



Covenant Journal of Research in the Built Environment (CJRBE) Vol. 11 No. 1, June 2023
ISSN: p. 2384-5724 e. 2384-5716 DOI: xxxxxxxxxxxxxxxxx

An Open Access Journal Available Online

Evaluation of Users' Satisfaction with Lighting Strategies in Selected Art Museum and Galleries in Nigeria

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Received: 18.07.2023 Accepted: 10.08.2023

Date of Publication: July, 2023

Abstract:

To achieve effective communication between displayed works and users in art museums and galleries, some environmental factors must be satisfied. Paramount among such factors is lighting. The provision of adequate lighting is a vital component for achieving effective and sustainable display areas in art museums and galleries. To assess the adequacy of lighting in the display areas, users' opinion is central. This study evaluated users' satisfaction with lighting strategies in display areas of selected art museum and galleries in Nigeria, to identify areas for further improvements. The study adopted qualitative and quantitative research methods. Qualitative data was collected with the aid of an observation guide from one museum and two galleries, and content analysed. Whereas quantitative data was gathered with a closed-end structured questionnaire from 175 respondents across the three selected establishments and analysed with Statistical Product and Service Solutions software. The results were presented descriptively with the aid of tables, figures, and plates for better comprehension. The results showed that users were to a considerable extent satisfied with the lighting strategies employed which were predominantly artificial lighting which includes, fluorescent and incandescent lighting. The strategies employed are: down, up, front, side, and back-lighting. However, to enhance users' satisfaction, the majority of the respondents suggested the use of daylighting strategies in the display areas where the exhibited works are not susceptible to light damage. The study recommended that while seeking to adopt lighting strategies that protect and preserve the value of artworks in display areas, architects should take into consideration the utmost importance of users' visual comfort and well-being. Safe artificial and daylighting strategies should also be integrated right from the site planning to the lighting design and implementation stages.

Keywords: Artificial Lighting Strategies, Art Gallery, Art Museum, Daylighting Strategies, Lighting, Users' Satisfaction, Nigeria

1.0 Introduction

Art museums and galleries are knowledge depositories that have been established for a variety of reasons, including serving as a factor of economic growth, contributing to the good quality of Life in the communities in which they are located, attracting

tourism to a geographical area, boosting civic pride, or even communicating explicitly ideological philosophies (Gustafsson & Ijla, 2017; Omoh, 2015; Perera, 2013). For intellectual and entertainment purposes, displayed items in display areas of art museums and galleries communicate nonverbally with users. To establish

effective communication in such spaces, numerous environmental requirements must be satisfied, including acceptable visual, thermal, acoustic, and air conditions. According to Hutmacher (2021), vision is the most powerful of the five senses; it can provide information from an extremely distant region of an area. Therefore, for vision and visual satisfaction in display areas to be successfully enhanced, lighting is a key component (Kwong, 2020; Aderonmu, Adesipo, Erebor, Adeniji, Ediae, 2019; Adewale Okubote, Temowo, 2020; Ekhaese and Solaja, 2022; Henning, 2020; Greenhalgh, 2019; Maddox, 2019; Varzgani, 2016; Onuwe, Adebisi, Goshi, and Alonge, 2015). Humans have a unique ability called perception. We can appreciate the elegance of displayed artwork and sense the history of an old artefact. Although none of these sensations is caused by the light directly, they are all connected to it.

Aesthetic and visually appealing features in display areas are highlighted by lighting. Nothing can be observed or perceived while the illuminations are eliminated (Luce and Light, 2022; YUJILEDS, n.d.). Artificial or daylighting in art museums and galleries is a useful design component that plays a significant part in the overall visual and psychological impression of the users as the interpretation of the visual experience might be negative or positive (Kwong, 2020; Adewale *et al.*, 2020; Hamedani, Solgia, Skatesa, Hineb, Fernandoa, Lyonsa, Duprea, 2019; Bazán, Ajmat and Sandoval, 2018; YUJILEDS, n.d.). It is a crucial component in exhibit spaces in museums and art galleries where diverse emotional states are evoked from the audience. It has the potential to influence people's physiological feelings. As a result, lighting strategies are frequently employed to create various sorts of settings or to induce certain emotional states. It is an effective tool for both passive and active communication. Adequate illumination is intended to increase people's attention and appreciation of the displayed works. And when lighting becomes more important as a successful design component, the subject of users' satisfaction arises (Emascaró, 2021; Kwong, 2020; Adewale *et al.*, 2020; Aderonmu *et al.*, 2019). Lighting improves the visual environment, but if not regulated properly, it can cause visual discomfort for users.

Studies have shown that there is a link between artificial or daylighting in buildings and the visual comfort and discomfort of users. Some of the studies include (Kusumawardani, Ramadhan, and Maknun, 2022; Adewale *et al.*, 2020; Santiago, 2020; Kwong, 2020; Hamedani *et al.*, 2019; Bazán *et al.*, 2018; Kunwar, 2018; Singh, 2018; Varzgani, 2016; and Frontczak and Wargocki, 2011).

According to the aforementioned studies, visual comfort or discomfort is influenced by the kind and amount of light present, as well as how the individual perceives it. The phrase "visual comfort" describes a condition of visual satisfaction due to adequate lighting. The criteria that characterize adequate lighting needs include brightness, light dispersion, brilliance, light intensity, glare, lighting levels, colour, and homogeneity (Frontczak and Wargocki, 2011). Poor lighting, unsuitable lighting, glare, reflections, and shadows are examples of conditions that can cause visual discomfort. The visual discomfort caused by admitting uncontrolled prominent levels of lighting into an area is called glare. There are two forms of glare: discomfort glare and disability glare. Disability glare is caused by high-level stray light being dispersed within the eye, resulting in total impairment of vision while a visual experience caused by dazzling light intensity or light level contrast placed side by side in an area of sight that does not necessarily hinder vision, but is viewed as unpleasant is known as discomfort glare ('Disability Glare Definition', n.d.; Hamedani *et al.*, 2019).

A saturating visual impact when the light source occupies a disproportionately larger portion of the visual field making vision difficult (for example, when a huge opening lets in direct sunshine), is defined as glare discomfort. Observers do not always gaze directly at a brilliantly lit source; therefore, discomfort glare typically occurs when an observer is focused on a visual task (e.g., viewing an exhibited object) and the bright source is inside their peripheral field of vision. Uncontrolled high lighting in display areas can provide glaring brightness and high-luminance reflection, both of which are bad for vision (Singh, 2018). Lighting for visual comfort in display areas of art museums and galleries is burdened by its uniqueness, peculiarity, and hue. It must not only fulfil the physical criteria for ensuring the longevity and material safety of

displayed items for the future but must also communicate to the audience the visual richness of the displayed works (Hurlbert & Cuttle, 2020).

There are several advantages to having daylight in display areas that are less vulnerable to light damage. However, there are also a ton of long-term benefits for both mental, visual and physical well-being (Santiago, 2020). The issue with using daylighting in art museums and galleries is that it produces a high luminous output with significant concentrations of UV radiation which produces visual discomfort and damage fabrics and artefacts. As a result, architects are claimed to pay little or no consideration to harness daylight potential in the design of art museum and gallery buildings due to the risk it poses to exhibited items (Onuwe *et al.*, 2015). The architect's task as a creative professional is therefore to strike an equilibrium between developing intriguing display areas through lighting and appealing environments while safeguarding the user's visual comfort and visual well-being.

Some studies have shown that daylighting can be employed in museums and galleries to enhance users' satisfaction, but it must be done strategically. Such studies include research conducted by: Wilson, 2021; Designing Buildings Wiki, 2021); Greenhalgh, 2019; Shakya, 2018; Singh, 2018; Sylvania, 2015; and Fernández and Besuievsky, 2012. Based on these identified studies, galleries and museums used direct daylighting strategies with daylighting systems like louvres and skylight/roof-light, because it is the optimum way to introduce light into display areas.

Some physical examples are the magnificent calligraphy façade used for daylighting the Museum of the Future, Dubai; The glass pyramid for admitting maximum daylight in the Louvre Museum, Paris; The use of skylight glazing in the Parrish Art Museum, New York; The brilliant use of glass roof over the Calderwood Courtyard in Harvard Art Museums, United States; Natural light comes not only via the three courtyards but also through the small plexiglass skylights along the top of the cycloid barrel vaults in Kimbell Art Museum, United States. The aforementioned studies indicate that adequate lighting is an important factor in effectively accomplishing tasks and highlighting artworks in museums and galleries. This shows that lighting has an influence on both observers and displayed works in

exhibition spaces. To this end, users' feedback on the quality of lighting is fundamental to identifying areas that require enhancement in the development of display areas in museums. In Nigerian, some studies conducted by Ekhaese & Solaja, 2022; Adewale *et al.*, 2020; Aderonmu *et al.*, 2019; Onuwe *et al.*, 2015 focused on lighting, lighting strategies and users' satisfaction. However, limited studies were found to have investigated users' satisfaction with the various artificial and daylighting strategies implemented in exhibition areas of art museums in Nigeria, which is the gap this study was conducted to fill.

Consequently, the aim of the study is to evaluate users' satisfaction with the lighting strategies employed in selected art museum and galleries in Nigeria. To accomplish the study's goal, two research questions were formulated. They include: what are the lighting strategies employed in the display areas and how adequate are the strategies in meeting users' satisfaction? To provide suitable answers to the research questions, two objectives were established. The first is to identify lighting strategies employed in the display areas, and the second is to determine the adequacy of the strategies in meeting users' satisfaction.

The scope of the study investigation covers both artificial and daylighting strategies in the display areas. The units of examination and observation for which the study was conducted are users' satisfaction and lighting strategies at three selected art museum and galleries in Nigeria. The study was divided into seven parts as follows: title section (topic, authors information, abstract and keywords; introduction (background to the study, research problem clarification, research questions, aim and objectives development, justification for the study and literature review); methodology; presentation of results with discussion of the findings; conclusion; acknowledgements; and references. The study is a valuable reference material for increasing designers', students', and instructors' awareness of lighting strategies useful in display areas for improving users' experience and satisfaction levels. The research is also a useful resource material for researchers to consult, appraise, utilise and improve on. The study manuscript is a freely accessible academic material. This helps to promote the fourth target of the

17 Sustainable Development Goals (SDGs), which involves providing learning opportunities for everybody.

2.0 Methodology

The study was conducted to evaluate users' perception of lighting strategies employed in selected art museum and galleries in the study area. Two objectives were established to attain the goal of the study, as indicated in the ninth paragraph of the introduction. The study adopted a pragmatic research approach. This means that the most suitable research approach to address each objective was considered and adopted. This necessitated the use of a mixed research method that employed both qualitative and quantitative research methods to conduct. Three buildings that were purposely designed for the display of artworks were purposively selected for the study. The buildings include one art museum and two art galleries in the study area. The selected museums were derived from the total number of architectural and art museums in Nigeria. Such museums include Discovery Museum, Abuja, Nike Art Gallery, Lagos, and the Thought Pyramid, Abuja. The chosen buildings were the only ones whose management granted the researchers access to use their facilities for the research within the study area. Table 1 shows the selected museum and galleries, as well as their locations.

Table 1: Selected Museum and Art Galleries in Nigeria

SN	Name of Museum and Galleries	Location
1	Discovery Museum	Wuse II, Abuja
2	Nike Art Gallery	Lekki, Lagos
3	Thought Pyramid Art Centre	Wuse II, Abuja

Data gathered to address the objectives of the study were field data. The first objective was to identify the lighting strategies employed in the selected art museum and galleries. This necessitated the use of a qualitative research approach that made use of an observation guide developed for the study to gather data. The observation guide was utilized to obtain data regarding the attributes of the selected lighting strategy's functionality and serviceability. A schedule of crucial factors was created to compile the availability of the

lighting strategies. The observation guide was divided into three parts. The first part was used to note the general attributes of the buildings. The second part was used to document the lighting categories employed. Whereas the third section was utilized to note the lighting strategies that were used. The observations conducted in each of the buildings were documented and captured with a photographic device. Content analysis was used to analyse the qualitative data.

The second objective was to evaluate users' satisfaction with the lighting strategies employed in the display areas of the selected buildings. Due to the large number of respondents involved, the study adopted a quantitative research approach that made use of a closed-ended structured questionnaire to collect data. The data obtained was derived from 180 shared questionnaires, out of which a total of 175 were retrieved, and found to be useful and utilized. This amounted to a retrieval rate of 97.2%. Simple random sampling was used to distribute the questionnaires to gather quantitative data. The participants were mainly visitors to the art museum and galleries. The questionnaire was divided into four sections. The first section was used to gather the participant's relevant personal profile, while the second part was used to investigate the quality of the lighting strategies adopted in the display area. The third section was used to collect data on significant problems related to the lighting strategies. Whereas the last section was employed to investigate the general satisfaction of the users on the lighting strategies.

In the first part of the questionnaire, a formal introduction of the researcher was first made, followed by an explanation on the reason for the research. Participants were assured that the information they provide will only be used for the purpose of the research and treated anonymously. To this end, the survey instrument did not request the respondents' identities, which eliminated personal information. In addition, no coercion, force, or manipulation was used on the participants throughout the procedure. The data they provided was given out of free will. The study team ensured that each subject felt free and comfortable and was rid of any obligation to participate in the data-gathering process. The outcomes were also treated with

utmost discretion and the data acquired were used strictly for the study.

The survey key questions were provided with options to pick from. 5 Likert scales were used for the measurement. The options provided to address the questions were either, Strongly Agree (5); Agree (4); Undecided (3); Disagree (2); Strongly Disagree (1); or Highly Satisfied (5); Satisfied (4); Undecided (3); Partially Satisfied (2); and Not Satisfied (1). The quantitative data were analysed with the aid of Statistical Product and Service Solutions software. In the buildings that utilized daylighting, data was gathered within the peak sun effect hours in the display areas of the buildings, that is, 10 am to 3.30 pm. This was especially critical for the field measurements, as it was necessary that the questionnaire responses were taken when the sun's effect was felt in such buildings. The findings were presented in themes with tables, plates, and figures for easy comprehension and clarity in the next section.

3.0 Results and Discussion

The results of the data analysis conducted are presented as follows:

3.1 Overview of the Selected Art Museum and Galleries

3.1.1 Discovery Museum

The Discovery Museum, also known as Art Tech District (ATD) is located in Wuse II Abuja, Nigeria. It is Nigeria's first theme museum devoted to technology. It offers a

wide variety of entertaining, immersive, and interactive activities. The museum develops a collective vision of Nigerian and global science, technology, art, and history, all combined into one creative field. A variety of educational activities are available at the museum. They include exploring the museum and taking part in interactive historical retelling using innovative technology.

3.1.2 Nike Art Gallery

The Nike Art Gallery is a gigantic five-story building that is filled with 8,000 renowned pieces of art works ranging from batik, adire, metalwork, drumming, beadwork, painting to carvings. It is situated outside of the city of Lagos in the Lekki neighbourhood and offers free entry into the massive building. The Nike Art Gallery is said to be the largest gallery in West Africa. It routinely hosts exhibitions by both established and diverse emerging African artists.

3.1.3 Thought Pyramid Art Centre

The Thought Pyramid is a remarkable art gallery with a spacious open layout that accommodates several pieces of artwork for display. The Centre's mission is to collect, preserve, and study modern and contemporary works of art from Africa and the African diaspora. Exhibitions, theatrical productions, symposiums, workshops, musical events, talks, and art education initiatives like, music, art, and poetry programme (MAP) are all held at the Thought Pyramid Art Centre.

Table 2: General Building Characteristics

SN	Description	Art Museum and Galleries		
		Discovery Museum, Wuse II, Abuja	Nike Art Gallery, Lekki, Lagos	Thought Pyramid Art Centre, Wuse II, Abuja
1	Building configuration	Rectangle	Rectangle	Rectangle
2	Building story	Two stories	Five stories	Two stories
3	Ceiling construction material(s)	Wood	Wood, Concrete slab	Wood
4	Walls construction material(s)	Corrugated wall panels, Wood,	Concrete Hollow Blocks	Concrete Hollow Blocks
5	Floor construction	Metal panels	150mm R.C.S.	150mm R.C.S.

	material(s)			
6	Interior ceiling finish(es)	Aluminium finish, Wooden finish	Matte paint, wood	P.O.P.
7	Interior wall finish(es)	Wooden finish	Matte Paint	Paint
8	Interior floor finish(es)	Wooden finish	Ceramic Floor Tiles	Ceramic Floor Tiles
9	Exhibition type(s)	Travel Type	Travel Type	Travel Type
10	Ceiling interior colour(s)	Black, white, green, cream	White, Brown.	White
11	Wall interior colour(s)	Green, White, Orange, Cream, Black, Brown	White	White
12	Floor interior colour(s)	Brown	White	Cream

The selected buildings characteristic in Table 2 shows potential IRC factors which include colour, finishes, and exhibition types. All these elements usually play a part in enhancing or reducing the adopted lighting strategy potentials.

3.2 Lighting Categories in the Display Areas

The lighting categories used in the art museum and galleries are presented in Table 3 (Daylighting Systems) and Table 4 (Artificial Lighting Types).

Table 3: Daylighting Systems

SN	Natural Lighting Systems	Art Museum and Galleries		
		Discovery Museum, Wuse II, Abuja	Nike Art Gallery, Lekki, Lagos	Thought Pyramid Art Centre, Wuse II, Abuja
1	Windows	—	✓	✓
2	Skylights	—	—	—
3	Lay Light	—	—	—
4	Atrium	—	—	—
5	Translucent Walls	—	—	—

6	Light Tubes	—	—	—
7	Courtyards	—	—	—

Present (✓); Absent (—)

Table 4: Artificial Lighting Types

SN	Natural Lighting systems	Art Museum and Galleries		
		Discovery Museum, Wuse II, Abuja	Nike Art Gallery, Lekki, Lagos	Thought Pyramid Art Centre, Wuse II, Abuja
1	Ambient Lighting	✓	—	—
2	Decorative Lighting	✓	—	✓
3	Spotlighting	✓	✓	✓
4	Accent Lighting	✓	—	✓
5	Wall Washing	✓	—	—
6	Dimming	✓	—	—
7	Floodlights	✓	—	✓
8	Beam Angles	✓	✓	✓

Present (✓); Absent (—)

The main lighting approach of the Discovery Museum is the use of artificial lighting without the application of any kind of natural lighting, as presented in Table 3. Whereas, the Thought Pyramid Art Centre admits daylighting into the main display spaces with the aid of large windows. Nike Art Gallery used mostly artificial lighting, but complemented this with the use of daylighting in the display sections for metal works. The artificial lighting types are environmentally friendly fluorescent lamps. The Discovery Museum exclusively made use of artificial lighting sources in the exhibition areas, utilizing a variety of lighting styles that seeks to lessen eye strain, while adequately highlighting the objects on display and giving them their unique personality, as shown in Table 4.

3.3 Lighting Strategies in the Display Areas

The lighting strategies found in the selected art museums and galleries are shown in Table 5 and Table 6. Table 5 shows daylighting strategies, which are direct top or side lighting. While Table 6 presents the artificial lighting strategies employed in the display areas.

Table 5: Daylighting Strategies in the Display Areas

SN	Daylighting Strategies	Art Museum and Galleries		
		Discovery Museum, Wuse II, Abuja	Nike Art Gallery, Lekki, Lagos	Thought Pyramid Art Centre, Wuse II, Abuja
1	Direct-lighting	—	✓	✓
2	Sunspace	—	—	—
3	Sun Tempering	—	✓	✓
4	Combined System	—	✓	✓

Present (✓), Absent (—)

Table 6: Artificial Lighting Strategies in the Display Areas

S/N	Artificial Lighting Strategies	Art Museum and Galleries		
		Discovery Museum, Wuse II, Abuja	Nike Art Gallery, Lekki, Lagos	Thought Pyramid Art Centre, Wuse II, Abuja

1	Down-lighting	✓	✓	✓
2	Up-lighting	✓	—	—
3	Front-lighting	✓	—	—
4	Side-lighting	✓	—	—
5	Back-lighting	✓	—	—

Present (✓), Absent (—)

Table 5 indicates that no daylighting strategy was used at the Discovery Museum, hence no instances of daylighting technique was present. The museum uses a variety of artificial lighting strategies because its main goal was to highlight the displayed works using manually adjustable lighting types and strategies. The museum solely uses aesthetically pleasing artificial lighting strategies as shown in Plate 1 – 3.



Plate 1: Front lighting a Display Area of Discovery Museum



Plate 2: Side lighting a Display Area of Discovery Museum



Plate 4: Direct lighting a Display Area of Nike Art Gallery



Plate 3: Up lighting a Display Area of Discovery Museum

Plate 4 and Plate 5, indicate that Nike Art Gallery employed both natural and artificial lighting strategies. It is observed that direct and sun-tempering daylighting strategies are used alongside other artificial lighting strategies. One artificial lighting technique, down lighting, is used in the art gallery and found to be the dominant strategy in the centre. This implies that the daylighting strategy is a supporting strategy. The artificial down-lighting strategy effectively lit up the display areas and is more energy-efficient when compared with other artificial strategies.



Both natural and artificial lighting strategies are used in the display areas of the Thought Pyramid Art Centre. Large windows are used for direct lighting and sun tempering to allow for adequate illumination during the day. By utilizing the sun's full power, this lighting method lowers the energy required for artificial lighting. Plate 6 shows that the predominant artificial lighting strategy in this gallery is down-lighting. Also, the employment of direct lighting in the centre is prominent due to the design of the building display area as shown in Plate 7. The seamless integration of daylighting strategies makes the artificial strategy a supporting strategy and is therefore viewed as a good architectural sustainable intervention.



Plate 6: Downlighting a Display Area of Thought Pyramid Art Gallery



Plate 7: Direct and Down-lighting Two Display Areas of Thought Pyramid Art Gallery

3.4 Profile of the Respondents

Table 7 shows the users' profile which includes their gender, age, educational level, and frequency of visits to museums and galleries.

Plate 5: Downlighting a Display Area of Nike Art Gallery

Table 7: Profile of the Respondents

SN	Variables	Categories	Frequency (N=175)	Retrieval Percentage (N=97.2%)
1	Gender Distribution	Female	102	58.29
		Male	73	41.71
2	Age Range	15 – 25	77	44.00
		26 – 35	50	28.57
		36 – 45	30	17.14
		46 – 55	10	5.71
		56 – 65	8	4.57
		66 and Above	0	0.00
3	Educational Qualification	WASCE	94	53.71
		O.N.D./H.N.D.	9	5.14
		B.Sc.	66	37.71
		M.Sc.	6	3.42
		Ph.D	0	0.00
	Number of Museums or Galleries Visited	1	0	0.00

4	2	40	22.85	
	3	109	62.28	
	4	17	9.71	
	5 and above	9	5.14	
5	Frequency of Visits to Museums or Galleries	Always	0	0.00
	Sometimes	23	13.14	
	Undecided	10	5.71	
	Occasionally	134	76.57	
	Rarely	8	4.57	

3.4.1 Gender Distribution

Table 7 shows that the gender distribution of the respondents indicates that out of 175 participants that took part in the study, 58.29% are females, while 41.71% are males. This implies that majority of the respondents are female, but with a significant number of male participants as shown in Fig. 1.

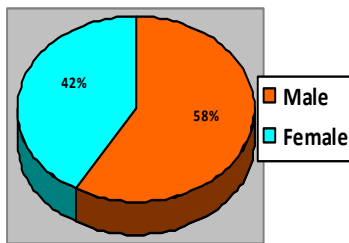


Figure 1: Gender Distribution of Respondents

3.4.2 Age Range

Regarding the age range of the respondents, Table 7 indicates that 44% of the participants ages range from 15 – 25, 28.57% range from 26 – 35, 17.14% range from 36 – 45, 5.71% range from 46 – 55, 4.57% range from 56 – 65, while none of the respondents is above 66 years of age. The result shows that majority of the visitors to the art museum and galleries are between the age range of 15 and 35 as shown in Fig. 2.

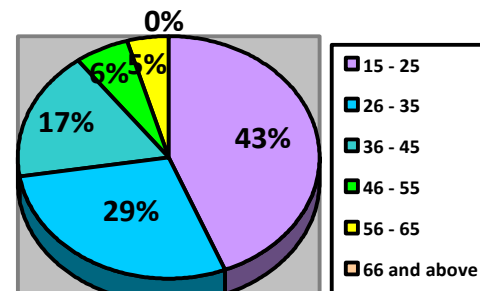


Figure 2: Age Range of the Respondents

3.4.3 Educational Qualification

On the educational qualification of the respondents, Table 7, shows that 53.71% of them have WASSCE, 5.14% have O.N.D./H.N.D., 37.71% are B.Sc, holders, 3.42% are M.Sc, holder and none was found to have obtained a Ph.D degree. This shows that majority of the respondents have WASSCE while a significant number of them hold a B.Sc. degree as shown in Fig. 3.

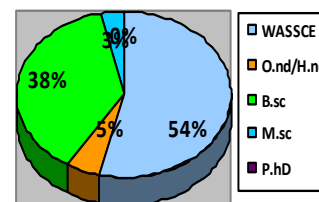


Figure 3: Educational Qualification

3.4.4 Number of Museums or Galleries Visited

The data in Table 7 indicates that all the respondents have visited more than one museum or gallery. 22.85% of them have visited two establishments, 62.28% have visited three, 9.71% have visited four, and 5.15 have visited five. This indicates that most of the participants have visited three museums or galleries as presented in Fig. 4.

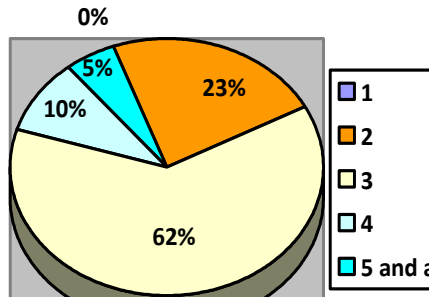


Figure 4: Art Museum or Galleries Visited

3.4.5 Frequency of Visits to Museums or Galleries

None of the participants was found to always visit museums or galleries. 13.14% of them visit sometimes, 5.71 are not sure of their opinion, 76.58% visit occasionally, while 4.57% rarely visit. The findings show that majority of the respondents visit museum or galleries occasionally, as shown in Fig. 5.

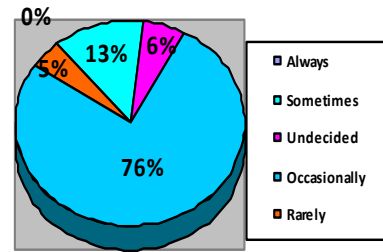


Figure 5: Frequency of Visits to Art Museums or Galleries

3.5 Users' Satisfaction Level with Lighting Categories and Strategies at the Display Areas

Table 8 shows the users' satisfaction index with rating values and quartile of the museum and galleries.

Table 8: Users' Satisfaction Index

S/N	Rating Values	Degree of Impact	Quartile
1	4 – 5	High Satisfactory Impact	First
2	3	Medium Satisfactory Impact	Second
3	1 – 2	Low Satisfactory Impact	Third

Table 9 and Table 10 show the users' satisfaction level with lighting strategies identified in the display areas of the art museum and galleries.

Table 9: Lighting Quality of the Adopted Strategies at the Display Areas

SN	How satisfied are you with the Following?	Museum and Art Galleries														
		Discovery Museum, Wuse II, Abuja.					Nike Art Gallery, Lekki, Lagos.					Thought Pyramid Art Centre, Wuse II, Abuja.				
		5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
1	The visual quality of the display areas from the lighting strategies	✓					✓					✓				
2	The level of artificial lighting	✓					✓					✓				
3	The level of natural lighting									✓		✓				
4	The positions of the lighting	✓					✓					✓				

	strategies on the displayed art works			
5	The enhancement of the displayed works by the lighting positions	✓	✓	✓

Highly Satisfied (5), Satisfied (4), Undecided (3), Partially Satisfied (2), Not Satisfied (1)

Table 10: Significant Issues Related to Lighting Strategies at the Display Areas

S/N	How Satisfied Are You with the Following?	Museum and Art Galleries														
		Discovery Museum, Wuse II, Abuja.					Nike Art Gallery, Lekki, Lagos.					Thought Pyramid Art Centre, Wuse II, Abuja.				
		5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
1	The visual quality of the displayed objects from the daylighting strategy						✓					✓				
2	The visual discomfort on the displayed objects from the daylighting strategy						✓									✓
3	The visual quality of the displayed objects from the artificial lighting strategy	✓					✓					✓				
4	The visual discomfort on the displayed objects from the artificial lighting strategy	✓		✓			✓					✓				
5	The heat experienced from the lighting strategy			✓					✓							✓

Highly Satisfied (5), Satisfied (4), Undecided (3), Partially Satisfied (2), Not Satisfied (1)

Table 9 shows that in all the investigated buildings, the rating values range from 2 – 5, with 2 being the least chosen and 5 being the most selected. The rating value of 5 occurred eleven times, but the value of 4 occurred two times with two of the ratings recorded in the Thought Pyramid Art Centre. The rating value of 2 was

recorded once in Nike Art Gallery. The result indicates that a substantial number of the respondents are highly satisfied with the lighting quality adopted in the display areas of the establishments. However, a significant contrast was noticed in the satisfaction level recorded between artificial and daylighting strategy at Nike Art

Gallery. The level of satisfaction with the lighting quality from the natural strategies employed indicated that the respondents are not satisfied with them but are highly satisfied with that of artificial strategies implemented. In the Discovery Museum, daylighting was completely absent, thus no users' satisfaction rating was recorded at the museum.

Table 10 shows the users' satisfaction level with the significant issues related to lighting strategies employed in the display areas. Questions on the visual discomfort, visual quality and heat experienced at the display areas were asked. In the Discovery Museum, there was no use of natural lighting, therefore no significant issues related to the daylighting strategy was recorded. The users' satisfaction with the visual quality of the display objects from the use of artificial lighting strategies was

high with a rating value of 5 for all the selected art museum and galleries. However, the heat discomfort rating values recorded range from 3 – 5. Majority of the users were partially satisfied with the heat experienced from the lighting strategy in most of the display areas of Discovery Museum. In Nike Art Gallery, the rating value of 5 was prevalent while the Discover Museum and the Thought Pyramid Art Centre had rating values of 2 and 3 respectively. The visual quality from the use of both daylighting strategies was positive with a rating value of 5 in both Nike Art Gallery and the Thought Pyramid Art Centre. In the Thought Pyramid Art Centre, the visual and thermal discomfort as a result of heat experienced from the daylighting strategy is most likely to be due to the use of untreated large windows, which results in glare and the admission of ultraviolet rays from the sun.

Table 11: General Users' Satisfaction with the Lighting Strategies in the Display Areas

SN	How Would You Rate the Following Statement?	Museum and Art Galleries														
		Discovery Museum, Wuse II, Abuja.					Nike Art Gallery, Lekki, Lagos.					Thought Pyramid Art Centre, Wuse II, Abuja.				
		5	4	3	2	1	5	4	3	2	1	5	4	3	2	1
1	The lighting strategy enhances the quality of the objects	✓					✓					✓				
2	The lighting strategy affects the displayed objects negatively				✓						✓				✓	
3	Natural lighting strategy should be encouraged in the display areas	✓		✓			✓					✓				
4	Artificial lighting strategy alone is enough for all display areas		✓							✓						✓
5	The use of both natural and artificial lighting strategies should be encouraged	✓					✓					✓				

Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), Strongly Disagree (1)

Table 11 presents the general users' satisfaction with the lighting strategies in the display areas. Questions about the adopted lighting strategy and the impact of the adopted strategies on the displayed works and spaces were asked. It was strongly agreed that the adopted lighting strategy enhanced the quality of the displayed works judging by the ratings of 4 and 5 recorded generally. In some display areas the visual comfort ratings recorded ranged from 1 – 3 to indicate that visual discomfort is being experienced across the three selected art museum and galleries. Nevertheless, the rating value of 5 was recorded with the need to use daylighting strategies in the display areas, indicating that the users strongly agreed to the use of daylighting strategy in some display areas. However, the value of 2 was also recorded, indicating that some users disagreed with the introduction of daylighting strategies in some display areas. This could be due to the visual discomfort also associated with daylighting. Majority of the users in the Discovery Museum and Nike Art Gallery strongly agreed that the use of artificial lighting strategy was adequate for all display areas, but in the Thought Pyramid Art Centre, the rating recorded was 1. This implies that the users strongly disagree that the use of artificial lighting in the display areas was adequate in the Centre.

3.6 Discussion

In the display sections, the study identified five artificial and four daylight strategies. As observed by Onuwe *et al.* (2015), the study also found that using daylighting strategies is a frequent design concern for museums and galleries, hence majority of them rely on artificial lighting. For instance, Discovery Museum avoided the use of daylighting to rely on varieties of artificial lighting strategy options available. Although the main artificial lighting strategy (down-lighting strategy) employed in

Nike Art Gallery is fluorescent lamps which requires less power to perform the tasks for which they were installed, the near-total reliance on artificial lighting usually led to high energy demand and an increase in greenhouse gas emissions. The two predominant artificial lighting choices, incandescent and fluorescent bulbs, both of which make use of expensive energy sources, are routinely utilized by all the art museum and galleries. The Thought Pyramid Art Centre successfully blended the use of both natural and artificial lighting strategies. Daylighting (direct and sun tempering) and artificial lighting (down-lighting and front lighting) were the common lighting strategies employed.

It was also observed from the participants' responses that both high and low satisfaction levels were recorded. The satisfaction level for the daylighting and artificial lighting strategies also varied. Respondents gave a rating value of 5 for the lighting quality indicating that they were satisfied with the quality of lighting produced. However, the heat produced from the daylighting and artificial lighting strategies was not so favourable as it received a rating of 3. The low rating indicated a display of visual dissatisfaction with the heat produced by the lighting strategies used. According to the Users' Satisfaction Index, a rating value of 4 – 5 are termed satisfactory, and from the responses, the highest rating value recorded were 4 – 5. This indicates that the users were highly satisfied with the lighting strategies in the display areas of the selected art museum and galleries. The research findings from Adewale *et al.* (2020); Asif ul Haq *et al.* (2020); Aderonmu *et al.* (2019); Maddox, (2019); Singh, (2018); Onuwe *et al.* (2015), as well as the users' response obtained from the retrieved questionnaires suggested the simultaneous use of artificial and daylighting strategies in the display areas. This will help to improve the sustainability level of the lighting as well as

reduce the energy consumption level of the art museum and galleries.

4.0 Conclusion and Recommendations

This research evaluated users' satisfaction with lighting strategies in the display areas of three selected art museum and galleries in Nigeria. The study investigated both artificial and daylighting strategies. Two objectives were set to achieve the aim of the study. The first was to identify the lighting strategies used in the display areas, while the second was to determine the adequacy of the strategies in meeting users' satisfaction. The findings indicated that, users were satisfied with the lighting strategies in the display areas. However, as indicated in the studies by Aderonmu *et al.* (2019) and Adewale *et al.* (2020), while attempting to implement lighting strategies in display areas that maintain and preserve the value of displayed items, architects should aim to prioritize the users' visual comfort and well-being. From site planning to final lighting design stage, safe use of artificial and daylighting strategies should be always the target.

Based on the study findings, the following recommendations are made towards enhancing user's satisfaction levels with lighting strategies in display areas of art museums and galleries: ultraviolet filters should be used in order to decrease ultraviolet exposure which is harmful to the human eyes; appropriate specifications should be made for the filters, which can be included in the glazing in order to reduce or mitigate the heat problem; and visual comfort of user's should be considered at every stage of the building procurement process. Also, in conducting the study, no light measuring equipment was used. Therefore, the absence of an illuminance and ultra-violet recorder to

simultaneously measure the illuminance in the display areas and match the value with the participant's responses to provide insight on the illuminance value that produced their responses, constitutes a limitation to the study.

However, this does not diminish the contributions of the research which include providing empirical evidence on the lighting strategies employed in the selected art museum and galleries, as well as providing empirical data on the level to which users' are satisfied with the strategies. In conclusion, the study also recommends that similar studies that will make use of illuminance and ultraviolet recorders to simultaneously record the illuminance levels in display areas as the questionnaires are being administered and filled by the participants, should be conducted to address the limitation of the study.

5.0 Acknowledgements

The authors are grateful to the management of Covenant University for providing the enabling environment and facilities used for conducting the research. The authors also appreciate researchers whose intellectual materials were consulted while gathering data for the research. Such published works data that were extracted and used towards achieving the aim of this study were appropriately cited in the manuscript and credited in the following reference section.

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