



IMPORTANCE OF DAYLIGHTING IN THE DESIGN OF ART GALLERIES IN BAYELSA.

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ABSTRACT

The unavailability of art galleries with well-designed daylighting function is a problem in Bayelsa State, as most of the state's art galleries are housed in shopping malls or hotels with poor and defunct daylighting systems. In order to deal with this issue, an understanding of how natural light impacts a space, with careful consideration to the amount of daylight entering an exhibition hall was required, prompting the study of daylighting design models to know their effects on the general layout of art galleries; carrying out case studies on some existing art galleries, with emphasis on the daylighting design models adopted; and also evaluating the sensitivity of users on the related problems on the daylighting experienced in art galleries. A deductive research was carried out on similar cases, highlighting the concepts of daylighting and the different daylighting patterns and models adopted in each case. In order to deal with this issue of defunct daylighting systems in art galleries, an understanding of how natural light impacts a space, with careful consideration to the amount of daylight entering an exhibition hall was required, prompting the study of daylighting design models. This required an approach that would take into consideration the improved sensitivity of the fine details on art works (Schielke, 2020), the different stimulating effects in that specific space (Hunt, 2009) as well as the deterioration caused by direct sunlight (Ajmat et al. 2011). The study proved that the use of daylighting in art galleries could be achieved without a worry for its effects on both the artifacts and the users; only if there is a resolution between the enhancement quality of daylighting, and the undesirable effects it has on artifacts and users alike.

Keywords: Art gallery, circulation, daylight, user experience.

1.0 INTRODUCTION

In art galleries, light plays a dynamic role and influences user experiences of spaces as well as the general wellbeing of the users over a significant percentage of the day in the facility. Light (Natural light or Daylighting) is seen as one of the most important attributes that influence both the physical and psychological comfort of users of different structures (Kellert, 2008). Satisfactory daylighting gives an accurate measure of lighting for legitimate colour rendering and has greatness, which

gives appropriate human responses to visual expressions in the display. It likewise brings the experience of sentiment, happiness, and brilliance, which has a significant effect on audiences (Li & Lam, 2001). Natural lighting is significant for achieving a conducive visual environment in an exhibition hall, and its transmission influences the degradation of artworks. However, the healthier application of daylight may lessen the requirement for artificial lighting and thermal warmth brought about by solar energy and electric lighting (Carla & Elena, 2010). Arthur van der Zaag (2017), opined that “appropriate lighting techniques will give the watcher an encounter of both the physiological, sociological and mental impact apparent from the works of art”. Also (Lords & Piacente, 2014). opined that “The basic point of lighting design and the set is to make the best condition for viewing objects”

The role of light in art galleries is not just to facilitate viewers to see the work but also to preserve the artwork. This makes art gallery designs one of the most complex designs to be lit up by daylight.

Most times, high light intensities can lead to damage of light sensitive artworks such as photographs, prints and drawings etc. Some artworks made with paints, inks and fabrics can bear the long exposure to daylight. The application of direct sunlight on light sensitive artworks will lead to deterioration because of the high sun lux. Using an undesirable daylight intensity in art galleries, most artworks go through photochemical (fading) and photomechanical damage (structural damage).

1.1 STATEMENT OF THE PROBLEM

The unavailability of art galleries with well-designed daylighting function is a problem in Bayelsa State, as most of the state's art galleries are housed in shopping malls or hotels with poor and/or a lack of daylighting. Exhibition spaces with natural lighting signify precise curatorial defiance (Schielke, 2020), drawing attention to a work of art. The volume of daylight and the model with which it is filtered into a space will possibly create several different stimulating effects in that specific space. Hunt (2009) states that while daylight enhances the inclusive atmosphere of the space, this light has an undesirable effect on artifacts. Hence, daylight and conservation of artifacts generally conflict. Ajmat et al. (2011) opined that light is ostensibly

perhaps one of the best reasons for the deterioration in artifacts, characterising both elements of pleasure and pain (due to the improved sensitivity of fine details on art works and also its deterioration). These two rudiments have a tendency to clash with each other therefore, the question “how can art galleries be designed with enhanced daylighting models to provide a comfortable environment for both the art works and the users” needs to be addressed.

Hence, there needs to be an understanding of how natural light impacts a space, with careful consideration to the amount of daylight entering an exhibition hall (Hunt, 2009). Doing so will also require that the following objectives are met:

1. To study daylighting design models to know their effects on the general layout of art galleries.
2. To carry out Case studies of some existing art galleries, with emphasis on the daylighting design models adopted and flaws in order to avoid repeats.
3. To evaluate the sensitivity of users on the related problems on the daylighting experienced in art galleries.

1.2 SIGNIFICANCE OF THE STUDY

The study will look into design concepts that can be used to develop practical architectural and adaptable approaches to art gallery space design. The purpose of the research is to better understand the benefit of daylighting as a concept that can be applied to a wide range of building types, not just art galleries. Hence, there is an immense need to be wholly familiar with the concept of daylighting and its method of application in the design of large facilities such as an art gallery to ease user anxiety which results from application of inadequate daylighting models. As a result, designing a new standard for art gallery that employs adequate daylighting and user friendly environments will be helpful

2.0 LITERATURE REVIEW

2.1 ART GALLERY DEFINITION AND BACKGROUND

The term art gallery has two words; art and gallery. Art can be described as a product or visual manifestation of human creativity and imagination. In Architecture, a gallery is any covered passage that is open at one side, such as a portico or a colonnade. In the late medieval and Renaissance Italian architecture, a gallery is a narrow balcony running the length of a wall. In Romanesque architecture, a gallery is an arcaded wall-passage on the outside of a structure. (Britannica.com).

Hence, an art gallery is a space or building dedicated to the exhibition sale of works of art (Oxford English Dictionary, 1989).

Furthermore, an art gallery is a building or section where works of art such as paintings, sculptures, pottery, glass, and weaving are displayed for public viewing and may contain art and art supply sales (Law Insider Dictionary, 2022).

Art galleries are exhibition halls where the "spaces are committed to the demonstration of craftsmanship perfect works of art" (Bell, 2002).

An art gallery is archetypally assumed by the public as a place to stock and display artistic creations made by different artists applying different kinds of mediums and creativity. Art galleries could be focused on the demonstration of expressive arts of a particular kind, class, or period or gems by an explicit craftsman or social occasion of experts. Some works of art will be sold to the public, while others will be kept in the gallery indefinitely for future reference. The prime purpose of an art gallery is to exhibit works of art; it can also offer creative events such as singing and dancing performances and poetry readings. Hence, it can act as a community jamboree center.

Art galleries are the primary connection between artists and collectors. At the high end of the market, a handful of elite auction houses and dealers sell the work of celebrity artists. The low end artists sell their work from their studios, or in informal venues such as restaurants. Point-of-sale (POS) galleries connect artists with buyers by hosting exhibitions and openings. The artworks are usually on batch, with the artist and the gallery splitting the incomes from each sale. Depending

upon the expertise of the gallery owner and staff, and the particular market, the artwork shown may be more innovative or more traditional in style and media.

2.2 DAYLIGHTING

Daylighting is the practice of placing windows, skylights, other openings, and reflective surfaces so that sunlight (direct or indirect) can provide effective internal lighting. (wikipedia) Light (Natural light or Daylighting) is seen as one of the most important attributes that influence both the physical and psychological comfort of users of different structures (Kellert,

2008). Lighting is not frequently considered in art galleries, but it plays an important role in enhancing spaces for proper functionality, wellness, and enhancing the culture of a place. It is a primary system for accomplishing energy efficiency and visual utmost satisfaction. Satisfactory daylighting gives an accurate measure of lighting for legitimate colour rendering and has greatness, which gives appropriate human responses to visual expressions in the display. It likewise brings the experience of sentiment, happiness, and brilliance, which has a significant effect on audiences (Li & Lam, 2001). The likelihood of conserving delicate objects of art is strictly associated with the likelihood of monitoring thermal and lighting conditions within the exhibition area. However, the healthier application of daylight may lessen the requirement for artificial lighting and thermal warmth brought about by solar energy and electric lighting (Carla & Elena, 2010).

2.2.1 DAYLIGHTING TYPES

2.2.1.1 PASSIVE DAYLIGHTING: This is a system of collecting sunlight using static, non-moving, and non-tracking systems such as windows, sliding glass doors, skylights, light tubes, etc and reflecting the collected daylight deeper inside the proposed space with elements such as light shelves.

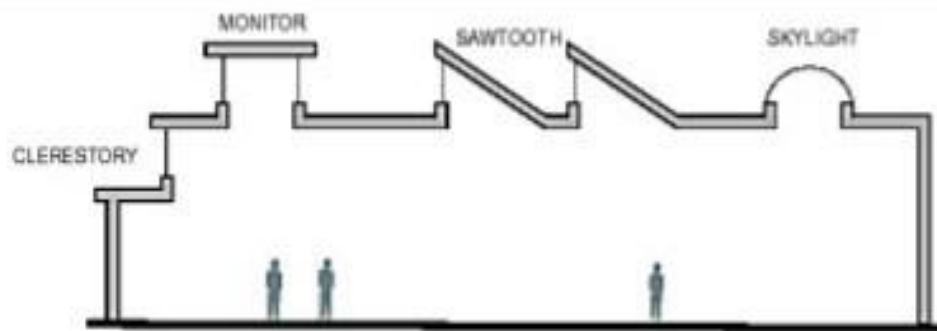
2.2.1.2 ACTIVE DAYLIGHTING: This is a system of collecting sunlight using a mechanical device to increase the efficiency of light collection for a given lighting purpose. This system tracks and/or follows the sun, and rely on mechanical mechanisms to do so.

2.2.2 SOME DAYLIGHTING SYSTEMS

2.2.2.1 SIDE-LIGHTING: This is the method of bringing in daylight through the apertures created on the walls. This method admits a strong directional light which diminishes as the distance increases.

2.2.2.2 VERTICAL WINDOWS: Vertical windows are the conventional and typical method of natural lighting. In a gallery space, side-lightings are often discouraged, as they occupy the space on walls and are likely to produce glare.

2.2.2.3 TOPLIGHTING: In this concept, the light is allowed from the top of the room into the space. Daylighting pattern from toplighting is different from the side-lighting systems. Toplighting restricts natural light to upper level of the building. If the rooflight is not placed strategically, it may allow direct sunlight which can cause a discomfort glare inside the space.



Example of Toplighting Strategies

Figures 2.2.2.3: Top lighting strategies

SOURCE: Qahtan, (2017)

2.2.2.4 CLERESTORIES WINDOWS: These are vertically placed windows. For a gallery space, this method of introducing light is the most affective. The daylight is admitted from a height into a space without creating any discomfort glare. This method also allows brighter and deeper daylight penetration into the space with less variation in the illuminance as compared to other systems. Light entering from higher point reaches the vertical surface without any obstruction, thus avoiding unwanted shadows. Clerestories are commonly used for daylighting in art galleries.

Often, clerestory windows also shine onto interior wall surfaces painted white or another light colour. These walls are placed so as to reflect indirect light to interior areas where it is needed. This method has the advantage of reducing the directionality of light to make it softer and more diffuse, reducing shadows.



Figures 2.2.2.3: A clerestory window

SOURCE: Wikipedia

1. **THE SINGLE CLERESTORY:** This prototype creates immediate and aberrant lighting by the presentation of light through a vertical clerestory window. A portion of the lighting getting through the vertical clerestory window might be reflected downwards from the ceiling into the space contingent upon the adjoining ceiling. Likewise, the site orientation or the orientation of the structure of the site ought to be all around considered as a relatively high level of direct light can cause glare and discomfort to the occupants of a space (Alrubaih, et al., 2013).
2. **THE SAW SINGLE TOOTH CLERESTORY:** This prototype produces direct and indirect light with a high percentage of the light bouncing off an adjacent slanted window in the space, thereby increasing the amount of light coming downwards and minimize the amount of direct light entering the space (Qahtan, 2017).
3. **THE DOUBLE CLERESTORY:** This prototype is also known as the monitor. It permits the entrance of daylight in abundance into space or building with the proper choice of glazing, especially in buildings where orientation or weather does not permit the saw tooth clerestory window or other unusual designs of apertures (Qahtan, 2017). In galleries, this concept is mostly used as it does not obstruct the exhibition space. This system is often combined with louvers and translucent textures in order to avoid the direct sun entering the room.

2.2.2.5 SKYLIGHT/ ROOF LANTERN: Skylights are light transmitting fenestration, forming all or a portion of the roof of a building. Skylights are widely used in daylighting design in residential and commercial buildings, mainly because they are the most effective source of daylight on a unit area basis. While a roof lantern is a daylighting cupola that sits above a roof, as opposed to a skylight. A modern skylight is fitted into a roof's construction. But roof lanterns serve as both an architectural feature and a method of introducing natural light into a space, and are typically wooden or metal structures with a number of glazed glass panels. Roofs are planes on which these apertures are located and will allow a large quantity of light inside which can be distributed throughout the room. In galleries, this concept is mostly used as it does not obstruct the exhibition space. This system is often combined with louvers and translucent textures in order to avoid the direct sun entering the room.



Figures 2.2.2: A Roof Lantern

SOURCE: Wikipedia

2.2.2.6 LAYLIGHTS: A laylight is a glazed panel usually set flush with the ceiling for the purpose of admitting natural or artificial light. Laylights typically utilize stained glass or lenses in their glazing, but can also use alternative materials. A laylight differs from a glazed (or closed) skylight, in that a skylight functions as a roof window or an interior space. When paired with a roof lantern or skylight on a sloped roof, a laylight functions as an interior light diffuser. Laylights allow transmission of light between floors in larger buildings, and are not always paired with skylights.



Figures 2.2.2.6: Skylights above laylights at the Lyme Art Association Gallery

SOURCE: Wikipedia

2.2.2.7 ATRIUM: This is a large open space located within a building. It is often used to light a central circulation or public area by daylight admitted through a glass roof or wall. The main function of an atrium is to provide a visual experience and a degree of contact with the outside for people in the working areas. The daylighting of successive storeys of rooms adjoining an atrium is interdependent and requires a balanced approach. Light from the sky can easily penetrate the upper storeys but not the lower, which rely primarily on light reflected from internal surfaces of the atrium such as floor-reflected light. The upper stories need less window area than the lower ones, and if the atrium walls are light in color the upper walls will reflect light toward the lower stories.

2.3 ARCHITECTURAL DAYLIGHTING

Architectural daylighting manages natural lighting in a building. Its drive is to meet each commitment for better than average optical work and significant situations by making arrangements for ideal illumination in a room (Singh, 2018). Daylighting is the meticulous induction of direct daylight or natural light into the building and through the appropriate arrangement of a satisfactory connect to the dynamic and makes any building design enliven (De Chiara and Corbie, 2007). Daylight persistently changes and consistently is combined into the collaborative spaces. Mindful thought must be given to the effect of daylight to have an element of the daylight that would be acceptable to penetrate the gallery is inside. Investigating factors, for example, sunlight-based beams, glare, reflection, and space acclimation, must be done successfully (Alshaibani, 2015).

2.3.1 DAYLIGHTING IN ARCHITECTURAL DESIGN

Lighting design is vital for sustainable buildings (Ferna, 2012). Singh in 2018 stated that Daylighting is a freely disseminated essential component of most buildings. Daylighting is using sunlight to diminish artificial lighting (Mohapatra, Kumar, & Mandal, 2018). They also stated that daylighting is most operative when sunlight falls on fenestration throughout the day. The light is brought into space through fenestrations. Fenestrations are effortlessly understood to be equally a lighting device and an architectural motive (Oksanen & Norvasuo n.d.). Every building has its peculiar daylighting problems, and the concentration of daylighting that is used for such buildings. The amount of daylighting going into an interior is dependent on the fenestration area (Li, Cheung, Cheung, & Lam, 2010). It also depends on the amount of daylighting available on-site and materials used for filling the openings.

2.3.1.1 DAYLIGHT AND VISUAL COMFORT

Daylight is distributed at will, the general element, which is a component of most buildings. The majority of the building that has fenestrations consider daylighting concerning the function and planning of spaces (Singh, 2018). Singh (2018) states that sensation and their physical causes are considered when looking at the visual comfort of a person within a space. However, daylight established through fenestrations can expressively subsidize to the lessening of lighting energy ingesting in buildings (Fasia & Budaiwi, 2015). Peji, Djori, and Djeli (2014) found that if natural daylighting illumination is well distributed and controlled, it has excellent advantages on energy consumption, visual comfort, and health in general.

Visual comfort is subjective to the quality and amount of light within any given space at a given time. The notion of visual solace is subject to our capacity to regulate the light levels within our immediate environment. Visual comfort has to do with sensation and adaptation within a space. The human eye can see things and work under extremely splendid lighting conditions, just as adjust to moonlight and noontime daylight. This value is called adaptation. (Hunt, 2009). She stated that visual adaptation is the level of time it takes the natural eye to conform to the new environment. The eye can likewise make any article its point of convergence. Hunt (2009) also opined that the breaking points to the extent of luminance that the eye can conform to at any one time, and locales

where brightness is too high would create glare. Therefore, visual solace in a room is comparative with the force of light from the exterior of the building and connecting rooms.

2.3.1.2 BUILDING ORIENTATION AND DAYLIGHT

Building orientation has been an ancient problem in buildings because of its positive significance. Numerous years back, individuals sufficiently realized to design their homes facing the south or south-east and west or to utilize the skylight to get more daylight. Be that as it may, these days, with the guide of science, we can utilize various perceptions and the consequence of analyses or computations to discover the most reasonable orientation for various types of buildings (Foldbjerg, 2017). The standards of orientation are diverse for the various climate. In the tropics, the sun is commonly extremely splendid and sweltering, and the ideal orientation is away from the sun and toward winning breezes. In temperate zones, buildings ought to be intended for two unmistakable atmospheres: tropic in summer and sub- cold in winter. The expanse of sunlight received by a building is subject to both the building's shape and orientation. However, to provide sufficient sunlight and increase the psychological effect on wellbeing, all living quarters ought to be facing north/south direction as much as possible.

2.3.2 DAYLIGHT IN ART GALLERIES

Daylight helps the human sight and enhances visibility. The most important consideration in the lighting plans of exhibition halls is the nature of light. Even though all objects of art and artifacts need adequate light to show their color and appearance, the overall splendor of works of art and contrast, and glare coming about because of direct daylight are the most significant issues (Arthur van der Zaag, 2017). As ultraviolet light will, in general, deteriorate most works of art in plain view in exhibition halls, it would appear to be imperative to work with low brightening levels and to verify that these are kept up for the brief span intervals. It likewise recommends that all-natural light sources ought to be fit for being darkened so that daylighting can be directed when it gets extreme and, if fundamental, wholly rejected. It is hard to give a "safe" level of brightening for delicate materials because any light may cause some weakening. Somewhat the point of confinement forced on the light level must be self-assertive and reliant on the object being illuminated (Simon, 2015). The nature of light acquired from north-bound openings has, for quite some time, been considered as the best; nonetheless, different components may make it difficult

to get light with "north" light characteristics. At whatever point directional sunlight is utilized in the exhibition hall, the opening letting it be known, ought to be planned so the light is reviewed and glare avoided. Openings ought to likewise be set in such a position or screened in such a way that the eye will not see the sky or other brilliant territories. Commonly, daylighting in the exhibition hall is always provided by using elevated opening and clerestories (Hunt, 2009).

2.3.2.1 REFLECTANCE

Interior surfaces have a significant impact on the performance of daylight in a space. Ceilings are considered the most crucial surface in order to reflect and distribute the incoming daylight. After the daylight is entered into the room, walls are the second-most crucial surfaces. Simultaneously, walls have a significant role in art galleries as one of the mediums on which artworks are displayed. The third impact is on the floors.

1. **LIGHT SHELVES:** This has become an important iconic component in controlling daylight in buildings. It is constructed of metal, painted wood, or gyp-board and is located on the south on the walls of buildings separating a lower "vision-glass" from an "upper daylight glass".



Figures 2.2.2.6: Light Shelves

SOURCE: <http://www.2030palette.org/intermediate-light-shelves/>

They are always white for reflective purposes but some have mirrored tops. The purpose of the light shelf is to bounce the sunlight deeper into the space without causing glare, to reduce the difference in light levels at the front of the room and deep within the room, and to block heat gain from entering the main vision window during the cooling season on the external portion of the light shelf.

2.3.3 SIGNIFICANCE OF DAYLIGHTING IN ARCHITECTURAL DESIGN

Foldbjerg (2017) opined that Daylighting has a lot to do with more excellent morale, an enhanced state of mind, less weariness, and decreased eye fatigue. He also stated that Daylighting is very important to humans as it has an impact on the wellbeing of the individuals, society, and economy at large (Foldbjerg, 2017). Daylighting is believed mostly to brand individuals progressively caution, and well-daylit spaces are ordinarily observed by occupants to be "better" than reduce hopeless ones (Mardaljevic, 2012). The daylight utilized in the buildings is of actual significance for corporal comfort, especially on visual and human wellbeing productivity. More often than not, spent by people is done within the building (Choi, Beltran, & Kim, 2012). A study carried out by Veitch, Newsham, Boyce, & Jones (2008) stated that fulfillment with lighting conditions adds to ecological fulfillment, which thus leads to more significant wellbeing of the users. A review, including eight urban areas across Europe, indicated that people who report deficient natural light in their homes have a progressively noteworthy risk of sadness and falls (Brown, 2011).

In a brief summary, Daylighting helps in energy efficiency and has several psychological effects on animals in a habitat, ranging from the general wellbeing of humans, society, and economy at large. Daylighting progresses the total attitude and wellbeing of building occupants and saves the environment from hazards. Hence, enhancing the general wellbeing of users and inhabitants of a building and region.

3.0 RESEARCH METHODOLOGY

The research methodologies used in this study includes.

DEDUCTIVE RESEARCH: which comprises of the data gathered from both primary sources (literary works, thesis, physical examination of existing malls and site visits) and secondary sources (alldata gotten from online publications, journals and articles).

CASE STUDIES: Case studies of existing art galleries were carried out, highlighting the different types of daylighting plans adopted.

4.0 CASE STUDY

Proper studies were carried out on existing art galleries and the impacts of the studies are examined here.

4.1 CRITERIA FOR ASSESSMENT OF CASE STUDIES:

The source for the assessment of the selected case studies includes the terms highlighted as follow.

1. **PLAN LAYOUT:** The design layout should be done to best suit the project. **Accessibility:** The users of the art gallery should be able to access the facility with ease.
2. **LOCATION:** The site location of the art gallery should be feasible.
3. **AESTHETICS:** The physical appearances of building elements and spaces should be pleasing to the eyes.
4. **SUSTAINABILITY:** Environmental performance of the building elements and strategies should be energy efficient.

4.2 SELECTION OF THE STUDY AREAS:

The facilities mentioned below were chosen as case studies based on the research topic and it's ability to meet the functionality requirements of the spaces in an art gallery. They are;

1. Nimbus Gallery, Ikoyi, Lagos;
2. Nike Art Gallery Centre, Lagos, Nigeria;
3. Terra Kulture Art Gallery,
Victoria Island, Nigeria.;
5. Thought Pyramid Art Centre, Abuja, Nigeria;
6. Shuyang Art Gallery, Jiangsu Province, China;
7. Yu Quingcheng Gallery, Tianjin, China.

4.3 CASE STUDY DEDUCTION

Daylighting generally has effects on users of space either negatively or positively. From literature, it was deduced that many exhibition halls are not initially designed and built to be an exhibition hall. However, direct daylighting on artifacts has adverse effects on such works of art, and users generally move towards a naturally lit area. Although some art galleries in Nigeria are naturally lit, there is the deterioration of artifacts, while others are artificially lit. From the study carried out, there is a need to pay attention to visual comfort in exhibition spaces and the visibility of objects displayed. In conclusion, natural lighting should be considered appropriate, as this enhances user experience in a space. Also, the positioning of the opening should be carefully considered to avoid glare. Other deductions are as follows;

1. **NATURE OF SITE:** the site should be set free from significant streams, interceding streets, easements etc.
2. **LAND AREA:** the site must cover enough land space to enhance proper construction of facilities and also allow for future expansion.
3. **ZONING:** existing zoning must allow art gallery development within that zone.
4. **LOCATION:** the site should be located in the most suitable area as proven by the economic survey. Architectural character: The use of glazing highlighted the need for transparency which is necessary to the architecture of an art gallery.
5. **STRUCTURE AND MATERIALS;** Main materials used in the studied facilities includes steel, light metal cladding, PVC tensile fabric, reinforced concrete and glass. The facilities were mainly of reinforced concrete framed construction. Steel trusses were mostly used as roof members. Coated and well treated wooded trusses were also used.

4.4 THE SITE STUDY

Site and Environmental Analysis. Bayelsa lies in the heaviest rainfall area in Nigeria, with heavy rain forest and a short dry season having more than three quarters of its total area covered by water, with a moderately low land. Site and environmental analysis is therefore necessary as it helps in revealing issues within the site such as climatic impacts, topography, vegetation, nature of the soil

etc. as to determine the type of foundation, method of construction, materials to be used for construction etc.

Analysis of the Geographical location and Topography of study area; The state is geographically located within latitude $4^{\circ}15'$ North and latitude $5^{\circ}23'$ south. It is also within longitudes $5^{\circ}22'$ West and $6^{\circ}45'$ east. The state is enclosed by Delta State on the north, Rivers State on the east and the Atlantic Ocean on the western and southern parts.

4.4.1 GEOLOGY: Bayelsa State is situated inside the lower delta plain accepted to have been shaped during the Holocene of the quaternary time frame by the collection of sedimentary stores. The major topographical trait of the state is sedimentary alluvium. The whole state is framed of deserted sea shore edges and because of numerous feeders of the River Niger in this plain, impressive geographical changes actually flourish.

4.4.2 SOILS: The significant soil types in the state are youthful, shallow, ineffectively depleted soils and corrosive sulfate soils. There are varieties in the dirt of Bayelsa State; some dirt kinds possess broad territories while others are of restricted degree

4.5 BIOCLIMATIC DATA

4.5.1 RAINFALL:

The environment is homogeneous. Precipitation in Bayelsa State fluctuates in amount starting with one territory then onto the next. The state encounters central sort of environment in the southern the most part and tropical downpour towards the northern parts. Downpour happens commonly all year long with substantial storm. The state encounters significant high precipitation however these declines from south to north. Akassa town in the state has the most noteworthy precipitation net record in Nigeria. The environment is tropical for example wet and the dry season. The measure of precipitation is satisfactory for lasting through the year crop creation. The wet season isn't under 340 days.

Average days with precipitation per month



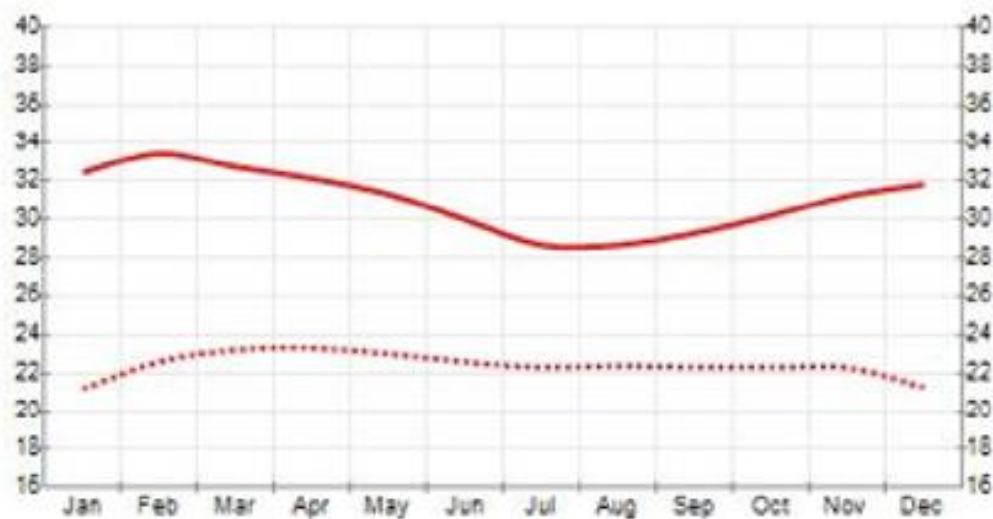
Figures 4.5.1: The Average Days with Precipitation Per Month

SOURCE: Meteoblue, (2016)

4.5.2 TEMPERATURE AND HUMIDITY:

The mean month to month temperature is in the scope of 25°C to 31°C. Mean greatest month to month temperatures range from 26°C to 31°C. The mean yearly temperature is uniform for the whole Bayelsa State. The sultriest months are December to April. The distinction between the wet season and dry season on temperatures is about 2°C and no more. Relative suddenness is high in the state reliably and reduces imperceptibly in the dry season.

Average temperature per month



Figures 4.5.2: The Graph for Average Temperature and Precipitation Per Month

SOURCE: Meteoblue, (2016)

4.5.3 VEGETATION: Like some other state in the Niger Delta, the vegetation of Bayelsa State is made out of four natural legitimate zones. These include: beach front obstruction island woods, mangrove woodlands, freshwater swamp for example backwoods and swamp tropical jungles. These unique or vegetation types are related with the different soil units around there, and they establish part of the intricate Niger Delta environments. Portions of the new water swamp woods in the state establish the home of a few compromised and surprisingly imperiled for plant and creature species. By and large, along the edges over the tideline, exist vegetation of palms with dissipated trees while mangroves overwhelm the water courses slicing through the sand to the ocean and on the edges of tidal ponds and behind sand edges. There are beach front obstruction good country timberlands and mangrove woods. Beach front boundary high country backwoods vegetation is limited to the tight edges along the coast. Low saltiness open minded new water plants portray this vegetation belt.

5.0 INTERPRETATION AND DISCUSSION OF FINDINGS

In order to deal with this issue of defunct art galleries with inefficient lighting, an understanding of how natural light impacts a space, with careful consideration to the amount of daylight entering an exhibition hall was required, prompting the study of daylighting design models. This required an approach that would take into consideration the improved sensitivity of fine details on art works (Schielke, 2020), the different stimulating effects in that specific space (Hunt, 2009) as well as the deterioration caused by direct sunlight (Ajmat et al. 2011).

Therefore, the question “how can art galleries be designed with enhanced daylighting models to provide a comfortable environment for both the art works and the users” required that the following objectives are met:

1. To study daylighting design models to know their effects on the general layout of art galleries.
2. To carry out Case studies of some existing art galleries, with emphasis on the daylighting design models adopted and flaws in order to avoid repeats.
3. To evaluate the sensitivity of users on the related problems on the daylighting experienced in art galleries

Considering majorly the works of Schielke (2020), Hunt (2009) and Ajmat et al. (2011), it was concluded that each display in the exhibition hall should be housed in a 1m² cabinet. The viewing distance should increase in proportion to the object's size. The gallery areas should be no more than 6.6m wide, 19.8m to 24.3m long, and 3.6m to 5.4m tall. Antiques should be displayed in regions of 3m – 5m² per painting space and 6m – 10m² each sculpture (floor space). The exhibition halls' atriums should be designed to meet quickly.

5.1 LIGHT SHELVES:

The purpose of the light shelf is to bounce the sunlight deeper into the space without causing glare, to reduce the difference in light levels at the front of the room and deep within the room, and to block heat gain from entering the main vision window during the cooling season on the external portion of the light shelf.



Figures 2.2.2.6: Light Shelves

SOURCE: <http://www.2030palette.org/intermediate-light-shelves/>

It is constructed of metal, painted wood, or gyp-board and is located on the south on the walls of buildings separating a lower "vision-glass" from an "upper daylight glass". They are always white for reflective purposes but some have mirrored tops.

Lighting, while it enhances a location's mood and stimulating effects of the artifacts, safeguarding its integrity is paramount. Therefore, the artificial lighting requirements (in lux) should be rated at thus:

1. Circulation area: 200
2. Shops: 600
3. Toilets: 150
4. Workshop: 200/500/750
5. The theatre seating area requires 300, while the demonstration area requires 600
6. Exhibition halls: 500/300/100
7. Working areas: 500 tasks, 300 ambient.

Therefore, the use of light shelves is one way of ensuring that the sensory perception of fine details on art works are articulated without affecting the stimulating effects in that specific exhibition space, as well as keeping the deterioration caused by direct sunlight in check.

6.0 CONCLUSION AND RECOMMENDATION

Most times, improper lighting in art galleries can cause damages to some works of art as well as create an uneasy visual atmosphere. This study aim was achieved through a deep research into the different concepts of daylighting and underlining the different daylighting patterns from previous researches on existing art galleries.

The study shows a way of using daylighting design models to develop practical architectural and adaptable approaches to art gallery design. Furthermore, the aim of a better understanding of the benefits of daylighting as a practical design concept can now be applied to a wide range of building types, not just art galleries. Hence, bridging the knowledge gap as regards the concept of daylighting and its design models by designing a new standard and method of application in the design of art galleries.

6.1 RECOMMENDATION

The use of light shelves is one way of ensuring that the sensory perception of fine details on art works are articulated without affecting the stimulating effects in that specific exhibition space, as well as keeping the deterioration caused by direct sunlight in check. Regardless of these findings, I believe more research needs to be carried out towards a more efficient and effective way of using daylighting design models in art galleries and other buildings of the same typology.

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