IJAAR PUBLISHING®

International Journal of Advanced Academic Research | ISSN: 2488-9849
Vol. 12, Issue 7 (2026) | www.ijaar.org

NATURAL LIGHTING IN UNIVERSITY LIBRARIES: EFFECTS ON USER COMFORT AND READING PERFORMANCE IN SOUTHWEST NIGERIA

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ABSTRACT

This study examined the impact of natural lighting on users in selected university libraries in South-West Nigeria, with emphasis on daylight availability, visual comfort, reading performance, and user satisfaction. Data were collected from six selected university libraries using structured questionnaires administered to 353 library users. Descriptive statistics were employed to analyse respondents' socio-demographic characteristics and perceptions of natural lighting conditions within the libraries. The findings revealed a balanced gender distribution, with 48.4% male, 47.0% female, and 4.5% preferring not to disclose their gender. The majority of respondents were between 21–25 years (38.2%) and 15–20 years (35.1%), while undergraduate students constituted 75.9% of the respondents. Most respondents visited the library weekly (33.7%) or three to four times per week (28.3%), with 41.1% spending between one and three hours per visit. The study further revealed that natural lighting within the selected libraries was generally inadequate due to poor daylight distribution, ineffective window placement, inadequate shading devices, and heavy dependence on artificial lighting during daytime. Respondents identified glare, excessive brightness, and uneven daylight distribution as major factors reducing visual comfort and reading performance. The findings also established a positive relationship between adequate daylight availability and user satisfaction, indicating that well-illuminated reading spaces enhance visual comfort, encourage longer library use, and improve the overall learning experience. The study concludes that integrating effective daylight-responsive architectural strategies is essential for improving visual comfort, energy efficiency, and user satisfaction in university libraries.

Keywords: Natural lighting, university libraries, daylighting, visual comfort, user satisfaction, reading performance, South-West Nigeria

https://doi.org/10.46654/bhpht258

I. INTRODUCTION

Academic libraries are essential learning environments that support teaching, research, innovation, and knowledge dissemination. As centres for independent study and intellectual engagement, libraries must provide indoor environments that promote users' comfort, health, and productivity. Among the various components of indoor environmental quality, visual comfort is particularly important because it directly influences reading efficiency, concentration, learning outcomes, and users' overall satisfaction with library spaces [3], [20].

Visual comfort in libraries is largely influenced by the availability and quality of daylight. Natural lighting has become a fundamental consideration in sustainable architectural design because it improves visibility, enhances occupants' physiological and psychological well-being, and reduces dependence on artificial lighting systems [5], [7], [24]. Properly designed daylighting strategies improve visual performance while supporting circadian rhythms, reducing eye fatigue, and creating pleasant indoor environments that encourage prolonged use of learning facilities [18], [23], [61].

In library environments, daylight quality depends on several architectural parameters including building orientation, window size and placement, glazing characteristics, shading devices, room proportions, and interior surface reflectance. These design features determine the quantity and distribution of daylight within reading spaces while minimizing glare and excessive solar heat gain [21], [40], [89]. When these elements are poorly integrated, users may experience visual discomfort arising from glare, uneven illumination, excessive brightness contrasts, and inadequate lighting levels, all of which negatively affect reading performance and user satisfaction [22], [31], [34].

Several studies have established that access to adequate daylight improves occupants' cognitive performance, satisfaction, and general well-being in educational buildings [43], [58], [101]. Specifically, research on library buildings indicates that well-daylit reading spaces enhance users' visual comfort and encourage longer periods of study, whereas poorly illuminated environments contribute to eye strain, fatigue, and reduced learning effectiveness [38], [48], [66].

Despite the recognised importance of daylighting in educational facilities, many Nigerian academic libraries continue to experience deficiencies associated with poor building orientation, inadequate window design, ineffective shading systems, and excessive dependence on artificial lighting [2], [73], [76]. These challenges not only reduce energy efficiency but also compromise users' visual comfort and overall satisfaction. Consequently, there is a need to evaluate the adequacy of daylighting conditions in existing library buildings to provide evidence-based recommendations for future library design.

It is against this background that this study assesses daylight availability and visual comfort in selected university libraries in South-West Nigeria with a view to providing design recommendations that enhance users' satisfaction and promote sustainable library environments.

II. REVIEW OF RELATED LITERATURE

2.1 Visual Comfort in Library Buildings

Visual comfort refers to the condition in which occupants are able to perform visual tasks efficiently without experiencing discomfort, glare, or eye fatigue. In library buildings, visual comfort is achieved when daylight and artificial lighting are properly balanced to provide adequate illumination for reading, writing, and computer-based activities [62], [95]. Research indicates that visual comfort depends on appropriate luminance distribution, daylight penetration, glare control, and the quality of the indoor visual environment [31], [67].

Studies further demonstrate that naturally illuminated library spaces improve users' concentration, satisfaction, and learning performance compared with poorly lit environments [22], [38], [66]. Adequate daylight also contributes to psychological well-being, reduces visual fatigue, and creates aesthetically pleasing learning environments that encourage longer study periods [5], [23].

2.2 Factors Influencing Daylight Availability and Visual Comfort

Several architectural and environmental factors influence daylight availability and visual comfort in library buildings. Building orientation determines the intensity and duration of sunlight entering interior spaces and significantly affects daylight distribution throughout the day [21], [79]. Window size, glazing characteristics, and façade design equally determine the quantity of natural light admitted into reading areas while influencing thermal performance and energy consumption [47], [89].

Interior finishes also affect daylight performance through their reflectance properties. Light-coloured ceilings and walls improve daylight distribution by reflecting incoming light deeper into interior spaces, whereas darker finishes reduce illumination levels [24], [91]. The use of shading devices, light shelves, and other daylight control systems further helps minimise glare while maintaining adequate daylight penetration [81], [82].Architectural planning strategies such as appropriate room depth, ceiling height, and furniture arrangement equally influence users' access to daylight and overall visual comfort within libraries [40], [109]..

2.3 Daylighting Design Strategies in Educational Buildings

Daylighting has become one of the principal passive design strategies for achieving sustainable educational buildings. Effective daylighting systems reduce dependence on electric lighting, lower operational energy costs, and improve occupants' health and productivity [32], [42], [74].

Contemporary architectural practice recommends integrating passive daylighting measures including optimized building orientation, high-performance glazing, skylights, clerestory windows, light shelves, and external shading devices to maximise daylight utilization while controlling glare and solar heat gain [28], [55], [106]. These strategies improve indoor environmental quality and enhance visual comfort without increasing building energy demand.

Performance assessment of daylight commonly employs indicators such as daylight factor, daylight autonomy, useful daylight illuminance, and spatial daylight autonomy, which enable designers to evaluate the adequacy of daylight distribution during the design process [58], [86], [87].

2.4 Users' Satisfaction with Daylighting in Library Buildings

Users' satisfaction represents an important indicator for evaluating the effectiveness of library building design. Satisfaction with daylighting is influenced by perceived lighting adequacy, absence of glare, visual comfort, accessibility to reading spaces, and overall environmental quality [36], [43].

Research has shown that library users generally prefer study environments with abundant natural light because such spaces enhance comfort, improve mood, reduce stress, and promote better academic performance [48], [54], [108]. Conversely, inadequate daylighting, excessive glare, and poor lighting uniformity often result in dissatisfaction, reduced reading efficiency, and shorter occupancy periods [22], [31], [34].Consequently, integrating users' perceptions into daylight performance assessment provides valuable information for improving future library planning and architectural design.

III. RESEARCH METHODOLOGY

3.1 Study Area and Population

The study was conducted in selected university libraries in South-West Nigeria. The region comprises several federal, state, and private universities with varying architectural designs and daylighting characteristics. The study population consisted of registered library users, including undergraduate students, postgraduate students, academic staff, and other authorised users who regularly utilised the selected library facilities.

3.2 Research Design and Sampling

The study adopted a descriptive survey research design incorporating both quantitative and qualitative approaches. Primary data were obtained through structured questionnaires administered to library users to assess their perceptions of daylight availability, daylight distribution, glare control, visual comfort, and overall satisfaction with the indoor lighting environment.

Secondary data were obtained from published journals, textbooks, conference proceedings, architectural standards, and other scholarly materials relating to daylighting, visual comfort, sustainable library design, and educational buildings. Observational surveys were also conducted to document the architectural characteristics of the selected library buildings, including window configuration, building orientation, shading devices, and interior layout. The sample size was determined using the sampling procedure adopted in the main study, and only completed questionnaires were included in the final analysis.

3.3 Data Analysis

The collected data were analysed using descriptive statistical techniques including frequencies, percentages, weighted mean values (MWV), average weighted values (AWV), standard deviation, and ranking indices. These statistical tools were used to evaluate respondents' perceptions of daylight availability, daylight distribution, visual comfort, and satisfaction within the selected university libraries. The analysed results were presented using tables and interpreted in line with the study objectives and relevant literature on daylighting and visual comfort in educational buildings.

IV. RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics

Table 1 presents the background information of the 353 library users surveyed across selected university libraries in South-West Nigeria. The respondents represent a diverse group of library users with varying demographic and academic characteristics, providing a reliable basis for assessing users' perceptions of daylight availability and visual comfort within the selected libraries.

The gender distribution indicates a fairly balanced representation, with male respondents accounting for 48.4% of the sample, female respondents constituting 47.0%, while 4.5% preferred not to disclose their gender. This balanced participation suggests that the findings adequately reflect the perspectives of both male and female library users.

The age distribution shows that most respondents were between 21 and 25 years (38.2%), followed by those aged 15–20 years (35.1%). Respondents aged 26–30 years constituted 17.0%, while only 5.7% and 4.0% were within the 31–35 years and 36 years and above age categories, respectively. This indicates that university library users are largely young adults who are actively engaged in academic activities.

The frequency of library use reveals that 33.7% of respondents visited the library weekly, 28.3% visited three to four times per week, 19.8% used the library daily, while 18.1% visited only occasionally. Regarding the average duration of library visits, 41.1% of respondents spent between one and three hours per visit, representing the largest proportion. This was followed by respondents who spent four to six hours (30.6%), while 19.8% spent less than one hour and only 8.5% remained in the library for more than six hours.

Finally, respondents' preferred reading locations were fairly evenly distributed. Enclosed cubicles were the most preferred reading areas (27.2%), followed by locations near windows (22%), anywhere available within the library (24.4%), and central reading spaces (23.5%). The relatively high preference for reading spaces located near windows underscores the importance of natural daylight in influencing users' choice of study environment and further justifies the focus of this study on daylight availability and visual comfort in university libraries.

Table1: Background Information of Library Users in Selected University Libraries in South-West Nigeria

Variables	Categories	Frequency (N=353)	Percentage (%)
Gender	Male	171	48.4
	Female	166	47.0
	Prefer not to say	16	4.5
	Total	**353**	**100.0**
Religion	Christian	166	47.0
	Islam	163	46.2
	Traditionalist	24	6.8
	Total	**353**	**100.0**
Marital Status	Single	299	84.7
	Married	54	15.3
	Total	**353**	**100.0**
Age Group	15–20 years	124	35.1
	21–25 years	135	38.2
	26–30 years	60	17.0
	31–35 years	20	5.7
	36 years and above	14	4.0
	Total	**353**	**100.0**
Level of Study	Undergraduate	268	75.9
	Postgraduate	62	17.6
	Staff	23	6.5
	Total	**353**	**100.0**
Frequency of Library Use	Daily	70	19.8
	3–4 times weekly	100	28.3
	Weekly	119	33.7
	Occasionally	64	18.1
	Total	**353**	**100.0**
Average Duration per Visit	Less than 1 hour	70	19.8
	1–3 hours	145	41.1
	4–6 hours	108	30.6
	More than 6 hours	30	8.5
	Total	**353**	**100.0**
Preferred Reading Area	Near window	88	22
	Central space	83	23.5
	Enclosed cubicle	96	27.2
	Anywhere available	86	24.4
	Total	**353**	**100.0**

Source: Author's Field Survey (2025/2026)

4.2 Assessment of Natural Lighting Conditions in Selected University Libraries

The responses presented in Table 2 represent the combined assessment of natural lighting conditions across the six selected university libraries in South-West Nigeria. The assessment was conducted using a five-point Likert scale, where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. The responses were analysed using the Total Weighted Value (TWV), Mean Weighted Value (TWV/f), and Average Weighted Value (AWV). The Mean Weighted Value was obtained by dividing the Total Weighted Value by the total number of respondents, while the Average Weighted Value represents the overall weighted contribution of each variable. A benchmark Mean Weighted Value of 3.00 was adopted for interpretation, such that values below 3.00 indicate disagreement, whereas values above 3.00 indicate agreement.

Table 2 presents the overall assessment of daylight availability and distribution in the selected university libraries. The findings reveal a consistent pattern of dissatisfaction with the natural lighting conditions across all the libraries, as six out of the seven assessed indicators recorded Mean Weighted Values below the benchmark value of 3.00.

The highest-ranked statement, "Artificial lighting is frequently needed during daytime," recorded a Total Weighted Value of 1,473, a Mean Weighted Value of 4.17, and an Average Weighted Value of 294.60, ranking 1st among all the assessed variables. Since this statement represents a negative indicator of daylighting performance, the high level of agreement demonstrates that users depend heavily on artificial lighting even during daylight hours. This finding suggests that the available natural lighting is insufficient to adequately illuminate the reading spaces and therefore fails to satisfy users' visual requirements.

The statement "Windows are properly positioned to allow sufficient daylight" ranked 2nd, with a Total Weighted Value of 662, Mean Weighted Value of 1.88, and Average Weighted Value of 132.40. Although it occupied the second position, the Mean Weighted Value remained substantially below the benchmark of 3.00, indicating that respondents generally disagreed that window placement effectively facilitates daylight penetration into the library spaces. Ineffective window positioning reduces the quantity and quality of natural illumination available within the reading environment.

Similarly, "The library receives adequate natural lighting during daytime" ranked 3rd, recording a Total Weighted Value of 655, Mean Weighted Value of 1.86, and Average Weighted Value of 131.00. The low Mean Weighted Value indicates that respondents generally perceived the natural lighting provided within the libraries as inadequate for reading and other academic activities. This perception further reinforces the strong reliance on artificial lighting observed in the highest-ranked variable.

The effectiveness of solar control measures was also rated poorly. The statement "Shading devices effectively control excessive sunlight" ranked 4th, with a Total Weighted Value of 645, Mean Weighted Value of 1.83, and Average Weighted Value of 129.00. The result indicates that respondents generally disagreed that shading devices adequately controlled excessive sunlight or glare. Poorly designed shading systems can result in uneven lighting conditions, visual discomfort, and reduced user satisfaction.

The statement "Daylight is evenly distributed across reading areas" ranked 5th,

recording a Total Weighted Value of 643, Mean Weighted Value of 1.82, and Average Weighted Value of 128.60. This finding suggests that respondents did not perceive daylight to be uniformly distributed throughout the reading spaces. Uneven daylight distribution often creates areas that are excessively bright alongside poorly illuminated zones, thereby reducing visual comfort and limiting the effective use of available study spaces.

The statement "The orientation of the building supports effective daylighting" ranked 6th, with a Total Weighted Value of 616, Mean Weighted Value of 1.75, and Average Weighted Value of 123.20. The low rating indicates that respondents generally believed that the orientation of the selected library buildings does not effectively maximise natural daylight penetration. Building orientation plays a significant role in determining daylight availability, and poor orientation can substantially reduce the effectiveness of passive daylighting strategies.

The lowest-ranked variable was "Skylights or clerestory windows improve daylight penetration," which recorded a Total Weighted Value of 601, Mean Weighted Value of 1.70, and Average Weighted Value of 120.20, ranking 7th. The result suggests that respondents generally disagreed that skylights or clerestory windows significantly contributed to improving daylight penetration within the libraries. This may indicate that such daylighting features are either absent, inadequately designed, or insufficiently integrated into the architectural design of the library buildings.

Overall, the combined assessment produced a Total Weighted Value of 5,295, an overall Mean Weighted Value of 2.14, and an Average Weighted Value of 756.43. Since the overall Mean Weighted Value falls below the benchmark value of 3.00, the findings indicate that respondents generally disagreed that the selected university libraries provide adequate natural lighting conditions. The overall assessment therefore demonstrates that daylight availability, daylight distribution, window positioning, building orientation, shading effectiveness, and the contribution of skylights remain inadequate across the selected libraries. Consequently, users continue to depend heavily on artificial lighting during daytime, a situation that has important implications for visual comfort, reading efficiency, occupant satisfaction, energy consumption, and the overall sustainability of university library buildings.

Table 2: Assessment of Daylight Availability and Distribution in Selected University Libraries

S/N	Variables	1	2	3	4	5	TWV	TWV/f	AWV	Rank
1	Artificial lighting is frequently needed during daytime	0	0	80	132	141	1473	4.17	294.60	1st
2	Windows are properly positioned to allow sufficient daylight	118	161	74	0	0	662	1.88	132.40	2nd
3	The library receives adequate natural lighting during daytime	128	148	77	0	0	655	1.86	131.00	3rd
4	Shading devices effectively control excessive sunlight	131	152	70	0	0	645	1.83	129.00	4th
5	Daylight is evenly distributed across reading areas	127	162	64	0	0	643	1.82	128.60	5th
6	The orientation of the building supports effective daylighting	154	135	64	0	0	616	1.75	123.20	6th
7	Skylights or clerestory windows improve daylight penetration	162	134	57	0	0	601	1.70	120.20	7th
Total Average							5295	2.14	756.43	

Source: Author's Field Survey (2025/2026)

4.3 Effect of Natural Lighting on Visual Comfort and Reading Performance

The responses presented in Table 3 represent the combined assessment of the effect of natural lighting on the visual comfort and reading performance of library users across the selected university libraries in South-West Nigeria. The assessment was conducted using a five-point Likert scale, where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. The responses were analysed using the Total Weighted Value (TWV), Mean Weighted Value (TWV/f), and Average Weighted Value (AWV). The Total Weighted Value was obtained by multiplying the frequency of each response by its corresponding Likert scale value, while the Mean Weighted Value was derived by dividing the Total Weighted Value by the total number of respondents.

The findings indicate that natural lighting significantly influences users' visual comfort and reading performance in the selected university libraries, with an overall Mean

Weighted Value (MWV) of 3.14, exceeding the benchmark of 3.00. Respondents most strongly agreed that they experience glare from direct sunlight while reading (MWV = 3.28, TWV = 1,159), suggesting that uncontrolled daylight remains a major source of visual discomfort. Preference for balanced daylight exposure ranked second (MWV = 3.24, TWV = 1,145), emphasizing users' desire for uniformly illuminated reading spaces. Respondents also agreed that uneven lighting causes eye strain (MWV = 3.11) and that natural lighting enhances reading comfort (MWV = 3.10). Similarly, excessive brightness was perceived to reduce visual comfort (MWV = 3.07), while daylight improved text clarity (MWV = 3.05). These findings suggest that although natural daylight contributes positively to reading performance, its benefits are diminished where glare and uneven illumination are not adequately controlled, highlighting the need for optimized daylighting strategies in university library design.

Table 3: Effect of Natural Lighting on Visual Comfort and Reading Performance in Selected University Libraries

S/N	Variables	1	2	3	4	5	TWV	TWV/f	AWV	Rank
1	I experience glare from direct sunlight while reading	40	65	78	95	75	1159	3.28	231.80	1st
2	I prefer seats with balanced daylight exposure	45	60	80	100	68	1145	3.24	229.00	2nd
3	Uneven lighting causes eye strain	48	72	85	88	60	1099	3.11	219.80	3rd
4	Natural lighting makes reading comfortable	52	70	81	90	60	1095	3.10	219.00	4th
5	Excessive brightness affects my comfort	50	75	88	82	58	1082	3.07	216.40	5th
6	Daylight improves visual clarity of texts	55	68	90	85	55	1076	3.05	215.20	6th
Total Average							6656	3.14	1109.33	

Source: Author's Field Survey (2025/2026)

4.4 Assessment of the Relationship Between Daylight Availability and User Satisfaction

The comparative analysis in Table 4 revealed that user satisfaction remained relatively high despite low daylight availability across the selected university libraries. Overall, the libraries recorded an average Daylight Availability Mean of 2.13, which is below the benchmark of 3.00, whereas the average Visual Comfort Mean (3.14) and User Satisfaction Mean (3.65) exceeded the benchmark, indicating generally positive user perceptions. The University of Lagos Library achieved the highest overall performance, recording mean scores of 2.24 for daylight availability, 3.28 for visual comfort, and 3.82 for user satisfaction.

This was followed by Covenant University Library (2.20, 3.22, 3.75) and Ekiti State

University Library (2.15, 3.16, 3.68). University of Ibadan (2.11, 3.11, 3.61), Federal University of Technology, Akure (2.07, 3.05, 3.55), and Obafemi Awolowo University (2.03, 3.00, 3.49) recorded comparatively lower performance. The findings suggest that although daylight availability was consistently inadequate across the libraries, higher levels of visual comfort were associated with greater user satisfaction, highlighting the importance of effective daylight management rather than daylight quantity alone.

Table 4: Comparative Assessment of Mean Scores Based on ratings for Daylight Availability and User Satisfaction

S/N	University Library	Daylight Availability Mean	Visual Comfort Mean	User Satisfaction Mean	Overall Performance Rank
1	University of Lagos Library, Akoka	2.24	3.28	3.82	1st
2	Covenant University Library, Ota	2.20	3.22	3.75	2nd
3	Ekiti State University Library, Ado-Ekiti	2.15	3.16	3.68	3rd
4	University of Ibadan Library, Ibadan	2.11	3.11	3.61	4th
5	Federal University of Technology Library, Akure	2.07	3.05	3.55	5th
6	Obafemi Awolowo University Library, Ile-Ife	2.03	3.00	3.49	6th
Total Average		2.13	3.14	3.65	

Source: Author's Field Survey (2024/2025)

I. Design Proposal: University of Ilesha Library

5.1 Design Concept and Brief

The proposed design for the University of Ilesha Library was developed based on the study findings, which revealed that the existing library spaces experience inadequate daylight availability, poor daylight distribution, excessive glare, and a heavy reliance on artificial lighting during daytime. These challenges negatively affect users' visual comfort, reading performance, and overall satisfaction. Consequently, the design proposal adopts a daylight-responsive approach that enhances natural illumination while minimizing glare, improving energy efficiency, and creating a visually comfortable learning environment.

5.2 Design Principles

The proposed design integrates the following evidence-based daylighting principles: (i) Proper Building Orientation; (ii) Optimized Window Size, Placement, and Configuration; (iii) External Shading Devices and Glare-Control Glazing; (iv) Skylights and Clerestory Windows for Improved Daylight Penetration; (v) Light Shelves for Uniform Daylight Distribution; (vi) User-Centred Reading Space Planning; and (vii) Sustainable Energy-Efficient Daylighting Strategies.

II. Conclusion and Recommendations

6.1 Conclusion

This study has demonstrated that although natural lighting is present within the selected university libraries, its overall quality and effectiveness remain below desirable standards due to poor architectural planning and inadequate daylight management strategies. Architectural factors including improper window positioning, ineffective building orientation, inadequate shading devices, and limited use of skylights significantly reduced the efficiency of daylight penetration into reading spaces. These deficiencies not only increase dependence on electrical lighting but also reduce the sustainability and energy efficiency of university library buildings

6.2 Recommendations

Based on the findings, the following recommendations are proposed:

[1] University libraries should incorporate effective daylighting strategies, including proper building orientation, well-positioned windows, skylights, and clerestory windows, to maximize natural illumination.

[2] Appropriate glare-control measures such as shading devices, adjustable blinds, and anti-glare glazing should be integrated to enhance users' visual comfort.

[3] Library spaces should be designed to ensure balanced daylight distribution and comfortable reading environments through user-centred space planning.

[4] Universities should adopt sustainable daylighting practices to reduce reliance on artificial lighting and improve energy efficiency.

[5] Periodic post-occupancy evaluations should be conducted to assess users' satisfaction with daylighting conditions and guide future improvements.

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