PERCEPTION OF BUILDING OCCUPANTS AND PROFESSIONALS TOWARDS THE INFLUENCE OF THERMAL TRANSMISSION AND MICROCLIMATIC ON RESIDENTIAL BUILDINGS IN BOSSO ESTATE, MINNA, NIGERIA

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Abstract
This study examined the perception of thermal transmission and microclimatic influences in residential buildings in Bosso Estate, Minna, Nigeria. The study assessed occupants' perceptions of thermal transmission, evaluated the impact of microclimatic factors on indoor temperature, and identified building materials and architectural features affecting thermal comfort. A descriptive survey design was employed, encompassing 120 respondents, including 100 building occupants and 20 building professionals. Data were collected using a 51-item structured questionnaire and analyzed with mean, standard deviation, and independent t-tests at a 0.05 significance level. Findings indicate that thermal transmission is perceived through roofs, ceilings, windows, walls, and ventilation systems (M = 2.83–3.11), while microclimatic factors such as solar radiation, airflow patterns, and internal heat loads significantly influence indoor temperature (M = 2.77–3.01). Building materials and architectural features including insulation, glazing, shading devices, and ceiling height also affect thermal comfort (M = 2.71–3.02). No significant differences were observed between professionals and occupants ($p > 0.05$). The study recommends integrating climate-responsive design and thermally efficient materials to optimize residential indoor environmental quality.

Keywords: Thermal Transmission, Microclimatic Factors, Residential Buildings

Background of the study

The thermal performance of buildings plays a critical role in determining indoor comfort, energy efficiency, and the well-being of occupants. In residential environments, the ability of buildings to regulate heat significantly affects the thermal experiences of occupants. Thermal perception is influenced not only by indoor temperature but also by occupants' ability to adapt to their environment through openings, shading devices or cooling systems among others (Antonio, Hoz-Torres, & Diego, 2022). Differences in building materials, architectural designs, and surrounding environmental conditions often result in varying thermal experiences among residents.

Thermal transmission refers to the transfer of heat through conduction, convection, and radiation between building elements due to temperature differences and material properties (Yunus & Afshin, 2020). In hot climatic regions such as Minna, Nigeria, the use of materials with high thermal conductivity, including concrete walls and corrugated metal roofing sheets, can significantly increase indoor temperatures. These materials absorb solar radiation during the day and gradually release the stored heat at night, thereby prolonging thermal discomfort for occupants. In many cases, buildings are constructed using materials selected primarily for their affordability and availability rather than their thermal efficiency, which often results in heavy reliance on mechanical cooling systems such as fans and air conditioners (Adeyemi & Jimoh, 2021). However, irregular electricity supply and high operational costs limit the effectiveness of these cooling strategies in solving thermal transmission (Akinpelu, Adekunle, & Lawal, 2020).

In addition to building characteristics, microclimatic conditions surrounding buildings also influence thermal comfort. Microclimatic factors such as solar radiation, wind flow, vegetation cover, and surface materials affect how heat is absorbed, stored, and dissipated in the built environment. In Bosso Estate, intense solar exposure, widespread use of metal roofing, limited vegetation, and heat-absorbing surfaces such as asphalt roads and concrete pavements contribute to increased ambient temperatures and indoor heat gain (Ibrahim & Musa, 2023; Mohammed & Okonkwo, 2022). Poor building orientation and inadequate ventilation further restrict natural airflow, thereby increasing thermal discomfort in residential buildings (Ajayi & Adebayo, 2022).

The adaptive thermal comfort model proposed by De Dear & Brager (2022) emphasized that occupants' thermal perceptions are shaped through continuous interaction with their building environment and surrounding microclimatic conditions. The model suggests that individuals actively interpret thermal sensations based on factors such as heat transfer through building elements (roofs, walls, windows) and environmental variables like air temperature, solar radiation, and ventilation. Building professional and occupants serve as active agents in assessing and responding to thermal conditions, the model provides a theoretical basis for understanding the relationship between building structure, environmental factors, and perceived thermal comfort.

Given the combined influence of building materials, architectural design, and microclimatic conditions, understanding residents' perception of thermal transmission is important for improving building performance and promoting sustainable residential environments. Therefore, this study examines the perception of thermal transmission and microclimatic influences in Bosso Estate, Minna, with the aim of understanding how building characteristics and environmental conditions affect occupants' thermal experiences.

Statement of the Problem

Thermal transmission through building components has become a major concern in residential buildings located in hot climatic regions where high temperatures and challenging microclimatic conditions prevail. Buildings in this region are frequently exposed to intense solar radiation and elevated ambient temperatures, which significantly influence indoor thermal conditions. Heat penetration through building envelopes such as roofs, walls, and floors affect indoor thermal comfort and the overall living conditions of occupants (Mohammed & Okonkwo, 2022; Oliveira & Corvacho, 2021). This situation is often worsened by building designs that provide limited cross-ventilation and insufficient shading, thereby restricting the natural dissipation of heat and increasing indoor temperature levels.

The problem is further compounded by the widespread use of building materials selected mainly for their availability and affordability rather than their thermal efficiency. Materials with high thermal conductivity, such as metal roofing sheets and concrete, tend to absorb and transfer large amounts of heat into indoor spaces, thereby prolonging thermal discomfort for residents. Another issue facing the estate is restructuring the initial plan and architecture design where space for vegetation and trees were altered for the expansion of more structures overlooking microclimatic factors that pending the occupants comfort. As a result, many occupants rely on mechanical cooling systems such as fans and air conditioners, which increase energy consumption, electricity costs, and carbon emissions (Akinpelu, Adekunle, & Lawal, 2020).

Despite the growing concerns about indoor thermal discomfort and its economic and environmental implications, limited empirical attention has been given to residents' perception of thermal transmission and the influence of microclimatic factors such as solar radiation, wind flow, vegetation cover, and surrounding surface materials on building structures in Bosso Estate. Therefore, there is a need to examine the perception of thermal transmission and microclimatic influences in the building structure at Bosso Estate, Minna.

Objectives of the Study

The objectives of the study are to determine the perception of building occupants and professionals towards thermal transmission and microclimatic condition in the building structure in Bosso Estate, Minna. Specifically, the study sought to:

1. examine how building occupants and professionals perceived the influence of thermal transmission on different structures in Bosso Estate.
2. assess the perception of building occupants and professionals towards the influence of microclimatic factors (such as sunlight exposure, ventilation, and shading) in Bosso Estate
3. identify the common building materials and architectural features influencing thermal comfort in resident building in Bosso Estate**.**

Research Questions

The following research questions guide the study.

1. How do building occupants and professionals perceive thermal transmission in different structures in Bosso Estate**?**
2. How the perception of building occupants and professionals towards the influence of microclimatic factors in Bosso Estate**?**
3. What are the common building materials and architectural features influencing thermal comfort in resident building in Bosso Estate**?**

Hypotheses

The following hypotheses were tested at 0.05 level of significance

H_{O1}: There is no significant difference in the mean responses of the perception between building professionals and building occupants towards the influence on different structures.

H_{O2}: There is no significant difference in the mean responses of the perception between building professionals and building occupants towards the influence of microclimatic factors on indoor temperature in Bosso Estate.

H_{O3}: There is no significant difference in the mean responses between building professionals (builders, engineers, architects and urban planners) and building occupants on the common building material and architectural features influencing thermal comfort in resident building in Bosso Estate.

Methodology

The study employed a comparative descriptive survey research design and was carried out in Bosso Estate, Minna, Niger State, Nigeria. The population comprised both building occupants and building professionals, including builders, engineers, architects, and urban planners residing or practicing within the estate. Specifically, the population consisted of 100 building occupants and 20 building professionals, making a total of 120 respondents. Due to the relatively small size of the population, a census approach was adopted, and no sampling technique was employed.

The instrument used for data collection was a structured questionnaire comprising 51 items developed by the researchers. The questionnaire was designed to elicit information across three key sections. Section A obtained respondents' perceptions of the influence of thermal transmission, with response options rated as Highly Perceived (HP), Perceived (P), Moderately Perceived (MP), and Not Perceived (NP). Section B elicited information on respondents' perceptions of the influence of microclimatic factors, while Section C focused on common building materials and architectural features influencing thermal comfort. For Sections B and C, response options were rated as Highly Influenced (HI), Influenced (I), Moderately Influenced (MI), and Not Influenced (NI). A four-point Likert scale was adopted for the measurement of all items, with assigned values as follows: Highly Perceived/Highly Influenced (HP/HI) = 4 points, Perceived/Influenced (P/I) = 3 points, Moderately Perceived/Moderately Influenced (MP/MI) = 2 points, and Not Perceived/Not Influenced (NP/NI) = 1 point. The decision rule based on real limits of numbers was as follows: 3.50–4.00 = High (HP/HI), 2.50–3.49 = Moderate/Positive (P/I), 1.50–2.49 = Low (MP/MI), and 1.00–1.49 = Very Low (NP/NI).

The developed instrument was subjected to face and content validation by seven experts, comprising three lecturers from the Department of Industrial and Technology Education, Federal University of Technology, Minna, and four building professionals, including builders, engineers, architects, and urban planners. Their observations and suggestions were carefully incorporated to improve the quality of the instrument. The internal consistency of the instrument was determined using the Cronbach Alpha reliability method. To establish reliability, a pilot test was conducted with 10 building occupants and 3 building professionals from Lawu Estate in Niger State. The reliability coefficient obtained was 0.87, indicating that the instrument was highly reliable. The instrument was subsequently administered by the researchers, and a 100% return rate was achieved.

The following statistical tools (comparative descriptive survey design and independent sample t-test) were used to analyze the data. The comparative descriptive survey design (mean and standard deviation) addressed the three research questions and is appropriate because it allows for comparative analysis between two independent groups (building professionals and building occupants). While independent sample t-test was used to test the hypotheses at a 0.05 level of significance. The Independent Samples t-test was used to test the null hypotheses because the study involved comparing the mean responses of two independent groups (building professionals and building occupants). The data collected for the study were organized and analyzed on the basis of the research questions and hypotheses. Mean and standard deviation was used to answer the research questions, while a t-test was used to test the null hypothesis at 0.05 level of significance. All statistical calculations were done using the statistical package for social science (SPSS) version 25. The decision rule for the items in the research questions were based on the resulting mean score interpreted relative to the concept of real lower and upper limit of numbers on the four-point rating scale as shown above. While the decision on the hypotheses were based on comparing the significant value (level of significant) with (P ≤0.05). If the significance value is equal or greater than (P ≤ 0.05), the hypothesis is upheld or otherwise rejected.

Results

Research Question 1

How do building occupants and professionals perceive thermal transmission on different structures in Bosso Estate?

Table 1: Mean Responses of Building Occupants and Professionals on How Building Occupants Perceive Thermal Transmission on Different Structures in Bosso Estate.

		N_1 =20	**N_2 = 100**	
S/N	**ITEMS**	$\bar{x}$	**SD**	**REMARK**
1	Noticing Thermal coming through the roof during the day	3.05	.934	Perceived
2	Ceiling seems to absorb and release Thermal into the room spaces during the day/night.	2.83	1.087	Perceived
3	perceiving higher Thermal in rooms with aluminum window frames.	3.11	.986	Perceived
4	Window placements influences how hot or cool the room feels.	2.95	1.028	Perceived
5	Perceiving less indoor Thermal when doors and windows are closed.	3.03	1.016	Perceived
6	Feeling less of Thermal when cross-ventilation is available.	2.88	.972	Perceived
7	Noticing that poorly ventilated areas transmit more	2.98	1.029	Perceived

	Thermal to adjoining rooms.			
8	Noticing that the height of the ceiling affects Thermal buildup indoors	2.87	1.004	Perceived
9	Experiencing more Thermal in rooms facing direct sunlight	2.85	1.034	Perceived
10	Noticing that variation in daytime significantly influences Thermal indoors	3.08	1.001	Perceived
11	Noticing buildings with concrete walls retain Thermal for long periods.	2.98	1.029	Perceived
12	Noticing that the type of paint used on walls affects room temperature	2.88	1.081	Perceived
13	Noticing that buildings with insulation material feel cooler than those without	2.87	1.061	Perceived
14	Perceive less Thermal in brick or natural material buildings	2.99	.983	Perceived
15	Perceive more Thermal where there's no roof insulation	3.03	1.049	Perceived

KEY: N: 120, N1: No. of building professionals, N2: No. of building occupants, x̄: Mean of respondents SD: Standard deviation of respondents

The results in Table 1 indicate that respondents have a statistically positive perception of thermal transmission in different building structures, as all mean scores exceeded the criterion mean of 2.50 (M = 2.83–3.11). This suggests general agreement among respondents on the influence of structural elements on indoor thermal conditions. The relatively close mean values and moderate standard deviations (SD = 0.986–1.087) further imply consistency and a reasonable level of homogeneity in the responses across the measured variables.

Research Question 2

How the perception of building occupants and professionals towards the influence of microclimatic factors in Bosso Estate**?**

Table 2: Mean Responses of Building Occupants and Professionals on How Microclimatic Factors Influence Indoor Temperature in Resident Building in Bosso Estate?

		N_1 =20	N_2 = 100	
S/No	**ITEMS**	x̄	**SD**	**REMARK**
1	Air temperature variations throughout the day influence indoor temperature	2.90	1.048	Influenced
2	Air movement and ventilation patterns influence indoor temperature	2.82	1.097	Influenced
3	Solar radiation entering through openings influence indoor temperature	2.86	1.117	Influenced
4	Thermal generated by electronic devices influence indoor temperature	2.82	1.042	Influenced
5	Occupant density in a room influence indoor temperature	2.79	1.114	Influenced
6	Clothing worn by occupants/coating use by occupants influence indoor temperature	2.93	1.002	Influenced
7	Activity level of occupants (e.g., sitting vs. exercising)	3.01	1.041	Influenced
8	Presence of carpets or rugs affecting thermal retention	2.93	1.070	Influenced
9	Use of artificial lighting that generates thermal affect indoor temperature	2.77	.985	Influenced

10	Placement of furniture affecting air flow and influence indoor temperature	2.85	1.066	Influenced
11	Height of the ceiling and materials used influence indoor temperature	2.92	.984	Influenced
12	Presence of pool of water around the building influence indoor temperature	2.91	.996	Influenced
13	Window glazing type and thickness influence indoor temperature	2.96	1.072	Influenced
14	Thermal retention properties of different furniture materials influence indoor temperature	2.94	.998	Influenced
15	Use of smart thermostats for temperature regulation aids control of indoor temperature	2.91	.987	Influenced

The results in Table 2 reveals that respondents generally agree that microclimatic factors significantly influence indoor temperature in residential buildings in Bosso Estate. All the items recorded mean values above the decision threshold ($\bar{x}$ = 2.77–3.01), indicating that none of the factors were perceived as insignificant. Among the variables, occupants' activity level ($\bar{x}$ = 3.01) was rated as the most influential, while artificial lighting ($\bar{x}$ = 2.77) was the least, though still considered impactful. The relatively moderate standard deviation values (SD = 0.98–1.114) suggest a reasonable level of agreement among respondents. The findings imply that indoor temperature is influenced by a combination of environmental conditions, building characteristics, and occupant-related factors, highlighting the need for an integrated approach to thermal comfort management in residential buildings.

Research Question 3

What are the common building materials and architectural features influencing thermal comfort in resident building in Bosso Estate**?**

Table 3: Mean Responses of Building Occupants and Professionals on the Common Building Materials and Architectural Features Influencing Thermal Comfort in Resident Building in Bosso Estate

N_1 =20 N_2 = 100

S/No	ITEMS	$\bar{x}$	SD	REMARK
	Building Materials			
1	Concrete block	2.71	1.133	Influenced
2	Brick	2.85	1.074	Influenced
3	Hollow blocks	2.84	1.061	Influenced
4	Planks	2.93	1.047	Influenced
5	Glass walls	2.87	1.107	Influenced
6	Insulated panels	2.83	1.147	Influenced
7	Aluminum cladding	2.96	1.080	Influenced
8	Metal	2.94	1.048	Influenced
9	Wooden cladding	2.87	1.037	Influenced
10	Clay tile roofing	2.92	1.055	Influenced
11	Floor materials (e.g., tiles, cement)	2.87	1.107	Influenced
12	Roof insulation materials (e.g., fiberglass, foam)	2.88	1.086	Influenced
13	Carpeted floors	3.00	1.004	Influenced
14	Ceiling height	2.96	1.040	Influenced
15	Double-glazed windows	2.96	1.064	Influenced
16	Shading devices	2.93	1.098	Influenced
17	Reflective paint/coatings	2.95	1.020	Influenced
18	Prefabricated insulated panel	2.88	1.014	Influenced
	Architectural features			
19	Direction of openings in the building	2.90	1.064	Influenced
20	Selection of openings materials	2.84	1.152	Influenced

21	Lack of cooling features (pool, trees, open drainage) within/outside the building.	3.02	.996	Influenced

The results in Table 3 indicate that both respondents perceive the influence of building materials and architectural features on thermal comfort as all mean scores exceeded the benchmark of 2.50 (M = 2.71 – 3.02). For building materials**,** the results (M = 2.71 – 2.96) show a wide range of conventional and modern materials contribute to thermal conditions within buildings. Materials such as carpeted floors, aluminum cladding, ceiling height, and double-glazed windows recorded some of the highest mean values. For architectural features, lack of cooling features such as vegetation, water bodies, or open drainage systems recorded the highest mean ($\bar{x}$ = 3.02), indicating it is perceived as the most critical factor affecting thermal comfort. While, others were also identified as influential factors. The relatively moderate standard deviation values (ranging approximately from 0.996 to 1.152) suggest a reasonable level of agreement among respondents, although slight variability exists in perceptions.

Hypothesis 1:

H_{O1}: There is no significant difference in the mean responses of the perception between building occupants and professionals towards the influence on different structures in Bosso Estate.

Table 4: Summary of T-test Analysis of the Main Responses of Building Occupants and Professionals on Building Occupants' Perception of Thermal Transmission in Different Structures in Bosso Estate.

Respondent	N	$\bar{x}$	SD	Df	t-value	P-Value Sig. (2-tailed)	Alpha Level	Remark
Building Professionals	20	2.83	.501	118	1.126	.262	.05	NS
Building Occupants	100	2.98	.568					

Key: $\bar{x}_1$**=** mean of metal building professionals, $\bar{x}_2$ = mean of building occupants**,** N_1 = No. of building professionals**,** N_2 = No. of building occupants, SD_1 **=** standard deviation of building professionals, SD_2 **=** standard deviation of building occupants, **NS**=Not Significant**, S**= Significant, Df = Degree of freedom

The findings of the t-test analysis for Hypothesis 1 from Table 4 presented the mean response of building occupants (M = 2.98, SD = 0.568) was slightly higher than that of the building team (M = 2.83, SD = 0.501); however, the difference was not statistically significant (t = 1.126, df = 118, $p = 0.262 > 0.05$). Therefore, the null hypothesis (H_{O1}) is retained**,** indicating that there is no significant difference between the perceptions of building professionals and occupants regarding thermal transmission in different building structures, and both groups generally share similar views on this issue.

Hypothesis 2:

H_{O2}: There is no significant difference in the mean responses of the perception between building occupants and professionals towards the influence of microclimatic factors on indoor temperature in Bosso Estate.

Table 5: Summary of T-test Analysis of the Main Responses of Building Occupants and Professionals on How Microclimatic Factors Influence Indoor Temperature in Resident Building in Bosso Estate.

Respondent	N	$\bar{x}$	SD	Df	t-value	P-Value Sig. (2-	Alpha Level	Remark

						tailed)		
Building Professionals	20	2.51	.330	118	1.463	.170	.05	NS
Building Occupants	100	2.96	.560					

The findings of the t-test analysis for Hypothesis 2 from Table 5 showed that the mean response of building occupants (M = 2.96, SD = 0.560) was higher than that of the building team (M = 2.51, SD = 0.330); however, the difference was not statistically significant (t = 1.463, df = 118, p = 0.170 > 0.05). Therefore, the null hypothesis (H_{O2}) is retained**,** indicating that there is no significant difference between the perceptions of building professionals and occupants regarding the impact of microclimatic factors on indoor temperature in residential buildings. This suggests that both groups generally share similar views on how microclimatic factors affect indoor thermal conditions.

Hypothesis 3:

H_{O3}: There is no significant difference in the mean responses between building occupants and professionals on the common building material and architectural features influencing thermal comfort in resident building in Bosso Estate.

Table 6: Summary of T-test Analysis of the Main Responses of Building Occupants and Professionals on the Common Building Material and Architectural Features Influencing Thermal Comfort in Resident Building in Bosso Estate.

Respondent	N	x̄	SD	Df	t-value	P-Value Sig. (2-tailed)	Alpha Level	Remark
Building Professionals	20	2.51	.330	118	3.957	.129	.05	NS
Building Occupants	100	2.96	.560					

The t-test analysis in Table 6 revealed that the mean response of building occupants (M = 2.99, SD = 0.570) was higher than that of the building team (M = 2.47, SD = 0.194); however, the difference was not statistically significant (t = 3.957, df = 118, p = 0.129 > 0.05). Therefore, the null hypothesis (H_{O3}) is retained**,** indicating that there is no significant difference between the perceptions of building professionals and occupants regarding the common building materials and architectural features influencing thermal comfort. This suggests that both groups generally share similar views on the factors that affect indoor thermal comfort in residential buildings.

Findings of the Study

Based on the data collected and analyzed, the following findings emerged:

1. Building occupants on the Bosso Estate perceive thermal transmission in different structures through roofs, ceilings, aluminum window frames, window placements, ventilation availability, ceiling height, sunlight exposure, wall materials, and insulation types. The null hypothesis (H_{O1}) is retained therefore, both building occupants and professionals generally share similar views on this issue.
2. Microclimatic factors identified as impacting indoor temperatures include air temperature variations, ventilation patterns, solar radiation, electronic device heat, occupant density, clothing, activity levels, carpets, artificial lighting, furniture placement, ceiling height, window glazing, and the presence of water pools. The null hypothesis (H_{O2}) is retained therefore, both building occupants and professionals generally share similar views on this issue.

3. Common building materials and architectural features influencing thermal comfort identified by respondents include concrete blocks, bricks, planks, glass walls, aluminum cladding, roof insulation, carpeted floors, ceiling height, shading devices, double-glazed windows, reflective coatings, and the direction and material of openings. The null hypothesis (H_{O3}) is retained therefore, both building occupants and professionals generally share similar views on this issue.

Discussion of the findings

The findings of research question 1 indicated that building occupants in Bosso Estate generally perceive the presence and transmission of thermal through different building elements. This aligned with the studies of Nicol & Humphreys (2020); Zulaikha, Abdul Razak, & Sapari (2024) which revealed that occupants' perceptions of indoor thermal conditions are strongly influenced by building design features such as window placement, solar exposure, ventilation, and construction materials. The study of Oliveira & Corvacho (2021); De Dear and Brager (2021) are other evidences from tropical climate that buildings constructed with low heat-absorbing materials and poor ventilation tend to retain heat longer, leading to higher indoor temperatures and reduced occupant comfort. Therefore, the perceptions observed in Bosso Estate reflect typical thermal experiences in warm climates where building materials, insulation, and ventilation significantly affect indoor thermal performance.

The result of Hypothesis 1 showed no significant difference between the mean responses of the building professionals and building occupants on the perception of thermal transmission in different structures in Bosso Estate ($t = 1.126$, $p = 0.262 > 0.05$), indicating a shared understanding of how building structures and materials influence indoor thermal conditions. This suggests that occupants' practical experiences are consistent with the technical perspectives of building professionals.

The findings of research question 2 revealed that microclimatic factors significantly influence indoor temperature in residential buildings in Bosso Estate, with ventilation patterns, clothing insulation, solar radiation, internal heat sources and occupant activity level recording the highest influence. This indicates that indoor thermal conditions are determined by the combined effects of environmental variables, building design, and human behavior. In support of this finding, the studies of Jiang, Wu, & Teng (2020); Yunus & Afshin (2020) testified that residential building layouts and environmental factors such as airflow and solar radiation significantly influence microclimatic conditions and indoor thermal comfort. These results are consistent with recent studies (Oliveira & Corvacho, 2021; Therán-Nieto et al., 2023), which affirm the strong impact of airflow, solar exposure, and microclimatic variables on thermal comfort. Therefore, the findings of the current study reinforce the understanding that indoor thermal conditions are shaped by the interaction of environmental variables, building design characteristics, and occupant behavior.

The result of Hypothesis 2 showed no significant difference between the mean responses of building professionals and building occupants regarding the influence of microclimatic factors on indoor temperature in Bosso Estate ($t = 1.463$, $p = 0.170 > 0.05$), This indicates that both groups share similar perceptions about how ventilation, solar heat gain, internal heat sources, and occupant activities influence indoor thermal conditions.

The findings of Research Question 3 revealed that building materials and architectural features significantly influence thermal comfort in residential buildings in Bosso Estate. Respondents generally agreed that construction materials, building envelope characteristics, design features contribute to indoor thermal conditions. In addition, the lack of cooling features such as trees and other natural elements around buildings suggesting that the absence of passive environmental cooling strategies contributes to increased indoor thermal discomfort and were perceived to influence thermal performance. This supports the studies of Nicol & Humphreys

(2020); Brager and De Dear (2022); Arowoiya (2024) who emphasized that building envelope characteristics and passive design strategies play critical roles in achieving indoor thermal comfort in residential buildings. These indicated that the thermal properties of building materials and the configuration of architectural elements affect heat transfer and indoor temperature regulation. Similarly, Pachauri *et al.* (2021) studies described that building envelope materials and insulation systems significantly affect heat gain and indoor temperature regulation in residential buildings.,

The hypothesis testing 3 further showed no significant difference between the mean responses of building professionals and building occupants ($t = 3.957$, $p = 0.129 > 0.05$), indicating a shared perception regarding the influence of materials and architectural features on thermal comfort. This agreement suggests that both groups recognize the importance of appropriate material selection and architectural design in improving indoor thermal conditions in residential buildings.

Conclusion

The study concluded that indoor thermal comfort in residential buildings in Bosso Estate, Minna is influenced by a combination of building structural elements, microclimatic conditions, construction materials, and occupants' adaptive behaviors. The findings showed that occupants perceive thermal transmission through building components such as roofs, ceilings, windows, wall materials, and ventilation systems, while environmental factors like solar radiation, air temperature variation, and internal heat generation also affect indoor temperature conditions. The study further established that the choice of building materials and architectural features, plays a significant role in regulating thermal comfort. The study also revealed no significant difference between the perceptions of building professionals and occupants, indicating a shared understanding of the factors influencing thermal comfort and the importance of integrating climate-responsive design and adaptive strategies in residential buildings.

Recommendations

Based on the findings of the study, the following recommendations are hereby presented.

1. Building design and structural elements: builders, engineers, architects and urban planners should prioritize thermally efficient building designs by improving roof insulation, ceiling design, wall materials, window placement, and ventilation systems. Proper orientation of buildings and the use of materials with good thermal resistance should be encouraged to reduce heat transmission and improve indoor thermal comfort in residential buildings.
2. Consideration of microclimatic factors: Urban planners and building designers should incorporate climate-responsive strategies such as proper building orientation, improved natural ventilation, landscaping, and the inclusion of cooling elements like trees and water features. These measures can help moderate the effects of solar radiation, air temperature variations, and internal heat generation on indoor thermal conditions.
3. Selection of appropriate building materials and architectural features: The use of energy-efficient and thermally responsive materials (insulated roofing systems, reflective coatings, double-glazed windows, and shading devices) should be promoted in residential building construction. Policymakers and building regulatory agencies should also develop guidelines that encourage the use of materials that enhance thermal performance and energy efficiency.

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