



EFFECTIVE USE OF NATURAL LIGHTING STRATEGY IN MUSEUM

Ereonu Chicherem Chidi¹, F.F.O Daminabo²

¹Department of Architecture, Rivers State University, Nigeria.

²Department of Architecture, Rivers State University, Nigeria.

Email for correspondence: ereonu.chidi@gmail.com, Contact mobile no.:07039528803

ABSTRACT

Lighting design is important in museums since it enhances the whole experience.” (Lowe,43, 2009). A museum is a location to learn about the past, present, and future of creativity, as well as history. In fostering contact between humans and museum items in a defined space, lighting plays a significant role." Human engagement in a location requires enough lighting. From the concept and shape of the building to the materials and method of construction, museum architecture is all about designing a structure that tells a 'story.' Museums exist primarily for the purposes of preservation and exhibition; as a major source of art conservation and preservation of the country's cultural heritage, they have a significant impact on the country's cultural economy and have a significant meaning for social integration within socio-cultural and socio-economic contexts. All of these factors, as well as others, are influenced by how people move through and see exhibition spaces from one point to the next, which necessitates effective lighting to guide and direct them. To further address this issue of visual tour around the museum, effective lighting through natural lighting (daylight openings) has been implemented to improve the design, guiding tour, and exhibition in the museum, which will aid in remembering and presenting the story of Rivers state in relation to the nation at large. This study paper examines the impact of natural light on two- and three-dimensional objects, as well as the ideal lighting approach for each. In addition, the behavior of natural lighting on walls, ceilings, and floors was studied in relation to the materials employed.

Keywords: Museum, Architecture, Effective lighting design, Natural lighting and Daylighting.

1.0 INTRODUCTION

Lighting plays a significant role in developing interaction between humans and museum artifacts in one defined space." The goal of a museum is to create an interactive experience for the guests, as well as preserve the condition of artifacts. Lighting is a critical component in a museum environment because the space enables visitors to see objects, experience new sights and react to the surrounding environment. Typically, environments have two types of light–natural and artificial. For a museum, the role of light is an essential part of creating an atmosphere prime for discovery, while also preserving artifacts. This can be a very difficult balancing act between meeting preservation needs and forming interactive experiences that achieve the goal of the museum—a place to discover, explore and learn. "Light is the only way for form to exist, and our experience of the world around us is completely reliant on it." Monet, Claude (N.D). The primary goal of this study is to analyze the advantages and

disadvantages of natural lighting (daylight openings) solutions in order to determine their efficacy in integrating and improving the museum space experience for both users and artworks. This research begins with a review of the literature on how museum daylighting design affects their connection to the outdoors, with three subheadings: daylight openings in museum galleries over time, benefits and considerations of daylight introduction in museum galleries, and types of daylight openings and connection to the outdoors. Finally, the state of Rivers lacks an adequate museum, which poses a challenge in terms of storing the numerous historical and cultural art pieces that contribute to the state's tourism.

1.1. DEFINITION OF TERMS

Museum (Palak, 2013) according to (Siegel) in *The Emergence of the Modern Museums*, is a "collection of repositories of rare and fascinating items in nature and arts established for the purposes of study." It is a semi-formal educational institution that collects, displays, and examines artefacts of various kinds, collections, and paintings for educational and historical reasons.

Natural Lighting (Daylighting) often known as daylighting, is a technique that uses exterior glazing (windows, skylights, etc.) to efficiently bring natural light into your home, minimizing the need for artificial lighting and saving energy. Natural light has been shown to improve building inhabitants' health and comfort.

Effective is producing a determined, definite, or desirable effect. It also refers to produces or has the potential to produce a desired result or a striking effect.

Strategy is a behavior, metabolism, or structure adaptation (or a group of adaptations) that serves or seems to serve a significant function in achieving evolutionary success.

2.0 LITERATURE REVIEW

As defined by the International Council of Museums (ICOM): "A museum is a public, non-profit organization that acquires, conserves, researches, communicates, and shows the tangible and intangible legacy of humanity and the environment for the purposes of teaching, study, and enjoyment." Their roles and audiences shift over time, but collecting, conservation, and display remain their major responsibilities. The importance of architecture in museum design is not just limited to the creation of space and the display of items, but it also includes the creation of a narrative.

DAYLIGHT OPENINGS IN MUSEUM GALLERIES THROUGH TIME

The first museum of the world open to the public is considered to be the Capitoline Museums. It was not until 1779, when the first purpose-built public museum opened its doors in Germany. It was museum Fridericianum in Kassel, designed by architect Simon Louis du Ry. These early museums relied on natural light for their exhibition spaces. During the day, natural light would enter the galleries through windows and roof openings. In most cases, the repetitive rhythm of big openings in the facades created uniform light for the interior, illuminating sufficiently paintings and sculptures that were the primary display objects. The appearance of the objects would alter throughout the day, depending on how natural light was directed by the architecture of the space. In 1857, the Victoria and Albert Museum in London became the first museum in the world to use artificial light in its galleries, forever altering museum lighting.

However, throughout the second part of the century, the first studies on the effects of light on exhibits began to be undertaken, leading to many museums using artificial lighting as their primary source of illumination, sometimes even omitting natural light. "Natural illuminated galleries are now technically outmoded for most forms of exhibit, and are expected to decline in the future," according to a 1945 assessment from the Institute of Engineering and Science in the United States. Because the natural partner in the combination varies greatly in chromaticity and quantity from day to day and season to season, and frequently changes in both color and quantity in a matter of minutes, no appropriate combination of natural and artificial lighting for art galleries is achievable." Museum architecture, on the other hand, has continued to successfully incorporate daylighting design in museum galleries, adhering to conservation rules and ensuring that artworks are displayed in the best possible light. Museums were designed with advanced daylight design and an attempt to improve viewing conditions by architects.

BENEFITS OF DAYLIGHT IN MUSEUM GALLERIES

"Natural light can be utilized to great effect to accentuate and enliven the architecture of any building," says one museum architect (De Chiara, 690, 2007). In interacting areas, daylight shifts constantly and is frequently merged. Reflection, glare, acclimatization, and space demarcation should all be taken into consideration. The following are some of the advantages of using daylight in museum galleries as a strategy:

Optimized Visual Experience of Artwork

The quality of light in museum galleries has a big influence on how visitors perceive and experience the artifacts on display, because it affects how their visual features are displayed.

Art can be more pleasurable and satisfying when viewed in natural light than artificial light. Furthermore, the visitor's experience will be different every time due to the ever-changing nature of daylight. The most significant components in visitor needs when seeing exhibits, according to research, are clarity of object form (for sculptures) and item color accuracy (for paintings, drawings). Natural light can provide a decent level of visual comfort in a place and allow for visual acuity, as well as maintaining the naturalness of the appearance and revealing items in their true form. Natural light is ideal for sculptural exhibits. By establishing shade patterns, the movement of daylight can help to improve the volume's dynamic forms. The human eye can adjust to changes in sunshine and preserve an accurate sense of an object's color despite the variations in daylight.

Emotional impact

Daylight is extremely important for biological, aesthetic, and emotional reasons due to its continual fluctuations. By introducing daylight into museum galleries, a dynamic interior is created, which can provide a reference to the weather, time, and season through lighting shifts. It can also help to alleviate museum weariness and encourage visitors to remain longer. Daylight is the light to which human vision has physically adapted; it is a stimulant to the human circadian clock and is preferred in indoor places for promoting a sense of well-being and increasing mood. Because it is given in huge quantities with a spectrum that provides superb color rendering, it has a higher chance of maximizing visual performance than most forms of electric lighting. People's perceptions and behaviors can be influenced directly by lighting in confined spaces. A reduction in visitor interest in exhibits is referred to as "museum tiredness." The usage of side-lighting apertures can also help with the exhibition's rhythm and transition zones.

Identity

The purpose of museum architecture is to create an exhibition space with a spatial character that not only provides the best framework for presenting art, but also tells a story to the viewer. Curating and exhibition design have been used to help people better understand and appreciate art. However, popular curatorial practices like as the white cube and the black box have a tendency to convert galleries into mundane and neutral environments. Also, the purpose of museum architecture is to tell a story through form and aesthetics, not to overshadow art, but to provide a framework for it. Because they create an integrated experience of the space, daylight openings and associated management systems lend individuality to museum galleries. They connect the visual experience to the place by allowing views of the urban surroundings (a principal guiding architectural design).

Sustainability

Natural light is one of the most abundant renewable energy sources, and its utilization in architecture is crucial to the long-term viability of our built environment. The usage of electrical lighting in both display and other rooms can account for 20% of the building's energy consumption, therefore distributing daylight in museum spaces is a major technique for green design. As a result, combining natural light with artificial light and lighting management technologies can significantly enhance the energy efficiency of museums. In order to achieve best sustainable design, natural light apertures must be addressed early in the architectural design process. The kind, size, and direction of daylight openings can affect the building's ability to maintain a high or low level of sustainability. Top-lighting apertures may diffuse light over wider regions, however side-lighting openings have a depth limitation since illuminance levels steadily decrease as the distance between the openings increases. Furthermore, by affecting the air temperature in the interior of spaces, the materials and glazing chosen for the openings can have a major impact on energy efficiency.

CONSIDERATION ASPECTS OF DAYLIGHT IN MUSEUM GALLERIES

Preservation

The preservation of collections and cultural heritage is one of museums' primary tasks. As a result, they should ensure the best possible display circumstances, as unguided natural light exposure to particular materials could cause harm. Light may cause significant physical and chemical damage to materials. Fading is one of the most visible forms of light damage, but it can also cause severe physical and chemical damage. Because such effects are almost always irreversible, things in display require preventive conservation measures. Light is a spectrum of energy that includes ultraviolet (UV) wavelengths at the short end, visible light in the middle, and infrared (IR) wavelengths at the long end. UV and infrared rays are the most damaging. Ultraviolet light can induce photochemical degradation, and infrared light can produce radiant heating, thus their rays should be filtered and avoided to the greatest extent possible.

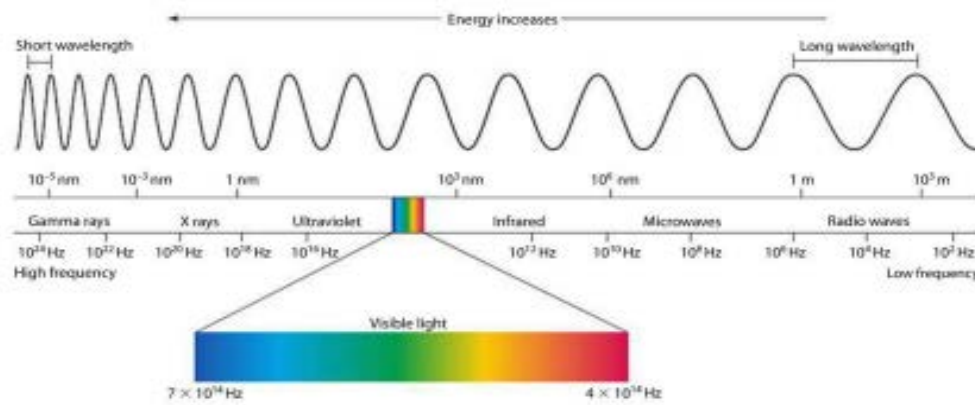


Figure 2.1- Electromagnetic Spectrum

Visual comfort

Daylight can improve visual performance, but if it is not adequately controlled, it can cause visual adaption issues for both visitors and gallery staff. It will also have an impact on the ability of visitors to enjoy the artwork. Glare, high contrast areas, reflections, and shadows are all examples of situations that might impair visual acuity. Glare, whether direct or indirect, can cause pain, distraction, or even obstruct vision. The brightest area in the field of view attracts the human eye. To cope with these shifts in brightness, daylight design should strive for adequate ambient lighting across the space. Shadows and reflections may also induce distraction by altering or reducing the perception of artworks. The use of proper daylight management design and technologies can help to reduce shadows and generate ideal viewing conditions. To prevent distracting reflections, low-reflectivity interior materials and finishes should be chosen.

TYPES OF DAYLIGHT OPENINGS AND CONNECTION TO THE OUTDOOR ENVIRONMENT

The sort of daylight openings utilized in galleries has a significant impact on how natural light is distributed throughout the space and on the sense of connection to the outside. Opening design is an important element in the architectural process, and it is frequently linked to the architectural movement (style) in which the building is created, as they are an inherent part of the aesthetic concepts espoused. Side-lighting and top-lighting are the two most common types of daylight aperture. The illuminance distribution inside the rooms is influenced by their architectural geometry, orientation, placement, and number.

Side-lighting

There are two main types of side-lighting openings: windows and clerestories.

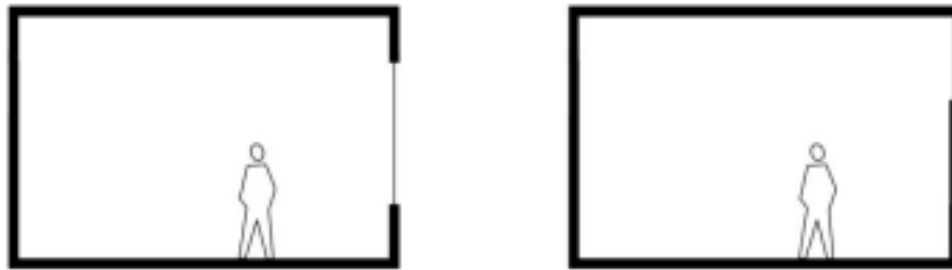


Figure 2.2- Windows and Clerestories

Windows give light, view, and ventilation, so they are the most prevalent method of daylighting in most types of structures. They have historically been employed in many galleries in museums, however this is primarily due to the museum role being assigned to existing structures. Because it may let direct sunlight across the room or generate high contrast sections, this style is likely the most problematic to use in museum galleries. As previously stated, inside galleries, the lighting principles must reduce sunlight penetration while also providing suitable shading and glare management. Direct sunlight can be reduced or removed with appropriate design and shade measures. The shading patterns will make sculptures appear more alive if they are placed close to and facing the openings. Paintings and photographs, on the other hand, should be hung at right angles to the windows and tilted rather than facing the openings, which might cause reflection issues.



Figure 2.3- Jewish Museum, Berlin / Architect: Studio Libeskind

Side openings higher in the wall are known as clerestories. Because they are higher than eye level, they allow for deeper light penetration and reduce the likelihood of glare. The light distribution inside the space can be made consistent by combining clerestories facing opposite directions. Because they are higher than the eye's level, however, the vision is limited to the sky or higher surroundings, but it might sometimes be absent. As a result, they create a lower sensation of openness than windows do.



Figure 2.4- New Art Gallery Walsall, Walsall (UK) /Architects: Caruso St John Architects

Top-lighting

Top-lighting is recommended to produce ambient and uniform illumination while also reducing the risk of glare. Ceiling apertures allow for openings without interfering with the space's organizational scheme, and they leave the entire wall surface available for exhibition. Skylights, overall daylight roofs, atriums, and lightwells are all examples of top-lighting apertures. Top-lighting openings reduce or eliminate views of the sky or higher surroundings, and in certain cases, provide no view at all. They can, in any case, provide information on changes in the outside environment as a result of time and weather.



Figure 2.5- Whitney Museum of American Art (New building), New York / Architect: Renzo Piano Building Workshop

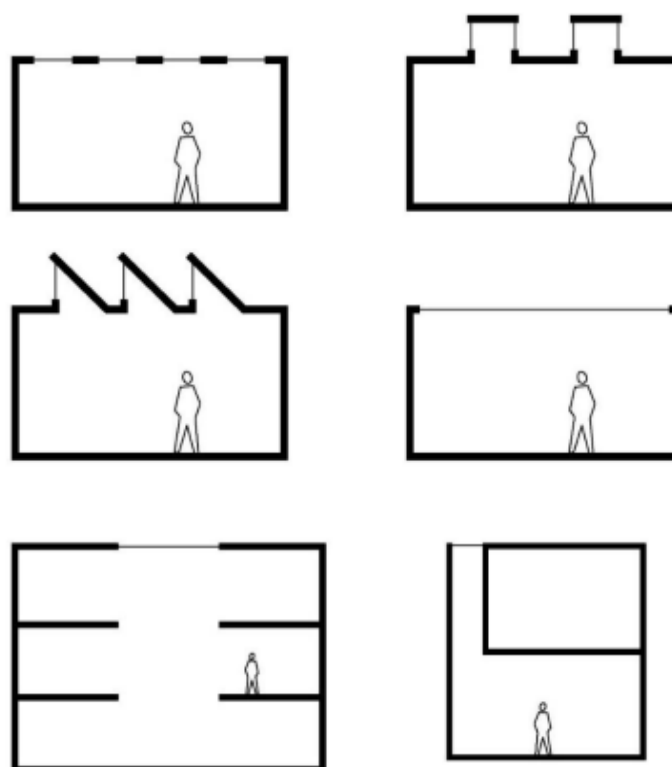


Figure 2.6- Different types of top-lighting openings

View

The presence of an exterior view establishes a strong connection between the galleries and the surrounding environment. The content of this view can be either the urban surrounds or the sky, depending on the typology of the openings. It is vital to remember, however, that transparency allows you a look into the galleries. Museums should be welcoming and open to the public as symbols of education. Transparency is essential to openness because it establishes a visual link between the inside and outside.

3.0 METHODOLOGY

This chapter explains the research approach. This study intends to analyze the influence and effectiveness of daylight openings and their link to the external environment in museum architecture, using a case study approach and a systematic analysis of relevant literatures on natural lighting (daylight openings) design in museums. The study focused on two museums: Museum Boijmans Van Beuningen and Gemeentemuseum Den Haag, both of which used daylight apertures as a major architectural strategy in the structure's construction. The data was acquired from a review of existing literature as well as research on the impact and effectiveness of natural lighting strategies in museum design.

4.0 FINDINGS AND DISCUSSIONS

The focus of this chapter was on two museums: Museum Boijmans Van Beuningen and Gemeentemuseum Den Haag, both of which exploited daylight apertures as a primary architectural approach in the design of their structures.

MUSEUM BOIJMANS VAN BEUNINGEN

The Museum Boijmans Van Beuningen is one of the oldest museums in the Netherlands, and it is located in the city of Rotterdam. It was founded in 1849 and relocated to its current position in 1935, in a new structure constructed by Adriaan Van der Steur, the city architect. The architectural concept aimed to bring light into all galleries, either through side or top lighting, depending on the collections, and to create intimate places for the artworks.



Figure 4.1- Museum Boijmans Van Beuningen in 1935 Figure 4.2- The new extension of the museum in 1972



Figure 4.3- The last extension in 2003

Top-lighting design

Van der Steur and Hannema made lighting a top focus (the museum director at the time). They found most procedures already in use inadequate after touring a number of museums. Their goal was to construct a design that directed light to the walls rather than the center, as most museums at the time did, which resulted in dark nooks due to light falling to the floor. A central fake ceiling was built into the construction of the roof to generate this illusion. It was made out of a perimeter of slats that directed light to display walls and a central closed section. The design resembled a web spun by a spider. Matt glass panels were positioned above the slats to filter the light. Artificial lighting was installed between the ceiling and the roof to create indirect lighting for use in the evening.

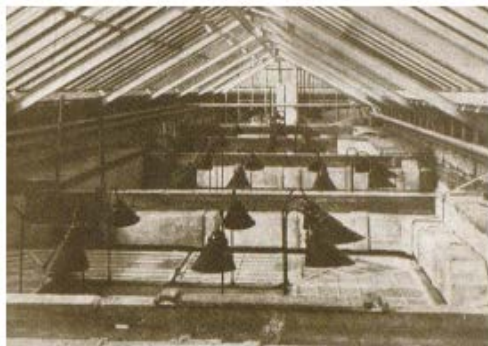


Figure 4.4- Lamps placed between the roof and the ceiling, the design of the slats is visible



Figure 4.5- The design of the ceiling from the interior of a gallery

The natural lighting strategies used at the galleries are:

- A mix of side and top lighting apertures for gallery 36.
- The use of a top-lighting aperture without side-lighting apertures in gallery 23 allows the entire wall area to be utilized for displaying, while diffused glass prevents any exterior views.



Figure 4.6- Interior view of gallery 36



Figure 4.7- Interior view of gallery 23

- Gallery 15 is part of a bigger area that includes two other galleries on either side. There are no openings in the other two galleries that can be seen. There is a total of twelve windows in the gallery, which are distributed across two walls. The paintings

are protected from direct sunlight by translucent roller blinds, the material of which allows for exterior views, although the outdoor features are difficult to discern from a distance.

- The gallery's side and top daylighting openings are combined for gallery 9. It has a long, narrow window in the west wall that starts at around one meter and extends to the ceiling height. Natural light floods the display walls, thanks to the ceiling's architecture (as described previously).



Figure 4.8- Interior view of gallery 15



Figure 4.9- Interior view of gallery 9

- The lower half of the windows in galleries 42 and 43 are obscured by diffused glass. Because the apertures are designed to seem as one, they give the impression of continuity. Up to eye level, the walls are grey, while the upper portion is white. The floor is light brown marble, and the ceiling is white.
- Gallery C is a temporary exhibition gallery that is part of the museum's first addition. A side-opening that spans the width of the space lets in plenty of natural light. Despite its size, the aperture appears to be smaller in comparison to the gallery's dimensions.



Figure 4.10- Interior view of galleries 42, 43

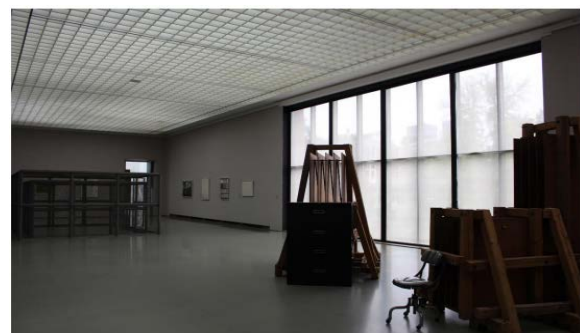


Figure 4.11- Interior view of gallery C

GEMEENTEMUSEUM DEN HAAG

The Gemeentemuseum Den Haag is one of the most well-known museums in the Netherlands, not only because of its art collection but also because of its architecture. It was

designed by Henrik Petrus Berlage, a contemporary architecture pioneer, and is regarded as his final work. The museum first opened its doors in 1935, with several groundbreaking innovations in natural lighting, construction, climate control, and tourist amenities. Berlage's architectural design sought to incorporate daylight throughout all of the museum's galleries in order to preserve the naturalness of the space's materials, improve the sight of artworks, and present visitors with the experience of shifting daylight. The top floor galleries let in natural light through false glass ceilings built into the roof structure, which tempers the light and creates a more intimate ambiance. A system of metal slats was also installed beneath the roof's windows to respond to changing weather conditions.



Figure 4.12- Exterior view of the museum from the street side



Figure 4.13- Section of the museum, the design of top-lighting apertures in the top galleries and suspended elements inside the roof structure is visible

The natural lighting strategies used at the galleries are:

- The permanent display includes Gallery 31, which is located on the first floor. An indirect top-lighting opening on the room's ceiling, inside the roof structure, allows natural light to enter the space. The horizontal rectangular aperture in the center of the space is filled with translucent glass and covers the largest section of the room.
- Gallery 26 is a permanent display on the first floor. Inside the roof structure, the room features an indirect top-lighting opening in the interior ceiling. The horizontal rectangular aperture in the center of the space is filled with translucent glass and covers the largest section of the room. The opening is covered by a velarium (translucent diffuser).



Figure 4.14- Interior view of gallery 31



Figure 4.15- Interior view of gallery 26

- Gallery 21 is part of the permanent exhibition and is likewise housed on the first floor of the building. A clerestory runs the length of the upper half of the north wall, allowing natural light to flood in. This is an indirect aperture that is contained under the roof, just like the other first-floor galleries. Diffused glass surrounds the entrance.
- The museum's temporary exhibition space, Gallery 18, is located on the first floor. It has both side and top lighting apertures, all of which are indirect; the windows face the central atrium, which is covered by a glass canopy, and the top-light openings, like those in earlier galleries, are part of a secondary ceiling beneath the roof structure. Translucent glass is used to conceal the top-lighting apertures in the gallery's ceiling.



Figure 4.16- Interior view of gallery 21



Figure 4.17- Interior view of gallery 18

- The museum's temporary exhibition space, Gallery 32, is located on the ground floor. It has three windows in the north wall, starting at 1.40m and rising to the ceiling height. The apertures are evenly spaced apart, although their widths differ.



Figure 4.18- Interior view of gallery 32

5.0 CONCLUSION AND RECOMMENDATIONS

Architecture is a visual and emotional kind of art that creates one-of-a-kind and inspiring settings for humans. Museums should be designed in a way that encourages visitors to explore. As previously said, museum design serves as a container for art, and daylight apertures serve as perforations in this container, allowing for a conversation between the interior and outdoor environments. With three subheadings: daylight openings in museum galleries over time, benefits and considerations of daylight introduction in museum galleries, and types of daylight openings and connection to the outdoors, it can now be said that the design of daylight openings determines the way and degree the gallery communicates with the outdoors.

Due to the importance of architecture and transparency in developing a link with the urban environment, daylighting design is an important component in establishing a connection between art and the city. Openings with a look out but also into the galleries during the day can involve art as a part of the city... *Why not, because galleries are related to the urban context, their presence in public life may encourage individuals to seek out art in their daily lives...*

REFERENCES

- A. Liljefors, "Lighting - Visually and Physically," Lighting Department, School of Architecture, KTH, Stockholm, 1999.
- "A House for Art - The Museum Building," Museum Boijmans van Beuningen, [Online]. Available: <http://collectie.boijmans.nl/en/in-depth/the-museum-building>. [Accessed July 2017].
- B. O'Doherty, Inside the White Cube, San Francisco: Lapis Press, 1976.
- C. Cuttle, Light for Art's Sake. Lighting for Artworks and Museum Displays, Butterworth-Heinemann, 2007.
- D. Hafiz, "Daylighting, Space, and Architecture: A Literature Review", Enquiry the ARCC Journal, vol.12 is.1, 2015.
- Echy, "Natural light in museums", September 15, 2016 [Online]. Available: <http://www.echy.fr/natural-light-in-museums/?lang=en> [Accessed April 2017].

Lewis, G. D. (2000, September 25). History of museums. Retrieved March 2017, from
Encyclopaedia Britannica: <https://www.britannica.com/topic/history-of-museums-398827>.

"Museum building," Gemeentemuseum, [Online]. Available:
<https://www.gemeentemuseum.nl/en/museum/museum-building>. [Accessed August
2017].

S. Hefferan, "Working with Daylight in the Museum Environment", WAAC Newsletter, vol.
30, pp. 22-24, 2008.

S. Cannon-Brookes, "Daylighting museum galleries: a review of performance criteria,"
Lighting Restoration Technology, vol. 32, pp. 161-168, 2000.

