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Correlates of Acoustic and Visual Comforts in Selected Lecture Theaters in Ladoke Akintola University of Technology, Ogbomoso, Nigeria

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ABSTRACT*: The challenge of having good acoustics and visual comfort in lecture theatres was explored in the study. The aim was to evaluate the visual and acoustic comfort levels of users in lecture theatres with a view to establishing their significance in future designs. The study selected seven (7) lecture theatres representing 58.33% out of a total of 12 in Ladoke Akintola University of Technology Ogbomoso as the sample size using simple random sampling techniques. Capacity of each lecture theatres were determined and questionnaires were randomly administered on 4% of the total Users in each. The questionnaire was to determine the hearing audibility levels, visual clarity levels and general comfort/satisfaction levels of users at periods they were receiving lectures. A total of 248 questionnaires were administered. Sources of noise in the lecture theatres were also determined through questionnaire administration. Data were descriptively and inferentially analysed. The study found furniture movements as the major source of noise in the lecture theaters studied. Also, it was realized that there was a significant correlation between users' satisfaction levels and each of visual clarity and hearing audibility (acoustic comfort) despite that users indicated that it was possible for them to hear speaker's speeches without seeing the board; It was hence suggested that determinant factors of these two criteria such as shape of buildings, sizes/volume and sources of noise should be critically put into consideration at design inception stages. Other recommendations that could foster appropriate synergy between acoustic and visual comforts in Lecture Theatres were given.*

KEYWORDS: acoustic comfort, lecture theatre, vision clarity, hearing audibility, user's satisfaction.

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INTRODUCTION

Lecture theatres (LTs) are big spaces in a higher institute of learning where interactions between instructors and students are facilitated. Among other spaces, LTs consists of the auditorium, stage, projection room as well as some other auxiliary spaces such as back stage, offices and conveniences (Ayandokun, 2020).

Pumia and Jain (2005), affirmed that effectiveness of LTs depends primarily on their visual and acoustic properties as they affects users' visual clarity and hearing audibility; hence, the synergy between them should be taken into consideration when designing. This is also in line with the submissions of Adekalu and Halil (2018) who indicated that in any educational set-up, the effectiveness of the LT spaces for teaching-learning could be achieved through good sightlines and speech intelligibility. Hence, a good knowledge of these factors and their synergies is essential. Acoustics is the science of sound and is concerned with its propagation from source to the expected recipients in form of speech, music or noise. The concept of acoustic can however be made intelligible through the incorporation of appropriate design and construction elements (Pumnia and Jain 2005); this involves taking essential measures capable of optimizing audible conditions in spaces where speech and music are to be held. These measures involved the building form and finishing materials adopted to subdue noise, reverberations and echoes hence, acoustic comfort in buildings is the perception of building users with the levels of sound propagation in their spaces; it entails a subjective decision of the quietness and lousiness of their spaces. Similarly, Visual comfort is the perception of building users with such values as how bright or how dark their building interiors are (ASHRAE, 2009, Afolami, Akeremale and Ikudaisi, 2017). Furthermore, visual comfort is one of the sub credits for health and wellbeing aspect of the Building Research Establishment Environmental Assessment Method (BREEAM, 2014).

According to Research, well designed environment and building with good visual and acoustic comfort makes users perform better and be free from unwanted sound diseases or illnesses. In school and offices, learning and working is less stressful and tiring when there is visual clarity and elimination of unwanted sounds. This aids better communication, assimilation and concentration. Harmful sounds or noise affect not just the occupants hearing but also the whole body mentally and physically with diseases or illnesses such as headache, displeasure, psychosomatic illnesses, decreased physical and mental performance and so on (Adekalu et al, 2018) and similarly, poor lightning conditions influences body temperature, sleep and hormonal changes and can cause untimely ageing of the skin, eye impairment and skin cancer (Afolami et al., 2017). Thus, when building occupants are visually and acoustically comfortable with good light levels and noise elimination, they tend to be more productive, happier and healthier.

Good sightlines and speech intelligibility are essential considerations in a teaching-learning environment (Amasuomo, 2014). All students within, should have unobstructed sight lines, i.e. be

able to see the lecturer and the board/screen clearly without any interference and also be of close proximity in order to recognize the facial expression of the lecturer. This keeps the minds of students or participants focused on what is being taught, aids understanding at a quicker rate which in turn ensures adequate communication between students and lecturers.

Effective education depends on having a goal, the appropriateness of the physical and social environment of the lecture theatre, motivation of lecturers and students for teaching and learning activities, visual and sound management of the class (Gilavand and Jamshidnezhad, 2016). Yet, studies on visual and acoustic comfort in LTs in Nigeria are limited (Afolami et al, 2017). The few ones focuses on examining either of the two factors in their studies; hence, there is limited information for designers of LTs to work with. The aim of this study is hence to evaluate the visual and acoustic comfort of users in selected LTs in Ladoke Akintola University of Technology (LAUTECH) Ogbomoso in order to establish a baseline characteristics of LTs in the study area and to invigorate on their significance in the future design of LTs.

Study Area

The study was carried out in Ladoke Akintola University of Technology, (LAUTECH) Ogbomoṣo, Oyo state, Nigeria; Ogbomoso is situated on Latitude 8°8′0″N of the Equator and Longitude 4°16′0″E of the Greenwich meridian. LAUTECH was established in April 1990 and has a land mass of 9880.771 hectares. The university has eleven faculties and a post graduate school where courses are administered in various fields of Pure and Applied Sciences, Agriculture Sciences, Engineering and technology, Environmental sciences, Basic Medical Sciences, Management sciences, Food and Consumer Sciences, Clinical sciences, Computing Studies and Nursing Science.

Plate 1: Lautech imagery showing some Lecture Theatres
Source: Google maps, 2023

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METHODOLOGY

The study employed subjective approach using questionnaire to obtain data on the visual and acoustic comfort of users and their general satisfaction with the LTs. Seven LTs (MKO, SIFAX, FAG, FPAS, FET, MGS and 250LT) were randomly selected as Sample size out of a total of twelve (12) LTs available in the institution as at the time of the study; this represents 58% of the sample frame. In the distribution of Questionnaires, 4% of the seating capacity of the selected LTs was chosen giving a total of Two hundred and forty-eight (248) respondents; and respondents were randomly selected. Visual clarity, hearing audibility, users satisfaction and severity of sources of disturbances were assessed from their sitting positions and rated on Likert four (4) point scale. For Visual clarity: 4-'*very clear*', 3-'*clear*', 2- '*faintly*' and 1-'*can't see anything at all'*. For Hearing Audibility: 4- '*very audible*', 3- '*audible*', 2- '*faintly*' and 1- '*can't hear anything at all'*. For user satisfaction: 4- '*excellent*', 3- '*good*', 2- '*fair*' and 1- '*poor'*. For Severity of sources of disturbance: 4- '*very severe*', 3- '*severe*', 2- '*not severe*' and 1- '*I'm not disturbed'*

Shape of LTs and sources of noise in and around them were identified; the sources of disturbances listed were: furniture (seats, tables), foot impact, electrical fittings, low tone conversation, vehicles, passers-by, generators, noise from adjacent buildings, noise from rain on the roof and other sources not listed were specified and rated. Sitting positions were strategically grouped into nine (9) i.e., *front-left, front-centre, front-right, middle-left, middle-centre, middle-right, back-left, back-centre* and *back-right*. Observation on the shape, surface finishes and type of the lecture theatres were compared with the acoustic requirements for LTs and result was descriptively and inferentially analysed.

FINDINGS

The LTs can be grouped into three shapes viz: Rectangular shape was found in MKO and MGS, Irregular Hexagon in FET; Fan shape was found in 250 LT, SIFAX LT, FAG LT and FPASS LT (see table 1). Additionally, one seating row on each seating thread/tier serves was found in 250, MKO, MGS and FET, the other three lecture theatres had two rows of seat on a seating thread/tier.

Table 1: Shapes of LTs

S/n	LTs	Shapes
1	MKO	Rectangle
2	MGS	Rectangle
3	FET	Irregular Hexagon
4	250 LT	Fan
5	SIFAX LT	Fan
6	FAG LT	Fan
7	FPASS LT	Fan

Source: Authors field work, 2021.

Effectiveness of the LTs was assessed with respect to users sitting position, their vision clarity, hearing audibility and satisfaction. In Table 2 below, Vision clarity, hearing audibility and users satisfaction was highest at the *front centre* sitting position with mean values of 3.91, 4.27 and 3.09 respectively; but lowest at the back with mean values of 1.54 (*back-left*), 2.16(*back right*) and 1.76 (*Back Right*) respectively. For sitting positions, the mean values for the three indexes were highest at the centre for the front, middle and back. This could be because there are lesser effects of external noise interference at the centre positions compared to left and right sitting positions.

250LT had the highest value for vision clarity and user satisfaction; there is a likelihood that it is due to its shape and small size as respondents signified that could see clearly and hear audibly from all sitting positions even without the use of public address system. FET LT had the lowest value for the three indexes. This could be because of their hexagonal shape; respondents found it difficult to see the board from the Front-Right and Front-Left sitting positions as well as the Back-Right, Back-Centre and Back-Left sitting positions, also because public address system was not used at the time the questionnaire was administered. MGS LT had a low mean value for vision clarity due to its rectangular shape as light reflections were also cast on the board. It had a high value for hearing audibility because public address system was used during the lecture and the second highest value for user satisfaction, showing the correlation between hearing audibility and user satisfaction.

Table 2: Description of vision clarity, hearing audibility and user satisfaction across sitting positions and lecture theatres

Sitting Positions	**Vision Clarity**				**Hearing Audibility**			**Users Satisfaction**		
	N	Mean	Std. Deviation	Std. Error	Mean	Std. Deviation	Std. Error	Mean	Std. Deviation	Std. Error
Descriptive for Sitting Position										
Front Right	27	2.04	1.605	0.309	3.96	1.160	0.223	2.63	0.967	0.186
Front Centre	22	3.91	1.342	0.286	4.27	0.985	0.210	3.09	1.151	0.245
Front Left	23	2.30	1.690	0.352	3.87	1.180	0.246	2.13	1.014	0.211
Middle Left	25	2.52	1.046	0.209	2.92	1.352	0.270	2.40	1.291	0.258
Middle Centre	26	2.85	1.377	0.270	3.31	1.350	0.265	2.62	1.235	0.242
Middle Right	27	2.04	1.480	0.285	2.85	1.562	0.301	2.04	1.372	0.264
Back Left	24	1.54	1.250	0.255	2.58	1.442	0.294	2.17	1.274	0.260
Back Centre	27	1.78	1.396	0.269	3.22	1.155	0.222	2.70	1.068	0.205
Back Right	25	1.60	1.000	0.200	2.16	1.068	0.214	1.76	1.052	0.210
Total	226	2.26	1.508	0.100	3.23	1.401	0.093	2.39	1.207	0.080
Descriptive for Lecture Theatres										
MGS	36	2.11	1.753	0.292	4.33	1.069	0.178	3.28	1.162	0.194
FAG	36	2.17	1.444	0.241	3.33	1.394	0.232	2.61	0.934	0.156
FPASS	36	2.31	1.215	0.202	3.33	1.121	0.187	2.17	1.000	0.167
SIFAX	36	2.25	1.663	0.277	2.94	1.548	0.258	2.03	1.230	0.205
MKO	27	2.07	1.207	0.232	2.63	1.363	0.262	2.19	1.001	0.193

FET	45	2.07	1.405	0.209	2.58	1.215	0.181	1.87	1.254	0.187
250 LT	10	4.40	0.966	0.306	4.00	1.054	0.333	3.40	0.843	0.267
Total	226	2.26	1.508	0.100	3.23	1.401	0.093	2.39	1.207	0.080

Source: Authors field work, 2021

MKO LT has the least value for vision clarity, second lowest value for hearing audibility and a low value for users' satisfaction. Its rectangular shape also made vision clarity from the front-left and front-right sitting position difficult due to light reflections on the board; all these could have been the reason for low vision clarity. The lecture theatre is also located close to a vehicular road with high traffic, there were noise interference from vehicles passing by, and the effect was most felt at the right side of the lecture theatre which is close to the road. This could have been the reason for low hearing audibility and low user satisfaction in the lecture theatre.

SIFAX LT, FAG LT and FPAS LT had close range of values (below average) for vision clarity due to their Fan shape and similarity in seating arrangement. FPAS and FAG had similar high mean values for hearing audibility because public address systems were used, while SIFAX had a slightly lower value than the former even though public address system was also used. However, the three lecture theatres had varying mean values for user satisfaction; FAG had the highest mean value among the three, followed by FPAS and SIFAX had the least among them.

Table 3**:** Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.	Levene Statistic	df1	df2	Sig.
	Sitting Positions				**Lecture Theatres**			
Vision Clarity	2.575	8	217	0.011	3.463	6	219	0.003
Hearing Audibility	1.020	8	217	0.422	0.928	6	219	0.475
User Satisfaction	2.300	8	217	0.022	4.235	6	219	0.000

Source: Authors Analysis, 2021

Table 3 shows the Test of Homogeneity of Variance carried out on the values of the three indexes against the sitting positions and the lecture theatres respectively. For sitting positions, the significance (P value) is less than the alpha level (0.05) for two indexes (vision clarity and user satisfaction), hence the variance is not significant. The result showed that the opinions of people based on ability to see the board and level of satisfaction was dependent on where they sat, hence equal variance can't be assumed. However for Hearing audibility, the P value was greater than the alpha level, implying they could hear irrespective of where they sat due to the use of public address system in some halls. Across the lecture theatres, the P value is less than the alpha level for vision clarity and user satisfaction. However, for hearing audibility, the significance level is greater than the alpha level. This could be due to the use of public address systems which improved hearing audibility. User satisfaction is dependent on both vision clarity and hearing audibility.

However some people assumed satisfaction only because they could hear due to use of public address system

Table 4 below shows the analysis of variance for visual clarity, hearing audibility and user satisfaction between groups (sitting positions) and across the lecture theatres. The result showed that the mean differs significantly in the three indexes across the groups (sitting positions) at 95% confidence interval. This means that the sitting position has effect on all the indexes.

Table 4: Analysis of variance for visual clarity, hearing audibility and user satisfaction between groups (sitting positions)

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
		Sitting Position					**Lecture Theatres**				
Vision Clarity	Between Groups	102.734	8	12.842	6.816	0.000	49.601	6	8.267	3.919	0.001
	Within Groups	408.863	217	1.884			461.996	219	2.11		
	Total	511.597	225				511.597	225			
Hearing Audibility	Between Groups	92.910	8	11.614	7.230	0.000	82.328	6	13.721	8.367	0
	Within Groups	348.581	217	1.606			359.163	219	1.64		
	Total	441.491	225				441.491	225			
Users Satifaction	Between Groups	32.372	8	4.046	2.973	0.004	60.31	6	10.052	8.232	0
	Within Groups	295.363	217	1.361			267.424	219	1.221		
	Total	327.735	225				327.735	225			

Source: Authors Analysis, 2021

Table 5: Correlations between vision clarity, hearing audibility and user satisfaction

	Vision Clarity	**Hearing Audibility**	**Users Satisfaction**
Vision Clarity	1	.281**	.340**
Hearing Audibility		1	.555**
User Satisfaction			1

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Authors Analysis, 2021

As seen in Table 5, the correlation of all the three indexes shows that they relate significantly. However, user satisfaction has slight correlation with vision clarity and moderate correlation with hearing audibility. Public address systems used in some of the lecture halls helped improve hearing audibility and has a moderate effect on users satisfaction. The weak correlation between visual clarity and hearing audibility (0.281) shows that the factors responsible for these two indexes are

distinct. There is disparity in what students hear and see, i.e. it's possible to hear the lecturer and not see the board. However, for effective learning, students should be able to see and hear clearly at the same time. Steele (2015) also observed that the most fundamental principle of places of assembly; theatres, concert halls, etc., is that the audience must see and hear.

The frequency of Severity of disturbances were analyzed across the lecture theatres as shown in Table 6 below.

Table 6: Table on severity of disturbances in the selected lecture theatres

	Furniture	Foot Impact	Electric Fittings	Low Conversations	Vehicle	Passers by	Generator	Adjacent Building	Rain Noise	Other Sources
250 LT	8 (80%)	5(50%)	1(10%)	7(70%)	3(30%)	2(20%)	3(30%)	3(30%)	1(10%)	1(10%)
FAG	27(75%)	0	4(11%)	33(91%)	10(27%)	7(19%)	4(11%)	6(16%)	10(27%)	2(5%)
FET	30(66%)	11(24%)	7(15%)	35(77%)	7(15%)	9(20%)	5(11%)	2(4%)	3(6%)	0
FPASS	28(77%)	13(36%)	3(18%)	27(75%)	3(8%)	2(5%)	2(5%)	2(5%)	18(50%)	0
MGS	4(11%)	10(27%)	1(2%)	25(69%)	1(2%)	3(8%)	2(5%)	3(8%)	3(8%)	0
MKO	23(85%)	9(33%)	0	20(74%)	14(51%)	10(37%)	2(7%)	1(2%)	0	0
SIFAX	29(80%)	16(44%)	12(33%)	24(66%)	1(2%)	5(13%)	2(5%)	8(22%)	15(41%)	4(11%)

Source: Authors Analysis, 2021

In 250LT, the severe disturbances had low values; the frequency of severe disturbances are 8(80%) for Furniture and 7(50%) for Low conversations. In FAG LT, the frequency of severe disturbances are 27(75%) for furniture, and 33(91%) for low conversation. For MKO LT, the frequency of severe disturbances are 23(85%) for furniture, 20(74%) for low conversation and 14(51%) for vehicles. The frequency of severe disturbances in FET LT, are 30(66%) for furniture and 35(77%) for low conversations. In FPAS LT, the frequency of severe disturbances are 28(77%) for furniture, 27(75%) for low conversation and 18(50%) for rain noise. The frequency of severe disturbance in MGS LT is 25(69%) for low conversation. In SIFAX LT, are 29(80%) for furniture and 24(66%) for low conversation. Across the lecture theatres, the highest frequency of disturbance is low conversations, followed by furniture, then foot impact. Other severe disturbances have low frequencies.

The values of users' satisfaction in terms of visual clarity, hearing audibility and severity of disturbances in each lecture theatre agree to a good extent. The Users satisfaction, vision clarity and hearing audibility properties of the selected lecture theatres are summarized as follows:

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Summary of Vision Clarity, Hearing Audibility and Users Satisfaction properties of the selected LTs.

The vision clarity, hearing audibility and users' satisfaction levels in each of the LTs were rated on low, medium and high values; while low values represent poor situation, high values represent optimum situation as presented on table 7. It was observed that a total of six (6) LTs representing 85.7% presented a low visual clarity levels while only one (1) representing 14.3% presented an optimum visual clarity levels. This is an indication that there is a generally low vision clarity levels in LTs in the study area. However, Hearing audibility levels in LTs in the study area was in a different dimension, a total of three (3) LTs representing 42.9% presented an optimum hearing audibility levels while the remaining four (4) has reasonable audibility values; None of the LTs was observed to present a poor hearing audibility values; this is an indication that acoustic comfort was taken more as a priority in the design of LTs in the study area while less attention was paid on visual clarity.

The effect of this was however observed in the users' satisfaction levels; majority of users in five (5) LTs representing 71.4% expresses dissatisfaction with the comfort levels of their LTs during work periods while only two (2) LTs representing 28.6% was observed to ensure optimum users.

Table 7: Summary of Users Satisfaction, Visual Clarity and Hearing Audibility properties of the selected LTs

LTs	Visual Clarity			Hearing Audibility			Users satisfaction		
	L	M	H	L	M	H	L	M	H
MKO	✓				✓		✓		
SIFAX	✓				✓		✓		
MGS	✓					✓			✓
FAG	✓				✓		✓		
FPASS	✓					✓	✓		
FET	✓				✓		✓		
250			✓			✓			✓
Total	06 (85.7%)	00	01 (14.3%)	00	04 (57.1%)	03 (42.9%)	05 (71.4%)	00	02 (28.6%)

L = Low M= Medium H= High.

Source: Authors analysis, 2021

CONCLUSION AND RECOMMENDATIONS

Findings revealed that Furniture movements was the major source of noise disturbance in the LTs in the study area (see table 6 above), hence, furniture materials that present less noise such as plastic is recommended for future use.

Also, it was observed that there is a high correlation between users satisfaction and visual clarity and also, user satisfaction and hearing audibility hence, these two factors should be critically taken into consideration when LTs are to be designed most importantly, decisions should be taken at design inception stages; however, the weak correlation of 0.281 observed between visual clarity and hearing audibility indicated that different factors are responsible for each of them; these factors among others may include shape of LTs, sizes/capacities and sources of noise. This is however evident in the observed disparity between respondents' satisfaction with hearing and seeing in the selected LTs; i.e., respondents affirm that it is possible for them to hear an Instructor's speech without seeing the board.

On a general note, LTs in the study area was noticed to perform excellently well in hearing audibility levels when compared with users satisfaction and visual clarity levels; this is evident in that users signifies a good hearing audibility in 42.9% of the selected LTs as against 28.6% LTs that present an overall users satisfaction levels. However, visual clarity in LTs in the study area was noticed to be the poorest as only 14.3% LTs were agreed to having good visual clarity by respondents.

250 LT was noticed to present the best visual clarity, hearing audibility and gives users the required satisfaction levels; hence, a replica of similar design could be adopted in future designs in the study area.

Conflict of interests

The authors have not declared any conflict of interests.

References

Adekalu Oluwasayo Benjamin, Halil Zafer, (2018). *Achieving Acoustic Comfort in the Architectural Design of a Lecture Hall*, Vol. 6, Issue 2, pp.(161-184), Month: October 2018 - March 2019, Available at: www.researchpublish.com

Afolami, A. J., Akeremale, I. D. amd Ikudayisi, A.E. (2017) Assessment of light levels and visual comfort in a lecture hall of a university in Akure, Nigeria In: *Laryea, S. and Ibem, E. (Eds) Procs 7th West Africa Built Environment Research (WABER) Conference*, 16-18 August 2017, Accra, Ghana, 337-346.

Amasuomo, J.O.M. (2013). Speech Intelligibility and Good Sightline for Vision in Lecture Hall Acoustics as Determinant for Effective Learning/Teaching Environment: *International Journal of Scientific & Technology Research*, Volume 2, Issue 11, November.

American Society of Heating, Refrigeration and Air Conditioning Engineers, USA, ASHRAE (2009). ASHRAE Fundamentals.

Ayandokun, T. N. (2020). Assessment of Thermal Comfort in Lecturer Theatres as a Desgn Consderation for Proposed Faculty of Architecture, LAUTECH, Ogbomoso. *An Unpublshed Master's Thesis in the Department of Architecture, Ladoke Akintola university of Technology, Ogbomoso*.

Building Research Establishment Environmental Assessment Method (BREEAM), (2014). UK Building Construction Regulatons. *Retrieved from www.breem.com*

Gilavand, A., & Jamshidnezhad, A. (2016). The Effect of Noise in Educational Institutions on Learning and Academic Achievement of Elementary Students in Ahvaz , South- West of Iran, International Journal of Pediatrics, Vol. 4, Issue 27, pp 1453–1463.

Pumnia, B.C. and Jain, A.K. (2005), "*Building construction*", Firewall Media, NewDelhi.

Steele R. (2015). Understanding sightlines in a raked floor facility, retrieved from https://www.linkedin.com/pulse/understanding-sightlines-raked-floor-facility-rose-steele