PA) systems recorded the highest mean value (3.71), followed by microphone systems (3.56) and loudspeaker distribution (3.50), indicating that sound amplification facilities were relatively well provided across the lecture theatres. Ceiling height suitability (3.41), theatre shape design (3.38), seating arrangement (3.34), and seat spacing (3.29) were also moderately to adequately represented.

Table 4.1: Analysis of Acoustic Design Features Using Likert Scale

S/N	Acoustic Design Feature	Very Well Provided (5)	Adequately Available (4)	Moderately Available (3)	Poorly Available (2)	Not Available (1)	TMV	AMV	Decision	Rank
1	PA System	140	120	60	20	14	1314	3.71	Adequately Provided	1st
2	Microphone System	130	110	70	28	16	1262	3.56	Adequately Provided	2nd
3	Loudspeaker Distribution	120	115	75	30	14	1242	3.50	Adequately Provided	3rd
4	Ceiling Height Suitability	110	120	70	35	19	1207	3.41	Adequately Provided	4th
5	Theatre Shape Design	105	118	72	40	19	1196	3.38	Moderately Available	5th

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6	Seating Arrangement	100	110	75	45	24	1182	3.34	Moderately Available	6th
7	Seat Spacing	95	105	80	50	24	1165	3.29	Moderately Available	7th
8	Mechanical Noise Control	90	100	85	50	29	1121	3.16	Moderately Available	8th
9	Sound Reflection Control	85	100	85	60	24	1107	3.13	Moderately Available	9th
10	External Noise Insulation	50	70	80	90	64	860	2.43	Poorly Provided	10th
11	Acoustic Ceiling Materials	45	65	85	95	64	828	2.34	Poorly Provided	11th
12	Window Treatment	40	65	85	95	69	803	2.27	Poorly Provided	12th
13	Acoustic Wall Panels	40	60	80	110	64	790	2.23	Poorly Provided	13th
14	Sound Absorbing Floor	30	55	70	120	79	726	2.05	Poorly Provided	14th
15	Acoustic Door Seals	35	50	75	110	84	708	2.00	Poorly Provided	15th

Source: Author's Field, 2026

In contrast, passive acoustic features recorded lower ratings. Mechanical noise control (3.16) and sound reflection control (3.13) were moderately provided, while external noise insulation (2.43), acoustic ceiling materials (2.34), window treatment (2.27), and acoustic wall panels (2.23) were poorly provided. Sound-absorbing floor systems (2.05) and acoustic door seals (2.00) recorded the lowest ratings, indicating their limited provision within the selected lecture theatres.

The findings therefore reveal a clear dominance of active acoustic systems over passive architectural acoustic treatments. This suggests that greater emphasis has been placed on amplification systems for lecture delivery, while features required for sound absorption, insulation, and control of unwanted reflections and external noise remain limited. Similar concerns have been reported in Nigerian university learning environments, where inadequate acoustic treatment and inappropriate material selection contribute to poor acoustic performance (Ayinla *et al.*, 2023; Ajala & Adeniran, 2021). Effective lecture theatre design therefore requires a balanced integration of sound reinforcement and passive acoustic features to support speech intelligibility and acoustic comfort.

B. Factors Influencing Users' Perception of Acoustic Conditions in Lecture Theatres

The factors influencing users' perception of acoustic conditions in the selected lecture theatres at Ladoke Akintola University of Technology are presented in Table 4.3. The results indicate that users perceived environmental noise, building design, teaching characteristics, and occupancy conditions as important factors affecting acoustic quality. External traffic noise recorded the highest mean value (MWV = 4.09), indicating that it was the most influential factor affecting users' acoustic experience. This was followed by the quality of acoustic design of the building (MWV = 4.03), generator or mechanical noise (MWV = 3.97), quality of sound amplification system (MWV = 3.91), and students' noise during lectures (MWV = 3.91). These results show that both external and internal noise sources, together with the quality of acoustic design and sound reinforcement, strongly influence acoustic conditions within the lecture theatres.

Ranking of Factors Affecting Acoustic Conditions

Rank	Factor	MWV
1st	External traffic noise	4.09
2nd	Quality of acoustic design of the building	4.03
3rd	Generator or mechanical noise	3.97

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4th	Quality of sound amplification system	3.91
4th	Students' noise during lectures	3.91
6th	Ventilation system noise	3.81
7th	Class size (crowding)	3.79
8th	Lecturer's voice projection	3.76
9th	Corridor activities	3.75
10th	Building materials	3.67
11th	Room size and volume	3.66
12th	Distance from the lecturer	3.63
13th	Shape of the lecture theatre	3.55
14th	Seating position	3.53
15th	Ceiling height	3.47

Other factors also recorded relatively high mean values. Ventilation system noise had a mean value of 3.81, followed by class size or crowding (MWV = 3.79), lecturer's voice projection (MWV = 3.76), corridor activities (MWV = 3.75), building materials (MWV = 3.67), and room size and volume (MWV = 3.66). These findings suggest that users' acoustic experience is influenced not only by noise sources but also by the physical characteristics of the lecture theatres and the conditions under which teaching takes place.

Distance from the lecturer (MWV = 3.63), shape of the lecture theatre (MWV = 3.55), and seating position (MWV = 3.53) were also perceived as influential. Ceiling height recorded the lowest mean value (MWV = 3.47), although it remained influential in determining acoustic conditions. Overall, the findings demonstrate that environmental noise and acoustic design factors exert greater influence on users' perception than individual spatial characteristics. The results therefore emphasize the need for lecture theatre design to address external and internal noise control, appropriate acoustic materials, effective sound amplification, room configuration, and seating arrangement to improve speech intelligibility and acoustic comfort.

V. CONCLUSION AND RECOMMENDATIONS

The study revealed that acoustic quality in the selected lecture theatres at Ladoke Akintola University of Technology (LAUTECH) is strongly influenced by the availability of acoustic design features and the level of environmental and internal noise. The findings showed that active acoustic facilities were relatively better provided than passive acoustic treatments. Public Address (PA) systems recorded the highest rating (MWV = 3.71), followed by microphone systems (MWV = 3.56) and loudspeaker distribution (MWV = 3.50), indicating adequate provision of sound amplification facilities. However, important passive acoustic features, including external noise insulation (MWV = 2.43), acoustic ceiling materials (MWV = 2.34), window treatment (MWV = 2.27), acoustic wall panels (MWV = 2.23), sound-absorbing floors (MWV = 2.05), and acoustic door seals (MWV = 2.00), were poorly provided. This indicates an over-reliance on amplification systems without corresponding architectural measures for sound absorption, insulation, and reflection control.

The study further established that external traffic noise was the most influential factor affecting users' perception of acoustic conditions, with an MWV of 4.09. This was followed by the quality of acoustic design of the building (MWV = 4.03), generator or mechanical noise (MWV = 3.97), quality of sound amplification systems (MWV = 3.91), and students' noise during lectures (MWV = 3.91). Ventilation system noise, class size, lecturer's voice projection, and corridor activities also recorded relatively high ratings. These findings demonstrate that acoustic conditions in the lecture theatres are shaped by a combination of external noise sources, internal activities, building design, sound reinforcement, and spatial characteristics.

Overall, the findings indicate that improving acoustic quality in LAUTECH lecture theatres requires a shift from dependence on sound amplification towards a more integrated architectural acoustic approach. Therefore, the incorporation of acoustic ceiling and wall treatments, sound-absorbing floor finishes, effective door and window seals, and appropriate external noise insulation is recommended. Lecture theatres should also be carefully planned and located to minimise exposure to traffic and mechanical noise, while adequate control of generator and ventilation noise should be incorporated into building services design. Effective seating arrangements, appropriate room geometry, and properly distributed sound reinforcement systems should also be maintained to improve speech intelligibility and acoustic comfort.

It is therefore recommended that future renovation and design of lecture theatres at LAUTECH and similar Nigerian universities should prioritise both passive and active acoustic strategies. Particular attention should be given to controlling external traffic noise, improving sound insulation, introducing sound-absorbing materials, and ensuring appropriate acoustic treatment of ceilings, walls, floors, windows, and doors. Such measures would provide a more balanced acoustic environment, enhance speech intelligibility, reduce listening difficulties, and support effective teaching and learning.

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