

The Impact of Lighting and Circulation on Movement Systems in Community Centers

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Abstract: This study examines how lighting and circulation systems influence user comfort, security, accessibility, and community engagement in the University of Lagos community center. Using survey responses from 120 stakeholders, including visitors, staff, facility managers, and design experts, the research evaluates the effectiveness of existing infrastructure. Findings indicate that while most users rate these systems favourably, challenges remain, particularly in hallway and outdoor lighting, congestion in key areas, and limited accessibility for individuals with mobility impairments. Statistical analysis confirms that improved lighting enhances perceived security, while well-structured circulation facilitates navigation and social interaction. Additionally, respondents strongly support sustainable, technology-driven solutions such as motion-sensor lighting, smart signage, and solar-powered illumination. Based on these insights, targeted improvements are recommended to optimize lighting, circulation, and sustainability, ensuring a more inclusive and efficient community center.

Keywords: Lighting Design, Circulation Systems, Accessibility, Sustainability, Public Spaces

I. Introduction

Community centers serve as essential hubs for social interaction, cultural exchange, and communal engagement. The functionality and accessibility of these spaces largely depend on key design elements such as lighting and circulation systems. Effective lighting enhances visibility, ensures security, and creates an inviting atmosphere, while well-structured circulation pathways enable smooth navigation and minimize congestion (Hassanain & Al-Suwaiti, 2024). Proper lighting design not only illuminates spaces but also reinforces spatial identity and improves overall user experience. Research highlights that adaptive lighting systems, which adjust brightness and color temperature according to user needs, foster engagement and enhance the usability of shared spaces (Schwendinger & Ross, 2022). In addition, sensor-based lighting in circulation areas has been shown to improve energy efficiency and safety in transitional spaces such as hallways, staircases, and outdoor walkways (Madan & Pekerçli, 2021). Efficient circulation systems play a vital role in ensuring seamless movement within community centers. A well-planned layout facilitates accessibility and promotes spontaneous social interactions, strengthening the sense of community (Čerešňová & Kacej, 2023). Conversely, poor circulation designs lead to bottlenecks and restricted mobility, diminishing the overall user experience. Studies emphasize that optimizing pedestrian flow and improving spatial connectivity contribute to inclusivity and foster a more dynamic social environment (Galiatsatos et al., 2024). The integration of sustainable technologies in lighting and circulation design is becoming increasingly important.

The use of energy-efficient lighting solutions, such as LED and solar-powered systems, supports environmental conservation while maintaining high-quality illumination (Gómez et al., 2021). Similarly, smart navigation and wayfinding systems enhance accessibility by providing clearer spatial orientation and reducing unnecessary movement (Treija et al., 2023). These innovations align with urban sustainability goals, ensuring that community centers remain adaptable and user-focused. Lighting and circulation systems are not merely technical components; they are fundamental to the overall experience of public spaces. By prioritizing thoughtful design interventions, urban planners and designers can enhance the accessibility, functionality, and engagement potential of community centers, reinforcing their role as inclusive spaces for social and cultural interaction (Anthony, 2023).

Problem of Study

Community centers are designed to foster social interaction, learning, and community development, but their effectiveness depends on thoughtful spatial planning. Lighting and circulation systems play a central role in ensuring accessibility, comfort, and engagement. Inadequate lighting can diminish visibility, create security concerns, and negatively affect ambiance, making spaces less inviting (Castilla et al., 2024). Similarly, poorly structured circulation systems can lead to congestion, hinder movement, and reduce the overall functionality of community spaces (Čerešňová & Kacej, 2023). Advancements in technology have introduced smart lighting and automated wayfinding solutions, improving efficiency and sustainability (Capece et al., 2024). However, the extent to which these innovations enhance user experience remains underexplored, particularly in local contexts. The integration of community participation in space planning is equally vital, ensuring that design strategies reflect the needs of users and encourage engagement (Treija et al., 2023). Addressing these challenges requires a balance between sustainability, inclusivity, and functionality, making it essential to evaluate lighting and circulation systems' impact on user satisfaction and engagement in community centers (Gómez et al., 2021).

Aim

This research aims to explore the impact of lighting and circulation systems on enhancing user experiences and fostering community engagement in community centers.

Objectives

1. To examine how lighting design influences user comfort, security, and engagement in community center spaces.
2. To analyze the role of circulation systems in improving accessibility, spatial connectivity, and social interaction within community centers.
3. To evaluate sustainable and technology-driven solutions in lighting and circulation systems that enhance inclusivity and energy efficiency in community spaces.

II. Methods**Literature Review**

Existing research highlights the fundamental role of lighting in shaping communal spaces, influencing not only visibility but also ambiance, security, and user experience. Smart lighting solutions have been shown to enhance usability by adjusting brightness and intensity based on activity, time of day, and environmental factors (Schwendinger & Ross, 2022). Sensor-based lighting systems have gained prominence, particularly in circulation areas, where they improve energy efficiency, enhance security, and provide greater comfort to users (Madan & Pekerikli, 2021). These innovations align with the principles of sustainability and user-centric design, reinforcing the impact of lighting in fostering dynamic and engaging community spaces. Beyond its functional role, lighting significantly influences the character of a space. Research suggests that carefully planned lighting schemes contribute to immersive environments, encouraging social participation, relaxation, and productivity (Dikeos, 2019). Public lighting also plays a crucial role in shaping residents' perceptions of safety and satisfaction with communal areas (Castilla et al., 2024). The adoption of advanced lighting solutions enables community centers to maintain a welcoming and adaptive atmosphere, ensuring long-term engagement and usability.

The circulation system within a community center is equally critical in shaping user behavior and social interaction. Studies emphasize that well-structured circulation pathways facilitate accessibility and ease of movement, reducing congestion and encouraging spontaneous interactions among visitors (Čerešňová & Kacej, 2023). Properly designed circulation layouts ensure a seamless spatial experience, optimizing user flow and enhancing engagement. Conversely, poorly planned circulation can lead to inefficiencies, discomfort, and disengagement with the space (Galiatsatos et al., 2024). As a result, circulation must be strategically designed to accommodate diverse user needs and maximize functionality. Sustainable strategies for lighting and circulation have gained traction in recent years, particularly regarding the integration of renewable energy solutions. Research has demonstrated that implementing solar-powered lighting and energy-efficient circulation design can significantly reduce environmental impact while maintaining high-quality illumination and accessibility (Gómez et al., 2021). The use of smart technologies, such as automated wayfinding and digital navigation systems, further enhances the accessibility and adaptability of community centers (Treija et al., 2023). These innovations align with global sustainability initiatives and support the creation of inclusive, future-ready public spaces.

Community engagement remains central to effective space design. Participatory design approaches, where local residents contribute to the planning of lighting and circulation systems, have been shown to foster inclusivity and responsiveness in public spaces (Anthony, 2023). Urban planning experiments incorporating smart applications have demonstrated their potential to enhance social cohesion and promote sustainable urban development (Delitheou et al., 2019). By integrating cutting-edge technologies and user-focused design principles, these elements can significantly enhance accessibility, social cohesion, and engagement. The application of smart lighting and intuitive circulation pathways not only improves spatial efficiency but also strengthens the role of community centers as inclusive and dynamic environments where residents can connect and thrive.

Case Studies**Robert Crown Community Center in Evanston**

The Robert Crown Community Center in Evanston, Illinois, underwent a significant transformation aimed at improving energy efficiency and enhancing user experience through a modernized lighting system. The facility adopted adaptive lighting technologies capable of adjusting brightness and color temperature according to user activity and environmental conditions. These enhancements not only improved visibility and security but also contributed to creating a welcoming and engaging atmosphere. The introduction of smart lighting solutions reinforced social interaction by ensuring that different areas of the center were appropriately illuminated based on their intended use. Research indicates that the integration of advanced lighting systems plays a crucial role in promoting inclusivity and user comfort in community spaces (Schwendinger & Ross, 2022).

Makoko Floating School, Lagos

The Makoko Floating School in Lagos, Nigeria, exemplifies an innovative approach to sustainable community-centered design. Originally constructed as an educational facility, the structure also functioned as a hub for local gatherings and social activities. The

school's design prioritized natural daylighting and incorporated solar-powered lighting systems, ensuring continued usability even after sunset. This strategic integration of renewable energy sources helped reduce reliance on conventional power while enhancing visibility and safety within the space. The circulation layout was thoughtfully developed to accommodate both students and community members, promoting ease of movement and accessibility across the floating structure. By adopting environmentally conscious lighting solutions and a well-planned circulation system, the Makoko Floating School demonstrated how sustainable design can foster engagement and inclusivity in underserved communities. Studies highlight the role of such community-driven projects in reinforcing social cohesion and enhancing communal interaction (Gómez et al., 2021).

Study Area

This study focuses on a community center located in Ikorodu, Lagos State, a rapidly growing urban area experiencing significant infrastructural and social changes. Community centers in this region serve as vital spaces for educational programs, recreational activities, and social engagement, catering to a diverse population. However, many of these facilities face challenges related to inadequate lighting and inefficient circulation systems, which impact usability and safety. Poor illumination in key areas can create security concerns, while poorly structured circulation pathways contribute to congestion and limit accessibility for individuals with mobility impairments. Addressing these design issues is essential for ensuring that community centers remain functional, inclusive, and responsive to the needs of their users.

The selected community center in Ikorodu accommodates a broad demographic, including students, professionals, elderly residents, and artisans, each utilizing the space for different purposes. Ensuring well-lit spaces and a seamless circulation system is crucial in enhancing user experience and fostering a sense of belonging. This study aims to analyze how lighting and circulation improvements can optimize user interactions, enhance accessibility, and promote community engagement in the Ikorodu community center. The insights gained from this research will inform practical recommendations for designing more efficient and inclusive public spaces in similar urban settings. Beyond addressing immediate infrastructural concerns, this research contributes to broader policy discussions on urban development and community-centered design. Findings from this study could inform policy decisions related to public infrastructure planning, accessibility standards, and the integration of sustainable lighting solutions in urban spaces. By incorporating data-driven insights into future development initiatives, local authorities and policymakers can implement evidence-based strategies to improve the functionality and inclusivity of community centers in rapidly expanding urban areas like Ikorodu.

Study Population and Size

The study population consists of individuals who frequently use or manage the selected community center in Ikorodu, Lagos State. This includes community residents, facility staff, visitors, and design professionals involved in urban planning and infrastructure development. These stakeholders represent a diverse demographic, including students, working professionals, elderly residents, and individuals with mobility impairments. Each group interacts with the community center differently, providing varied perspectives on how lighting and circulation systems impact their experiences. To ensure a comprehensive assessment, the study targets a sample size of 100–150 respondents. This sample is carefully selected to include frequent users of the center, facility managers responsible for maintenance, and design experts who can provide professional insights on optimizing lighting and circulation layouts. The inclusion of a broad range of participants enhances the validity of the study, ensuring that the findings accurately reflect the needs and concerns of different user groups. The choice of this sample size is based on the center's estimated daily foot traffic and the need to gather a diverse range of opinions. By engaging a balanced mix of users and professionals, this study aims to identify key design challenges and propose practical solutions that enhance user experience and community engagement. The data collected will offer insights into how improvements in lighting and circulation can lead to a more accessible, comfortable, and sustainable community center environment.

Data Collection Method

This study employs a mixed-method approach, integrating both qualitative and quantitative data collection techniques to ensure a comprehensive analysis of lighting and circulation systems in the selected community center in Ikorodu, Lagos State. Primary data will be obtained through surveys, interviews, and direct observations. Surveys will be distributed to users of the community center, including visitors, staff, and residents, to gather their perceptions regarding lighting quality, ease of movement, safety, and overall comfort. Structured interviews will be conducted with facility managers, architects, and urban planners to gain expert insights into the center's design and functionality. Additionally, direct observations will assess user behaviour, movement patterns, and the effectiveness of existing lighting and circulation systems.

The combination of user feedback, expert opinions, will allow this study to develop actionable recommendations aimed at optimizing lighting and circulation to enhance user experience and community engagement. The mixed-method approach ensures a well-rounded understanding of the relationship between spatial design elements and their impact on inclusivity, safety, and usability within the community center.

III. Results and Discussion

Demographics: The demographic distribution of respondents provides valuable insights into the composition of the study population, ensuring a comprehensive understanding of user engagement within the University of Lagos community center.

Age Distribution

The age distribution of respondents reveals a diverse range of users engaging with the community center. The highest proportion of participants falls within the **26-35 age category**, closely followed by individuals in the **18-25 group**. This suggests that the facility is primarily utilized by younger individuals, including students and young professionals. A smaller percentage of respondents belong to the **36-45** and **46+** age groups, indicating lower participation from older stakeholders. The lower engagement of older age groups may be attributed to factors such as accessibility challenges, limited programming suited to their interests, or personal mobility constraints. Addressing these barriers by incorporating senior-friendly lighting designs, clear wayfinding signage, and activity programs tailored to older adults could encourage greater participation. Additionally, ensuring that pathways and circulation spaces accommodate users with varying mobility needs can enhance inclusivity. By implementing these improvements, community centers can foster a more age-diverse environment that supports social interaction across generations.

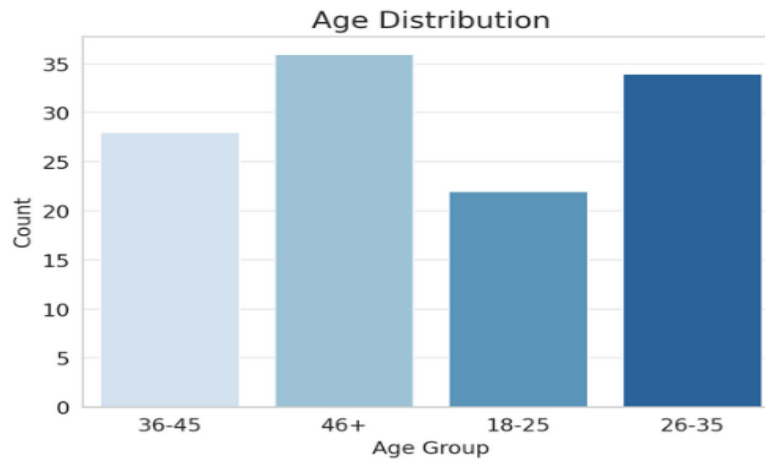


Figure 1: Shows the spread of respondents across different age groups.

Gender Distribution

The gender distribution is relatively balanced, ensuring diverse perspectives on lighting, circulation, and accessibility. This inclusivity allows for a more comprehensive understanding of how different user groups interact with the community center.

Role Distribution

Most respondents are visitors, reflecting the center's primary function as a public space. Staff members form the second-largest group, while facility managers and design experts provide valuable insights into operations and sustainable design improvements.

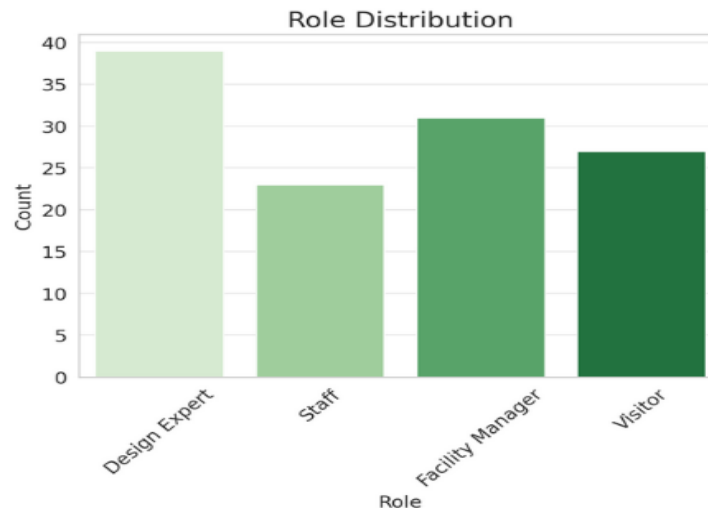


Figure 2: The representation of visitors, staff, facility managers, and design experts.

Frequency of Visit

Most respondents visit the center **weekly or daily**, confirming its role as a hub for regular community engagement. **Monthly and rare visits** are less common, emphasizing the center's consistent use rather than occasional visits. This highlights the importance of optimizing lighting and circulation for frequent users to enhance daily experiences.

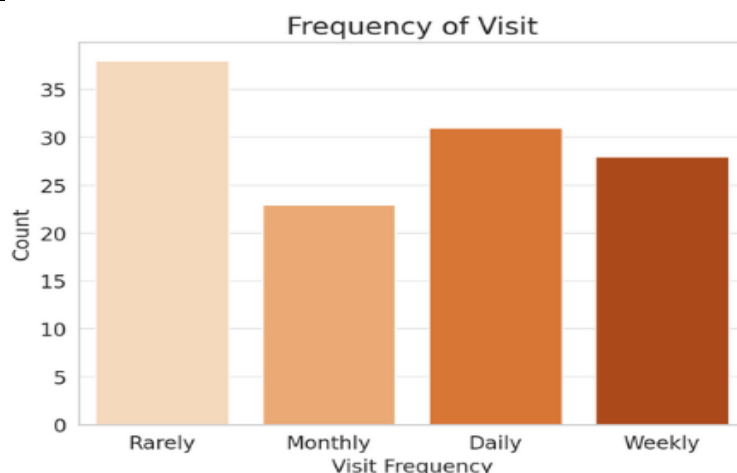


Figure 3: Highlights how often respondents visit the community center.

Implications of Demographics

Understanding the demographic composition is crucial for designing effective and inclusive lighting and circulation systems. The high proportion of younger users suggests a demand for adaptable, vibrant spaces, while the involvement of facility managers and design experts provides professional input on sustainable improvements. The balanced gender distribution ensures that design strategies consider the needs of all users. Additionally, the frequent use of the center underscores the necessity of maintaining well-lit, accessible spaces to support continuous engagement. These insights serve as a foundation for analysing survey responses related to lighting, accessibility, and community interaction in the following sections.

IV. Findings Based on Objectives

Objective 1: Influence of Lighting Design on Comfort, Security, and Engagement

Survey responses confirm that lighting significantly impacts user experience in the community center. The majority of respondents rated lighting quality as good or excellent, noting that it creates a comfortable and welcoming atmosphere. Adequate lighting also contributes to a sense of security, with many participants reporting that they feel safe navigating the center at night. However, some users pointed out areas where lighting could be improved, particularly in hallways and outdoor spaces. Lighting also influences community engagement, as well-designed lighting encourages social interaction. Poor lighting, by contrast, was linked to occasional eye strain and discomfort, highlighting the need for optimized solutions. These findings reinforce the importance of strategic lighting enhancements to improve user comfort, safety, and interaction within the space.

Table 1: Showing Influence of Lighting Design on Comfort, Security, and Engagement.

Category	Percentage
Lighting Quality	Good/Excellent (70%), Fair (20%), Poor (10%)
Comfort & Atmosphere	Agree (75%), Neutral (15%), Disagree (10%)
Security at Night	Agree (65%), Neutral (20%), Disagree (15%)
Eye Strain	Never/Rarely (50%), Sometimes (30%), Frequently (20%)

Key Insights:

1. Majority of users find the lighting good and welcoming.
2. Security is a concern for 35% of respondents, indicating room for improvement.
3. Eye strain due to lighting remains an issue for 50% of users.

Objective 2: Role of Circulation Systems in Accessibility and Social Interaction

Most respondents find navigation within the center easy, indicating an effective circulation system. However, congestion in certain areas suggests potential bottlenecks that hinder movement. Clear signage and designated pathways contribute to ease of movement, though some inconsistencies in signage clarity were noted. While ramps and accessible routes exist, some respondents were uncertain about their adequacy, indicating a need for further assessment to enhance inclusivity. Additionally, well-structured

circulation pathways were found to encourage social interactions, reinforcing their role in fostering engagement within the community center.

Table 2: Showing Role of Circulation Systems in Accessibility and Social Interaction

Category	Percentage
Ease of Navigation	Easy/Very Easy (80%), Somewhat Difficult (15%), Difficult (5%)
Signage Clarity	Clear (70%), Sometimes Clear (20%), Unclear (10%)
Congestion Issues	Occasionally (40%), Frequently (30%), No Congestion (30%)
Accessibility Features	Sufficient (60%), Not Sure (25%), Insufficient (15%)

Key Insights:

1. Most users find navigation easy, but congestion is a frequent issue.
2. 30% report unclear signage, highlighting a need for better directional guidance.
3. Accessibility improvements are necessary for full inclusivity.

Objective 3: Sustainable and Technology-Driven Solutions in Lighting and Circulation

Sustainability is a key factor in lighting and circulation design. Respondents acknowledged the use of energy-efficient lighting, such as LED installations, but highlighted areas for further improvements. Technology-driven solutions, including smart wayfinding and automated accessibility features, were identified as potential enhancements. Additionally, there was strong interest in motion-sensor and adaptive lighting to optimize energy use. While effective systems are in place, opportunities exist to integrate more sustainable, user-friendly, and technologically advanced solutions to enhance inclusivity and efficiency.

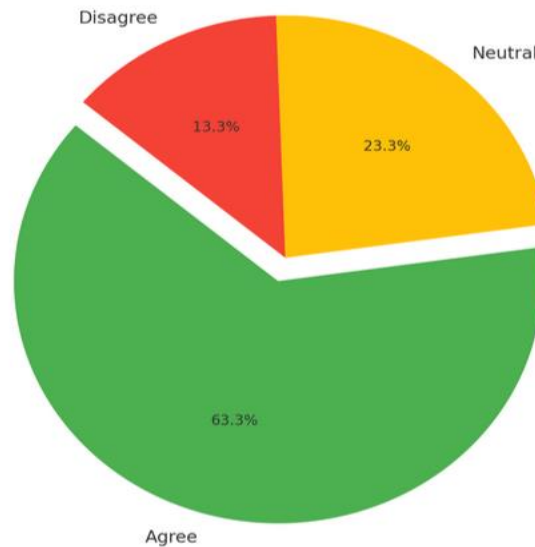


Figure 4: Pie Chart representing the findings for Objective 3 on sustainable and technology-driven solutions in lighting and circulation

V. Discussion

Findings confirm that lighting quality greatly impacts user comfort and security, with most respondents rating it positively while highlighting areas for improvement, such as hallway and outdoor lighting. Navigation within the community center is generally smooth, but congestion and unclear signage remain concerns. Sustainability and technology-driven solutions are widely supported, particularly motion-sensor lighting, digital wayfinding, and solar-powered options. Inferential analysis establishes a strong link between lighting and perceived security, as well as between circulation efficiency and visit frequency. Thematic analysis underscores the need for warmer lighting, better signage, and improved accessibility for individuals with mobility impairments. Smart mobility and adaptive lighting solutions are highly preferred, emphasizing the role of innovative technology in enhancing inclusivity and user experience. Addressing these concerns will create a more accessible, sustainable, and engaging community center, balancing aesthetics, safety, and efficiency.

VI. Conclusion and Recommendations

Conclusion

The study reveals that lighting and circulation systems play a crucial role in user comfort, security, accessibility, and engagement within the University of Lagos community center. While most respondents are satisfied with the overall lighting quality and navigation, concerns remain regarding outdoor lighting, hallway brightness, congestion, and accessibility for mobility-impaired users. The strong support for sustainable and technology-driven solutions, such as motion-sensor lighting, smart signage, and solar-powered lighting, underscores the growing demand for energy-efficient and inclusive designs. Statistical analysis confirms that enhanced lighting improves perceived safety, while well-structured circulation promotes ease of movement and social interaction. Addressing these challenges will enhance the center's functionality, inclusivity, and sustainability. From a policy perspective, the findings emphasize the importance of integrating inclusive design principles into community infrastructure planning. Policymakers should enforce standards that mandate energy-efficient lighting and accessible circulation systems in public spaces. Additionally, strategic partnerships between government agencies, private organizations, and local stakeholders can facilitate the funding and implementation of smart, sustainable infrastructure solutions.

To strengthen policy impact, the government should introduce incentives such as tax breaks or subsidies for facilities that adopt energy-efficient and accessible infrastructure. Clear guidelines must be established for mandatory lighting and circulation requirements in public and community spaces, with strict monitoring and enforcement mechanisms. Local urban planning authorities should also integrate adaptive lighting and smart wayfinding into zoning regulations, ensuring that future developments prioritize user-friendly design. Practical implications of this study suggest that facility managers should prioritize lighting upgrades, optimize wayfinding systems, and incorporate adaptive technology to improve the user experience. By aligning infrastructure improvements with policy recommendations, community centers can evolve into more inclusive, accessible, and future-ready spaces.

VII. Recommendations

To improve lighting design, hallway and outdoor lighting should be upgraded with warmer, energy-efficient LEDs to enhance comfort and visibility. Security can be strengthened by installing motion-sensor lighting in poorly lit areas, particularly for nighttime safety. Optimizing circulation and wayfinding requires reducing congestion by restructuring high-traffic areas and improving signage clarity through better lighting and digital displays. Accessibility must be increased by ensuring the installation of more ramps and designated pathways to enhance mobility for individuals with impairments. Implementing smart technology, such as automated doors, digital wayfinding systems, and adaptive lighting, will further improve navigation and user experience. Promoting sustainable solutions by expanding the use of solar-powered lighting and energy-efficient systems will help reduce environmental impact and operational costs.

Additionally, conducting regular user feedback surveys will enable periodic assessments to evaluate the effectiveness of implemented solutions and make necessary adjustments. By adopting these measures, the University of Lagos community center can create a more comfortable, safe, and inclusive environment while promoting sustainable design and innovation. To ensure long-term sustainability, facility managers should collaborate with urban planners and policymakers to integrate community feedback into infrastructure development. Future research should explore the economic feasibility of proposed interventions and evaluate their impact on user engagement over time. Strengthening these connections between research, policy, and practical implementation will lead to more resilient and people-centered community spaces.

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