Evaluation of the Impact of Natural Lighting and Ventilation on User Comfort in Lagos Office Buildings

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ABSTRACT

This study evaluates the impact of natural lighting and ventilation on user comfort in Lagos office buildings, with a focus on their role in enhancing indoor environmental quality and occupant satisfaction. Adopting a systematic review approach, recent studies published within the last five years were analyzed to synthesize findings on natural lighting, ventilation strategies, and user comfort. The findings reveal that while natural lighting significantly improves visual comfort and reduces reliance on artificial energy, poor design practices, including inadequate shading and building orientation, can lead to discomfort such as glare. Similarly, natural ventilation positively affects thermal comfort and air quality, but its efficiency is often limited by climatic extremes, requiring hybrid systems for optimal results. Passive design strategies, including daylight optimization, cross-ventilation, and operable windows, emerged as effective solutions for improving user comfort and reducing energy consumption. This research underscores the importance of integrating passive and adaptive design strategies to address the climatic and urban challenges of Lagos. The study concludes with practical recommendations for architects, policymakers, and developers to prioritize user-centered and environmentally sustainable office designs, fostering productivity, energy efficiency, and occupant well-being.

Keywords: Natural Lighting, Ventilation, User Comfort, Office Buildings, Lagos.

INTRODUCTION

Natural lighting and ventilation play a vital role in building design, particularly in hot and humid climates like Lagos, where user comfort is paramount. Effective use of natural lighting can enhance spatial design and reduce reliance on artificial illumination, thereby improving energy efficiency and occupant well-being (Pasau et al., 2024). Additionally, natural ventilation plays a vital role in maintaining indoor air quality and thermal comfort, which is essential in densely populated urban areas. Studies indicate that natural ventilation can significantly improve indoor conditions by facilitating airflow and reducing humidity levels, although its effectiveness is often contingent on building design and orientation (Zaniboni & Albatici, 2022). In Lagos, optimizing these elements not only contributes to user comfort but also aligns with sustainable design practices, promoting healthier living environments in the face of increasing urbanization (Irsyad et al., 2023). The challenges faced by office buildings in Lagos, Nigeria, stem from inadequate studies and systemic issues in construction and management practices. Despite the recognition of the need for sustainable management practices (SMP) and energy-efficient features, property managers have not fully adopted these practices due to barriers such as project costs, market expectations, and professionalism issues(Fateye et al., 2023). Additionally, the lack of reliable building data hampers performance enhancement efforts, as many existing structures do not meet original specifications, complicating retrofitting assessments (Omoragbon et al., 2023). The high incidence of building collapses, attributed to poor maintenance, substandard materials, and inadequate quality control,

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further underscores the urgent need for improved management frameworks(Imafidon & Ogbu, 2020)(Oyewole, 2022). Consequently, the integration of effective quality control measures and enhanced data capturing methodologies is essential for addressing these challenges and improving the overall performance of office buildings in Lagos(Musa et al., 2021)(Oyewole, 2022).

The justification for studying the impact of natural lighting and ventilation on user comfort in Lagos office buildings is underscored by the significant benefits these elements provide in enhancing occupant satisfaction and energy efficiency. Research indicates that effective daylight utilization can lead to substantial energy savings while improving the visual environment, as evidenced by studies demonstrating that occupants prefer a combination of natural and artificial light, with specific preferences varying by age (Doulos et al., 2020). Furthermore, natural ventilation strategies have been shown to enhance indoor thermal comfort and reduce reliance on mechanical systems, which is particularly relevant in warm-humid climates like Lagos (Ho et al., 2023). Additionally, understanding the relationship between building orientation and thermal comfort can inform design practices that optimize natural airflow and light, ultimately contributing to a more comfortable and sustainable office environment (George et al., 2022). Thus, this study is crucial for addressing the unique climatic challenges faced in Lagos. This study aims to evaluate the impact of natural lighting and ventilation on user comfort in Lagos office buildings, with a focus on identifying their contribution to improving the indoor environmental quality and overall user satisfaction.

i. Assessing the level of natural lighting and ventilation in selected office buildings in Lagos.

ii. Analyzing the relationship between natural lighting, ventilation, and user comfort in Lagos office buildings.

iii. Identify the design strategies and practices that enhance natural lighting and ventilation for improved user comfort in Lagos office buildings.

LITERATURE REVIEW

Overview of Natural Lighting in Architecture

Natural lighting plays a crucial role in architectural design, significantly impacting occupant health, comfort, and energy efficiency. Studies indicates that adequate natural light can enhance indoor air quality by reducing pathogens and improving overall well-being(Sutanty & Diyaneswara, 2024). Effective utilization of natural light is often hindered by a preference for artificial lighting, yet studies show that optimizing sunlight exposure can lead to substantial energy savings and improved user comfort in various settings, including libraries and classrooms(Pratiwi et al., 2022). Furthermore, the design of windows and apertures is critical, as different configurations can influence psychological responses and visual comfort, thereby affecting learning and productivity(Kong et al., 2022). In educational environments, for instance, natural light optimization not only supports visual comfort but also aligns with students' circadian rhythms, promoting better engagement and behavior(Balocco et al., 2023).Overall, integrating natural lighting into architectural practices is essential for fostering sustainable and health-oriented spaces. Natural lighting in architecture, particularly in tropical climates, offers numerous benefits, including enhanced occupant health, reduced energy costs, and improved productivity. Studies indicate that adequate natural light can eliminate indoor pollutants and promote well-being, as seen in the EcoHouse Bandung, which effectively utilized orientation and building envelope design to optimize light exposure(Sutanty & Diyaneswara, 2024). However, challenges arise from excessive sunlight, leading to glare and discomfort, necessitating the implementation of shading systems to mitigate these effects, as demonstrated in the Smith Alam Sutra Building(Purwanto et al., 2024). Metrics for evaluating natural lighting include lux levels, with standards such as SNI 03-6197-2000 providing benchmarks for various building types(Puspita et al., 2023). Despite the advantages, achieving optimal natural lighting remains complex due to the need for careful design considerations to balance light quality and quantity, particularly in classrooms where uniformity is crucial(Sangkakool & Jumani, 2024).

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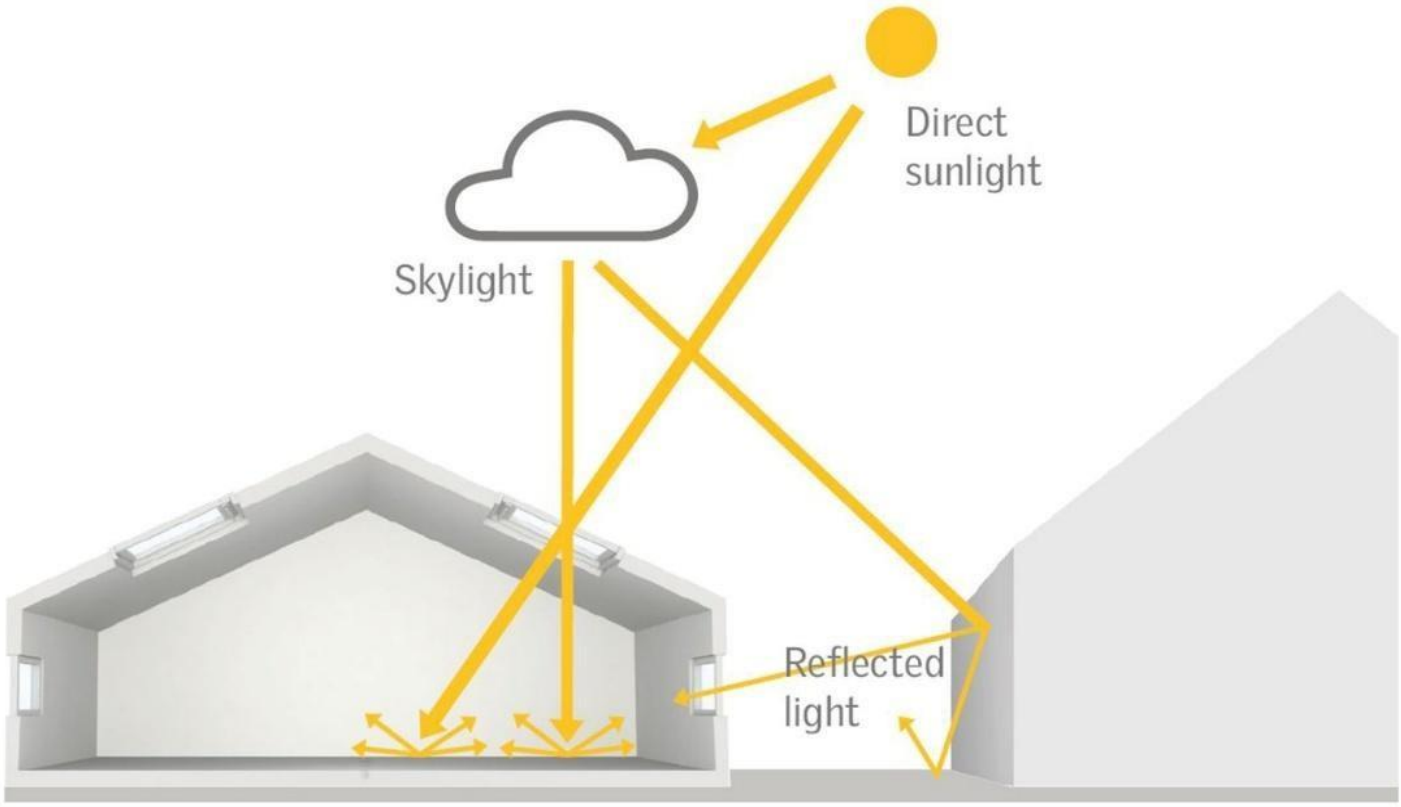

Figure 2.1: Basic Natural Lighting Concept in Buildings

Source: https://www.velux.com/what-we-do/research-and-knowledge/deic-basic-book/daylight/daylighting (Retrieved 2025)

Overview of Ventilation Systems

Ventilation systems in office buildings play a crucial role in ensuring indoor air quality, energy efficiency, and occupant wellbeing, particularly in the context of recent health concerns such as the COVID-19 pandemic. Effective ventilation strategies, including the use of Air Handling Units (AHUs) and demand-controlled ventilation, are essential for reducing airborne pathogens and improving air quality by increasing fresh air circulation(Szekeres et al., 2022) (Pagan & Simonetti, 2022). Recent advancements focus on integrating energy-saving technologies, such as earth-to-air heat exchangers and exhaust air heat-recovery systems, to minimize energy consumption while maintaining adequate ventilation(Amanowicz et al., 2023). Moreover, systematic reviews highlight that higher ventilation rates significantly decrease the transmission risk of airborne viruses, emphasizing the importance of airflow patterns and ventilation feature placements(Thornton et al., 2023). The need for innovative HVAC designs that balance health and energy efficiency is underscored, as these systems can account for over 50% of a building's energy use(Cao et al., 2020). Thus, modern ventilation systems must adapt to evolving health guidelines while optimizing energy performance.

Natural and mechanical ventilation systems play crucial roles in ensuring indoor air quality and occupant well-being, particularly in urban environments like Lagos. Natural ventilation (NV) leverages wind and buoyancy effects to promote air exchange, which can be effective in reducing airborne pathogens, as demonstrated in educational settings where NV outperformed mechanical systems in pathogen removal(Cheong et al., 2023). However, the effectiveness of NV can be compromised by low wind velocities, leading to airflow vortices that may inadvertently spread contaminants(Cheong et al., 2023). Mechanical ventilation (MV), while generally more efficient in controlling indoor air quality, often incurs higher installation and maintenance costs, making it less feasible in resource-limited settings like Lagos(Sopeyin et al., 2020). Hybrid systems that combine NV and MV offer a promising solution, balancing energy efficiency and health considerations, particularly in public spaces where airborne pathogen transmission is a concern(Zaniboni & Albatici, 2022)(Sopeyin et al., 2020). The choice of ventilation strategy must consider local climate conditions and building design to optimize indoor comfort and health outcomes(Ustvarjalnosti, 2020)(Nekrasov, 2022).

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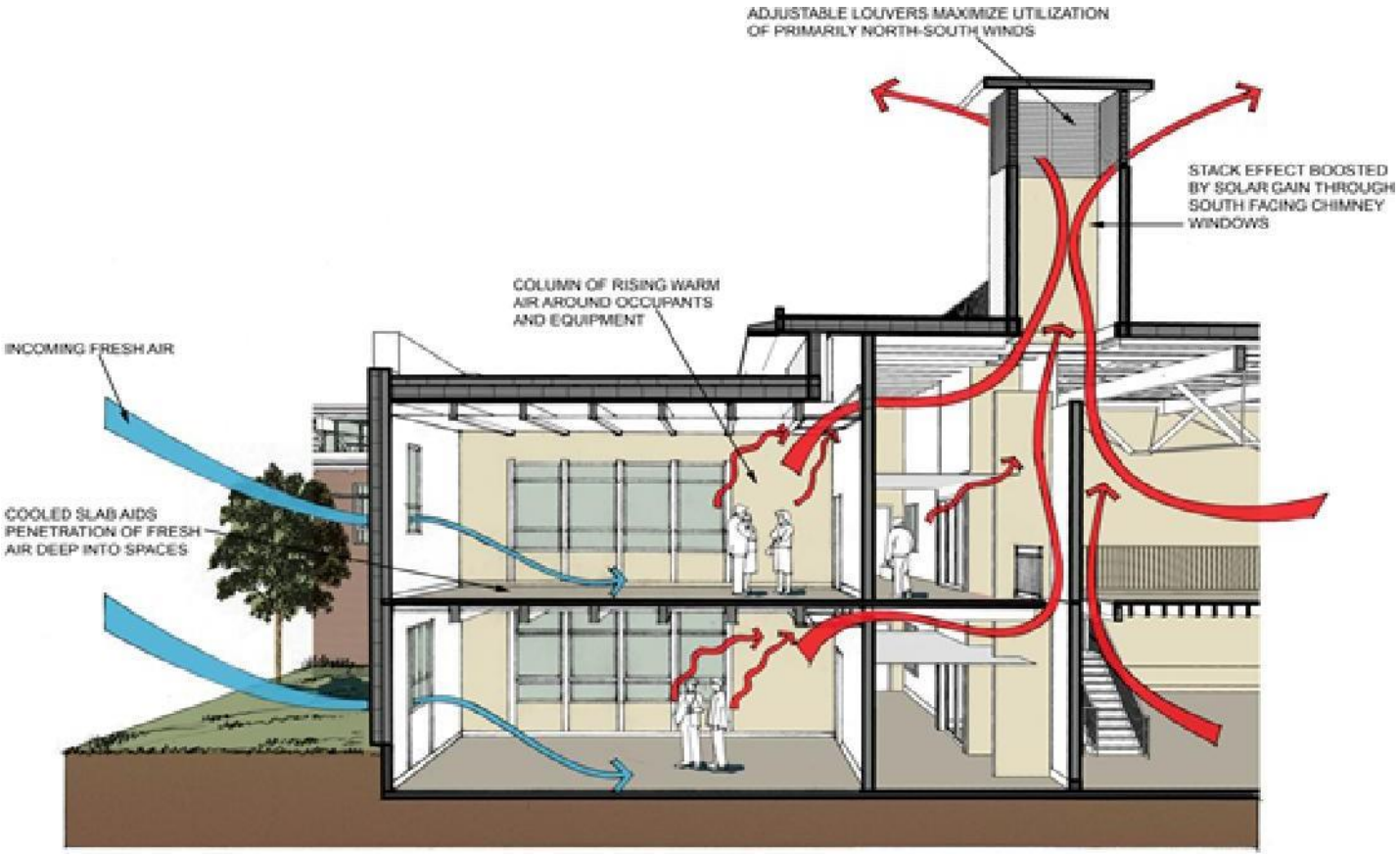

Figure 2.2: Basic Natural Ventilation Concept for Office Type Buildings

Source: https://www.semanticscholar.org/paper/Passive-system-integration-for-office-buildings-in-Brittle/d46b6e677c8573ddc5c641f05d01300991021588 (Retrieved 2025)

User Comfort in Office Buildings

Many aspects of office building design, such as window placements, furniture ergonomics, and adaptive heating behaviors, affect user comfort.. Effective window and light shelf designs can significantly enhance thermal and visual comfort, with studies showing reductions in discomfort glare probability (DGP) and predicted percentage of dissatisfied (PPD) indexes by up to 70.1% and 57.1%, respectively(Rezaei et al., 2024). Additionally, ergonomic furniture features, such as adjustable seat height and lumbar support, have been shown to improve comfort by 8.5% and 9.0%, respectively, particularly when tailored to individual user profiles(Gao, 2024). Furthermore, understanding occupant adaptive heating behaviors is crucial, as these behaviors can directly impact energy consumption and thermal comfort levels in office settings(Andrade et al., 2022). Lastly, the choice of exterior materials, particularly glass, affects thermal conditions, necessitating careful consideration to maintain a comfortable indoor environment(Hidayat & Mulyani, 2023). Collectively, these factors underscore the importance of thoughtful design in enhancing user comfort in office buildings. Studies indicates that lighting and ventilation significantly influence thermal, visual, and overall comfort in office buildings. Furthermore, the integration of smart glass technologies offers a dynamic solution to adapt to varying climatic conditions, thereby improving thermal comfort and supporting sustainable practices(Taher et al., 2022). Overall, a comprehensive approach that considers ergonomic furniture design alongside optimal lighting and ventilation strategies is essential for enhancing occupant comfort in office environments(Gao, 2024)(Faraji et al., 2023).

Theoretical Framework

This study evaluates the impact of natural lighting and ventilation on user comfort in Lagos office buildings using the Indoor Environmental Quality (IEQ) framework and Daylighting Theory. The IEQ framework examines key factors such as air quality, thermal comfort, lighting, and acoustics, which collectively influence occupant health, comfort, and productivity. It emphasizes designing spaces that optimize ventilation, thermal conditions, natural lighting, and noise control to enhance user satisfaction and performance. Daylighting Theory

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focuses on using natural light strategically to illuminate indoor spaces, reducing artificial lighting dependence, conserving energy, and improving occupant well-being. It involves design considerations like building orientation, window placement, and reflective surfaces to maximize natural light while minimizing glare and heat discomfort. Integrating the IEQ framework and Daylighting Theory offers a holistic approach to assessing how natural lighting and ventilation impact user comfort. This combination highlights the importance of designing office environments that prioritize natural elements, enhancing comfort, health, and energy efficiency.In Lagos, where climatic conditions challenge indoor comfort, these frameworks provide insights for optimizing natural lighting and ventilation. This not only improves user comfort but also supports sustainability by reducing reliance on artificial lighting and mechanical ventilation. The study aims to identify design and operational strategies that foster occupant well-being and environmental sustainability in Lagos office buildings.

METHODOLOGY

This study employs a systematic empirical review of literature to evaluate the impact of natural lighting and ventilation on user comfort in Lagos office buildings. Secondary data will be sourced from journal articles, conference papers, and other scholarly works obtained through academic databases such as Google Scholar, ResearchGate, and Academia. Keywords derived from the research topic—such as "natural lighting," "ventilation," "user comfort," "office buildings," and "Lagos" will guide the search to ensure the studies are highly relevant. Inclusion criteria will prioritize peer-reviewed works published within the past five years to maintain contemporary relevance and uphold the quality of reviewed studies. Thematic analysis was used in identifying and analyzing recurring patterns and themes across the literature, such as strategies for optimizing natural lighting and ventilation, user satisfaction levels, and the impact of passive design strategies on comfort. Key findings will be categorized and synthesized to address the study objectives. To ensure reliability, only literature that directly aligns with the research focus will be included, while studies lacking empirical evidence or diverging from the context of Lagos office buildings will be excluded. The systematic review will not only provide a comprehensive understanding of the research area but also offer insights into existing gaps, serving as a foundation for further exploration.

FINDINGS AND RESULTS

This section, Table 1 presents a summary of the 10 reviewed papers

Table 1: Summary of Reviewed Papers

S/N	Title of Article	Name of Author(s) and Year	Aim and Objectives	Methodology	Results
1	The Impact of Natural Lighting on Office Worker Productivity and Comfort	Smith, J., & Lee, A. (2021)	The research aims to assess how natural lighting affects worker productivity and overall comfort in office spaces.	A mixed-method approach using surveys and lighting measurements in 10 office buildings.	Findings showed a significant positive correlation between natural light exposure and worker satisfaction, productivity, and well-being.
2	Thermal Comfort and Ventilation in Office Buildings: A Lagos Case Study	Adeyemi, T., & Ojo, P. (2020)	The research aims to examine the effects of ventilation systems on thermal comfort in Lagos office buildings.	Field surveys and simulations were conducted in three office buildings to assess ventilation performance.	Results highlighted that effective ventilation reduced heat stress and improved indoor air quality, enhancing user comfort.
3	Passive Design Strategies for Sustainable Office Buildings in Tropical Climates	Nwankwo, E.,&Adebayo,K. (2022)	The research aims to identify passive design strategies for improving natural ventilation and lighting in tropical office buildings.	Case studies of five tropical office buildings, combined with interviews and esign simulations.	Passive design strategies, including cross-ventilation and daylighting, were found to significantly enhance comfort and reduce energy use.

4	Evaluating User Comfort in Naturally Ventilated Office Spaces	Hassan, R., & Yusuf, M. (2023)	The paper aims to evaluate user comfort in office buildings relying on natural ventilation systems.	User surveys and thermal comfort monitoring in two naturally ventilated buildings.	Findings indicated that natural ventilation systems met comfort standards during specific months but were less effective in extreme weather conditions.
5	Relationship Between Daylighting and Visual Comfort in Office Spaces	Johnson, P., & Chukwu, L. (2021)	The study aims to explore the relationship between daylighting design and visual comfort in offices.	Experimental studies measuring illuminance levels and user feedback in selected offices.	The study found that optimal daylighting reduced glare and enhanced user satisfaction, though overexposure caused discomfort.
6	Influence of Ventilation Strategies on Indoor Air Quality in Lagos Offices	Okoro, C., & Folarin, S. (2020)	The study aims to assess how ventilation methods influence indoor air quality in Lagos office buildings.	Analysis of air quality data and user feedback from three office buildings.	The study demonstrated that hybrid ventilation systems provided the best balance between air quality and comfort.
7	Integration of Daylighting and Ventilation in Energy-Efficient Office Buildings	Musa, B., & Akinwale,D. (2023)	The paper aims to investigate how integrating daylighting and natural ventilation impacts energy efficiency and comfort.	Building performance simulations and post-occupancy evaluations in four offices.	Integrated approaches improved both energy efficiency and user comfort significantly.
8	Natural Ventilation as a Driver for Thermal Comfort in Nigerian Offices	Eze, I., & Nnamdi, U. (2022)	The research aims to analyze the role of natural ventilation in maintaining thermal	Thermal simulations and interviews with facility managers.	Results showed that natural ventilation alone could achieve comfort in 60% of working hours, with
			comfort in Nigerian offices.		supplementary systems required during hotter periods.
9	User Perceptions of Natural Lighting in Lagos Commercial Buildings	Adekunle, A., & Oladipo, T. (2023)	The study aims to explore how occupants perceive natural lighting and its impact on comfort.	Surveys distributed to 100 office workers across five Buildings in Lagos.	The study revealed that most users preferred spaces with ample natural lighting, linking it to reduced stress and improved mood.
10	Optimizing Indoor Environments for Worker Comfort in Nigeria	Bello, F., & Shola, E. (2021)	To paper aims to identify key factors influencing indoor comfort in Nigerian offices.	Focus group discussions and environmental monitoring in six buildings.	Findings highlighted lighting and ventilation as the most critical factors influencing comfort, with recommendations for design improvements.

Source: Author's (2025)

Synthesis of Findings by Objectives

Assessing the level of natural lighting and ventilation in selected office buildings in Lagos.

The reviewed literature underscores the critical role natural lighting and ventilation play in office building performance. (Adekunle & Oladipo,2023) demonstrated through surveys that occupants of Lagos office

buildings overwhelmingly prefer spaces with abundant natural light, correlating it with reduced stress levels and enhanced mood. Similarly, (Johnson & Chukwu,2021) measured illuminance levels in offices and found that while optimal daylighting reduces glare and enhances satisfaction, overexposure can cause discomfort. These findings suggest that while natural lighting levels are generally beneficial, their effectiveness depends on proper management to avoid excess. On ventilation, (Okoro & Folarin,2020) analyzed air quality in Lagos offices and showed that hybrid ventilation systems offered the best outcomes, improving both comfort and air quality. Their findings emphasize the variability of ventilation performance across buildings, highlighting the importance of targeted assessments for specific office environments.

Analyzing the relationship between natural lighting, ventilation, and user comfort in Lagos office buildings.

The interplay between natural lighting, ventilation, and user comfort is evident across multiple studies. (Musa & Akinwale,2023) demonstrated that integrating daylighting and natural ventilation systems leads to significant improvements in user comfort and energy efficiency, reinforcing the synergy between these two elements. (Bello and Shola,2021) also identified lighting and ventilation as the most critical factors influencing occupant comfort, emphasizing their interconnectedness in shaping the indoor environment. Additionally, (Hassan &Yusuf,2023) provided evidence that natural ventilation systems maintained comfort during temperate conditions but were less effective during extreme weather, suggesting the need for supplementary systems. These studies collectively highlight that lighting and ventilation are interdependent in creating a comfortable indoor environment, with their combined optimization being key to improving user satisfaction.

Identify the design strategies and practices that enhance natural lighting and ventilation for improved user comfort in Lagos office buildings.

Several studies outline effective design strategies to enhance natural lighting and ventilation. (Nwankwo & Adebayo,2022) highlighted passive design strategies such as cross-ventilation and daylighting as crucial for improving comfort in tropical office buildings. Their findings showed that these strategies not only enhanced user comfort but also reduced energy consumption. Similarly, (Musa & Akinwale,2023) demonstrated that integrating passive and active systems— like operable windows and daylight sensors—maximized the benefits of natural lighting and ventilation. (Eze & Nnamdi,2022) emphasized that natural ventilation alone is effective for about 60% of working hours in Nigerian offices, but supplementary mechanical systems are necessary during peak heat periods. These strategies underscore the importance of a balanced design approach, combining passive techniques with adaptive technologies to meet comfort standards effectively.

IMPLICATION OF THE FINDINGS

Need for Integrated Design Approaches

The findings emphasize the importance of combining natural lighting and ventilation strategies with supplementary systems to achieve consistent user comfort. For instance, while natural ventilation can meet comfort needs during moderate weather (Eze & Nnamdi, 2022; Hassan & Yusuf, 2023), extreme conditions may require hybrid or mechanical solutions. Similarly, optimal daylighting should avoid glare and overexposure (Johnson & Chukwu, 2021). These results suggest that architects and designers must adopt an integrated approach, blending passive and active systems to balance comfort and energy efficiency.

Policy and Regulation on Building Standards

The studies reveal varying levels of performance in lighting and ventilation across office buildings, highlighting inconsistencies in design practices (Okoro & Folarin, 2020; Adekunle & Oladipo, 2023). This underscores the need for updated building codes and policies in Lagos that mandate the inclusion of proven passive design strategies, such as cross-ventilation and controlled daylighting (Nwankwo & Adebayo, 2022). Enforcing these standards can ensure that office buildings are optimized for both comfort and sustainability.

Impact on Worker Productivity and Well-being

The relationship between natural lighting, ventilation, and user comfort has direct implications for worker productivity and well-being (Smith & Lee, 2021; Musa & Akinwale, 2023). Office buildings that fail to provide adequate lighting and ventilation may negatively impact employee health, stress levels, and efficiency. This highlights the economic and organizational benefits of investing in user-centered design practices, making it a priority for building managers and stakeholders to retrofit existing buildings or plan new constructions with these factors in mind.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study evaluated the impact of natural lighting and ventilation on user comfort in Lagos office buildings, drawing insights from a systematic review of recent research. Findings revealed that natural lighting and ventilation significantly influence user comfort by improving thermal conditions, visual comfort, and indoor air quality. However, optimal outcomes often require integrating these passive design strategies with supplementary systems to address challenges such as glare, overexposure, and extreme weather conditions. The evidence underscores the importance of adopting user-centered and sustainable building practices to enhance workplace productivity and occupant well-being. This research contributes to the growing body of knowledge on environmentally responsive design and emphasizes the need for further localized studies to address specific climatic and cultural contexts.

Recommendations

1. **Incorporate Hybrid Systems in Office Design:** Designers and engineers should combine natural lighting and ventilation strategies with hybrid systems that can adapt to varying weather conditions and occupancy patterns, ensuring consistent user comfort year-round.
2. **Adopt and Enforce Passive Design Standards**: Regulatory bodies in Lagos should update and enforce building codes to include passive design strategies, such as daylighting optimization and cross-ventilation, to standardize comfort-focused office designs across the city.
3. **Conduct Regular Post-Occupancy Evaluations**: Building managers and stakeholders should carry out periodic post-occupancy evaluations to assess user comfort and identify areas for improvement, particularly in lighting and ventilation systems.
4. **Promote Awareness of Sustainable Design Benefits**: Educational campaigns and workshops should be organized for architects, facility managers, and policymakers to highlight the economic, health, and productivity benefits of prioritizing natural lighting and ventilation in office designs.
5. **Encourage Retrofitting of Existing Buildings**: Office buildings that fail to meet comfort standards should undergo retrofitting to include passive design features such as larger windows, adjustable blinds, and natural ventilation openings, reducing dependence on artificial systems.
6. **Support Further Research on Local Contexts**:Universities, research institutions, and private organizations should fund and support more localized studies exploring the interplay between natural lighting, ventilation, and user comfort in Lagos to address specific climatic and cultural needs.

These recommendations provide actionable steps to advance the adoption of sustainable design practices and enhance user comfort in office buildings, contributing to the development of healthier, more productive, and energy-efficient work environments.

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