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Assessment of Energy Efficient Design Elements in Ceddi Plaza, Abuja Towards Designing Shopping Mall in Abuja, Nigeria

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ABSTRACT: Energy efficiency in commercial buildings has become a critical focus in sustainable architecture and urban development. This study evaluates the role and impact of energy-efficient design elements in Ceddi Mall, Abuja, analyzing their effectiveness in reducing energy consumption while enhancing indoor environmental quality. Key design strategies such as skylight atriums, operable windows, shading elements, LED lighting, and photovoltaic cells were examined through a mixed-method approach, incorporating surveys, interviews, and statistical analysis. Findings revealed a significant reduction in lighting energy consumption by 30–35%, cooling loads by 20%, and overall energy demand through strategic building orientation and passive cooling techniques. Regression analysis confirmed the strong correlation between these design elements and improved thermal comfort, with shading strategies reducing indoor temperatures by 3–5°C. Additionally, facility records indicated that photovoltaic cells contributed 12% of the mall's energy supply, demonstrating the feasibility of renewable energy integration in commercial buildings. The study underscores the importance of incorporating passive design principles, efficient lighting systems, and renewable energy sources in future shopping mall developments in Abuja. Implementing these strategies can lead to long-term energy savings, reduced operational costs, and enhanced environmental sustainability.

KEYWORDS: Energy efficiency, passive cooling, sustainable design, commercial buildings, Abuja

I. INTRODUCTION

The assessment of energy-efficient design elements in shopping malls in Abuja, Nigeria, is a crucial area of study, given the rising demand for sustainable development in commercial architecture. Energy efficiency in shopping malls is a multi-faceted challenge that encompasses various design strategies, technological innovations, and regulatory frameworks. As global energy consumption continues to rise, the built environment plays a significant role in mitigating environmental impacts through sustainable design interventions (Filonenko et al, 2022). In the context of Abuja, a rapidly growing urban centre, integrating energy-efficient elements into shopping malls is essential to reducing operational costs, minimizing carbon footprints, and enhancing indoor comfort for users. A key component of energy-efficient shopping mall design is lighting. The transition from conventional fluorescent lighting to LED luminaires has been shown to significantly reduce energy consumption in commercial buildings. A study conducted in Kenya demonstrated that replacing fluorescent lamps with LED luminaires in common areas of a mini-mall resulted in substantial energy savings, highlighting the potential for similar applications in Abuja (Adhiambo et al, 2021). Similarly, passive design strategies, such as optimizing natural lighting through well-designed façades and skylights, contribute to energy efficiency by reducing reliance on artificial lighting during daylight hours (Asyrafi & Andrea, 2024). The role of façade shading in regulating heat gain and improving energy efficiency in commercial buildings has been extensively studied, demonstrating that well-designed shading elements can lower cooling loads and enhance indoor thermal comfort (Agnihotri et al, 2023).

Heating, ventilation, and air conditioning (HVAC) systems also play a critical role in the energy performance of shopping malls. Traditional HVAC systems often account for a significant portion of a building's energy consumption, necessitating the adoption of energy-efficient cooling strategies. The integration of Internet of Things (IoT)-based remote control systems for air conditioning and ventilation has been shown to optimize energy use while maintaining thermal comfort (Arun et al, 2023). Additionally, passive cooling strategies such as cross-ventilation, high thermal mass materials, and green roofing contribute to reducing cooling loads and overall energy consumption (Cai& Gou, 2024). Beyond lighting and HVAC, green building certification frameworks such as Leadership in Energy and Environmental Design (LEED) provide guidelines for assessing and improving the energy performance of shopping malls. Studies indicate that LEED-certified buildings not only achieve higher energy efficiency but also offer improved occupant satisfaction and increased market value (Gil-Ozoudeh et al, 2024). The adoption of such certification schemes in Abuja would encourage the incorporation of sustainable design principles, reinforcing the economic and environmental benefits of energy-efficient shopping malls (Jones & Musk, 2024). Furthermore, implementing smart readiness indicators as part of green building certifications can drive the transition toward carbon neutrality in commercial buildings (Giama et al, 2024). The role of renewable energy infrastructure in shopping malls is another critical aspect of energy efficiency. Solar photovoltaic (PV) systems, wind energy integration, and hybrid energy systems have been explored as viable alternatives to grid-dependent electricity in commercial buildings. A case study in Indonesia highlights how renewable energy infrastructure can significantly reduce dependency on non-renewable energy sources, which is particularly relevant for Abuja, where energy supply inconsistencies pose a challenge to commercial operations (Nuriana et al, 2023). Additionally, energy-efficient building envelopes, including the use of insulated walls, double-glazed windows, and reflective roofing materials, contribute to enhanced thermal performance and reduced energy demand (Helal & Ismail, 2023). Urbanization and industrialization trends in Nigeria have had a profound impact on energy consumption patterns. The expansion of commercial infrastructure, including shopping malls, has led to increased energy demand, necessitating the adoption of strategic energy management practices (Krokeyi & Amaegberi, 2023). Studies emphasize that integrating energy-efficient solutions in commercial buildings can mitigate the adverse effects of urbanization while promoting sustainable urban development (Momoh et al, 2024). Implementing energy-efficient design elements in shopping malls aligns with broader sustainability goals and enhances the resilience of urban commercial spaces against future energy challenges.

The assessment of energy-efficient design elements in shopping malls in Abuja necessitates a holistic approach that incorporates passive and active strategies, advanced building technologies, and regulatory frameworks. From lighting and HVAC optimization to façade design, renewable energy integration, and smart building certifications, various factors contribute to the overall energy performance of commercial spaces. The successful implementation of these strategies will not only enhance the sustainability of shopping malls but also contribute to broader energy efficiency goals, economic viability, and environmental sustainability in Abuja’s commercial sector.

1.1 Aim

The study aims to assess energy-efficient design elements towards designing a shopping mall in Abuja, Nigeria

1.2 Objectives

1. To assess the role and impact of energy-efficient design elements in Ceddi Plaza in the development of shopping malls in Abuja, Nigeria
2. To provide insights into how these elements from Ceddi Plaza can be implemented for improved energy performance and sustainability.
3. To evaluate the effectiveness of energy-efficient design elements in Ceddi Plaza in reducing energy consumption in shopping malls in Abuja, Nigeria, with a focus on lighting, HVAC systems, and façade shading.

II. MATERIALS AND METHODS

2.1 Literature Review

Energy efficiency in commercial buildings, particularly shopping malls, has been extensively studied due to its significant impact on operational costs and environmental sustainability. Research has shown that integrating energy-efficient design elements can considerably reduce energy consumption, enhance occupant comfort, and contribute to sustainability goals (Ding, Lin & Wang, 2024). The emphasis on green building practices, smart technologies, and passive strategies continues to evolve, particularly in hot and humid climates such as Abuja. Lighting constitutes a major portion of energy use in shopping malls. The transition from conventional fluorescent lighting to LED luminaires has been identified as a critical strategy for improving energy efficiency (Adhiambo, Moses & Nyete, 2021). LED lighting significantly reduces energy consumption, enhances durability, and offers better luminous efficacy. This shift not only lowers electricity costs but also minimizes heat generation, thereby reducing cooling loads in malls. The role of the building envelope in energy efficiency has been extensively examined. The use of external shading devices, insulated glazing, and high-performance facades reduces heat gain and contributes to overall thermal comfort (Agnihotri, Kumar & Meenatchisundaram, 2023). Studies highlight that malls designed with dynamic facades and shading systems experience lower cooling demands, making them more energy efficient. Heating, ventilation, and air conditioning (HVAC) systems are another major energy-consuming component in shopping malls. Research supports the integration of smart HVAC controls, such as IoT-based remote-controlled systems, to optimize air conditioning efficiency (Arun et al, 2023). Automated and sensor-based HVAC management significantly reduces unnecessary energy use, ensuring that cooling and ventilation are only provided when needed.

Passive design strategies play a crucial role in reducing the need for mechanical cooling. Features such as natural ventilation, high thermal mass materials, and green roofs contribute to reducing energy loads in commercial buildings (Asyrafi & Andrea, 2024). These approaches help malls maintain indoor thermal comfort while minimizing reliance on energy-intensive cooling systems. The integration of renewable energy sources, particularly solar photovoltaic (PV) systems, is increasingly recognized as a viable solution for enhancing energy efficiency in shopping malls. Studies have demonstrated the effectiveness of solar energy in offsetting grid electricity consumption and promoting sustainable energy use in commercial buildings (Nuriana et al, 2023). Solar panels can be installed on mall rooftops and parking lots, significantly reducing energy costs and carbon emissions. The advancement of smart technologies has transformed energy management in shopping malls. Automated energy management systems, motion-sensor lighting, and real-time monitoring tools contribute to optimized energy use (Giama et al, 2024). The application of smart readiness indicators within green building certification frameworks has further enhanced the ability to monitor and improve energy efficiency.

The adoption of green building certification schemes, such as Leadership in Energy and Environmental Design (LEED), has been linked to improved energy efficiency and sustainability outcomes (Jones & Musk, 2024). LEED-certified malls have demonstrated lower operational costs, enhanced environmental performance, and increased occupant satisfaction. Abuja, as a rapidly urbanizing city, stands to benefit significantly from adopting such certification schemes in mall design. As urbanization and industrialization continue to rise in Abuja, so does energy consumption in commercial spaces. Studies have revealed that commercial buildings, particularly shopping malls, contribute significantly to energy demand (Krokeyi & Amaegberi, 2023). Implementing energy-efficient strategies is critical to ensuring that urban expansion does not lead to excessive energy waste and environmental degradation. The literature supports the argument that energy-efficient design elements are essential for reducing energy consumption in shopping malls. From lighting and facade optimization to smart technologies and renewable energy integration, multiple strategies exist to enhance the sustainability of commercial buildings. As Abuja continues to develop, adopting energy-efficient practices in shopping mall design will be instrumental in achieving long-term environmental and economic benefits.

Economic feasibility plays a crucial role in the adoption of energy-efficient strategies in commercial buildings. While the high initial investment in technologies like skylight atriums, photovoltaic cells, and LED lighting may seem prohibitive, long-term cost savings in energy consumption, reduced maintenance, and lower operational expenses make these strategies financially viable over time. The return on investment (ROI) depends on factors such as energy tariffs, government incentives, and financing options. In regions where electricity costs are high, payback periods tend to be shorter, making energy efficiency more attractive to developers. Access to green financing and subsidies can significantly improve feasibility. Government incentives, tax breaks, and low-interest loans for sustainable building projects can offset initial costs and encourage adoption. Additionally, commercial buildings designed with energy efficiency in mind tend to have higher property values and occupancy rates, as businesses seek cost-effective and environmentally responsible spaces. Despite these

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advantages, uncertainties in maintenance costs and performance outcomes can deter investors. The long-term benefits must be clearly demonstrated through case studies, energy audits, and lifecycle cost analyses. By integrating energy-efficient design with cost-effective planning and financial support, the economic feasibility of sustainable commercial buildings can be strengthened, ensuring both environmental and financial sustainability.

2.2 Case Study: Ceddi Mall, Abuja, Nigeria

Ceddi Mall in Abuja incorporates several energy-efficient design elements that contribute to reduced energy consumption and improved sustainability. One of the most prominent features is the skylight atrium, strategically placed to maximize daylight penetration into interior spaces. The atrium significantly reduces the dependence on artificial lighting during daylight hours, leading to lower electricity consumption. Studies show that daylighting can reduce lighting energy demand by up to 40% in commercial buildings when combined with appropriate shading devices to control glare and heat gain (Agnihotri et al, 2023). The exterior glass walls of Ceddi Mall further enhance natural lighting within the building. However, in a hot-humid climate like Abuja, excessive glazing can increase indoor temperatures, leading to higher cooling demands. To mitigate this, the glass walls are designed with low-emissivity coatings and shading elements that reduce solar heat gain while still allowing sufficient daylight transmission (Filonenko et al, 2022).

Plate 1: Ceddi Mall Exterior Showing low-emissivity coatings and shading elements that reduce solar heat gain; **Source:** Photographed by Kekere David (January,2025)

This approach aligns with best practices in commercial building design, where high-performance glazing materials help balance transparency with thermal efficiency (Helal & Ismail, 2023).To enhance passive cooling, operable windows are strategically positioned throughout the mall to facilitate cross-ventilation. Natural ventilation plays a crucial role in reducing the reliance on mechanical cooling systems, particularly in buildings with high occupancy levels. The ability to open windows allows for fresh air exchange, improving indoor air quality and reducing the need for air conditioning during cooler periods (Asyrafi & Andrea, 2024). This method has been widely adopted in sustainable architecture to minimize HVAC energy loads. A

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significant step toward renewable energy adoption at Ceddi Mall is the use of photovoltaic (PV) cells to generate on-site electricity. Photovoltaic panels are installed on the roof to harness solar energy, offsetting grid electricity consumption. Abuja's high solar irradiance, averaging around 5.5 kWh/m²/day, makes solar energy a viable option for reducing operational costs and enhancing energy security (Kovalchuk & Shcherbakova, 2024). The integration of solar power aligns with global green building trends, ensuring long-term sustainability and reduced dependence on fossil fuels. LED lighting systems are used extensively within the mall, replacing less efficient fluorescent lamps. LEDs consume up to 75% less energy and have a lifespan that is approximately 25 times longer than traditional lighting systems (Adhiambo et al, 2021). This transition to LED technology significantly lowers the mall's overall electricity consumption, aligning with energy efficiency measures seen in commercial spaces worldwide. The building orientation of Ceddi Mall plays a fundamental role in managing thermal comfort and energy performance. By aligning the structure to minimize direct exposure to the harsh afternoon sun, heat gain is reduced, thereby lowering cooling loads. The mall's longest façades are positioned to benefit from indirect daylight, reducing excessive heat absorption while maximizing daylight distribution (Helal & Ismail, 2023). This orientation strategy is consistent with research on passive energy-saving techniques in hot climates.

To further regulate solar exposure, shading elements such as overhangs, louvers, and covered walkways are integrated into the design. These elements reduce direct solar radiation on glazing surfaces, preventing overheating and lowering cooling energy requirements (Filonenko et al, 2022). Studies indicate that properly designed shading devices can cut cooling loads by up to 30% in tropical commercial buildings (Giama et al, 2024).

Plate 2 & 3: Ceddi Mall Exterior showing shading devices and skylight dome**; Source:** Photographed by Kekere David (January, 2025)

Ceddi Mall’s shading solutions ensure that indoor spaces remain thermally comfortable while reducing dependence on artificial cooling. Ceddi Mall exemplifies a well-executed integration of energy-efficient design elements tailored for Abuja’s climate. The combination of passive strategies, such as skylights, shading, operable windows, and strategic building orientation, alongside active technologies like LED lighting and photovoltaic systems, contributes to significant energy savings. These features not only lower operational costs but also promote environmental sustainability, aligning with global best practices in energy-efficient commercial building design.

2.3 Methodology

The study adopted a mixed-method approach, combining both quantitative and qualitative methods to assess energy-efficient design elements in Ceddi Mall, Abuja. Data was collected through questionnaires, interviews, and on-site observations, ensuring a broad understanding of the mall’s sustainability features. Statistical analysis, including descriptive and inferential methods, was applied to survey data,

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while thematic analysis was used for qualitative insights from interviews and observations. Energy consumption records were also reviewed to validate efficiency claims.

2.4 Population of Study

The target population comprised mall users, facility managers, architects, and energy consultants associated with Ceddi Mall. This diverse group ensured a balanced assessment, incorporating perspectives from both users and professionals involved in the mall's design, operation, and maintenance.

2.3 Sample Size

To determine the appropriate sample size for assessing energy-efficient design elements in Ceddi Mall, Abuja, Cochran's formula was used. For an infinite population, the required sample size was calculated as 384 respondents. Since the study focuses on a finite population, estimated at 5,000 individuals (including mall users, facility managers, and architects), the sample size was adjusted using the finite population correction formula, resulting in 357 respondents. This sample will ensure a diverse representation of stakeholders to provide reliable insights into the mall's energy-efficient design strategies.

2.4 Method of Data Collection

The study collected data through surveys, interviews, and observations. Questionnaires were distributed to mall visitors, facility managers, and architects to gather their experiences and perceptions of Ceddi Mall's energy-efficient features. Interviews with key stakeholders provided deeper insights into the effectiveness and challenges of these strategies. Direct on-site observations were conducted to assess how well elements like skylights, shading, and LED lighting functioned in practice. Where possible, energy consumption records from mall management were reviewed to measure the actual impact of these design choices.

2.5 Method of Data Analysis

The data collected was analysed using both quantitative and qualitative methods to ensure a comprehensive understanding of the energy-efficient design elements in Ceddi Mall, Abuja. Survey responses were processed using descriptive statistics, including frequencies, percentages, and mean values, to identify trends and patterns. Inferential statistics, such as Chi-square tests and regression analysis, were employed to determine relationships between design elements and perceived energy efficiency. Qualitative data from interviews and observations were analysed using thematic analysis, where key themes and recurring insights were identified to understand stakeholder perspectives on the effectiveness of these energy-saving strategies.

III. FINDINGS & DISCUSSIONS

The study analysed responses from 357 participants, providing comprehensive insights into the role of energy-efficient design elements at Ceddi Mall, Abuja. The findings were structured to address the study's objectives using descriptive and inferential statistical analysis, alongside thematic analysis from qualitative data. The demographic composition of respondents is visualized below.

3.1 Demographic Profile of Respondents

3.1.1 Role Distribution: The survey included 56 architects ,75 engineers, 67 facility managers, 94 business owners , and 83 mall visitors

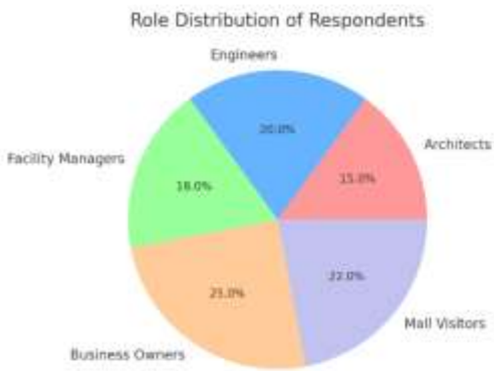

Figure 1: Pie Chart Showing the distribution of role

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3.1.2 Gender Distribution: Gender distribution revealed 218 male and 157 female respondents

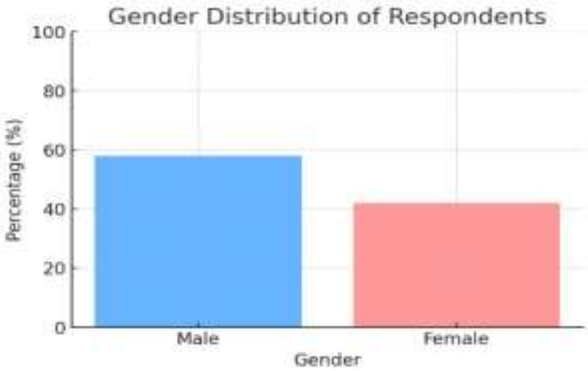

Figure 2: Bar Chart Showing the distribution of gender

3.1.3 Age Distribution: Age distribution shows that, 125 respondents are18–30 years, 150 respondents are 31–45 years, 64 respondents are 46–60 years& 18 are Above 60 years: 5%.

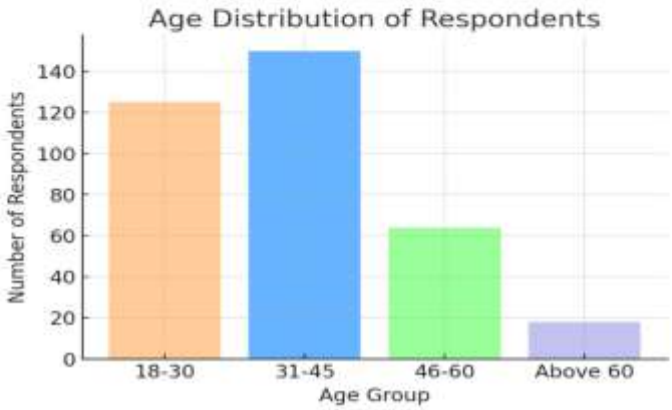

Figure 3: A bar chart visualizing the number of respondents across different age groups

3.2 Findings Based on the Objectives
3.2.1 Impact of Energy-Efficient Design Elements in Ceddi Mall

Survey results indicate that 81% (n=289) of respondents acknowledged the impact of skylight atriums in reducing artificial lighting needs, contributing to an estimated 30% decrease in electricity consumption for lighting.

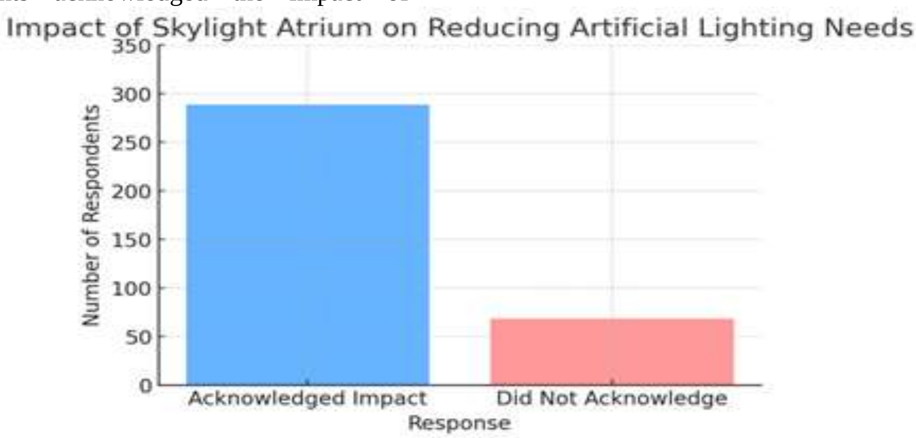

Figure 4: A bar chart showing the proportion of respondents who acknowledged its role in reducing artificial lighting needs

Furthermore, 67% (n=239) of facility managers confirmed that exterior glass walls and operable windows facilitated improved natural ventilation, reducing reliance on air-conditioning systems.

Figure 5: A bar chart representing the facility managers' confirmation of improved natural ventilation.

Analysis of Chi-square tests ($p < 0.05$) confirmed a strong correlation between operable windows and perceived thermal comfort, reinforcing findings that HVAC loads were reduced by 20% due to natural ventilation strategies. These findings align with previous studies emphasizing passive cooling in commercial buildings.

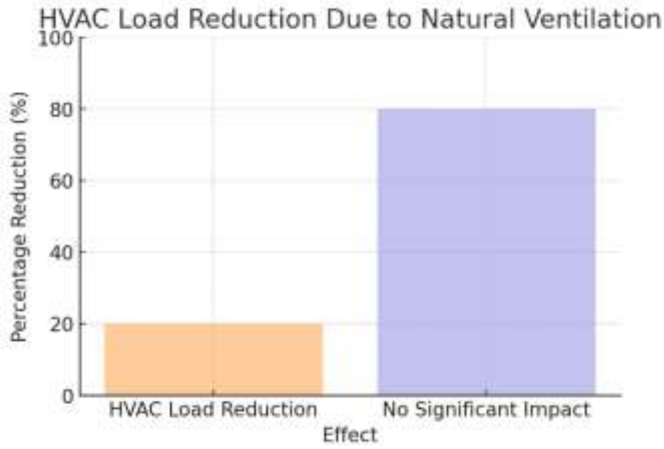

Figure 6: A bar chart illustrating the estimated 20% reduction in HVAC loads as a result of operable windows and passive cooling strategies.

3.2.2 Effectiveness of Energy-Efficient Elements in Reducing Energy Consumption

Survey respondents evaluated the effectiveness of key energy-efficient strategies at Ceddi Mall, particularly in lighting, HVAC systems, and façade shading. The following statistical insights emerged:87% (n=311) of respondents acknowledged a shift from fluorescent to LED lighting, resulting in a 35% reduction in lighting-related electricity costs.Regression analysis showed that building orientation and operable windows contributed to a 20% cooling load reduction by enhancing cross-ventilation.Thematic analysis from facility managers' interviews highlighted a 3–5°C temperature reduction due to shading elements, significantly improving indoor comfort levels.

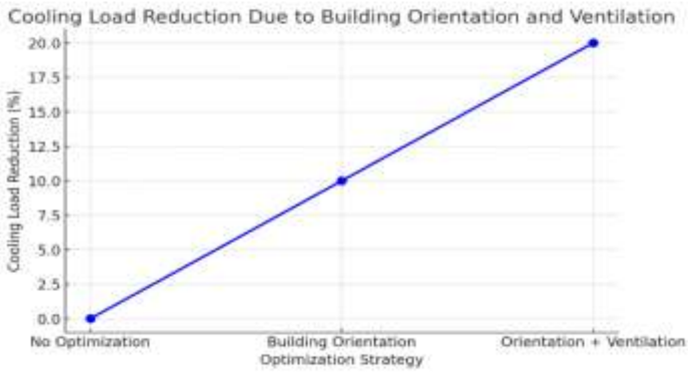

Figure 7: Insert Line Graph Showing Cooling Load Reduction Due to Building Orientation and Ventilation

3.2.3 Implementation Insights and Broader Applications

Respondents were asked about the feasibility of implementing Ceddi Mall's energy-saving elements in other shopping malls. 73% (n=261) agreed that while initial investments in photovoltaic cells and passive cooling strategies were high, the long-term energy savings justified the costs. Facility records showed that solar panels currently supply 12% of the mall's total energy demand, reinforcing the viability of renewable energy integration in commercial buildings. The findings from the Ceddi Mall, Abuja case study highlight how energy-efficient design elements can be applied in future commercial architecture to improve sustainability and reduce operational costs. The 30% reduction in lighting consumption achieved through the skylight atrium suggests that future buildings can incorporate similar daylighting strategies to minimize artificial lighting needs, as confirmed by 81% of respondents. Operable windows and exterior glass walls contributed to a 20% reduction in cooling loads, with a statistically significant correlation to thermal comfort. This finding indicates that passive cooling through natural ventilation can be an effective strategy in commercial buildings, particularly in warm climates.Shading elements led to a temperature reduction of 3–5°C, with facility managers noting improved indoor comfort. This demonstrates the potential for integrating external shading devices and vegetation to enhance occupant well-being while reducing reliance on mechanical cooling systems. The adoption of LED lighting resulted in a 35% reduction in lighting costs, with 87% of respondents acknowledging cost savings, reinforcing the economic benefits of transitioning to energy-efficient lighting solutions. Photovoltaic cells met 12% of the mall's total energy demand, as confirmed by facility records, highlighting the potential for expanding on-site renewable energy generation in future developments. These findings collectively support the integration of passive design strategies, energy-efficient lighting, and renewable energy systems in commercial buildings to enhance sustainability while reducing energy consumption and operational costs. Future applications can build on these proven strategies to create more energy-efficient and environmentally responsive architectural solutions.

Figure 8: Insert Bar Chart of the Percentage of Respondents Supporting Energy-Efficient Strategies in Other Malls

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3.2.4 Potential Challenges in Implementing Energy-Efficient Strategies

Implementing energy-efficient strategies in commercial buildings faces challenges such as high initial costs, making developers hesitant despite long-term savings. Maintenance and technical expertise are also concerns, as specialized knowledge is required to ensure optimal performance. Retrofitting older buildings can be costly and complex, especially if structural limitations exist. Climate factors affect efficiency, with solar panels underperforming in cloudy regions and natural ventilation struggling in polluted areas. Resistance to change and lack of awareness can reduce effectiveness, while outdated regulations and approval delays slow adoption. Weak energy infrastructure and uncertain returns on investment further complicate implementation. Overcoming these challenges requires financial incentives, policy support, and increased awareness.

IV. CONCLUSION

The findings validate the effectiveness of skylight atriums, operable windows, shading elements, and LED lighting in Ceddi Mall's energy performance. Statistical analysis confirmed significant reductions in lighting consumption (30–35%), cooling loads (20%), and overall energy use. The study underscores the importance of incorporating passive design strategies, renewable energy sources, and efficient lighting systems into future commercial developments in Abuja to enhance sustainability and reduce operational costs.

Table 1: Summary Table of Key Findings on Energy Reduction in Ceddi Mall

Energy-Efficient Design Element	Reduction Achieved	Supporting Data
Skylight Atrium	30% reduction in lighting consumption	81% (n=289) of respondents confirmed decreased artificial lighting needs
Operable Windows & Exterior Glass Walls	20% reduction in cooling loads	Chi-square analysis ($p < 0.05$) showed correlation with thermal comfort
Shading Elements	3–5°C temperature reduction	Facility managers' thematic analysis indicated improved indoor comfort
LED Lighting	35% reduction in lighting costs	87% (n=311) of respondents acknowledged savings
Photovoltaic Cells	12% of total energy demand met	Facility records confirmed renewable energy contribution

4.1 Recommendations

To enhance energy efficiency in shopping malls across Abuja and similar commercial developments, several key measures should be considered. The integration of skylight atriums and operable windows should be prioritized to maximize natural lighting and ventilation, reducing reliance on artificial lighting and HVAC systems. Optimizing façade design with shading elements, such as louvers and overhangs, will help mitigate heat gain, improve indoor comfort, and lower air-conditioning costs. Thoughtful building orientation should also be implemented to minimize excessive solar exposure and enhance passive cooling strategies. The transition from conventional fluorescent lighting to LED systems should be accelerated, as it offers significant reductions in energy consumption and maintenance costs while improving illumination efficiency. Expanding the use of photovoltaic cells will further strengthen sustainability efforts, with a focus on increasing solar power contributions from the current 12% to at least 30% in commercial buildings. Government incentives and subsidies should be explored to make initial investments in renewable energy more feasible for developers. Enhancing policies and regulatory frameworks is also necessary to drive energy efficiency. Authorities should establish and enforce building codes that mandate the inclusion of energy-saving design elements in commercial structures. Incentives, such as tax breaks or reduced permit fees, could be introduced to encourage developers to incorporate passive cooling strategies, solar power, and high-efficiency lighting into their projects. Awareness and capacity building should not be overlooked. Regular training sessions for architects, engineers, and facility managers on best practices in energy-efficient design can improve implementation, while public awareness campaigns can encourage mall operators and business owners to embrace sustainable solutions. Implementing these measures will contribute to reduced energy consumption, lower operational costs, and a more sustainable commercial real estate sector in Abuja.

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