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USER PERCEPTIONS AND PREFERENCES OF ACOUSTIC COMFORT PARAMETERS IN LARGE GATHERING FACILITIES IN YOLA, NIGERIA

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ABSTRACT

Acoustic comfort is fundamental to the functionality of conference centres and other large gathering facilities where speech communication constitutes the primary activity. However, the acoustic performance of such facilities is often insufficiently considered during architectural design, particularly in developing-country contexts. This study investigated acoustic comfort parameters, users' perceptions and preferences in large gathering facilities in Yola, Adamawa State, Nigeria. Specifically, the study identified key acoustic design parameters, assessed users' perceptions of existing acoustic conditions and appraised users' preferences for acoustic parameters in future gathering facilities. A descriptive survey component of a mixed-method research design was adopted. A structured questionnaire was administered to 120 potential users selected through purposive and stratified random sampling. Data were analysed using frequencies and percentages. Results showed that 93.3% of respondents were aware of acoustic comfort. Ceiling height (81.7%), room shape (78.3%) and wall finishes (77.5%) were the most frequently identified architectural factors affecting sound quality, while 70.0% identified speech intelligibility as the most critical acoustic parameter. Although 81.7% rated existing sound quality as fair, 72.5% often experienced difficulty hearing speakers and 65.0% described background noise as moderate. Regarding preferences, 73.3% preferred moderately quiet environments, 79.2% prioritized good sound distribution, 84.2% considered sound-absorbing finishes important or very important, 80.8% preferred combining natural acoustic design with electronic amplification, and 87.5% regarded external-noise isolation as very important. The findings reveal a substantial gap between existing acoustic conditions and users' desired acoustic environments. The study concludes that conference and large gathering facilities in Yola should integrate acoustic considerations from the earliest stages of architectural design, with particular emphasis on room geometry, speech intelligibility, sound distribution, reverberation control, absorptive materials and external-noise isolation.

Keywords: Acoustic Comfort; Architectural Acoustics; User Perception; User Preference; Speech Intelligibility.

1 INTRODUCTION

Acoustic comfort is an essential dimension of indoor environmental quality and building performance. In conference centres, lecture theatres, auditoria and other large gathering facilities, its importance is heightened because communication depends substantially on occupants' ability to hear and understand speech [1]. Acoustic deficiencies such as excessive reverberation, high background noise, echoes and uneven sound distribution may therefore undermine the primary function for which these spaces are created. Contemporary research increasingly recognizes

that acoustic comfort cannot be evaluated solely through physical sound measurements. It is also a perceptual phenomenon involving occupants' interpretation and evaluation of the acoustic environment. Torresin et al. [1], for example, demonstrated that indoor acoustic perception encompasses perceptual dimensions beyond sound-pressure level alone. More recent research has consequently advocated approaches that combine objective acoustic conditions with users' subjective assessments and preferences [2–5]. For speech-oriented environments, speech intelligibility, reverberation time, background-noise level and signal-to-noise ratio are particularly important. Choi [6] demonstrated that speech intelligibility in university classrooms is strongly related to acoustic parameters including signal-to-noise ratio and clarity. A related investigation of active classrooms showed strong relationships among speech transmission, noise and intelligibility [7].

Reverberation is especially important because excessive persistence of sound can mask subsequent speech signals. Chen and Ou [8] demonstrated that both reverberation time and traffic noise influence listening comprehension, while Mealings [9] found from a review of classroom interventions that acoustic treatment can improve listening, learning and well-being. A broader review of acoustic parameters likewise identifies reverberation and noise as critical determinants of learning and speech communication [10]. The relationship between architectural design and acoustic performance is consequently significant. Room volume, geometry, ceiling height, wall configuration, openings and surface materials influence the reflection, absorption and diffusion of sound. A recent investigation by Yang et al. [11] found excessive reverberation to be a major source of poor acoustic performance in a university lecture hall and demonstrated that strategically positioned sound-absorbing treatment could significantly improve performance. Studies are also increasingly moving toward user-centred acoustic design. Acoustic environments should not simply satisfy numerical standards but should correspond with the activities, expectations and preferences of occupants. Hamida et al. [12] argue that occupants' acoustic needs and preferences need to be incorporated into evaluations of educational environments, while Ipinza-Olatte et al. [13] found clear differences in users' perceptions of acoustic comfort across learning environments.

This issue is relevant in Nigeria, where buildings frequently operate within environments characterized by traffic, generators, commercial activity and other noise sources. In such settings, inadequate building envelopes, inappropriate openings and insufficient absorptive treatments can allow environmental noise and internal reverberation to undermine speech communication. Recent Nigerian evidence demonstrates that the problem extends to gathering facilities. Oluwatayo and Adele [14] investigated acoustic design strategies and user satisfaction in convention centres in Lagos and found that specific architectural strategies—including ceiling treatments, vegetation, upholstered furniture, insulation and absorptive materials—were associated with user satisfaction. Mba et al. [15] similarly emphasized optimal acoustic control as a central requirement in contemporary conference-centre design in Nigeria.

Despite this emerging research, evidence concerning acoustic comfort in North-Eastern Nigerian gathering facilities remains limited. This paper specifically identifies the need for context-sensitive evidence from Yola rather than simply transferring international acoustic findings to a substantially different climatic, material and social context. Yola serves as the administrative capital of Adamawa State and accommodates universities, government establishments, civil-society organisations and other institutions that regularly organise conferences, seminars, workshops and public gatherings. Large gathering facilities are therefore an important component of the city's institutional infrastructure. The parent study found that acoustic deficiencies are not merely theoretical. A large majority of respondents had personally experienced poor sound quality in conference and gathering facilities in Yola. Understanding both their perceptions of existing facilities and their preferences for future facilities can therefore provide an empirical basis for more responsive architectural design. Accordingly, this study combines the first three empirical objectives of the parent research.

The study sought to: identify the key acoustic design parameters for large gathering facilities; assess users' perceptions of acoustic comfort parameters in large gathering facilities in Yola; and appraise users' preferences for acoustic comfort parameters in large gathering facilities in Yola.

2 LITERATURE REVIEW

2.1 Acoustic Comfort in Large Gathering Facilities

Acoustic comfort represents an occupant's satisfactory interaction with the acoustic environment. It involves the control of unwanted sounds while simultaneously ensuring that desired sounds remain audible, intelligible and appropriately distributed. Recent research has moved beyond defining acoustic quality simply as the absence of noise. Torresin et al. [1] identified multidimensional components of indoor acoustic perception, demonstrating that comfort depends upon both physical sound characteristics and the meaning occupants attach to sounds. Hossain et al. [16] similarly concluded from a systematic review that indoor soundscape assessment increasingly incorporates activity and user responses alongside conventional acoustic measurements. This broader conception is particularly relevant to conference environments because the desired acoustic condition is not complete silence. Instead, occupants require an

environment in which intended speech can be transmitted effectively without substantial interference from reverberation or unwanted noise.

2.2 Speech Intelligibility

Speech intelligibility describes the extent to which listeners can accurately perceive spoken information. It represents one of the most important indicators of acoustic performance in speech-oriented spaces. Choi [6] examined speech intelligibility under realistic university lecture conditions and demonstrated the importance of signal-to-noise ratio and acoustic clarity. Speech intelligibility is influenced by both the strength of useful speech energy and detrimental components arising from reverberation and noise. More recent evidence reinforces this relationship. Bottalico et al. [17] found that speech intelligibility declines with increasing distance, noise and reverberation and that speakers' vocal adaptations do not fully compensate for acoustic degradation. Consequently, speech-oriented gathering spaces require appropriate room geometry, controlled reverberation and adequate sound distribution.

2.3 Reverberation and Sound Absorption

Reverberation time remains one of the principal parameters of architectural acoustics. Excessive reverberation allows reflected sound energy to persist and overlap with subsequent speech information. A review of acoustic parameters by Mealings et al. [10] demonstrates the importance of appropriate reverberation conditions for communication and learning. Yang et al. [11] similarly identified uncontrolled reverberation as the primary cause of acoustic deficiencies in a lecture hall and showed that appropriately distributed sound-absorbing materials could improve performance. De Salvio and D'Orazio [18] further demonstrated that acoustic treatments combined with appropriate public-address design can improve signal-to-noise relationships and sound coverage in lecture halls. These findings have direct architectural implications. Wall and ceiling finishes, seating, flooring and other interior materials need to be considered according to their acoustic properties rather than aesthetic characteristics alone.

2.4 Background Noise and External Noise

Background noise competes with desired speech and consequently reduces communication quality. Noise may originate internally from occupants, ventilation systems and mechanical equipment or externally from traffic, commercial activities and generators. Chen and Ou [8] demonstrated that traffic noise and reverberation jointly affect listening performance. Kwon and Yang [19] similarly found that reducing noise and reverberation improved speech recognition. Recent studies also demonstrate that background-noise conditions affect broader user outcomes. Research in naturally ventilated university classrooms identified a positive relationship between acoustic comfort and productivity and found that background noise, reverberation and signal-to-noise conditions collectively shape acoustic acceptability [20]. External-noise isolation should therefore constitute an important consideration when designing conference facilities in urban areas.

2.5 User Perceptions and Acoustic Preferences

The increasing adoption of post-occupancy evaluation and soundscape approaches has strengthened the role of users in evaluating acoustic environments. Topak and Yilmazer [21] demonstrated through a mixed-method indoor soundscape assessment that satisfactory physical acoustic conditions do not necessarily guarantee subjective acoustic comfort. Naeemae and Gül [4] investigated both perceived and preferred reverberation conditions and demonstrated that acoustic preference provides information beyond conventional measurements. Pittana et al. [3] similarly demonstrated relationships between physical environmental parameters and occupants' subjective perceptions. This body of evidence supports a user-centred approach in which intended occupants participate indirectly in establishing acoustic design priorities.

2.6 Recent Nigerian Evidence

There remains comparatively limited contemporary literature on user-centred acoustic comfort in Nigerian gathering facilities. Nevertheless, emerging studies provide important evidence.

Oluwatayo and Adele [14] investigated convention centres in Lagos and established that acoustic design strategies influence user satisfaction. Their findings reinforce the importance of incorporating acoustic considerations during architectural design rather than relying solely on corrective interventions after construction. Mba et al. [15] similarly investigated acoustic control in a Nigerian conference centre and emphasised the need for acoustically optimised environments to support communication. Recent Nigerian work has also examined users' perceptions of lecture-theatre acoustic quality, demonstrating continued interest in speech intelligibility and user-centred assessment in Nigerian architecture. However, North-Eastern Nigeria, and Yola specifically, remains inadequately represented. The present study therefore provides context-specific evidence concerning the acoustic perceptions and preferences of intended users.

3 METHODOLOGY

3.1 Research Design

The broader study adopted a mixed-method research design integrating structured questionnaire surveys and architectural case studies. The present article focuses on the quantitative survey addressing the first three empirical objectives. The questionnaire component enabled numerical assessment of users' awareness, experiences, perceptions and preferences concerning acoustic comfort. The parent methodology specifically identifies descriptive statistics as the principal approach for analysing these variables.

3.2 Study Population and Sample

The population comprised residents of Yola who were actual or potential users of conference and assembly facilities, including students, academics, civil servants, business persons, professionals and members of the general public. A sample of 120 respondents was selected. Participants were required to be at least 18 years old, reside or work in Yola and possess experience of a conference, seminar, workshop or public gathering.

3.3 Sampling Technique

Purposive and stratified random sampling techniques were combined. Purposive selection ensured that respondents possessed relevant experience of gathering facilities, while stratification was used to provide representation across gender, age, educational and occupational groups.

3.4 Instrument and Data Collection

A structured questionnaire was used. It contained categorical, multiple-response and five-point response questions covering demographic characteristics, knowledge of acoustic parameters, experiences of existing acoustic conditions and preferences for future gathering facilities. The instrument underwent expert review and pilot testing. The parent methodology established a Cronbach's alpha threshold of 0.70 for assessing internal consistency of appropriate Likert-scale sections.

3.5 Data Analysis

Data were analysed using frequencies and percentages. Multiple-response percentages were calculated against the 120 respondents rather than against the total number of responses.

4 RESULTS

4.1 Characteristics of Respondents

Table 1: Socio-demographic characteristics of respondents (N = 120)

Variable	Category	Frequency	Percentage (%)
Gender	Male	64	53.3
	Female	56	46.7
Age	18–25	56	46.7
	26–35	40	33.3
	36–45	14	11.7
	46–55	9	7.5
	56+	1	0.8
Occupation	Civil servant	35	29.2
	Academic	6	5.0
	Student	58	48.3
	Business person	10	8.3
	Other	11	9.2

Education	Secondary	2	1.7
	Undergraduate	73	60.8
	Postgraduate	39	32.5
	Others	6	5.0

Source: Field Survey.

The result in table 1 showed a relatively balanced by sex, although males constituted a slight majority (53.3%). Most respondents were between 18 and 35 years old. Students constituted 48.3%, followed by civil servants (29.2%). The respondents were predominantly educated, with 60.8% having undergraduate-level education and 32.5% postgraduate education. These distributions are those reported in Grace's original dataset.

4.2 Objective One: Key Acoustic Design Parameters

Table 2: Awareness and identification of factors affecting acoustic quality

Indicator	Frequency	Percentage (%)
Aware of acoustic comfort	112	93.3
Ceiling height affects sound quality	98	81.7
Room shape	94	78.3
Wall finishes	93	77.5
Ceiling finishes	65	54.2
Wall openings	54	45.0
Floor finishes	14	11.7
Ceiling structure	12	10.0
Floor type	11	9.2

Multiple responses permitted.

The results in table 2 indicate substantial awareness of acoustic design. 112 respondents (93.3%) were familiar with acoustic comfort. Ceiling height was the most frequently recognised architectural factor affecting sound quality (81.7%), followed by room shape (78.3%) and wall finishes (77.5%). These results demonstrate that respondents recognised spatial geometry and surface treatment as particularly important.

Table 3: Perceived importance of major acoustic parameters

Parameter	Frequency	Percentage (%)
Speech intelligibility	84	70.0
Reverberation control	17	14.2
Echo reduction	15	12.5
Background-noise level	4	3.3
Not sure	0	0.0

Results in Table 3 shows speech intelligibility was overwhelmingly identified as the most critical parameter, accounting for 70.0% of respondents, followed by reverberation control (14.2%) and echo reduction (12.5%). Furthermore, 97.5% regarded sound clarity as either important or very important.

4.3 Users' Perceptions of Existing Acoustic Conditions

Table 4: Users' perception of acoustic conditions in existing facilities

Indicator	Leading response	Frequency	Percentage (%)
Overall sound quality	Fair	98	81.7
Difficulty hearing speaker	Often	87	72.5
Background noise	Moderate	78	65.0
Left gathering because of poor acoustics	Sometimes	73	60.8
Satisfaction with existing acoustics	Neutral	88	73.3

The results in Table 4 present a consistent picture of acoustic inadequacy. Although 81.7% characterised overall sound quality as fair, 72.5% often experienced difficulty hearing speakers, while another 21.7% sometimes experienced such difficulty. Thus, 94.2% experienced hearing difficulty either often or sometimes. Background noise was moderate according to 65.0% and high according to 26.7%. Poor acoustics also affected users' participation: 60.8% indicated that they sometimes left gatherings early because of poor acoustic conditions. Thus, satisfaction was predominantly neutral (73.3%), while only 10.8% were satisfied.

4.4 Objective Three: Users' Acoustic Preferences

Table 5: Acoustic preferences of respondents (N = 120)

Preference	Leading response	Frequency	Percentage (%)
Preferred environment	Moderately quiet	88	73.3
Priority acoustic feature	Good sound distribution	95	79.2
Sound-absorbing finishes	Very important	90	75.0
Amplification strategy	Natural + electronic	97	80.8
External-noise isolation	Very important	105	87.5

Result in Table 5 the respondents expressed clear preferences. A moderately quiet environment was preferred by 73.3%, while another 25.8% preferred a very quiet environment. Thus, 99.2% preferred some degree of acoustic quietness. Good sound distribution across the hall emerged as the foremost priority, selected by 79.2%. Sound-absorbing walls, floors and ceiling finishes were rated very important by 75.0% and important by another 9.2%. A particularly important finding was that 80.8% preferred combining electronic amplification with natural acoustic design, rather than relying exclusively on either strategy. External-noise isolation produced the strongest preference: 87.5% considered it very important and 9.2% important. These results provide a clear acoustic design brief for future gathering facilities in Yola.

5 DISCUSSION

The results indicated that respondents demonstrated considerable acoustic awareness. Ceiling height, room shape and wall finishes were the most frequently identified architectural determinants of sound quality. This agrees with recent evidence showing that spatial configuration and surface treatment substantially influence reverberation and speech performance [11]. The prioritisation of speech intelligibility by 70.0% is also consistent with contemporary acoustic research. Choi [6] demonstrated the central role of speech intelligibility in university environments, while more recent work confirms that noise, distance and reverberation can substantially degrade speech perception [17].

Second, users' perceptions reveal significant weaknesses in existing facilities. The apparent contradiction between 81.7% rating sound quality as fair and 72.5% often experiencing hearing difficulty is particularly revealing. Broad satisfaction categories may understate acoustic deficiencies, whereas questions addressing specific communication experiences reveal their functional consequences. The finding is supported by recent research emphasising the importance of combining subjective evaluations with objective or activity-specific acoustic indicators [2,3,16].

Third, users' preferences provide direct architectural guidance. Their strong preference for sound distribution, absorptive surfaces, external-noise isolation and hybrid natural/electronic acoustic systems demonstrates that intended occupants have identifiable acoustic priorities. The 79.2% preference for good sound distribution is particularly significant. Conference centres need uniform sound coverage so that occupants seated at different positions can understand speakers with minimal variation in clarity. Similarly, the 84.2% combined importance assigned to sound-absorbing finishes supports the established role of material absorption in controlling reverberation. Acoustic treatments and appropriate spatial distribution of absorptive materials have been demonstrated to improve room acoustic performance [9,11,18]. The preference of 80.8% for combining natural room acoustics with electronic amplification suggests that users do not regard technology as a substitute for appropriate architectural acoustics. Instead, amplification should complement an acoustically responsive building.

This approach is consistent with contemporary research advocating integrated acoustic design rather than isolated corrective technologies. The strongest preference concerned external-noise isolation, with 87.5% considering it very important. This is understandable within urban contexts where transportation, generators and commercial activities contribute to background noise. Research demonstrates that background noise interacts with reverberation to influence speech comprehension and acoustic comfort [8,19,20]. The Nigerian context reinforces these findings. Oluwatayo and Adele [14] found that acoustic strategies influence user satisfaction in Lagos convention centres, while Mba et al. [15] emphasised acoustic optimisation in Nigerian conference-centre design. The present study extends this evidence geographically to North-Eastern Nigeria and demonstrates that Yola's intended conference-facility users possess identifiable acoustic perceptions and preferences.

6 CONCLUSION

This study investigated key acoustic design parameters, users' perceptions and acoustic preferences in large gathering facilities in Yola, Nigeria. The findings demonstrate that respondents possess considerable awareness of acoustic comfort. Ceiling height, room shape and wall finishes emerged as the most recognised architectural factors affecting acoustic quality, while speech intelligibility was considered the most critical acoustic parameter. Existing facilities, however, appear not to satisfy these expectations. Although most respondents rated overall sound quality as fair, hearing difficulty was widespread, background noise was predominantly moderate to high, and poor acoustic conditions had caused many respondents to leave gatherings prematurely.

Users consequently expressed clear preferences for future facilities. They favoured moderately quiet acoustic environments, uniform sound distribution, absorptive surface treatments, a combination of natural acoustic design and electronic amplification, and strong isolation from external noise. The study therefore establishes an empirical relationship between acoustic design parameters, users' current experiences and their desired acoustic conditions. Conference and assembly facilities in Yola should consequently integrate acoustic performance at the conceptual-design stage rather than treating acoustics as a post-construction correction. Room geometry, ceiling configuration, material selection, reverberation control, sound distribution and external-noise isolation should form part of the initial architectural design brief.

Recommendations

Architects designing conference and large gathering facilities in Yola should prioritise speech intelligibility and uniform sound distribution through appropriate room geometry and ceiling configuration. Sound-absorbing materials should be incorporated strategically into walls and ceilings to control excessive reverberation, while building envelopes, openings and site layouts should be designed to minimise external noise intrusion. Natural architectural acoustic strategies should be complemented by properly designed electronic sound reinforcement rather than replaced by amplification. Finally, user-perception assessment should become part of both the design and post-occupancy evaluation of large public gathering facilities.

Limitations and Further Research

The principal limitation is that the present survey measures users' subjective experiences rather than directly measuring reverberation time, STI, sound-pressure level or signal-to-noise ratio in individual facilities. The parent study itself identifies reliance on self-reported perceptions and the absence of detailed building-specific acoustic modelling as limitations. Future studies should therefore combine user surveys with physical measurements of RT60/T30, STI, C50, background-noise level and sound-pressure distribution. Such integration would enable researchers to determine how closely users' perceptions correspond to objectively measured acoustic performance.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The author declares no conflict of interest.

Statement of informed consent

Participation was voluntary, and respondents were informed that information collected was intended solely for academic research purposes.

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