



A Comprehensive Study Of The Impact Of Natural Lighting On Architectural Spaces

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Abstract: Natural lighting is a crucial component of architectural design, affecting the functionality of the building and contributing to sustainability. It addresses the perception of the spatial quality of the space and enhances the built environment. In the present time, the application of artificial light is an inevitable component of everyday life. However, the role of natural light in architectural spaces is significant, and understanding how it impacts and enhances the quality of a space is a crucial topic. This research explores a comprehensive examination of the intricate link between architecture and natural lighting, highlighting its significance and the diverse elements architects consider when incorporating it into their designs through the preliminary investigation of the relationship between natural light and architectural spaces. It also aids in comprehending how the place might be envisioned by assessing the user experience created by emotions and the interplay of light and shadows. This study explores how daylight and architecture have developed over time, focusing on windows and open spaces central to design. The methodology involves a thorough examination of the techniques used by various renowned architects, drawing insights from literature and observations gathered in user experience surveys.

Index Terms - Natural light, architectural space, survey, daylighting.

I. INTRODUCTION

The Sun has illuminated the Earth for almost four billion years; and in the last century, the role of daylight in human shelters has evolved significantly (Htet et al., 2023). Daylight is the holistic mix of the luminous properties of sunlight from direct solar radiation and skylight from diffuse solar radiation (Knoop et al., 2020). Natural light has been a fundamental aspect of architectural design, not just adding aesthetics to the built environment but also to its function, sustainability, and occupants' health. The features of the sun ray interacting on the space altering owing to the sky circumstances define the suitable degree and quality of natural light with homogeneous distribution (Oner, 2023). Daylight always depends on the contextual and geographical aspects. In the architecture field, daylighting is essential for interior of a building to improve energy efficiency and occupant comfort (Patra et al., 2024). Throughout the history of human civilizations and modern architecture, natural light utilization has come a long way, shaping the principles of design, the use of energy, and the human experience in the built environment. Because lighting is so important in the built environment, architects have done many research on related issues. Most of these research focused on artificial lighting and its importance in the domains of thermal efficiency, energy consumption, and new technologies (Sholanke et al., 2021a). Natural light captures the vibrant surroundings, while aesthetics and human elements are crucial in modern architecture. Few studies have examined the use of natural light in architectural design worldwide, and research on natural light in buildings mostly focuses on technology and art, including trials and data analysis from the perspective of technology (Kaheneko, 2021). Natural lighting in architecture transcends its conventional aesthetic and functional advantages. With the trend toward sustainable architecture globally, natural light is now a basic component in an energy-efficient design approach. The global shift

toward sustainable development and energy-efficient buildings has created the adoption of daylighting techniques that maximise the use of daylight while conserving energy. Electrical lighting accounts for more than 30% of a building's total energy use, with daylight hours using a significant portion of this energy. Moreover, it is feasible to decrease electric lighting consumption by a minimum of 50%, and the intentional application of shading to manage daylight can yield additional energy savings by lessening the demand for cooling (Htet et al., 2023). In addition to the economic and environmental advantages, the influence of natural light within architectural environments enhances the perception of space. Illumination has the potential to foster an impression of spaciousness within a confined area, thereby augmenting the perception of volume and contributing to an increased feeling of openness. By altering light in a space, architects and designers can influence how individuals perceive and interact with that built environment. For example, the interplay of natural light and shadow can generate a dynamic visual effect throughout time, altering a static environment into one that feels fluid and perpetually evolving. The sense of space is created by daylight, and it is important to investigate how daylight alters the quality of space in buildings and its impact on people.

II. METHODOLOGY

The methodology involves a comprehensive literature review centred on daylight, employing pertinent databases such as Scopus, the Web of Science, and various grey literature sources. The study examines a range of architectural analyses to explore the ways in which architects and designers incorporate natural light into various buildings and sustainable designs. The subsequent segment of the investigation encompasses survey data collected from 60 participants within the age range of 18 to 40 years. The analysis of results and the ensuing discussion led to the conclusion of the research paper.

III. LITERATURE STUDY

3.1 Natural light and well-being

Indoor quality has been demonstrated to influence people's mental health as well as their mood, therefore this parameter influences their general well-being (Morales-Bravo & Navarrete-Hernandez, 2022). Though these domestic interior settings are becoming more relevant to people's emotional well-being, little is known about which particular features of indoor environments cause bad feelings and stifle favourable ones (Smolders et al., 2013). In *Le Corbusier Plans 1940 - Studies in Sunlight* mentions that, Sunlight is a basic element of architecture; Le Corbusier himself understood that the architectural decisions of a structure influence the natural illumination features of interior areas (Smolders et al., 2013). A diverse array of studies illustrates how lighting conditions influence individuals' emotions at both psychological and neurophysiological levels that produce either happy or negative experiences (Kuller, 1986; Smolders et al., 2013). Beyond simple exposure via the creative interaction of light and shadow, diffuse and changing light, and the integration of light with spatial aspects, natural lighting may adopt aesthetically beautiful shapes and patterns (Karaman & Avci, 2022). Natural light in indoor environments fosters a deeper bond with the natural world and evokes a sense of tranquillity and balance with nature. The diverse intensity and orientation of natural light throughout the day facilitate adaptable environments that can accommodate a range of activities. In the design process, it is crucial to take daylight into account, as the orientation of spaces really helps to reach the ideal level of natural light.

Published over the past two decades, independent field investigations have produced a spectrum of findings ranging from surpassing expected savings by 56% to increasing energy consumption resulting from some dimming ballasts' or daylight controlled lights kept on after hours' higher voltage. Given these findings and the thermal interdependencies of daylight glazing, integrating daylight into a building can reduce or increase its energy usage (Van Den Wymelenberg, 2014).

3.2 Natural light and sustainability

Derek Philips, in his 1997 work *Natural Light in Architecture*, discusses the paramount aspect of daylight: its capacity for transformation, leading to an endless variety in the visual characteristics of daylight within interior spaces. He discusses the orientation that must be considered for the building to ensure it receives the optimum amount of beneficial daylight in the interior, as well as the nuances of daylight's color, which shifts from morning to evening and is influenced by the changing sky and weather patterns. In colder regions, the

predominant energy usage in buildings is attributed to space heating, whereas in warmer climates or throughout the summer, air conditioning plays a crucial role in influencing peak electricity demand(Phillips, 2004).

Richard Barret argues for daylighting based on its evolutionary roots, health, well-being, and space performance among inhabitants, as well as regulatory needs and ordinances. The author discusses daylight and its impact on building occupants' health and comfort in the article. Gallagher supported Barret's claim with 1999 northern US winter figures. He linked seasonal affective disorder (SAD) to light deficiency (Barrett, 2009). Six per cent of New Yorkers suffered severe depression during leisure time, while over 50% experienced minor symptoms, including poor energy and disturbed eating and sleeping patterns. Ruck also examined how light affects building inhabitants' physiological and biological health. He believed that non-visible light impacts influenced brain activation, body alignment, and balance; therefore, a light environment required careful ambient and task lighting design that considered the spectrum composition of light on individuals. He said that the Parthenon's architects and designers, Gothic cathedral artisans, and certain 20th-century architects understood natural light's importance in connecting humans to their environment (Barrett, 2009).

The research, Light in architecture as an inspired theme by Danuta Debowska highlights the significance of natural light in architectural design. In ancient times, the rays of the sun that reached our eyes filled us with inspiration. We designed it to forge a link between the celestial and the terrestrial. This idea played a central role in shaping the design of sacred places such as Stonehenge. It remains the main framework for church buildings. Over the years, the exploration of light and chiaroscuro in architecture has given rise to the unique characteristics and creativity of the Baroque style. The art of deception and the world of architectural optical illusions reached their peak through careful manipulation of light. During the modernist period, architects sought a clean simplicity, moving away from elaborate decorations and adopting the belief that functionality embodies true beauty. The honesty of forms and absence of embellishment did not suggest a disregard for light. A gentle light danced across the surface of a sleek wall. The designer crafted a robust password that reflects Mies van der Rohe's "less is more" philosophy in modern minimalist architecture (Dębowska, 2017).

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3.3 Natural Light in Architectural Design in the Era of Artificial Lighting

Balancing artificial and natural light not only adds to the physical and psychological well-being of the occupant but also helps create more sustainable and livable built environments. As we move forward with respect to innovation and technology, a deliberate attempt to incorporate daylight into built environments will be essential for peaceful coexistence with the artificial light that has become a part of everyday life today. Artificial lighting design also defines areas outside of the internal spaces. Lighting design should be able to define and characterize urban zones on a larger scale even while it aids in obtaining appropriate comprehension of the cityscape as a whole. Artificial lighting emphasizes urban furniture, enabling visitors to identify which areas are considered restricted and which are public open spaces. Residents or visitors therefore know where to sit, where to go, and which areas are off-limits. Identification of Lynch's five ideas in city development—paths, landmarks, nodes, districts, and edges—depends also on lighting master plans (Sholanke et al., 2021b). Vitamin D is the sunshine vitamin that has been produced on this earth for more than 500 million years (Wacker & Holick, 2013). During exposure to sunlight, 7-dehydrocholesterol in the skin absorbs UV B radiation and is converted to previtamin D3 which in turn isomerizes into vitamin D3 (Wacker & Holick, 2013). Sunlight is necessary for vitamin D synthesis in the body. With most people spending more time indoors, indoor activities and occupations taking precedence over outdoor exposure, it is necessary to ensure access to the required amount of sunlight in order to have optimal health. In addition to its role as an agent for vitamin D production in human blood, natural light can improve subjective mood, attention, cognitive performance, physical activity, sleep quality, and alertness in humans ("Natural Light and Productivity," 2016). Underlying the human preference for daylight are experiences that transcend immediate physical stimuli, often orchestrated by their nature to be interwoven with knowledge related to context; the sun has been worshipped in many civilisations, with sunlight and the qualities of shadows and darkness generally felt to be a source of spiritual and aesthetic experience as well as of health and well-being (Knoop et al., 2020). Natural light improves well-being, generates ambiance, and changes the character of spaces. Architects have meticulously planned public buildings, houses, and meeting areas across civilisations to maximise daylight in ways that would make structures seem open, friendly, and linked to the natural world.

IV. RESULTS

The results reveal somewhat notable age differences in architectural lighting design concepts. For 18- to 25-year-olds who value both natural and artificial illumination, they appreciate natural light but are indifferent about its influence on moods. Between the ages of 26 and 35, the study respondents ranked lighting as a fundamental element of design; they gave natural light top priority for its mood-enhancing qualities and sometimes considered it while examining the visual appeal. Regarding architectural environments, the 35-plus age group values lighting and how it influences ambiance and mood. They value both natural and synthetic lighting and know about it in structures. This study exposes age-related preferences and impressions, as well as the importance of lighting in design.

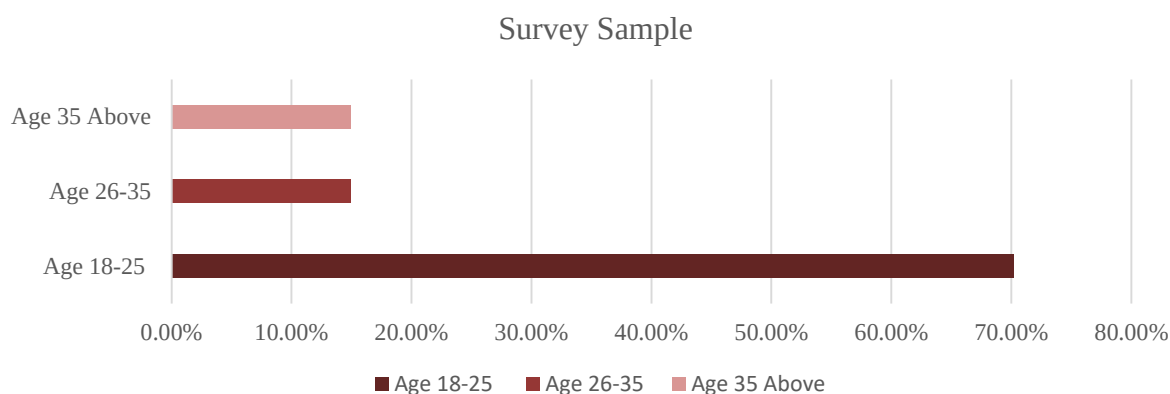


Figure 1 Sample age group of survey

The survey sample included individuals aged 18 to 40 years. This has been categorised into three age categories. 18 to 25 years, 26 to 35 years, and over 35 years. The age range of 18 to 25 is classified as students, 26 to 35 as young professionals, and individuals aged 35 and above as experienced professionals.

1. The Relevance of Natural light in Architectural Design

Relevance of Natural light in Architectural Design

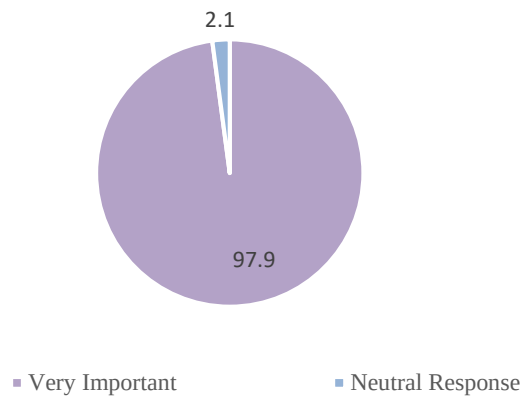


Figure 2 Pie chart - Relevance of natural light in architectural design

97.9% of answers indicate that natural light holds significant importance in architectural design. Only 2.1% of replies are neutral.

2. Impact of Lighting on the ambience of architectural spaces

Impact of Lighting on the ambience of architectural spaces

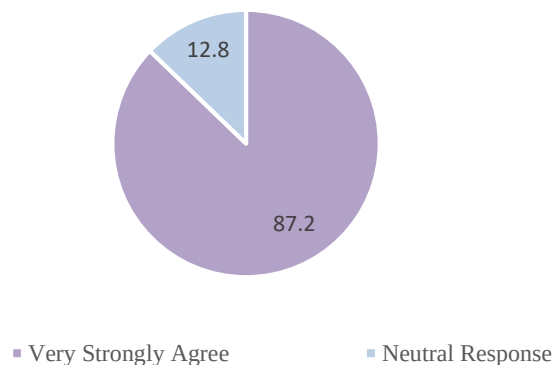


Figure 3 Pie chart-Impact on the ambience of architectural spaces

87.2% of respondents highly endorse the impact of lighting on the ambience of architectural spaces, encompassing both natural and artificial light. Furthermore, 12.8% provide neutral replies.

3. Preference for Natural vs. Artificial Lighting

Preference for Natural vs. Artificial lighting

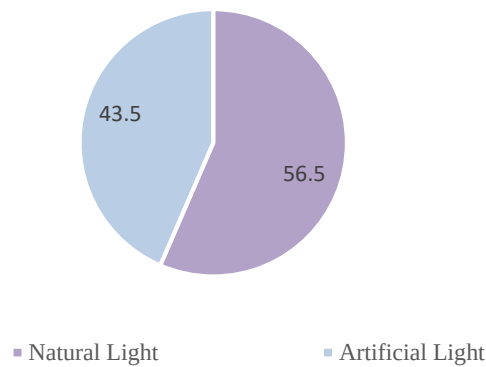


Figure 4 Pie chart - Preference for natural light vs artificial lighting

The poll reveals that preferences for artificial and natural lighting in architectural areas are comparable, with 56% of respondents favouring natural light and 43% preferring artificial light.

4. Consideration of Lighting as a Key Design Element

Respondents consider lighting as a key design element

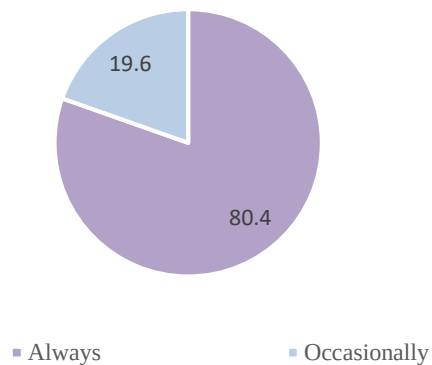


Figure 5 Pie chart - Lighting as a key design element

5. Awareness of Natural Light in Buildings

Awareness of Natural Light in Buildings

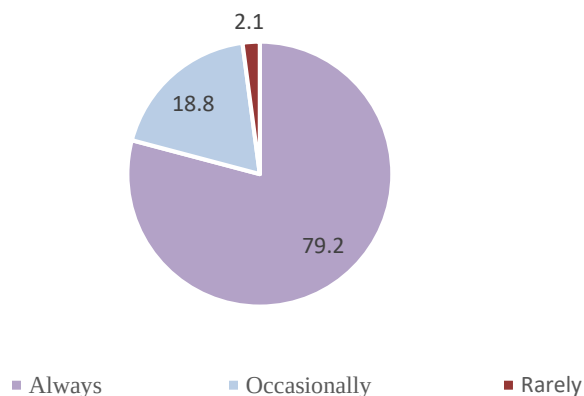


Figure 6 Pie chart - Awareness of natural light in buildings

There is a strong awareness of the necessity for natural light among 79.2% of the replies we received. The age group ranging from 26 to 40 years old maintains a greater level of consciousness, whereas the age group ranging from 18 to 25 years old has an uncommon awareness rate of 2.1% and occasionally 18.8%.

6. Influence of natural lighting on mood in a space

Influence of natural lighting on mood in a space

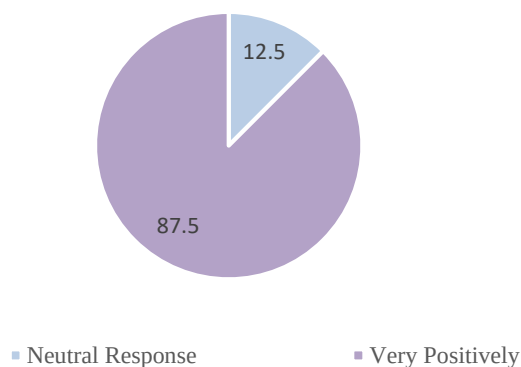


Figure 7 Pie chart - Influence of natural lighting on mood in a space

7. Preference for Buildings with more natural lighting

Preference for Buildings with more natural lighting

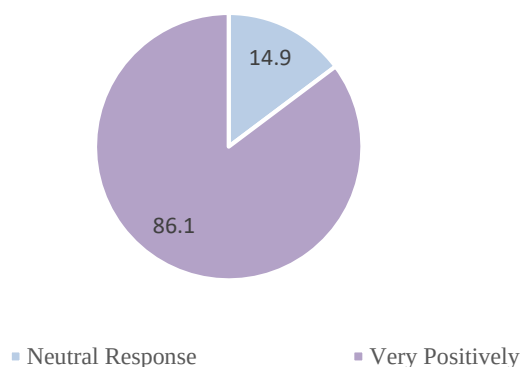


Figure 8 Pie chart - Preference for buildings with more natural lighting

86.1% of the respondents said that they would like the building to have natural illumination rather than artificial lighting. On the other hand, just 14.9% of respondents chose a neutral option, which indicates that they enjoy both natural and artificial light. On the other hand, the findings suggest that, in the present situation, the trend and pattern are influenced by the significance of natural light, and they favour the incorporation of natural light into interior areas.

V. DISCUSSION

The research entails a thorough analysis of the influence of natural lighting on architectural environments, highlighting the relevance of natural light in these places. The literature study demonstrates that natural light is essential for human psychological and physical well-being (Morales-Bravo & Navarrete-Hernandez, 2022). Moreover, natural light serves as a source of vitamins, providing biological advantages, and enhances overall well-being. Natural light enhances energy efficiency and promotes sustainable development. Natural light benefits the environment and is essential for humans and other living organisms. Similar to how plants rely on natural light to adapt to the sun's provisions, humans may also synchronise their activities with the availability of sunshine. The availability of sunlight may modify the routine in sustainable off-grid communities. A significant number of sustainable off-grid communities are implementing this method by adopting the routine according to sunlight availability (Crank, 2019). Thus, natural light is crucial to the notion of sustainability. The literature analysis indicates that architectural environments impact the ambience, enhance productivity, promote physical and psychological well-being, and possess a spatial quality. Natural light has a significant influence on architectural environments in terms of its ability to modify the perception of space (Phillips, 2004). The ambience and sense of the environment are conveyed by the interplay of light inside the room, and it can instantly impact the occupants. The survey results state that the majority of the occupants know the relevance of natural light, and they chose natural space in the indoor environment.

VI. CONCLUSION

The research concludes natural light has an important role in architectural design; it can influence spatial quality and can bring psychological and physical well-being. Through careful design and an optimum amount of daylight usage, an architectural design can turn into an energy-efficient one, and it can contribute to sustainable development. This research looks into the current trend, pattern, and awareness about the usage of natural light in indoor spaces, and the results show that the majority of respondents are highly aware of the need for natural light in architectural spaces. At the same time, it says that, from a functional standpoint, artificial light is also necessary, and the balance of natural light and artificial light is an important aspect of achieving energy efficiency. Future research can focus on balancing the proportions of artificial and natural light in various architectural spaces to achieve energy efficiency.

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