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Investigation Of Ambient Heat Conditions and Comfort in Church Building Occupancy in Port Harcourt

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Abstract- This study explored the impact of ambient heat on occupants of church buildings in Port Harcourt, Nigeria. The tropical climate of Port Harcourt, characterised by consistently high temperatures and elevated humidity year-round, poses significant thermal comfort challenges for religious buildings that typically accommodate large congregations for extended periods. Six purposively selected churches across the metropolis were investigated using a qualitative-dominant mixed-methods approach that combined non-intrusive observation, in-depth semi-structured interviews, and focus group discussions with occupants and administrators. Through thematic analysis of the collected data, the study identified that occupants experience substantial radiant heat discomfort arising primarily from building envelope surfaces, particularly roofs, walls, and windows. The findings revealed that roof surfaces contribute most significantly to occupants' sensation of overheating, followed by walls and glazing elements. Occupants consistently reported symptoms including excessive sweating, fatigue, reduced concentration, and general unease during worship services. The study identified inadequate natural ventilation, the use of heat-absorbing building materials, suboptimal building orientation, and insufficient shading as primary architectural factors amplifying radiant heat effects. The study recommends incorporating reflective roofing materials, improved cross-ventilation, strategic shading devices, and appropriate building orientation to mitigate radiant heat effects in church buildings.

Keywords: Ambient Heat, Thermal Comfort, Tropical Climate, Passive Cooling, Climate Responsive Architecture

I. INTRODUCTION

Religious buildings, particularly churches, function as critical social infrastructure in Nigerian communities, providing spaces for worship, community gathering, and spiritual development (Odoh, Jonas & Onwuzuligbo, 2025). In Port Harcourt, the capital city of Rivers State, church attendance is a significant weekly social activity, with many congregations numbering in the hundreds to thousands of worshippers.

The tropical climate of Port Harcourt creates unique challenges in preserving thermal comfort in these large-volume buildings, where solar radiation significantly affects the indoor environment (Weather Spark, 2024).

Ambient heat transfer is one of the primary methods Ambient heat transfers refers to the movement of heat between a space (or object) and its surrounding environment. Unlike convective heat transfer, which depends on air movement, (Fanger, 1970).

STATEMENT OF PROBLEM

Despite the proliferation of church buildings in Port Harcourt and the acknowledged issues posed by the tropical climate, there is a paucity of research that particularly examines the impact of ambient heat on occupant comfort in these buildings.

Many churches in the city have been constructed without adequate consideration of climate-responsive design principles, resulting in spaces that become uncomfortably hot during services, notably during peak attendance periods.

The large occupancy density typical of church services exacerbates thermal conditions via metabolic heat gain, while inadequate ventilation and inappropriate material selections additionally compound discomfort (Amagbakhen & Ogbeifun, 2022)

AIM

This study aims to investigate the impact of ambient heat on occupants of church buildings in Port Harcourt, Nigeria.

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OBJECTIVES

The specific objectives are to:

·Explore occupants' subjective experiences and perceptions of ambient heat discomfort during worship services.

·Formulate evidence-based recommendations for mitigating ambient heat effects and boosting thermal comfort through passive design strategies.

RESEARCH QUESTIONS

The following research questions guide this study:

1. What do occupants of church buildings in Port Harcourt experience and describe as ambient heat discomfort during worship services?
2. What design strategies can be recommended to reduce ambient heat gain and improve occupant comfort?

SCOPE OF THE STUDY

This study is delimited to church buildings located within Port Harcourt metropolis, Rivers State, Nigeria. It focuses specifically on the occupants' subjective experiences of ambient heat during regular Sunday worship services.

SIGNIFICANCE OF STUDY

Ambient heat is a key factor in church buildings, as it directly affects occupant comfort and provides important guidance for design and policy decisions. In practical terms, it helps architects, planners, and church administrators create spaces that are cooler, healthier, and more energy-efficient while supporting worshippers' well-being.

II. LITERATURE REVIEW

Ambient heat and Thermal Comfort

Ambient heat is the background heat in a space, distinct from heat from a single source, such as a heater or a fire. In buildings, occupants are continuously exposed to ambient heat from surrounding surfaces, including walls, ceilings, floors, and windows. The Mean Radiant Temperature (MRT) provides a single-value representation of the combined radiant effect of all surrounding surfaces.

In spaces with substantial solar exposure or on surfaces at high temperatures, MRT can exceed air temperature, leading to increased thermal sensation even when air temperature appears acceptable (ASHRAE Standard 55, 2020).

Conceptual Framework: Heat Balance Theory

This study is grounded in the Heat Balance Theory of thermal comfort, which states that thermal comfort is achieved when the body's heat production equals its heat loss to the environment (Fanger, 1970).

In the context of church buildings in Port Harcourt, ambient heat gain is a particularly significant component of the overall heat balance due to tropical solar exposure, large exposed roof and wall surfaces, and the typically long worship services.

Empirical Framework

Empirical studies on thermal comfort in religious buildings show important differences across locations and methods. Odoh et al. (2025), in Enugu, Nigeria, used survey- and observation-based methods and found that the cathedral had the highest thermal comfort performance, while also recommending improved shading and ventilation.

Akinwumi et al. (2023) in Lagos-Ogun, Nigeria, used qualitative observation and reported that passive cooling is often inadequate for mega-churches, leading to greater dependence on air-conditioning systems. In Malaysia, Tan et al. (2022) conducted a case study and interviews, finding that intimacy, proximity, and flexibility are key qualities for shared church spaces.

Similarly, in Nigeria, Amagbakhen and Ogbeifun (2022) used field measurements and identified radiant heat as a major contributor to thermal discomfort in tropical church settings.

Gaps in Literature

In Port Harcourt, research on thermal comfort in buildings has primarily focused on residential and commercial structures, with limited attention to religious buildings. The unique characteristics of church buildings, including large open volumes, high occupancy densities, and extended periods of use, necessitate specific investigation beyond general building thermal comfort studies.

III. METHODOLOGY

This study adopted a case study design and used non-intrusive observation, in-depth semi-structured interviews, and focus group discussions, an approach chosen for its capacity to investigate a contemporary phenomenon within its real-life context (Yin, 2009).

The sample churches were purposively selected based on predefined inclusion criteria: they were located within Port Harcourt, had a minimum seating capacity of 200, were at least two years old, and were regularly used for worship services, ensuring that the buildings were sufficiently established and suitable for assessing ambient heat and thermal comfort conditions in church spaces.

Primary data were collected through non-intrusive observation during Sunday morning services over a period, with occupants' behavioural responses to thermal conditions noted. In-depth semi-structured interviews were conducted with 30 church occupants and 12 key informants, including church administrators and facilities managers.

Three focus group discussions were also held to explore shared experiences of thermal discomfort and collective coping strategies. All qualitative data from the interviews, focus groups, and ethnographic field notes were analysed using thematic analysis, following the stages of familiarisation, coding, theme development, review, and theme definition (Braun & Clarke, 2006).

Data Collection Methods

Non-intrusive observation was conducted during Sunday morning services over a period, with two research assistants systematically recording occupants' behavioural responses to thermal conditions including seating preferences, use of personal cooling devices, clothing adjustments, and restlessness indicators alongside the physical characteristics of each church building (roofing material, wall construction, window size and operability, ceiling height, shading devices, and interior surface colours).

Particular attention was paid to areas near windows and doors, and under roof surfaces, and photographic documentation was undertaken with permission from the church authorities.

In addition, in-depth semi-structured interviews lasting 25–45 minutes were conducted with 30 church occupants following Sunday services, using open-ended questions to explore experiences of thermal discomfort, perceived contributing building features, adaptive strategies, and suggestions for improvement. All interviews were audio-recorded with informed consent and transcribed verbatim.

Three focus group discussions, each comprising six participants organised by gender (two female groups and one male group, reflecting higher female attendance) and lasting 60–90 minutes, were also held to explore shared experiences of thermal discomfort and collective coping strategies.

Semi-structured interviews were further conducted with 12 key informants—including church administrators, building committee members, and facilities managers—to capture institutional perspectives on building design decisions, awareness of thermal comfort issues, and maintenance practices.

All qualitative data from interviews, focus groups, and observational field notes were analysed using thematic analysis following Braun and Clarke's (2006) six-phase approach: familiarisation, initial coding, searching for themes, reviewing themes, defining and naming themes, and producing the report—facilitated using NVivo software.

Credibility was enhanced through independent double coding of a subset of transcripts, member checking with participants, and maintenance of an audit trail documenting analytical decisions throughout the process.

IV. FINDINGS AND DISCUSSION

Occupants' Experiences of Radiant Heat Discomfort

The analysis showed that the majority of participants experience significant thermal discomfort during worship services, with ambient heat from building surfaces identified as a primary contributor. The findings appeared across four major themes:

· Sensation of Overwhelming Heat from Above: Participants consistently described feeling a sensation of heat radiating downward from the ceiling and roof structure, particularly in churches with metal roofing.
·Wall Surface Heat and Solar Penetration: Participants in churches with large unshaded windows and dark-colored walls noted considerable discomfort from radiant heat, especially during morning services with direct solar penetration.

·Floor Surface Heat: In churches with concrete floors lacking surface covering, floor surface temperature was identified as a source of discomfort, radiating upward.

·Accumulated Heat Throughout Extended Services: Discomfort intensified as services progressed. Participants described an accumulation of heat within the building over time, typically peaking during the latter portions of services.

Identified Sources of Ambient Heat Discomfort
Analysis identified several architectural factors as the main contributors to ambient heat discomfort. The roof was consistently identified as a source, particularly uninsulated corrugated metal roofing, which heats rapidly under solar exposure.

Dark colored exterior walls and thin, single-leaf walls also contributed to heat absorption. Furthermore, large unshaded windows (especially east- or west-facing) allowed direct solar penetration. Key informants noted that building orientation was rarely considered, with east-west-oriented buildings experiencing greater solar gain.

Participants also detailed their coping strategies, the most common of which was strategic seating selection (near windows, doors, or fans). The use of hand fans was ubiquitous, and many adapted their clothing or brought water to cope with heat stress. A summary of these qualitative findings is presented in Table 1.

Table 1 summarises the key qualitative findings organised by theme:

Theme	Description	Respondents
Overwhelming heat from above	Sensation of heat radiating downward from the roof/ceiling	Reported by nearly all occupants
Wall surface heat	Discomfort from hot walls and solar penetration through windows	Reported by the large majority of occupants
Floor warmth	Warm floor surfaces radiating heat upward	Reported by fewer than half of the occupants
Heat accumulation	Discomfort is intensifying during extended services	Reported by the large majority of occupants
Roof as a primary source	Metal roofing is identified as the worst contributor	Reported by the large majority of occupants
Lack of shading	Unshaded windows and walls increase heat gain	Reported by close to two-thirds of occupants
Adaptive seating	Strategic seating selection for cooler locations	Reported by nearly all occupants
Use of fans	Hand fans as an essential coping device	Reported by all occupants

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Table 1: Summary of Qualitative Findings on Ambient Heat Discomfort

CONCLUSION

This study concluded that occupants of church buildings in Port Harcourt experience significant radiant heat discomfort during worship services. The findings show that roof surfaces are the primary source of radiant heat discomfort, followed by walls and windows.

The study identified inadequate natural ventilation, the use of heat-absorbing building materials (particularly uninsulated metal roofing), suboptimal building orientation, and insufficient shading as key architectural aspects contributing to poor thermal conditions.

RECOMMENDATIONS

Based on the findings, the following recommendations are made:

- Building Designers and Architects should incorporate climate-responsive design principles from the earliest stages. Prioritise roof insulation, reflective roofing materials, and double-roof systems. Optimise building orientation with long axes running north-south, and position windows to maximise cross-ventilation while minimising direct solar gain.
- Church Administrators should consider retrofitting existing buildings by adopting non-absorbing heat materials, improved ventilation openings, and external shading devices. Provide supplementary cooling aids such as ceiling fans in areas where natural ventilation is insufficient.
- Policy Makers should develop and enforce building guidelines specific to religious buildings that incorporate climate-responsive requirements, providing technical resources to support climate-adaptive church construction

REFERENCES

[1] Akinwumi, I. A., Oguntona, O. A., & Oloke, D. A. (2023). Use of passive cooling strategies in selected mega-churches within Lagos-Ogun megacity, Nigeria—Journal of Building Engineering, 65, 105781.

[2] AlHorr, Y., Arif, M., Katafygiotou, M., Mazroei, A., Kaushik, A., & Elsarrag, E. (2016). Impact of indoor environmental quality on occupant well-being and comfort: A review of the literature. https://doi.org/10.1016/j.ijsbe.2016.03.006

[3] Amagbakhen, O. O., & Ogbeifun, E. (2022). Thermal comfort assessment of church buildings in tropical climates: A case study approach. International Journal of Sustainable Built Environment, 11(2), 445–458.

[4] American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). (2020). ANSI/ASHRAE Standard 55-2020: Thermal Environmental Conditions for Human Occupancy. Atlanta, GA: ASHRAE.

[5] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101.

[6] International Organisation for Standardisation (ISO). (2005). ISO 7730:2005 Ergonomics of the Thermal Environment.

[7] Odoh, P. E., Jonas, O. M., & Onwuzuligbo, C. C. (2025). Climate adaptations of religious buildings in Enugu State, Nigeria. International Journal of Engineering and Technology, 1(1), 89–102.

[8] Santamouris, M., Sfakianaki, A., & Pavlou, K. (2011). On the efficiency of night ventilation techniques applied to residential buildings. Energy and Buildings, 42, 1309–1313.

[9] SimScale. (2024). What is ASHRAE 55? Thermal comfort basics.

[10] Tan, H. L., Samsudin, I. L., Azman, N. S., & Rasdi, M. T. M. (2022). The presence of multi-faith architecture. International Journal of Modern Trends in Social Sciences, 5(21), 1–17.

[11] Yin, R. K. (2009). Case Study Research: Design and Methods (4th ed.). Thousand Oaks, CA: Sage Publications.