



## POST OCCUPANCY EVALUATION OF FEDERAL UNIVERSITY ADMINISTRATIVE BUILDING TO SUSTAINABLE STANDARDS

Opeyemi A. Asaju<sup>1</sup>, Cephass A. Adelore<sup>2</sup>, Akintunde O. Onamade<sup>3</sup>, Samuel A. Daramola<sup>4</sup>

[aj.ope.aa@gmail.com](mailto:aj.ope.aa@gmail.com)<sup>1</sup>, [arcephas.adelore@gmail.com](mailto:arcephas.adelore@gmail.com)<sup>2</sup>, [onamadeakintunde@gmail.com](mailto:onamadeakintunde@gmail.com)<sup>3</sup>

Department of Architecture, Caleb University, Imota, Lagos<sup>1,3,4</sup>

Department of Architecture, University of Lagos, Lagos<sup>2</sup>

### Abstract

Administrative building in the university is the center for operational responsibilities of the institution and contains several units and departments. Functional spaces, building materials (both external and internal), the location of the building elements, window, landscape, communication and corridors, access to light, vulnerability to noise, and how it is managed, play significant role in determining the sustainability which in turn affects user's level of comfort. Empirical and conceptual works have established a strong correlation between building, health status, comfort, and the efficiency of users with different parameters having its influence on the users. The air quality influences the evaluation of the overall indoor environment with thermal comfort being ranked in the majority of cases to be of slightly greater importance for overall comfort than acoustic, visual comfort, and satisfaction. Hence, this research evaluated the user's comfort of the University of Lagos Senate building but the study did not measure the variable objectively. Indicative post occupancy evaluation was adopted in gathering data. The result showed 41.4% of users indicated that they are comfortable with the thermal environment, 14.6% neutral, and 43.9% uncomfortable. The acoustic respondents affirmed 56.1% were often disturbed with external sound while 43.9% indicated otherwise. In respect to visual comfort 68.3% were positive against 31.7% being negatively impacted. Findings revealed that the buildings perform well in terms of visual but acoustic and thermal comfort was slightly different. The study therefore established that the administrative building was not totally designed with sustainable architecture standard in mind. It has become essential that sustainable architectural principles should be incorporated into the existing structure to avert long term health and comfort related challenges for the occupants.

Keywords: Administrative Building, Federal University, Indoor Environmental Quality (IEQ), Post-occupancy, Sustainable standards

## **INTRODUCTION**

The University is an academic community that consists of several human and material resources. The buildings, people (students and staff) and vegetation are variables instrumented together in achieving sustainability goals and comfort ability of the environment. It also creates a good atmospheric ambience for work or study that foster comfort, health, efficiency, performance and productivity. Over the years, empirical and conceptual works have established a strong correlation between buildings, and the health status, comfort and the efficiency of users. Lecturer, n.d. asserted that providing a comfortable environment for employees contributes significantly to their optimum performance and reduced absenteeism. He further stressed that for one to build a culture of excellent performance, one need to take a close look at the office/workspace environment. Paradis, n.d. presented that, providing a comfortable environment for employees contributes significantly to their optimum performance and reduces absenteeism. The structure and arrangement of the workplace space should be considered in a working environment before considering any other factors (Nik Lah et al., 2015) as employees perform best when they can control their space (Lecturer, n.d.).

## **LITERATURE REVIEW**

### **UNIVERSITY OF LAGOS SENATE BUILDING**

The Senate Building of the University of Lagos is an iconic Building with a spectacular Ariel bridge from the Third Mainland Bridge. It is the institution administrative building and bear the load of the university as a whole lot of brain-tasking operations that require so much detailing and accuracy are carried out there. It was designed by James Cubitt and Partners and consists of simple forms. The architects diversified the form by using different heights and projecting a semi-cylindrical form from the approach elevation. The structural pillars are projected to the front of the elevation giving an illusion that they don't carry the weight of the building. The beauty of the building is further enhanced by the color combination used on the elevation. The use of sloping site allows the penetration of the wind into the building achieving partial cross ventilation so much desired in this highly humid area. The building is characterized by monotonous cubic general shapes and the use of the contemporary architectural style which was

dominant during the period the senate building was built, influenced the style of Architecture. The Senate building could be best described as a building with simple geometrical forms and exposed parapet walls having free plan as a preferred option. It has a flat roof, curtain walls and devoid of decorations. This have little regard for Nigerian culture or climate.



Plate 1: University of Lagos Senate Building

## **SUSTAINABLE ARCHITECTURE DESIGN STANDARDS**

Sustainable architecture designs are diverse group of hard measures of environmental quality and impacts to define a holistic approach to sustainable building. They are useful and beneficial in so many ways ranging from the economic benefits, socio-cultural, political and psychological benefits among many others (Ardiani & Shateri, 2018). Mancini et al. (2020) postulated that people who work in a building designed and built with sustainable architectural principles are more likely to be more comfortable and productive as the state of the building determines the efficiency and effectiveness of the users. Making a sustainable building germane to the efficiency of the workers and achievement of universities goals and objectives.

Despite sustainability design advantages, Wilkinson et al. (2011) have identified that both owners and stakeholders are yet to fully harness these benefits and adoption yet to be fully realized. These can be clearly explained as the construction sector is responsible for more than 10% of global GDP and thus has direct and indirect impacts on both occupants and the environment. “It produces 23% of global greenhouse gas (GHG) emissions, and buildings are responsible for between 30% and 40% of all material flows” (Huang et al., 2018) and thus it becomes very pivotal to adopt sustainable practices.

## **POST OCCUPANCY EVALUATION**

Post occupancy evaluation is a systematic and detailed inspection carried out to get a credible evidence about both positive and negative aspect of the building. Post occupancy evaluation (POE) according to Eke, Clinton and Wellington, (2013), comprises of broad range of activities aimed at understanding how the buildings perform to meeting occupants standards (Aliyu et al., 2016). Hence, bringing the occupants/users as the most valuable source of information. Bordass & Leaman, n.d. posited that POE tries to answer four broad questions: “How is this building working?”, ‘Is it intended?’, ‘How can it be improved?’ and ‘How can future buildings be improved?’. Empirical and conceptual works have been done on POE of different building types. Iweka & Chuks Okeibunor (2012) focused on the post-occupancy evaluation of dwelling density in public housing estates in Lagos, Nigeria concerning performance standards. He identified design density as a quality index factor that LSDPC needed to consider at the design stage of its multifamily housing units and recommended a policy framework to standardize design density data which will serve as quantitative technical performance guidelines.

## **INDOOR ENVIRONMENTAL QUALITY**

A sustainable building has a lot in provision of the right environment for users, with comfort being the basis. The indoor environmental quality (IEQ) of a building is determined by different variables ranging from the thermal, acoustic, visual comfort and lighting of the space. A comfortable IEQ is achieved by the level of control an occupant has on the indoor space (Alkabashi, 2019). Esfandiari et al. (2017) in a study on Human Comfort and self-estimated performance in relation to indoor environmental parameters and building features, tried to find which of the parameters influence comfort level most. The pleasantness of which is a factor of how sustainable the building is.

### **Thermal Comfort**

Thermal comfort has to do with ensuring that the users of a building don't feel too hot or cold as a building that easily gains heat and hardly discharge is very more likely to provide lesser comfort to the occupants as against a building that gains less heat and discharges easily (Hou, 2016). This means keeping the temperature, humidity, airflow and radiant sources within acceptable range. Autodesk Sustainability Workshop also cited ASHRAE (2017), to have defined it as that condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation. Thermal satisfaction is very central to other aspects of human comfort as there is a very high tendency that occupants in an office with good visual and

acoustic comfort, without thermal will have more health issues to contend with than without the first two forms of comfort.

Lecturer, n.d. reiterated that thermal comfort can be assessed based on building heights; individual differences, environmental and personal factors, passive or active technology or system, objective or subjective methods or approaches (Ko et al., 2020). Hou (2016) estimated that reasonable comfort can be established when a minimum of 80% indoor occupants are feeling comfortable with the thermal environment. Generally, thermal comfort can be measured in two major ways which are objective and subjective. The objective thermal measurement has to do with use of engineering to take measurements and then use how these measurements conform with the green or sustainable rating systems functional in the location of the evaluated building; while subjective measure is an occupant perception approach to understanding and measuring thermal comfort in a built environment.

### **Acceptable Acoustic Comfort**

Acoustic comfort in a building environment is a balanced situation where unwanted, harmful noise are blocked out and enhance those sounds that are wanted and indeed needed to be heard (Vardaxis et al., 2018). This simply means having the right level and quality of noise to use the space as intended. This condition is very essential and necessary for schools and office buildings (Zami & Lee, n.d.). Lecturer, n.d. noted that most of the time, the functionality and aesthetics of the building are the major concern of the architects and designers at the planning and designing stage of a building overlooking the acoustical environment. He explained that these factors overlooked are the vital components that contribute to the productivity of individuals using the workspace. He further asserted that acoustic comfort can only be achieved in a workplace when it provides appropriate acoustical support for interaction, enhance confidentiality and give room for work concentration.

Orola & David (2019) asserted that acoustic comfort is closely related to both the health and performance of occupants in built environment. The quality of which is linked to the sound physical quality and the indoor quality. The level of exposure of city dwellers to sound disturbance is on the increase as several sources contributes to these sounds (Taghipour et al., 2020). However, HVAV is said to improve the quality of the acoustic comfort in some cases with the provision of sound masking. This is common in open plan offices as it is the addition of background noise to reduce the impact of distracting noise sources (Glean et al., 2022).

### **Visual Comfort**

Vision is the most important of all the five senses, especially at work, hence a good lighting quality is strictly connected to people's comfort and consequently to performance (Munonye & Ji, 2018). Similarly, Lecturer, n.d. explained visual comfort to mean ensuring the sufficient and adequate provision of light for the users and then giving them good views. This definition was equally supported by reports on Health, Wellbeing and Productivity in Offices, that having a better view out of an office window is associated with better overall performance, with productivity increase of 7%–12%. From a different view, Frontczak (2011) in its Multi-Comfort program remarked that a “visual connection to the outside world through exterior views is crucial for an optimal sense of wellbeing and comfortability. Stating that “we can all appreciate that working in a window-less office, even under adequate lighting conditions, is a totally different experience to working in an office with an outside view”.

Space, form, texture and color are revealed and appreciated through light. This gives a psychological perception and architectural experience of the indoor environment (Alkabashi, 2019). Giarma et al. (2017) in their paper which focused on Daylighting and Visual Comfort in Buildings' Environmental Performance Assessment Tools: a Critical Review, examined different methods of determining visual comforts within global standard. The paper which considered standard methods of BREEAM (Building Research Establishment Environmental Assessment Methodology), LEED (Leadership in Energy and Environmental Design), CASBEE (Comprehensive Assessment System for Built Environment Efficiency), and SBTools (Sustainable Building Tool) presented a variety of parameters for assessing, determining or achieving visual comfort as shown below.

Table 1 Visual Comfort Rating Parameters

<b>BREEAM</b>	<b>LEED</b>	<b>CASBEE</b>	<b>SBTool</b>
---------------	-------------	---------------	---------------

<p>Glare control</p> <p>Daylighting</p> <p>View out</p> <p>Internal and external lighting levels, zoning and control</p>	<p>Interior lighting</p> <p>Daylight</p> <p>Quality views</p>	<p>Daylight</p> <p>Anti-glare measures</p> <p>Illuminance level</p> <p>Lighting controllability</p> <p>Perceived spaciousness and access to view</p>	<p>Appropriate daylighting in primary occupancy area</p> <p>Control of glare from daylighting</p> <p>Appropriate illumination levels and quality of lighting in non-residential occupancies</p> <p>Controllability (including several criteria with regard to the degree of control for lighting system.</p> <p>Access to exterior views from interior</p>
--	---	--	--

Source (Giarma et al., 2017)

### Indoor Air Quality

Indoor air quality is important for general health and well-being, and a primary consideration in ensuring a comfortable indoor environment. (Behnam, 2017). It is a subset of indoor environmental quality that is related to pollutants (e.g., biological, chemical, and physical) and can affect the health of occupants (Steinemann et al., 2017). The quality of air in spaces is occupants specific as individuals are affected differently. IAQ is critical as most people spend 90% of their time indoor (Kamaruzzaman, S.N., Egbu C.O., Mahyuddin, N., Zawawi, E.M.A., Chua, 2020). Indoor air quality could be affected by odor related complaints forming the

majority of air pollution within. It forms a major consideration in green certification scheme but very difficult to measure and assess.

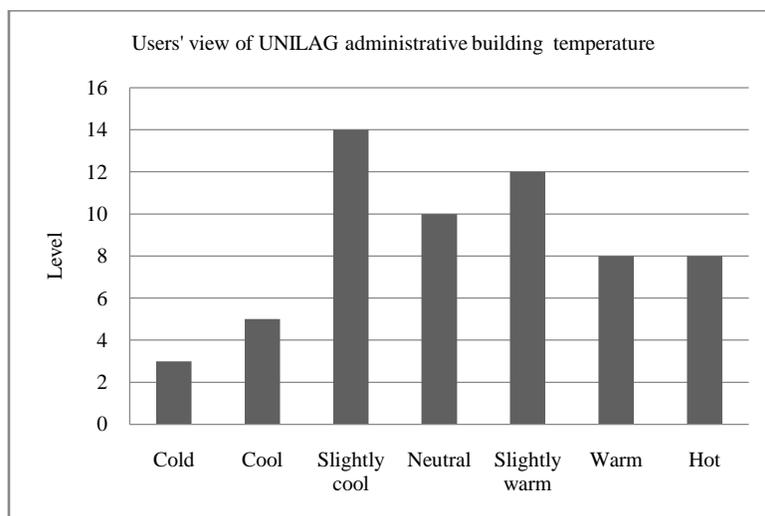
## METHODOLOGY

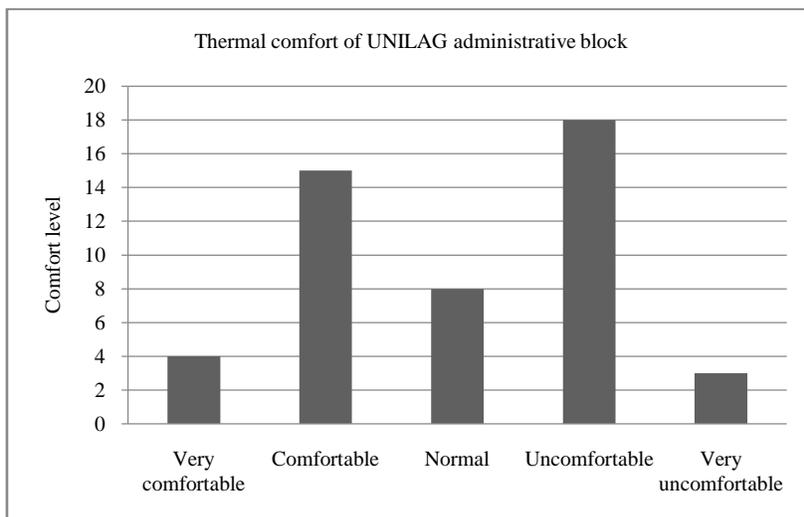
The research adopted a case study approach which involved comprehensive review, analysis and critique of University of Lagos administrative building to evaluate users' satisfaction in relations with the thermal, acoustic, and visual environment. These variables are measured subjectively. Data were gathered from the administrative staff members through structured confidential questionnaire data collection method. This confidentiality allowed each respondent to provide answers to the questions without any fear of sanction which makes the findings void of the researcher's subjectivity or manipulation.

Data gathered was entered into statistical package for social science (SPSS) to generate numerical data and explanation of the results. The data was coded for easy representation into table and charts. A comprehensive qualitative report was provided based on observations relating to the sustainable design principles visible in the buildings.

## FINDINGS AND DISCUSSIONS

### Thermal comfort

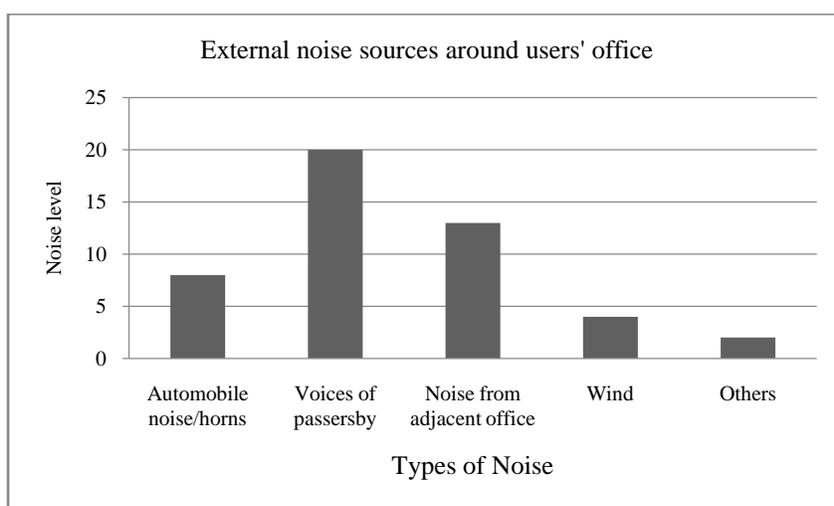




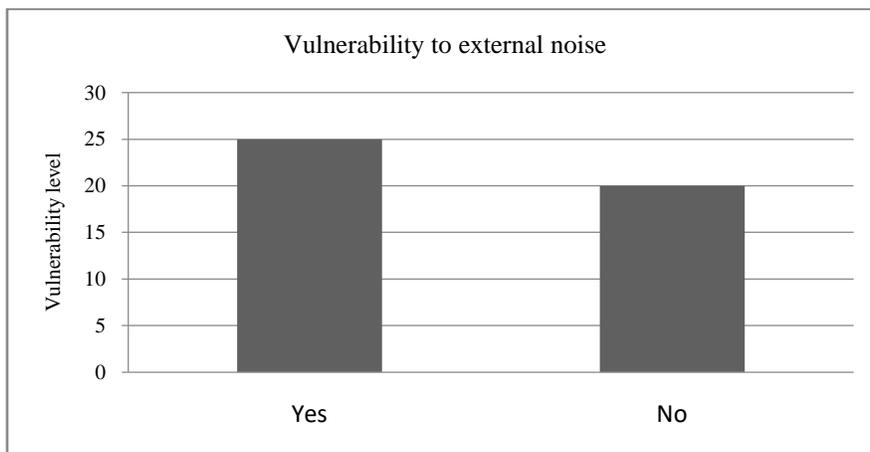
**Figure 1:** - Chart showing disparity in users’ assessment of thermal comfort

The result showed 41.4% of users indicated that they are comfortable with the thermal environment, 14.6% neutral, and 43.9% uncomfortable. Comparing professional and users’ view on thermal environment, 81% of them agreed that the buildings provide thermal comfort but for the users, only 21% agreed that they enjoyed thermal comfort in the building while about 55% of the users were undecided on this. It is obvious that there is no commonality in view. Thus, what professionals might rate as comfort because of its architecture and environmental influence, might not be same with the individuals whose subjective views, body temperature and health status strongly determine their comfort.

**Acoustic comfort**



**Figure 2:** - External Sources of Noise

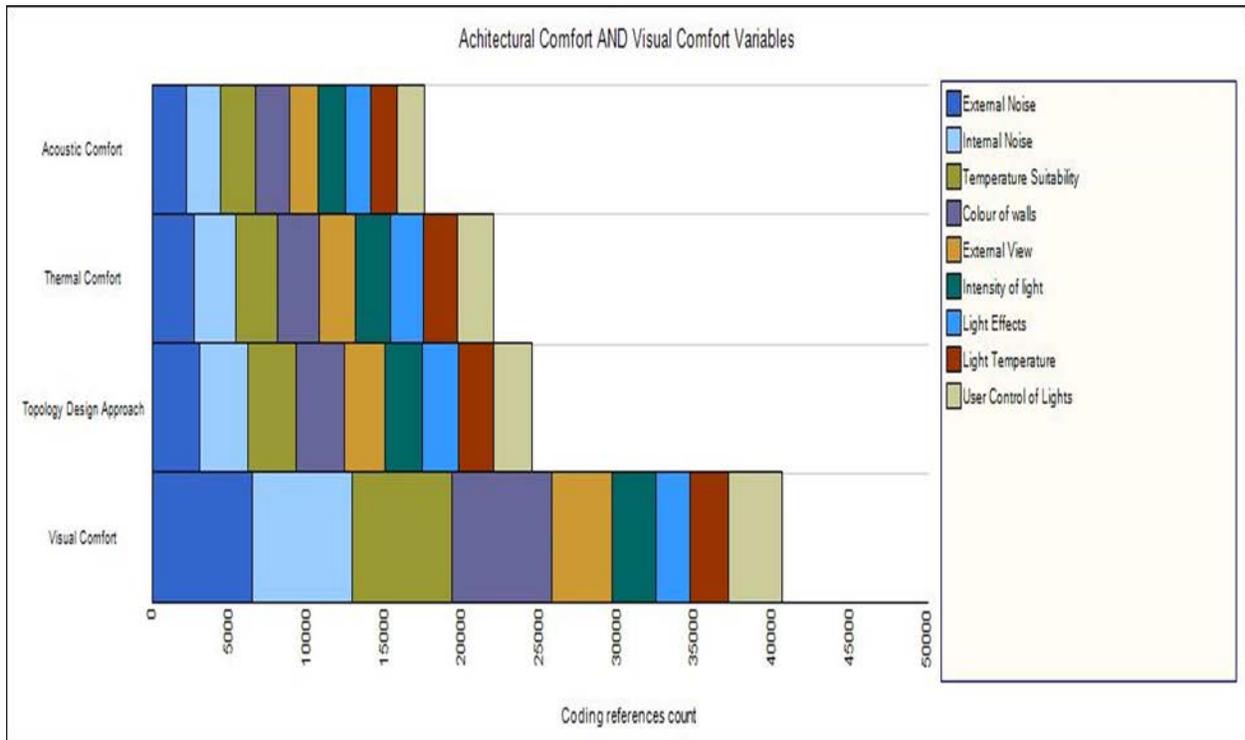


**Figure 3:** - Disparity in response to vulnerability of workspace to external noise

A close look at the responses showed that the office is not free from external and internally noise especially from adjoining offices and passers-by. Internally, about 60% reported that the most common noise are just phone rings, AC/FAN sounds and chats from corridors, adjacent offices and sometimes TV.

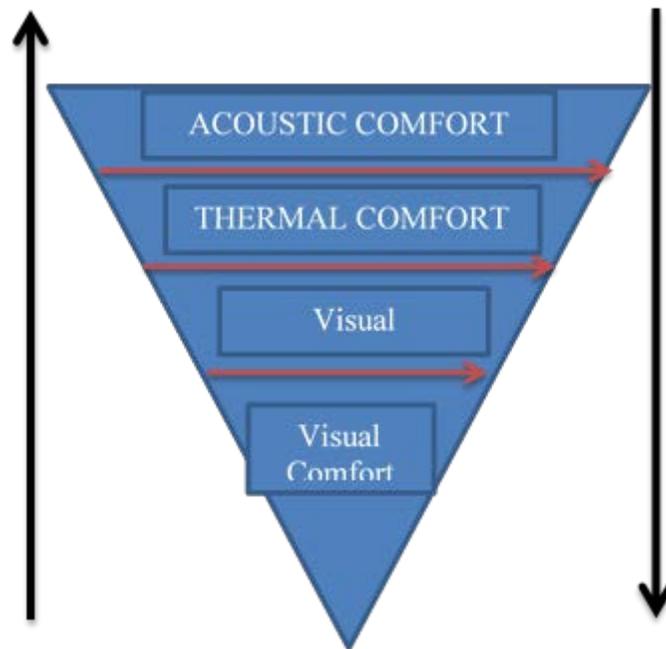
### **Visual comfort**

Lighting is a stronger determinant of visual comfort than other variables. The intensity, effects on users and control was evaluated alongside other variables of color and quality of external view. There is a strong connection between architectural and visual comfort variables. This is expressed in the chart below.



**Figure 4:** - Architectural comfort against comfort variables

The chart above measures the coding references count for Architectural Comfort variables against Visual Comfort. The variables are assigned with different color codes as seen the figure. The visual comfort variables are External view, Internal Noise, Temperature Suitability, Color of Walls, External View, Intensity of Light, Light Effects, Light Temperature and User Control of Light. While Architectural Comfort variables includes Acoustic Comfort that measure the degree of sound or noise effect, Thermal Comfort determines the heat or temperature of the building and Visual Comfort is talking above the color of walls, the effects of light, external views and intensity of light. From the figure, the highest coding reference counts occur at the visual comfort nodes with more 40000 words references regarding visual comfort with major emphasis on color of walls, external and internal noise, and temperature suitability.



**Figure 5:** Inverted Pyramid Models of Floor of Building and Comforts levels

The comfort level was however discovered to progress and degrees as indicated in the inverted pyramid model above. This displayed how the occupant opinion of different parameters measured of their comfort.

## CONCLUSION

Analysis of all the variables that make visual, thermal and acoustic comfort revealed that in contrast with expert opinion and assessment, there is a very weak ratio of the building users that enjoy visual, thermal and acoustic comfort. Interestingly as expected, visual comfort, thermal comfort, acoustic comfort, visual connection to exterior and quality fresh air is perceived differently by people different levels of the high-rise administrative buildings. Thus, a contrast between objective and subject comfort. However, on the aspect of thermal comfort, there is almost an overt dependence on artificial or mechanical cooling and heating systems in these offices despite designs to allow ventilation. The use of air conditioners all the time might properly provide thermal comfort to these users but not within sustainable parameters because air conditioners consume much energy and is not passive cooling. The study therefore established that the administrative building was not totally designed with sustainable architecture standard in mind. It has become essential that sustainable architectural principles should be incorporated into the existing structure to avert long term health and comfort related challenges for the occupants.

## RECOMMENDATION

In line with the conclusion and final findings of the study, it has become essential that sustainable architectural principles should be incorporated into the existing structures in the study area to avert long term health and comfort related challenges for the occupants. Importantly, bearing in mind the correlation between age, floor of building and comfort level. The study suggests that to improve the sustainability of the acoustic, thermal and visual compositions of the studied central university administrative buildings, inputs from professional sustainable architects is important. Overt dependence on mechanical or electrical system for cooling and lighting has a serious economic and energy challenges, and thus passive systems should be considered.

To avoid post construction and post occupancy challenges with comfort, physicians, architects, psychologists; landscapers, specialists in thermal and acoustic comforts as well as random selection of individuals with likely similar personal and psycho-demographic characteristics of potential occupants need to be involved in the pre-building and building phases of planning, design and construction. Individuals with physical challenges might find it challenging navigating around the building and even accessing the spaces, it is therefore recommended that multi-people-friendly frameworks should be considered for easily access to the buildings.

## References

- Aliyu, A. A., Muhammad, M. S., & Mohammed, B. (2016). *A REVIEW OF POST-OCCUPANCY EVALUATION AS A TOOL AND CRITERIA FOR ASSESSING BUILDING PERFORMANCE*. <https://www.researchgate.net/publication/303382704>
- Alkabashi, A. H. A. (2019). Bir sağlıklı yaşam merkezinin iç mekan fiziksel çevre kalitesinin nesnel, öznel ve mimari kriterler çerçevesinde incelenmesi. *MEGARON / Yıldız Technical University, Faculty of Architecture E-Journal*. <https://doi.org/10.14744/megaron.2019.47113>
- Ardiani, M., & Shateri, M. (2018). *Conceptual Framework for Sustainable Design*. 4(2), 15–24.
- ASHRAE. (2017). ASHRAE fundamentals (SI). In ASHRAE, “2017, ASHRAE fundamentals (SI),” in *2017, ASHRAE fundamental handbook SI, 2017th*.
- Behnam, N. (2017). A Review on Sustainable Building A Review on Sustainable Building ( Green Building ). *Munich Personal RePEc Archive*, 76588, 1–9.
- Bordass, B., & Leaman, A. (n.d.). *Phase 5: Occupancy-post-occupancy evaluation*.
- Esfandiari, M., Zaid, S. M., Ismail, M. A., & Aflaki, A. (2017). Influence of indoor environmental quality on work productivity in green office buildings: A review. *Chemical Engineering Transactions*, 56, 385–390. <https://doi.org/10.3303/CET1756065>
- Frontczak, M. J. (2011). General rights Human comfort and self-estimated performance in

- relation to indoor environmental parameters and building features. In *DTU Library* (Vol. 1).  
[www.byg.dtu.dk](http://www.byg.dtu.dk)
- Giarma, C., Tsikaloudaki, K., & Aravantinos, D. (2017). Daylighting and Visual Comfort in Buildings' Environmental Performance Assessment Tools: A Critical Review. *Procedia Environmental Sciences*, 38, 522–529. <https://doi.org/10.1016/j.proenv.2017.03.116>
- Glean, A. A., Gatland, S. D., & Elzeyadi, I. (2022). Visualization of Acoustic Comfort in an Open-Plan, High-Performance Glass Building. *Buildings*, 12(3), 1–10. <https://doi.org/10.3390/buildings12030338>
- Hou, G. (2016). *An investigation of thermal comfort and the use of indoor transitional space Thesis for the degree of Doctor of Philosophy*. 1–275.
- Huang, L., Krigsvoll, G., Johansen, F., Liu, Y., & Zhang, X. (2018). Carbon emission of global construction sector. *Renewable and Sustainable Energy Reviews*, 81(June), 1906–1916. <https://doi.org/10.1016/j.rser.2017.06.001>
- Iweka, B., & Chuks Okeibunor, A. (2012). *A POST-OCCUPANCY EVALUATION OF DWELLING DENSITY IN MULTIFAMILY APARTMENTS IN PUBLIC HOUSING ESTATES IN LAGOS*.
- Kamaruzzaman, S.N., Egbu C.O., Mahyuddin, N., Zawawi, E.M.A., Chua, S. J. L. (2020). Effect of Indoor Environmental Quality (IEQ) to the Human Occupation Health and Performance in Buildings. *PENGARUH PENGGUNAAN PASTA LABU KUNING (Cucurbita Moschata) UNTUK SUBSTITUSI TEPUNG TERIGU DENGAN PENAMBAHAN TEPUNG ANGKAK DALAM PEMBUATAN MIE KERING*, 274–282.
- Ko, W. H., Schiavon, S., Zhang, H., Graham, L. T., Brager, G., Mauss, I., & Lin, Y. W. (2020). The impact of a view from a window on thermal comfort, emotion, and cognitive performance. *Building and Environment*, 175, 0–29. <https://doi.org/10.1016/j.buildenv.2020.106779>
- Lecturer, S. (n.d.). *POST OCCUPANCY EVALUATION OF INSTITUTIONAL ADMINISTRATIVE BUILDING TO SUSTAINABLE STANDARDS*.
- Mancini, F., Nardecchia, F., Groppi, D., Ruperto, F., & Romeo, C. (2020). Indoor environmental quality analysis for optimizing energy consumptions varying air ventilation rates. *Sustainability (Switzerland)*, 12(2). <https://doi.org/10.3390/su12020482>
- Munonye, C. C., & Ji, Y. (2018). RATING THE COMPONENTS OF INDOOR ENVIRONMENTAL QUALITY IN STUDENTS CLASSROOMS IN WARM HUMID CLIMATE OF ULI, NIGERIA. In *African Journal of Environmental Research* (Vol. 1, Issue 2). <http://ajer.coou.edu.ng/index.php/journal>
- Nik Lah, N. M. I., Mohammed, A. H., & Abdullah Mohd Asmoni, M. N. (2015). Office space study: A review from facilities management context. *Jurnal Teknologi*, 75(10), 85–96. <https://doi.org/10.11113/jt.v75.5277>
- Orola, B. A., & David, S. A. (2019). An Assessment of Indoor Acoustic Condition in Students Hostels within Obafemi Awolowo University, Nigeria. *Open Journal of Acoustics*, 09(02), 13–25. <https://doi.org/10.4236/oja.2019.92002>
- Paradis, R. (n.d.). *Whole Building Design Guide Sustainable Historic Buildings Resource Page*.
- Steinemann, A., Wargocki, P., & Rismanchi, B. (2017). Ten questions concerning green

buildings and indoor air quality. *Building and Environment*, 112, 351–358.  
<https://doi.org/10.1016/j.buildenv.2016.11.010>

Taghipour, A., Athari, S., Gisladdottir, A., Sievers, T., & Eggenschwiler, K. (2020). Room Acoustical Parameters as Predictors of Acoustic Comfort in Outdoor Spaces of Housing Complexes. *Frontiers in Psychology*, 11(March), 1–17.  
<https://doi.org/10.3389/fpsyg.2020.00344>

Vardaxis, N. G., Bard, D., & Persson Waye, K. (2018). Review of acoustic comfort evaluation in dwellings—part I: Associations of acoustic field data to subjective responses from building surveys. *Building Acoustics*, 25(2), 151–170. <https://doi.org/10.1177/1351010X18762687>

Wilkinson, S. J., Reed, R. G., & Jailani, J. (2011). User Satisfaction in Sustainable Office Buildings: A Preliminary Study 17. *17th PRRES Pacific Rim Real Estate Society Conference, January*, 1–15.

Zami, M. S., & Lee, A. (n.d.). *EARTH AS AN ALTERNATIVE BUILDING MATERIAL FOR SUSTAINABLE LOW COST HOUSING IN ZIMBABWE*.  
[www.adobebuilder.com/index.html](http://www.adobebuilder.com/index.html)

