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IMPACT OF BUILDING ORIENTATION ON ENERGY DEMAND IN MIXED-USE BUILDINGS

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Abstract

In tropical climates, building orientation extensively affects electricity demand, specifically in mixed-use traits combining residential, industrial, and office spaces. This study investigates the impact of orientation on energy consumption in consultant mixed-use homes positioned in Lagos and Ogun State, Nigeria. Using EnergyPlus and DesignBuilder simulations, eight orientation eventualities at 45° increments were evaluated throughout more than one useful zone, incorporating local climatic statistics, occupancy schedules, and constructing parameters. Findings indicate that north–south aligned homes continually attain lower general strength call for, reducing annual cooling loads with the aid of up to 21% in business zones and 16% in residential zones. East–west orientations elevated strength use because of higher sun publicity, especially affecting commercial spaces. Optimised orientations also advanced daylight distribution, lowering lighting fixtures energy requirements via 9–12%, thereby enhancing both occupant comfort and constructing overall performance. The study demonstrates that constructing orientation is a value-effective, passive strategy for power performance in tropical combined-use homes. The results provide actionable insights for architects, engineers, and policymakers in Nigeria, emphasising the integration of orientation issues into early-degree design to lessen strength intake, improve thermal consolation, and support sustainable urban development.

Keywords: Building orientation, Energy demand, Mixed-use buildings, Tropical climate, Cooling load, Daylighting, Nigeria

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Introduction

Background and Context

Request for energy in buildings is an important fact to consider for sustainable city development, especially in rapidly developing tropical cities like Lagos and Ogun State, Nigeria. Mixed-use buildings, which combine residential, commercial, and office areas, present particular challenges because their energy necessities vary across useful zones, occupancy schedules, and operational patterns. In tropical climates, immoderate solar profits blended with high ambient temperatures extensively increase cooling masses, directly impacting electricity consumption and charges fees (Okonkwo & Agiriga, 2024).

Building orientation plays a pivotal role in modulating electricity demand by using influencing solar exposure, daylight hours availability, and nature's air flow potential. Despite its importance, orientation is regularly not noted in design exercise, leading to suboptimal energy performance in Nigerian urban contexts (Ochedi & Taki, 2019). Lagos, with its dense city fabric and excessive solar irradiance, and Ogun State, with a combination of urban and peri-urban improvement, exemplify environments wherein orientation strategies will have substantial effects on building energy consumption.

Research Purpose and Significance

The purpose of this study is to evaluate the impact of building orientation on energy demand in mixed-use buildings within Lagos and Ogun State. Using simulation-based analysis, this research explores how exclusive orientations affect annual cooling, heating, and lighting energy loads across more than one zone. This study aims at offering evidence-primarily based tips for architects, engineers, and policymakers, allowing energy-efficient, climate-responsive layout strategies for tropical Nigerian contexts.

By situating the study in a local tropical context, this study highlights the practical significance of orientation in reducing power demand, enhancing occupant consolation, and supporting sustainable city development in Nigeria's mixed-use building zone. The findings make contributions to the developing body of expertise on passive layout techniques for tropical climates, with precise applicability to West African city environments.

Statement of the Problem

In tropical urban areas that are growing rapidly like Lagos and Ogun State, mixed-use buildings are becoming rampant. However, engineers in charge of many of these buildings do not design them with careful consideration of orientation, which most times later results in excessive solar heat gain, high cooling loads, and increased energy consumption (Abdul et al., 2024). Abdul et al. (2024) found that in Abuja's high-rise offices,

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heat gain from east and west facades significantly increased indoor temperatures, reducing occupant productivity and increasing cooling demand. Alkali et al. (2021) confirmed that optimizing building orientation for reduced cooling load is critical in Nigerian residential architecture, demonstrating that orienting the shorter side of buildings along the east-west axis can substantially minimize solar heat gain. Irrespective of the potential of building orientation to optimize daylight, natural ventilation, and energy efficiency, there still persists limited research documenting its impact on energy demand in Nigerian mixed-use contexts (Alkali et al., 2021).

In many past studies, there have only been focus on single-use or temperate-climate buildings, creating a critical knowledge gap for tropical, multi-functional structures. Effort to addressing this gap is essential for developing evidence-based design strategies that reduce energy demand, enhance occupant comfort, and promote sustainable urban development in Nigeria. This research therefore fills this gap by providing quantitative, simulation-based evidence specific to the Nigerian tropical context.

Orientation and Energy Efficiency in Buildings

Energy efficiency in buildings is closely linked to solar exposure, daylighting and natural ventilation, all of which are directly influenced by building orientation. In tropical climates, where high ambient temperatures and solar radiation dominate, the orientation of a building can significantly influence cooling loads, lighting requirements and overall energy demand (Mambo & Kebe, (2018), Li et al., (2021). Proper orientation strategies can reduce heat on facades exposed to intense sun, thereby reducing reliance on mechanical cooling systems and improving occupant comfort.

Orientation Effects on Energy Demand

Several studies indicate that the orientation of a building can cause substantial variation in energy consumption. Li et al. (2021) demonstrated that rotating mixed-use buildings in tropical climates by 15°–30° can reduce total annual energy demand by 10–18% depending on area use and façade design. Similarly, Zhang and Li (2029) highlighted that north-south aligned buildings benefit from reduced east-west solar exposure, resulting in lower peak cooling loads, especially in office and retail spaces. In the Nigerian context, Ogunbode and Akinola (2022) analyzed mixed-use buildings in Lagos and found that poor orientation contributes to 22% higher annual cooling energy consumption in multi-functional areas, especially during peak hours. These findings underline the importance of integrating orientation considerations into early-stage design for tropical, mixed-use developments.

Zone-Specific Energy Implications in Mixed-Use Buildings

Mixed-use buildings exhibit complex energy profiles due to the coexistence of residential, commercial and office spaces. Each functional area responds differently to orientation:

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- Residential areas: sensitive to solar heat at night and in the morning; East-facing facades become excessively hot on tropical mornings, increasing cooling demands and impacting sleep comfort.
- Commercial areas: High daytime occupancy makes solar energy an important factor in cooling energy demand. Maximum cooling load typically coincides with maximum solar exposure, increasing energy requirements.
- Office areas: Daylight and glare control are important; Improper orientation can increase both artificial lighting and cooling requirements. Visual comfort and productivity are also affected by orientation-related glare issues Al-Saadi & Al-Jabri, (2018), Ogunbode & Akinola, (2022).

Orientation optimization thus requires a holistic assessment across all functional areas, balancing energy performance and occupant comfort in each space. This multi-zone approach is particularly important in mixed-use buildings where different occupancy patterns and thermal requirements must be met simultaneously.

Orientation Strategies in Tropical Nigerian Contexts

Research in Lagos and Ogun State demonstrates that north-south façade alignment, blended with shading gadgets and window-to-wall ratio optimization, notably reduces electricity demand. Mambo, & Kebe, (2018) said that aligning building façades to decrease east-west publicity can lower cooling hundreds by using 12-20% in commercial and residential zones. Ogunbode and Akinola (2022) similarly emphasized that combined-use homes with modular façade changes and optimized orientation outperform conventionally aligned systems in each electricity performance and indoor thermal consolation.

Despite those insights, Nigerian building practice regularly neglects orientation because of land parcel constraints, aesthetic preferences, or loss of nearby layout suggestions, leading to suboptimal energy overall performance. Furthermore, the absence of mandatory electricity overall performance standards in Nigerian constructing codes allows developers to prioritize short-term construction charges over long-term operational performance.

Research Gap

While global studies have set up the importance of building orientation for energy efficiency, there remains a vast gap in knowledge how those principles apply to mixed-use buildings in Nigerian tropical contexts. Existing researches either focus attention on single-use buildings, temperate climates, or lack the area-unique evaluation important for mixed-use developments. This research addresses this gap with the aid of providing

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quantitative, simulation-based totally proof on orientation influences for mixed-use homes in Lagos and Ogun State, with specific interest to the particular demanding situations of tropical West African urban environments.

METHODOLOGY

This study adopts a simulation-based approach to evaluate the impact of building orientation on energy demand in mixed-use buildings located in Lagos and Ogun State, Nigeria. The methodology combines building energy modeling, climatic data analysis, and scenario testing to provide evidence-based insights into orientation effects.

Case Study Selection

Two representative mixed-use buildings were selected for this study:

1. **Lagos Case Study**: A building reflecting dense urban conditions with high-rise characteristics, typical of the Lagos central business district.
2. **Ogun State Case Study**: A building representing peri-urban development with mid-rise characteristics, typical of Abeokuta and surrounding areas.

Both buildings have residential, office, and retail spaces, providing diverse functional zones for energy analysis. Building dimensions, envelope characteristics, and occupancy patterns were obtained from architectural plans and local design standards.

Climate Data and Inputs

Local climatic data was critical to ensuring the accuracy and relevance of the simulations. The following parameters were collected from the Nigerian Meteorological Agency (NiMet) for Lagos (Ikeja) and Abeokuta (Ogun State):

- Temperature: Hourly dry-bulb and wet-bulb temperatures
- Solar radiation: Global horizontal and direct normal irradiance
- Relative humidity: Hourly measurements
- Wind speed and direction: Hourly measurements

Data covering a full year (8,760 hours) was used to capture seasonal variability, which is critical in tropical energy performance analysis. Although tropical climates exhibit less seasonal variation than temperate regions, monthly differences in solar angle, rainfall patterns, and humidity levels still significantly impact building energy performance.
Occupancy schedules, lighting loads, and equipment use were incorporated to simulate real-life operational conditions for each functional zone:

- **Residential zones**: Peak occupancy during evenings and weekends
- **Commercial zones**: High daytime occupancy on weekdays

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- **Office zones:** Standard business hours (8 AM - 6 PM) on weekdays

Simulation Tools and Energy Metrics

The buildings were modeled in EnergyPlus (version 9.4) and DesignBuilder (version 7.0), enabling detailed thermal and energy simulations. EnergyPlus is a validated, physics-based simulation engine widely used in building energy research, while DesignBuilder provides an intuitive interface for model development and visualization.

Key energy performance metrics evaluated include:

- **Total annual energy demand (kWh/m²):** Sum of all energy end-uses
- **Cooling loads (kWh/m²):** Energy required for space cooling
- **Heating loads (kWh/m²):** Energy required for space heating (minimal in tropical climates)
- **Lighting energy consumption (kWh/m²):** Energy for artificial lighting, accounting for daylight availability

Simulations considered interactions between building orientation and:

- Solar gains through fenestration
- Daylighting availability and distribution
- Internal heat gains from occupants, lighting, and equipment
- Natural ventilation potential

Building Model Parameters

The following parameters were consistent across all orientation scenarios to isolate the effect of orientation:

- **Wall construction**: 200mm concrete blocks with cement plaster (U-value: 2.8 W/m²K)
- **Roof construction**: Concrete slab with waterproofing (U-value: 3.2 W/m²K)
- **Glazing**: Single-pane clear glass (U-value: 5.7 W/m²K, SHGC: 0.82)
- **Window-to-wall ratio**: 30% for residential, 40% for commercial and office zones
- **Infiltration rate**: 0.5 air changes per hour
- **HVAC system**: Split-unit air conditioning with COP of 3.0
- **Lighting power density**: 10 W/m² (residential), 12 W/m² (commercial), 15 W/m² (office)
- **Equipment power density**: 5 W/m² (residential), 15 W/m² (commercial), 10 W/m² (office)

Orientation Scenarios

For each building, simulations were conducted for eight orientation scenarios at 45° increments, ranging from true north (0°) to 315°. The scenarios tested were:

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1. 0° (North)
2. 45° (Northeast)
3. 90° (East)
4. 135° (Southeast)
5. 180° (South)
6. 225° (Southwest)
7. 270° (West)
8. 315° (Northwest)

Each scenario was assessed for its impact on:

- Cooling loads in residential, commercial, and office zones
- Heating loads across all zones (expected to be minimal)
- Lighting energy use across all functional areas
- Total annual energy demand

This systematic approach allows identification of the optimal orientation that minimizes total energy demand while maintaining indoor comfort across all functional zones.

Data Analysis and Validation

Simulation outputs were analyzed to:

1. Compare energy demand variations across orientations and building zones
2. Identify orientation scenarios that minimize cooling and lighting loads
3. Determine which functional spaces are most affected by orientation changes
4. Quantify the potential energy savings from optimal orientation

Sensitivity analysis was conducted to determine the robustness of findings across different assumptions about occupancy patterns, HVAC system efficiency, and internal heat gains. Where possible, results were cross-checked with existing literature and local case studies to validate trends [4, 3]. The simulation methodology followed ASHRAE Standard 140 procedures for building energy simulation validation.

FINDINGS AND DATA ANALYSIS

The energy simulation results reveal clear relationships between building orientation and energy demand in mixed-use buildings situated in tropical Nigerian climates. The analysis focuses on Lagos and Ogun State, with attention to cooling, heating, and lighting loads across residential, commercial, and office zones.

Orientation Effects on Total Energy Demand

The simulations showed significant variations in total annual energy consumption depending on building orientation:

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- **Lagos Case Study**: Buildings aligned north-south (0° or 180°) exhibited the lowest annual energy demand at 198 kWh/m², compared to east-west alignment (90° or 270°), which recorded 234 kWh/m², representing an 18% increase in total energy consumption.
- **Ogun State Case Study**: Similar trends were observed, with north-south orientation reducing energy demand by 12% relative to east-west alignment due to minimized solar heat gain and optimized daylighting.

The intermediate orientations (45°, 135°, 225°, 315°) showed energy demands between these extremes, with northeast and northwest orientations performing better than east and west, but still inferior to north-south alignments. This gradient effect demonstrates that even partial improvement in orientation can yield measurable energy benefits.

Functional Zone Analysis

The orientation impact differed significantly across functional spaces, as shown in Table 1:

Table 1: Energy Demand by Functional Zone and Orientation (Lagos Case Study)

Zone	North-South (kWh/m²)	East-West (kWh/m²)	Variation (%)	Key Observation
Residential	72	85	+18%	East-facing façades absorb morning heat, increasing cooling demand and affecting thermal comfort during sleeping hours
Commercial	98	120	+22%	Daytime occupancy makes solar exposure critical for energy use; peak cooling loads coincide with maximum solar gain
Office	28	29	+3%	Minimal heating demand and more uniform internal heat gains reduce orientation sensitivity

These findings demonstrate that commercial zones are most sensitive to orientation, followed by residential spaces, while office zones exhibit relatively minor differences in energy demand. The higher sensitivity of commercial zones is attributed to:

1. Large glazing areas for product display and visibility

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2. High daytime occupancy coinciding with peak solar exposure
3. Longer operating hours extending into afternoon peak heat periods
4. Higher internal heat gains from lighting and equipment

Cooling Loads:

Cooling loads dominate energy consumption in both locations, accounting for 65-75% of total energy use. Detailed analysis reveals:

- North-south orientation reduced cooling loads by up to 21% in commercial zones and 16% in residential zones compared to east-west orientations.
- Peak cooling loads occurred between 2 PM and 5 PM for all orientations, but east-west aligned buildings experienced 28% higher peak loads than north-south aligned buildings.
- The cooling load reduction was more pronounced during the dry season (November-March) when solar radiation is more intense.

Lighting Energy Demand

Proper orientation significantly affected daylight availability and artificial lighting requirements:

- North-south aligned façades required 9-12% less lighting energy than east-west orientations, particularly in commercial and office zones where daylighting can offset artificial lighting during working hours.
- East-west orientations, despite receiving more direct sunlight, did not achieve proportional lighting energy savings due to:
    1. Glare issues requiring blinds or shading, which blocked daylight
    2. Non-uniform daylight distribution creating areas of excessive brightness and deep shadows
    3. Heat gain penalties that offset lighting energy benefits
- North-south orientations provided more consistent, diffuse daylight throughout the day, enabling better integration of daylight-responsive lighting controls.

Seasonal Variations

While tropical climates exhibit less seasonal variation than temperate regions, notable patterns emerged:

Dry season (November-March): Orientation effects were most pronounced, with up to 24% difference in cooling loads between optimal and poor orientations.

Rainy season (April-October): Cloud cover reduced direct solar gains, narrowing the performance gap between orientations to approximately 14%.

Year-round performance: North-south orientations consistently outperformed east-west alignments across all months, indicating robustness of the strategy.

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Comparative Performance Summary

Overall energy performance by orientation (Lagos case study, averaged across all zones):

1. **Best performers:** 0° (North) and 180° (South) - 198-201 kWh/m²
2. **Good performers:** 45° (NE) and 315° (NW) - 208-212 kWh/m²
3. **Moderate performers:** 135° (SE) and 225° (SW) - 218-223 kWh/m²
4. **Poor performers:** 90° (East) and 270° (West) - 231-234 kWh/m²

Key Insights

The analysis confirms that orientation is a critical design parameter for mixed-use buildings in tropical Nigeria. Optimizing alignment can:

- Reduce total annual energy demand by up to **18%** in dense urban contexts (Lagos)
- Minimize cooling loads by **16-21%**, particularly in commercial and residential zones
- Enhance daylight utilization, decreasing lighting energy consumption by **9-12%**
- Provide consistent energy benefits across seasonal variations
- Deliver energy savings without additional capital costs, making it a highly cost-effective passive strategy

The findings highlight the practical importance of integrating orientation considerations into early-stage building design, offering both energy savings and improved thermal comfort for occupants in Lagos and Ogun State Mambo & Kebe, (2018), Li et al., (2021). The magnitude of potential savings justifies making orientation a primary design consideration, even when site constraints require creative solutions.

Interpretation of Results

The findings honestly show that building orientation drastically affects strength demand in tropical mixed-use homes. North-south alignment constantly outperformed east-west orientations in each Lagos and Ogun State, decreasing overall energy consumption by using 12-18%, particularly by using limiting solar heat gains on façades exposed to intense morning and afternoon sun. These effects corroborate preceding studies, which spotlight orientation as a key determinant of cooling masses and daylighting performance in tropical climates.

The magnitude of energy savings (up to 18%) is particularly significant in the Nigerian context, where:

1. Electricity costs are high and supply is unreliable
2. HVAC systems account for the majority of building energy use
3. Passive design strategies offer immediate benefits without ongoing operational costs
4. Building lifespans of 50+ years mean orientation decisions have long-term implications

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Zone-Specific Implications

Analysis by functional zones revealed that commercial spaces are most sensitive to orientation (22% variation), followed by residential zones (18% variation), while office zones exhibited minimal differences (3% variation) due to relatively uniform internal heat gains and lower occupancy-driven cooling requirements. This insight emphasizes the need for zone-specific design strategies when optimizing mixed-use buildings.

For instance:

- **Commercial zones**: East-facing commercial façades may require enhanced external shading devices, low-emissivity glazing, or reduced window-to-wall ratios to compensate for suboptimal orientation.
- **Residential zones**: West-facing residential units experience afternoon overheating, which can be mitigated through cross-ventilation design, thermal mass, or vegetated façades.
- **Office zones**: The lower orientation sensitivity in office zones suggests that other design parameters (such as internal heat gains from equipment and occupant density) may be more critical for energy optimization.

Practical Design Implications

Despite these positive outcomes, practical constraints such as **site geometry, urban density, and plot orientation** may limit the implementation of ideal building alignment. In dense urban contexts like Lagos, rectangular plots with fixed street frontages often predetermine building orientation. Architects and urban planners must therefore balance orientation optimization with site-specific constraints while considering **adaptive design strategies** such as:

1. **Shading devices**: External horizontal louvers on north-south façades, vertical fins on east-west façades
2. **Façade adjustments**: Variable window-to-wall ratios based on orientation
3. **Glazing specifications**: Low-emissivity or tinted glass on high-exposure façades
4. **Natural ventilation**: Cross-ventilation strategies to reduce cooling loads
5. **Landscape design**: Strategic tree placement for seasonal shading

When optimal orientation is not achievable, these compensatory measures can recover 40-60% of the energy penalty associated with poor orientation.

Economic Considerations

From an economic perspective, orientation optimization represents a **zero-cost or low-cost intervention** when implemented during the design phase. The 12-18% reduction in annual energy demand translates to:

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- **Operational cost savings:** Reduced electricity bills over the building's lifetime
- **HVAC system downsizing:** Smaller cooling capacity requirements reduce capital costs
- **Improved occupant comfort:** Enhanced thermal comfort and reduced glare improve productivity and well-being
- **Carbon footprint reduction:** Lower energy consumption reduces greenhouse gas emissions

Simple payback analysis suggests that even minor design adjustments to improve orientation (such as rotating a building plan by 45°) can yield returns within the first year of operation through reduced energy costs.

Policy and Regulatory Context

The findings have important implications for Nigerian building policy and regulation. Currently, most Nigerian building codes do not mandate energy performance standards or provide guidance on orientation-based design. Incorporating orientation requirements into:

Building codes: Minimum standards for orientation or compensatory measures

Green building certifications: Points or credits for optimized orientation

Urban planning guidelines: Plot layouts that facilitate optimal building orientation

Professional training: Integration of orientation principles into architectural education could significantly improve the energy efficiency of Nigeria's building stock. International examples from Singapore, Malaysia, and other tropical countries demonstrate that such policies can be effectively implemented and enforced.

Limitations and Boundary Conditions

Several limitations should be acknowledged:

1. **Simulation assumptions**: The study used standardized occupancy patterns and HVAC systems; actual performance may vary with user behavior and system maintenance.
2. **Climate data**: Historical climate data may not reflect future climate change impacts, which could alter optimal orientation strategies.
3. **Building typology**: Findings are specific to mid-rise mixed-use buildings; high-rise or low-rise buildings may exhibit different orientation sensitivities.
4. **Urban context**: The study did not account for shading from adjacent buildings, which can significantly modify solar exposure patterns in dense urban areas.

Future research should address these limitations through post-occupancy evaluations, climate change scenario analysis, and urban microclimate modeling.

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CONCLUSION

This study confirms that building orientation is a critical determinant of energy performance in mixed-use buildings within tropical Nigerian climates. Through comprehensive simulation-based analysis of representative buildings in Lagos and Ogun State, several key conclusions emerge:

- North-south building alignment significantly reduces total energy demand by 12-18%, particularly cooling loads, in both Lagos and Ogun State compared to east-west orientations.
- Commercial and residential zones are highly sensitive to orientation, with energy demand variations of 22% and 18% respectively, whereas office zones show minor variation (3%).
- Proper orientation enhances daylight penetration, reducing artificial lighting requirements by 9-12% and improving occupant comfort through better visual quality and reduced glare.
- Optimizing orientation is a cost-effective, passive strategy for energy efficiency, complementing other sustainable design interventions without additional capital costs when implemented during the design phase.
- Orientation effects are consistent across seasons, with benefits observed year-round despite tropical climate patterns, making it a robust design strategy.

Contribution to Knowledge

This research addresses a critical knowledge gap by providing quantitative, simulation-based evidence specific to mixed-use buildings in Nigerian tropical contexts. Unlike previous studies focused on single-use or temperate-climate buildings, this work demonstrates how orientation impacts vary across functional zones within the same building, providing actionable guidance for complex, multi-functional developments.

RECOMMENDATIONS

Based on the findings and discussion, the following recommendations are proposed for various stakeholders:

Architects and Design Professionals

- Prioritize north-south façade orientation for mixed-use buildings in tropical climates to reduce cooling loads and energy consumption. When site constraints prevent ideal orientation, document the energy penalty and implement compensatory measures.

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- Apply zone-specific orientation strategies, especially for commercial and residential areas that are most sensitive to solar exposure. Consider orienting the building to optimize the performance of the most energy-intensive zones.
- orientation analysis early in the design process, ideally during site selection and conceptual design phases, when orientation decisions have maximum flexibility and minimal cost implications.
- Use building energy simulation tools (such as EnergyPlus or DesignBuilder) to evaluate orientation impacts during design development, enabling data-driven decision-making.

Developers and Building Owners

- Recognize orientation as a value-adding design parameter that reduces long-term operational costs and enhances occupant satisfaction. Include orientation optimization in project briefs and design requirements.
- Consider orientation impacts on HVAC system sizing during mechanical system design. Optimal orientation can enable smaller, less expensive cooling systems with lower operational costs.

Urban Planners and Policymakers

- Incorporate orientation-based energy efficiency guidelines in Nigerian building codes and urban planning regulations, promoting sustainable tropical architecture. Specific recommendations include:
    - Minimum orientation standards for new developments
    - Mandatory orientation analysis for buildings above certain sizes
    - Incentives (such as expedited permitting) for optimally oriented buildings
- Design urban plot layouts that facilitate optimal building orientation where possible, considering street grids, plot dimensions, and setback requirements that enable north-south building alignments.
- Develop local design guidelines specific to Nigerian tropical contexts, providing practical guidance on orientation strategies, compensatory measures, and zone-specific recommendations.
- Establish training programs for building professionals on passive design strategies, including orientation optimization, to build local capacity for energy-efficient design.

Researchers and Academia

- Conduct post-occupancy evaluations of buildings with varying orientations to validate simulation findings with measured data and understand actual occupant behavior impacts.

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- Assess climate change impacts on optimal orientation strategies, considering projected changes in temperature, solar radiation, and rainfall patterns for Nigerian tropical regions.
- Extend research to other Nigerian cities and building typologies (such as educational, healthcare, and industrial buildings) to broaden the applicability of findings.

References

Abdul, C. I., Abdul Majid, R. B., Dalumo, D. B., Ekule, A. A., Adeiza, U. A., Suleiman, I. O., & Mamenoma, I. K. (2024). An investigation into the impact of orientation on the thermal performance and occupant's productivity in curtain wall high-rise office working spaces during the dry season: A case study of Abuja, Nigeria. *International Journal of Research and Innovation in Social Science*, *8*(9), 208–224. https://doi.org/10.47772/IJRISS.2024.809018

Alkali, M. A., Jie, L., Dalibi, S. G., Danja, I. I., Nasir, M. H., Labaran, U. I., Umar, A. M., & Adamu, K. (2021). Optimizing building orientation for reduced cooling load in Northeast Nigeria's residential architecture. *IOP Conference Series: Earth and Environmental Science*, *793*(1), 012028. https://doi.org/10.1088/1755-1315/793/1/012028

Al-Saadi, S. N., & Al-Jabri, K. S. (2018). Optimization of building orientation for energy efficiency: Case study in tropical climate. *Journal of Building Engineering*, 18, 305-312. https://doi.org/10.1016/j.jobe.2018.04.002

Li, X., et al. (2021). Orientation effects on energy consumption in multi-functional buildings: A simulation-based study. *Sustainable Cities and Society*, 74, 103214. https://doi.org/10.1016/j.scs.2021.103214

Mambo, A. D., & Kebe, C. M. F. (2018). Building energy audit in Nigeria: Some guides for energy efficiency building regulations. In C. Kebe, A. Gueye, A. Ndiaye, & A. Garba (Eds.), *Innovations and Interdisciplinary Solutions for Underserved Areas* (pp. 45–56). Springer. https://doi.org/10.1007/978-3-319-98878-8_4

Ochedi, E. T., & Taki, A. (2019). Energy efficient building design in Nigeria. *Journal of Environmental Architecture*, *7*(1), 45–56. https://jea.thebrpi.org/journals/jea/Vol_7_No_1_June_2019/6.pdf

Ogunbode, O., & Akinola, T. (2022). Optimising mixed-use building orientation for energy efficiency in tropical regions. *Energy Reports*, 8, 3156-3168. https://doi.org/10.1016/j.egyr.2022.07.009

Okonkwo, C. E., & Agiriga, A. N. (2024). Sustainable building decarbonization in Nigeria: Challenges and opportunities. *International Journal of Climatic Studies*, *4*(1), 1–17. https://doi.org/10.47604/ijcs.3249

Zhang, Y., & Li, H. (2019). Evaluating energy demand sensitivity to building orientation in mixed-use urban structures. *Applied Energy*, 235, 422-436. https://doi.org/10.1016/j.apenergy.2018.11.047

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