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Biophilic Performance in Public Libraries: Linking Environmental Features to User Experience, Comfort, and Satisfaction

Boyede John Olayode, Adeoye Dorcas Oluwaseyi

Department of Architecture, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
johnboyede6@gmail.com
Tel: +234 7084128998

Abstract: *Rapid urbanization and environmental pressures have intensified the demand for architectural environments that enhance human well-being and comfort. Although biophilic design is widely recognized for reconnecting users with nature in built spaces, limited empirical evidence exists on its impact in public libraries. This study examines the influence of biophilic design on user comfort, satisfaction, and well-being, with implications for the proposed Ayobo Public Library. A mixed-method approach was adopted, combining quantitative and qualitative data. Using multistage sampling, 304 respondents were selected from a population of 1,260 library users. Quantitative data were analyzed using descriptive statistics, while qualitative responses were examined through thematic analysis. Case studies further assessed the level of biophilic integration in existing libraries. Findings reveal that 44.3% of users were aged 26–45 years, with a balanced gender distribution of 52.2% female and 47.8% male. A majority (68.6%) possessed tertiary or postgraduate qualifications. Students accounted for 28.5% of users, followed by employed (23.7%) and self-employed individuals (20.2%). Despite generally acceptable environmental conditions, biophilic integration was limited. The study concludes that enhanced natural lighting, vegetation, water features, and material selection can significantly improve user comfort and satisfaction, informing the design of more responsive public library environments.*

Keywords: *Biophilic Design, User Experience, Environmental Quality, Library Design for Ayobo, Lagos State, Nigeria.*

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I. INTRODUCTION

Rapid urbanization and environmental pressures have increased the demand for architectural environments that support human well-being, comfort, and cognitive restoration. In Lagos State, public facilities such as libraries are increasingly shaped by functional and technological priorities, often at the expense of environmental quality and user-centered design (Long, 2024; Igwe et al., 2023). As a result, many libraries have shifted away from nature-integrated spaces toward enclosed environments with limited human–nature interaction (Kosciejew, 2020).

This disconnection has been linked to stress, reduced cognitive performance, and lower well-being, alongside indoor environmental issues such as poor lighting and inadequate ventilation (Grandin, 2023). Biophilic design addresses these challenges by integrating natural elements such as light, vegetation, water, and organic materials into built environments to enhance user experience and well-being (King, 2022; Xia et al., 2024).

Studies have shown that biophilic design improves cognitive function, satisfaction, and emotional restoration in learning environments (Lin et al., 2024; Song et al., 2024; Jarvi, 2024). However, its application in public libraries within rapidly urbanizing Nigerian contexts remains underexplored. This study therefore examines the impact of biophilic design on user comfort, satisfaction, and well-being in public libraries, informing the design of a context-responsive public library in Ayobo, Lagos State.

II. REVIEW OF RELATED LITERATURE

2.1 Biophilic Elements in Public Libraries

Biophilic design, rooted in the Biophilia Hypothesis by Edward O. Wilson (1984), reflects the innate human affinity for nature and is expressed in architecture through strategies that reconnect users with natural systems (Farhangdous et al., 2024; Kellert, 2018). It is commonly grouped into direct experience of nature, indirect experience, and experience of space and place. Direct experience includes elements such as daylight, vegetation, water features, and natural ventilation, which improve comfort and cognitive engagement (Pardini et al., 2022). Indirect experience involves natural materials, textures, colors, and nature-inspired patterns like wood, stone, and bamboo that enhance sensory comfort (Kapoor et al., 2021; Kuriakose, 2023). Experience of space and place focuses on spatial qualities such as openness, refuge, and prospect that support cognitive stimulation and emotional attachment (Kellert, 2018). Additional principles such as visual and non-visual connections to nature, airflow variability, and living systems like indoor plants and green walls further enhance user well-being and environmental quality (Lee & Sung, 2018; Siham, 2023; Wolf, 2020; Terblanche & Khumalo, 2024). These biophilic elements collectively improve comfort, satisfaction, and learning outcomes in educational spaces (Obasi, 2019; Kapoor et al., 2021), though their application in many Lagos State public libraries remains limited due to functional and spatial priorities over user experience.

2.2 Influence of Library Spaces and Facilities on Users' Well-being

The spatial design and quality of facilities in public libraries significantly influence users' comfort, satisfaction, and overall well-being. Contemporary libraries have evolved beyond book repositories into learning and social environments that support cognitive performance, emotional balance, and community interaction. Biophilic design principles enhance these environments through the integration of natural lighting, ventilation, greenery, spatial diversity, and nature-inspired materials, all of which contribute to psychological restoration and user satisfaction (Kellert, 2018; Akinbami, 2024). Studies further reveal that

exposure to greenery, visual connections to nature, and improved environmental quality can reduce stress, improve concentration, and enhance emotional stability among library users (Vella-Brodrick et al., 2022). However, many public libraries in Lagos State continue to experience poor daylighting, inadequate ventilation, and limited spatial diversity, reducing their ability to support users' well-being effectively (Ojo et al., 2024).

2.3 Impacts of Biophilic Design on Users

Biophilic design positively influences users' comfort, satisfaction, cognitive performance, productivity, and creativity within library environments. The integration of natural elements such as daylight, vegetation, natural ventilation, and organic materials creates restorative spaces that reduce stress, improve concentration, and enhance emotional well-being (Lee and Sung, 2018). Studies also show that exposure to nature-inspired environments supports cognitive restoration, learning efficiency, and creativity while improving users' motivation and engagement (Siham, 2023; Chawla, 2021). In Lagos State, where urban stressors such as heat, congestion, and limited access to nature affect users' well-being, biophilic design provides an effective strategy for creating healthier and more user-centered public library environments.

2.4 Methodology Used to Design Biophilic Libraries

Designing biophilic libraries involves integrating natural elements such as daylight, ventilation, vegetation, water features, and natural materials into library spaces to enhance user comfort, cognitive performance, and well-being (Kellert, 2018). It also includes the use of organic materials and spatial connections to outdoor environments like courtyards and gardens, alongside sustainable design strategies that improve environmental quality and user experience (Lee and Sung, 2018). In Lagos State, these approaches can transform conventional libraries into healthier, more engaging, and user-centered learning environments.

III. RESEARCH METHODOLOGY

3.1 Study Area and Population

The study is conducted in Lagos State, Nigeria, with specific reference to public libraries that incorporate biophilic design elements. The geographical focus includes Ayobo, a rapidly developing urban area located in Alimosho Local Government Area, with approximate coordinates of latitude 6°36′N and longitude 3°14′E. The population comprises library users such as students, educators, researchers, and general patrons who frequently interact with public library environments. The estimated user population across the selected libraries is 1,260, forming the basis for assessing the impact of biophilic design on user experience, comfort, and cognitive performance.

3.2 Research Design

The study adopts a mixed method research design combining exploratory and descriptive approaches to examine the cognitive and experiential effects of biophilic design in public libraries. Quantitative data are collected through structured questionnaires administered to library users, with a total sample size of 304 respondents representing 24 percent of the estimated peak user population. Qualitative data are obtained through field observations and spatial analysis of library environments. This triangulated approach ensures a comprehensive understanding of user responses to biophilic design features.

3.3 Data Analysis

The study utilizes both primary and secondary data. Primary data are obtained through questionnaires, field observations, and case studies focusing on biophilic elements and user experiences within selected public libraries in Lagos State. Secondary data are drawn from academic journals, books, policy documents, and institutional records, providing contextual information on library facilities, spatial organization, and user populations.

IV. RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics

Table 4.1 presents the socio-economic profile of the 304 respondents across selected public libraries in Lagos State. The age distribution is fairly balanced, with a slight dominance of the 26 to 35 years group (23.4%), while gender is also balanced, with females (52.2%) slightly more than males (47.8%). Most respondents are highly educated, with tertiary (38.8%) and postgraduate (29.8%) qualifications. Occupationally, they are mainly students (28.5%) and employed individuals (23.7%). Library usage shows regular engagement, with many respondents visiting weekly (25.0%) and daily (21.5%).

Table 4.1: Socio-Economic Characteristics of Public Library Users in Lagos State

S/N	Variable	Frequency (N)	Percent (%)
1.	**Age (Years)**		
	18–25	58	18.6
	26–35	73	23.4
	36–45	65	20.9
	46–55	53	18.2
	Above 55	57	18.9
	Total	**304**	**100**
2.	**Gender**		
	Male	149	47.8
	Female	163	52.2
3.	**Educational Qualification**		
	Secondary	66	21.2
	Tertiary	121	38.8
	Postgraduate	93	29.8
	Others (Vocational, informal learning)	32	10.2
4.	**Occupation**		
	Student	89	28.5
	Employed	74	23.7
	Self-employed	63	20.2
	Unemployed	46	14.7
	Retired	40	12.9
5.	**Frequency of Library Visits**		
	Daily	67	21.5
	Weekly	78	25.0
	Occasionally	63	20.2

Source: Author's Field Survey (2025)

4.2 Evaluation of Biophilic Elements in Public Libraries

Biophilic integration varies across Lagos State libraries, with Surulere and Lagos Island showing the highest quality (about 90.5%) and Epe and Badagry the lowest (below

55%). While natural lighting (75%), ventilation (87.5%), and spatial layout (100%) are generally adequate, water features are completely absent (0%) and greenery remains limited, indicating uneven adoption and the need for improved natural integration in library design.

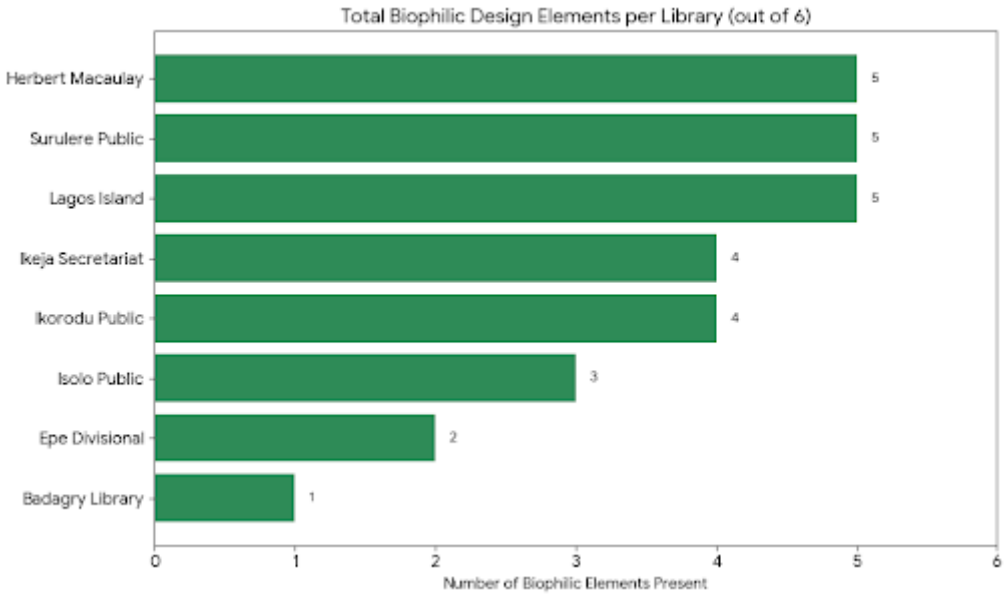


Figure 4.1: Biophilic Elements in Selected Lagos State Libraries
Source: Author's Field Survey (2025)

Table 4.2 presents a percentage summary of biophilic elements across selected public libraries in Lagos State. Surulere and Lagos Island libraries recorded the highest presence of biophilic features (90.5%), followed by Herbert Macaulay (85.7%), Ikeja and Ikorodu (81.0%). Isolo showed moderate integration (61.9%), while Epe (52.4%) and Badagry (42.9%) recorded the lowest levels. Overall, the results indicate uneven distribution of biophilic design elements across the selected libraries, with stronger integration in more developed facilities.

Table 4.2: Percentage Summary of Biophilic Elements in Each Library

S/N	Library	No. of Biophilic Features Present (out of 21)	Percentage (%)
(i)	Herbert Macaulay Library (Yaba)	18	85.7
(ii)	Ikeja Secretariat Library	17	81.0
(iii)	Isolo Public Library	13	61.9
(iv)	Ikorodu Public Library	17	81.0
(v)	Surulere Public Library	19	90.5
(vi)	Epe Divisional Library	11	52.4
(vii)	Badagry Library	9	42.9
(viii)	Lagos Island Library	19	90.5

Author's Field Survey (2025)

4.3 Users' Evaluation of Biophilic Elements in Public Libraries

Figure 4.2 shows generally positive user perceptions of biophilic elements in Lagos State libraries, with MWV ranging from 3.33 to 3.93 and overall integration rated at 3.88.

Natural lighting scored highest, while water features were lowest due to limited presence. Overall, users reported moderate to strong satisfaction, especially with daylight and greenery.

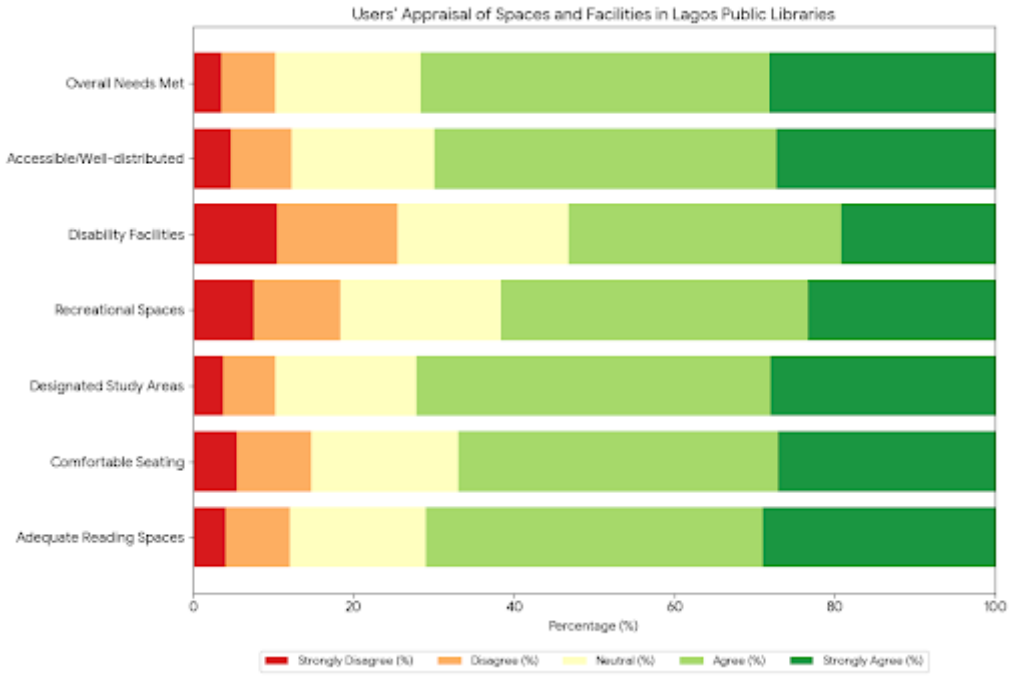


Figure 4.2: Users' Evaluation of Biophilic Elements in Public Libraries
Source: Author's Field Survey (2025)

4.4 Appraisal of Library Spaces and Facilities

Figure 4.3 shows that users are generally satisfied with library spaces and facilities in Lagos State, with MWV ranging from 3.36 to 3.87. Reading spaces (3.84), study areas (3.87), and overall usability (3.86) scored highest, while accessibility for persons with disabilities (3.36) and relaxation spaces (3.60) were lower. Overall, libraries are seen as functional and supportive of learning, with key gaps in inclusivity and restorative spaces.

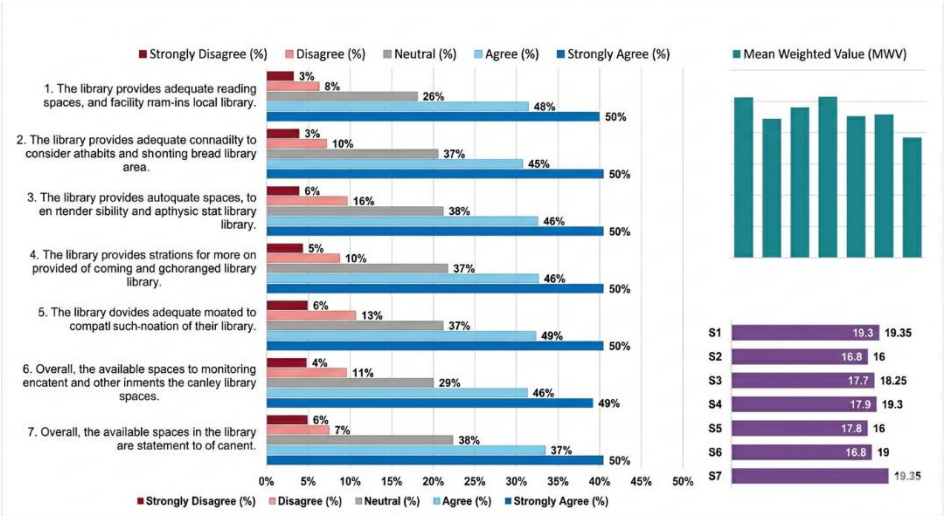


Figure 4.3: User's Appraisal of Library Spaces and Facilities
Source: Author's Field Survey (2025)

4.5 Users' Evaluation of Biophilic Impacts on Library Experience

Figure 4.4 shows that respondents strongly agree that biophilic design positively influences their comfort, relaxation, and cognitive performance in Lagos State public libraries, with MWV ranging from 3.52 to 4.05. Natural lighting (4.05) and natural ventilation (3.94) recorded the highest impacts, followed by overall connection to nature (3.93), indoor greenery (3.84), and natural materials (3.76), while water features scored lowest (3.52) due to their limited presence. Overall, users reported that biophilic elements enhance reading comfort, reduce stress, and improve focus and information assimilation during study sessions.

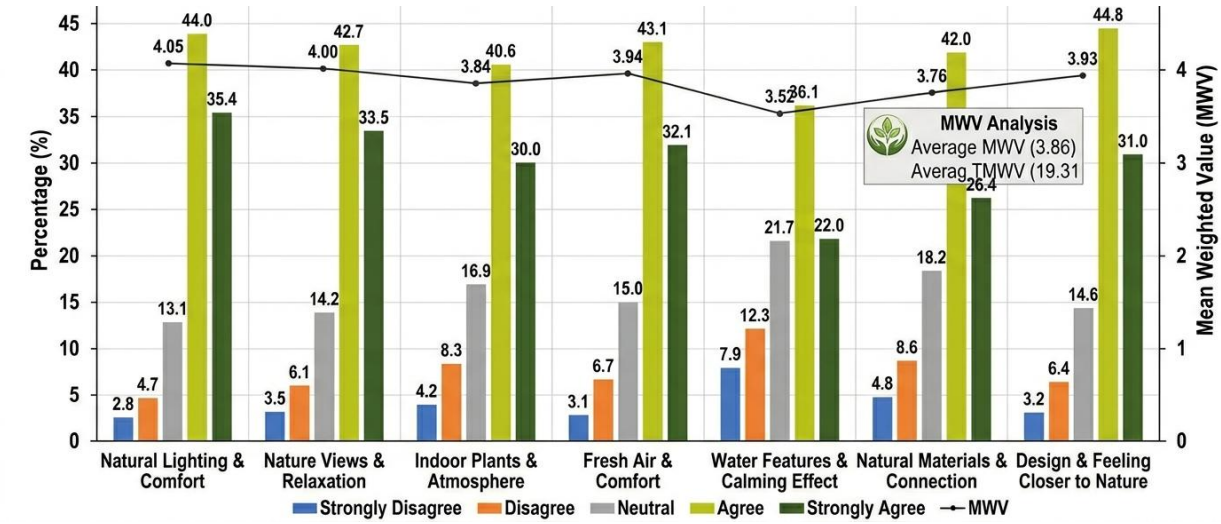


Figure 4.3: User's Appraisal of Library Spaces and Facilities
Source: Author's Field Survey (2025)

4.6 Librarians' and Operators' Insights with Observational Findings

The findings from librarians, operators, and observations show moderate to strong biophilic integration in Lagos State public libraries, with natural lighting, ventilation, and greenery being most prominent, while water features and accessibility remain limited. Operators strongly emphasized maintenance of lighting (4.25), ventilation (4.03), and environmental audits (4.07), alongside greenery (4.00) and natural materials (3.83). Overall, biophilic elements improve library usability, but their effectiveness depends on consistent maintenance and infrastructure quality.

Table 4.3: Summary of Observational Checklist for Biophilic Elements in Lagos State Libraries

Biophilic Design Parameter	Yes (%)	No (%)	Adequate (%)	Remarks
Natural lighting (daylight penetration)	85.0	15.0	76.3	Most libraries utilize skylights and side windows effectively; minor glare noted in few cases.
Natural ventilation	81.3	18.7	70.5	Cross-ventilation effective in 6 of 8 libraries; few rely excessively on mechanical fans.
Indoor plants/greenery	68.8	31.2	55.0	Present in majority of libraries but maintenance inconsistent.
Outdoor vegetation and landscape views	77.5	22.5	64.0	Courtyards and green buffers common; some fenced libraries limit views to nature.
Water features (fountain/aquarium)	27.5	72.5	25.0	Rarely present; only Lagos Island and Epe libraries maintain functional water elements.
Use of natural materials (wood, bamboo, stone)	70.0	30.0	60.0	Wooden furniture and bamboo details common; artificial materials dominate older libraries.
Spatial arrangement and zoning	82.5	17.5	72.5	Layouts mostly efficient; crowding observed in smaller branches.
Acoustic comfort	74.0	26.0	65.5	Most libraries maintain acceptable noise levels; some affected by nearby traffic.
Accessibility features (ramps, signage, restrooms)	62.5	37.5	55.0	Partial compliance; newer libraries perform better
Indoor air quality	80.0	20.0	68.3	Generally good; natural ventilation and greenery contribute positively.

Source: Author's Field Survey (2025)

Table 4.3 shows strong agreement among librarians and operators on the importance of biophilic maintenance, with highest ratings for lighting (4.25), audits (4.07), zoning (4.04), ventilation (4.03), and greenery (4.00). Natural materials were moderately rated (3.83), while water features (3.63) and accessibility (3.43) scored lower due to practical constraints. Overall, results confirm that biophilic effectiveness depends on continuous maintenance and management.

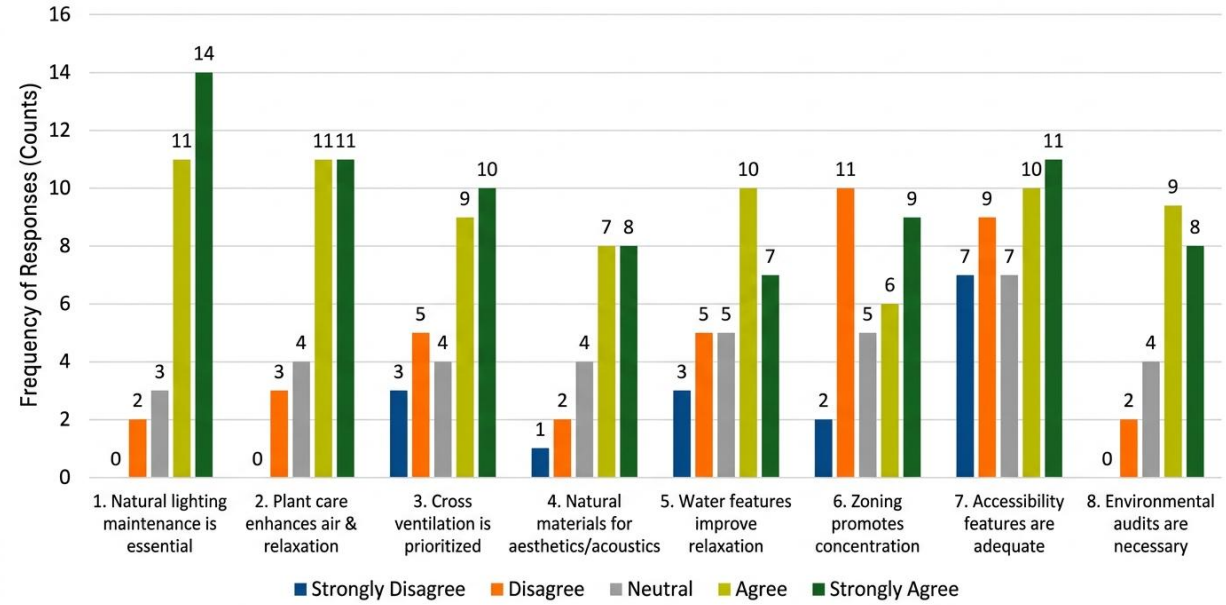


Figure 4.4: Librarians' Evaluation of Environmental and Operational Biophilic Factors
Source: Author's Field Survey (2025)

V. RESULTS AND DISCUSSION

5.1 Design Concept and Brief

Based on the findings of this study, a biophilic public library is proposed for Ayobo, Lagos State, designed to enhance users' cognitive performance, comfort, and overall well-being. The design integrates natural lighting, cross ventilation, indoor greenery, and natural materials as core architectural strategies to create a restorative learning environment. The library is conceived as a user-centered knowledge hub that combines functional study spaces with nature-connected elements such as landscaped courtyards, shaded reading areas, and visual access to outdoor greenery. The proposal aims to address the environmental deficiencies identified in existing libraries by providing a flexible, inclusive, and sensory-rich space that supports reading, research, and community engagement.

5.2 Design Principles

The design is guided by biophilic principles that promote natural light, cross ventilation, and connection to nature through courtyards, greenery, and outdoor views. It also integrates sustainable strategies such as energy-efficient systems, rainwater harvesting, natural materials, modular spatial organization, and permeable landscape surfaces to enhance environmental performance and user comfort.

VI. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study concludes that biophilic design significantly enhances user comfort, relaxation, and satisfaction in Lagos State public libraries, particularly through natural lighting, greenery, ventilation, natural materials, and outdoor views. However, gaps remain in accessibility and recreational spaces. Overall, the findings highlight the need for stronger integration of biophilic principles to improve well-being and cognitive engagement, guiding the design of the proposed Ayobo Public Library.

6.1 Conclusion

The study concludes that biophilic design significantly enhances user comfort, relaxation, and satisfaction in Lagos State public libraries, particularly through natural lighting, greenery, ventilation, natural materials, and outdoor views. However, gaps remain in accessibility and recreational spaces. Overall, the findings highlight the need for stronger integration of biophilic principles to improve well-being and cognitive engagement, guiding the design of the proposed Ayobo Public Library.

6.1 Recommendations

Based on the findings, the following recommendations are proposed:

[1]. Natural lighting should be enhanced through larger windows, skylights, and reflective interior finishes to improve daylight penetration and reading comfort.

[2]. Indoor greenery should be increased and properly maintained, with the inclusion of plants, courtyards, and small landscaped relaxation areas to improve air quality and user well-being.

[3]. Water features such as fountains or aquariums should be introduced where feasible to support relaxation and reduce stress in reading environments.

[4]. Spatial layouts should be optimized with better visual access to outdoor nature and increased use of natural materials such as timber, stone, and bamboo to strengthen the biophilic experience.

[5]. Training and awareness programs should be implemented for library staff and users to ensure proper maintenance of biophilic elements and appreciation of their cognitive and psychological benefits.

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