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Appraisal of Day-lighting in Sustainable Housing Development in Developing Countries

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Abstract

Using natural light in architectural spaces has been very beneficial in several ways including energy efficiency, cost control, health and wellbeing of users, and prevention of electricity dissipation and other negative effects of artificial lighting. Daylight in architecture satisfies both mental and physical human needs and reduces fossil energy consumption. This paper appraised the use of daylighting in sustainable housing development in developing countries and discussed the benefits of natural/daylight in housing designs, including the reasons for the sudden disapproval of daylighting in contemporary designs. The study employed a literature review technique, appraisal of case studies of selected daylight-driven buildings and personal observations. Findings revealed that building occupants now prefer daylight for both illumination and environmental stimulations because lack of daylight results in discomfort and stress and affects the psychological and physiological health of building occupants. The study concluded that architects in developing countries should embrace daylighting in their designs due to its numerous benefits in making them sustainable. The study recommended the inclusion of daylighting requirements in all architectural designs by planning authorities in developing countries.

1. Introduction

Natural light, which is nature's gift to man, has always helped to define and shape the creativity of architects in the design process. Thus, from the beginning, every good design of architecture was always based on the designer's understanding of using natural lighting as a basic feature and element of architecture. However, the discovery of electricity, also known as artificial lighting, changed the essence of creative design, giving rise to uncreative and very flexible designs without considering using natural light [1].

However, one fundamental truth is that natural light cannot be neglected if one is to enjoy maximum comfort in buildings. Hence, good use of natural lighting in design creates a feeling of visual comfort and wellbeing in addition to aesthetic appeal, energy efficiency and sustainability in buildings [2,3]. The continuous increase in population with increased demand and energy consumption to meet daily needs, coupled with its associated health and environmental challenges, has recently called for using natural lighting in buildings. Also, artificial lighting-dependent designs have exhibited poor architecture as many design considerations are often neglected, including disconnecting the occupants from nature through the absence of wide windows in buildings, creating a sense of alienation [1,4].

The meaning of daylighting varies depending on the authors' viewpoints, but whatever definition or meaning is given, it revolves around a central theme, 'sunlight or skylight', which is the only daylighting source. Accordingly, daylighting refers to controlling the admission of direct sunlight and the diffusion of skylight into a building interior to reduce artificial lighting and energy saving. However, daylighting goes beyond just providing interior lighting. It also deals with the process that harmonises heat gain and loss, control of glare, and varying daylight availability through careful design of interior spaces, window sizes, shading devices, and glass selection for efficient daylighting [5].

The recent concerns over global warming and calls for fossil fuel conservation and other negative effects of artificial lighting have become necessary for daylighting to be given due consideration in the design of buildings. It is estimated that about 50% of the world's energy consumption is for the construction and maintenance of buildings. These buildings consume a large amount of oil, natural gas and non-renewable energy to provide comfort by improving the indoor environment, which is still unsafe for humans. Thus, these increasing environmental challenges and the current global calls for sustainable development triggered the use of a natural renewable energy source in designs [6, 7]. This is not to say that daylighting should be the only source of illumination in buildings, but a careful integration of daylighting strategies with artificial lighting can help reduce the energy consumption rate, minimise each source's shortcomings and enhance the concept of sustainable buildings. Accordingly, it is argued that one can design buildings and control interior spaces actively by using electric fans and air-conditioners and passively by arranging the form and fabric of the building envelope to admit natural light/environment into the building [8, 4].

Therefore, this study aims to appraise the use of natural lighting (daylighting) in today's architectural design. It highlights the need and importance of daylighting techniques in the designs/construction of all building types meant for human habitation. The once-dependent and major design element, which was later neglected due to the discovery of alternative artificial lighting, should now be revisited and embraced for human comfort and sustainability.

2. Literature Review

The literature review is centred on the benefits of daylighting in architectural designs, characteristics of natural lighting, planning principles, techniques and lighting energy, among others.

2.1 Application of Natural light in Architecture

The importance of natural lighting in architecture cannot be overemphasised. This is due to the numerous benefits derivable from natural lighting. Therefore, the fact states that architecture cannot be without natural lighting. This is buttressed by the contribution of renowned architect, Le-Corbusier, who asserted that "the history of architecture is the history of the struggle for light". This assertion was supported by another celebrated architect, Louis Khan, who stated that "… a space can never reach its place in architecture without natural light". No wonder, in the history of architectural practice, the works of these two great architects whose concepts were natural light-base remain outstanding and cannot be forgotten. This is summed up by the words of Professor Rasmussen cited by [1] that "daylight was fundamental in allowing us to experience architecture, asserting that the same room can be made to give very different spatial impressions by the simple expedient of changing the size and location of its openings" [9].

Natural light refers to the radiation of the sun (solar radiation), which reaches the earth and gets absorbed, reflected, or dispersed by the relative movement between the earth and the sun, leading to different seasons, times, and latitudes [10]. Daylighting, on the other hand, refers essentially to a system integration task involving designs of building siting and orientation, fenestration, lighting systems, control system selection, and continuing maintenance [11]. It uses natural light (sunlight) to satisfy the visual demands of building users. Day-lighting could also be described as the 'use of natural light, which is either brilliant sunlight or muted overcast light to satisfy the visual demands of buildings occupants. Thus, natural light must be the primary source of daytime illumination for any space to be termed daylit. It must create a visually and thermally comfortable place connected to outdoor phenomena and persistently maximising electric lighting energy savings and minimising highest energy demand' [12]. The use of natural light in architecture is gradually changing the perception of both architects and clients (users) so that it is now being embraced and accepted by many. Thanks to the great works of architecture such as Louis Khan's Art Museum in Kimbell, Texas, the Assembly Hall in Dhaka, and Le Corbusier's Ronchamp chapel, to mention a few. These architects developed more sophisticated ways of manipulating natural light to influence their architecture. Also, recent research findings show that among the top five most desired elements in an office space, natural light ranks first with 42%, followed by quiet working space (22%), a view of the nature/sea (20%), live indoor plants (18%) and bright colours (15%) respectively, thus raising more awareness of the significance of daylight on the health of building occupants in addition to other benefits [13].

On the relationship of humans with daylight and architecture, it should be noted that architecture relates to people and the environment (natural light inclusive) to enjoy optimum comfort on earth. This is supported by [5], who asserted that an "intimate relationship exists between architectural form, people and daylight with daylight as the design variable stressing that daylight remains the most important design element that determines the scale and form of buildings, the orientation and interior spaces, the character of the spaces as well as users' response to the spaces". Moreover, daylight influences and exposes the aesthetic and real architectural experience of buildings, especially the appearance of indoor spaces due to their dynamic nature, shade, and intensity, making it an indispensable architectural design element for architects [14].

Furthermore, it is now evidently clear today that the world is rethinking the integration of natural light into current designs based on the several benefits of daylighting in an architectural design solution. Accordingly, daylight has become a key factor in the planning and design of buildings today. Thus, several research findings in recent times have revealed that beyond visual effects, daylight positively affects human health, both physical and mental, helping to improve productivity and performance in workplaces as well as enhancing happiness and colour perception [14]. Unfortunately, artificial light sources cannot provide these benefits, among others and because modernism now requires humans to spend over 80% of their time indoors, thereby separating humans from nature, demands that we bring nature back into the interiors of buildings. This is why European countries have recently decided to include daylight factor as a key requirement in design by specifying minimum recommended daylight provision in indoor spaces within their national construction regulations [15].

3. Materials and Methods

The methodology employed in this study includes literature review, observations and case study appraisal. First, an extensive literature review was carried out on daylighting concepts, benefits, principles and methods of admitting daylight to buildings. In addition, case studies of some notable buildings involving daylighting design and construction techniques were outlined and appraised to give a better and clearer understanding of designing with daylighting, especially for today's architects.

4. Discussions

Based on the methodology discussed above, the contour plot of resonant frequency for aluminium and titanium catenoid horns is shown in Figures 3 and 4, respectively. From the figures, resonant frequencies come up 34459 Hz and 34736 Hz, respectively, for aluminium and titanium catenoid horns, as frequencies of both horns are greater than 20,000 Hz, which is one of the core requirements for the horn to be used in USM. Hence both horns can be operated very effectively in an ultrasonic machine to manufacture hard and brittle materials.

4.1. Daylight Consideration in Architecture

In today's architecture, daylight is becoming a major consideration, just as in the earlier centuries when natural lighting was at the centre of architectural design. This is due to the global call for sustainable designs for a sustainable environment devoid of fossil fuel emissions, high energy consumption and dangers to human health, among other negative effects of over-reliance on artificial lighting.

Accordingly, it becomes very important to integrate the views and requirements of various disciplines and expertise in the built environment to plan for daylight because daylighting design begins with site selection and runs through the post-occupancy period [16].

However, some constraints and challenges hindered the integration of daylight design in buildings previously. These, according to [15], include (i) lack of evidence of the benefits of daylighting in buildings, (ii) Absence of or inadequate knowledge on daylight performance systems and lighting control and (iii) lack of suitable and accessible daylighting design tools. These challenges have since been resolved by the International Energy Agency (IEA) Solar Heating and Cooling (SHC) Task 21 through the following: (i) development of integrated design tools, (ii) assessment of the performance of systems and lighting control strategies, (iii) case studies of daylight performance in constructed and occupied buildings [16]. An additional solution is the introduction of computer simulations like the building energy simulations, which now help carry out parametric studies for daylight design processes and decisions [17].

Planning for daylight designs is dependent on the availability of natural light (sunlight) around which the design revolves. Thus, the design concept, form/shape (interior and exterior), orientation, window designs for illumination and colour selection in decoration depend solely on the prevailing natural lighting conditions. Good quality daylighting can create a pleasurable and comfortable living and working environment for building users. However, the diffused light and glare control provision ensures high-quality daylighting [18].

Day-lighting planning involves different stages with different objectives as with normal architectural design and according to [16], the stages are a) conceptual stage (decision on building shape, size of spaces, openings and inclusion of building systems); b) design stage (daylighting strategies to be used, integration of daylight system and services design of facades, interior finishes); c) construction stage (selection of materials, details of daylighting strategy); d) commissioning /post-occupancy stage (calibration of lighting control, ongoing operations and system maintenance).

4.2. Benefits of Day-lighting in Architecture

The benefits of daylighting in architecture cannot be overemphasised because lack of daylight results in discomfort and stress and affects the psychological and physiological health of building occupants. Studies reveal that daylight is now preferred by building occupants for two basic reasons: illumination of space and task and to experience some environmental stimulations. This is because daylight is known for its quality, spectral composition and variability [19, 16]. Hence, architects are advised to design buildings that will expose occupants to sunlight daily by creating windows and other openings for the admission of sunlight. Daylight through windows helps to connect people who are indoors to outdoors in order to help them relate to nature. On the other hand, lack of daylight (sunlight) results in vitamin D deficiency, leading to sicknesses such as cancer, diabetes, multiple sclerosis, osteoporosis and other immune system diseases [4].

Several studies have shown that people now spend more than 80% of their time indoors due to work and other engagements, separating them from natural light with its attendant consequences. Thus, a building should be designed not just for shelter purposes but as healing homes by admitting daylight into the buildings to prevent sicknesses and diseases such as Seasonal Affective Disorder (SAD) [4, 15].

Furthermore, several studies from [20], [21], [14] and research carried out by Scientists at the Lighting Research Centre (LRC) in Troy, New York and summarised by [12], the following are additional benefits of daylighting in architecture:

i. Daylight improves mood, productivity and performance in workplaces.

ii. Daylight increase happiness and colour perception. It is viewed as the 'real colour' and is the reference by which colour is judged.

iii. Daylight provides improved mental and visual stimulation that helps to regulate human circadian rhythms.

iv. Daylight help to improve students' performance in schools.

v. Daylight facilitates the healing /recovery process of patients in hospitals.

vi. Daylight help to prevent alienation of humans from the natural environment and reduce anxiety.

vii. Daylight help to reduce energy consumption in buildings by 10% - 60%.

However, some factors enhance the effective application of daylighting in architecture which must be considered. According to [18], these factors are:

(1) the amount of daylight available at the building site, (2) the orientation of the building concerning sunlight, (3) the size and position of windows and other openings which admit daylight into the building, (4) the design and purpose of the building, (5) the use of suitable transparent or translucent material for admitting and distributing daylight into the interior spaces for control of glare.

4.3. Methods of Admitting Natural Lighting into Buildings

4.3.1. Windows

Windows have been the most vital architectural feature for admitting natural light into building interiors throughout history. Windows are broadly categorised into windows on the side walls of buildings and windows on the roof (roof-light). Windows are either horizontal (most popular to date) placed high in the wall, which takes natural lighting deep into the interior and vertical (tall windows separated by masonry at intervals), which provides very simple structural solutions in buildings and illuminates interiors naturally [20]. However, the single-pane windows of old cannot meet present needs in modern buildings for better visual performance, thermal control, shading and light control, hence the development of special windows with metallic coatings and 'smart' windows which can provide both passive and active control of daylighting for light, heat and comfort. Smart windows could be photochromic windows (triggered by light), thermo-chromic windows (triggered by heat) and electrochromic windows triggered by voltage, respectively [15].

4.3.2. Roof-lights

These are 'windows on roof top'. Roof lights are described as glazed openings in the roof that permit daylight entrance into the interior and protect the interiors from wind and weather. Roof lights were initially regarded as domes that started with central courtyards or atria but have now developed into fully glazed barrel vaults and domes placed above areas that cannot be fully covered by side wall windows [20].

4.3.3. Atrium

The atrium is an improvement on the dome or vault, which transmit light into the central part of the building. It is an 'interior light space enclosed on two or more sides of the walls of a building glazed or unglazed and daylit the building from the roof of transparent and translucent material. It has the advantages of providing occupants with a sense of space, orientation and weather conditions and saving energy due to its ventilation features. The atrium may require some solar shading depending on the orientation and detail of the roof light.

4.3.4. Glazing

Glazing help to admit natural light into an interior space and reduce sunlight intensity. The onus lies with the architect to determine whether to use fixed or open window glazing depending on the need for lighting or ventilation. Three types of glazing exist, and these are:

**Clear glazing*: this allows both high daylight and solar radiation transmissions. It could be thick glass, a single, or a double sheet of glass. However, the level of thickness determines the level of daylight transmission.

**Tinted glasses*: these glasses are coated with microscopically thin layers of metallic oxides, which reflect heat out of the building. It could be a modified clear glass with different radiant heat transmission features. In addition, they are coated to act as protection against damage.

**Other forms of glazing*: this consist of patterned glass (used mainly for decorative purposes and diffusing sheets); wired glass (used for security purposes and protection to vulnerable skylights), laminated glasses (used for reducing daylight transmission to the interior, especially in museums for protection against ultra-violet light) and glass blocks (still popular today due to their structural nature and thermal features as well for daylight transmission into buildings).

4.3.5. Light Collection System

Beyond windows, natural light can also be harvested using collection systems transported and distributed into some interior spaces, particularly in buildings with large spaces where daylight cannot be easily accessed. These light collection systems are of two types: passive light collection systems and active light collection systems. The combination of the elements of the two systems can guarantee increased interior light comfort free of glare, reduce energy consumption and enhance occupants' comfort and productivity [15].

* *Passive Light Collection System:* this system which requires a very simple, low-cost strategy of light collection, uses one or more light reflections by mirrors and refraction of lenses to optimise, distribute and increase light collection by employing an optical collection system of fixed position and orientation. However, due to the large components required by this system spreading to areas of need, consideration should be given to the variations in daylight duration, shadows and solar angles during the design year-round.

* *Active Light Collection System*: this system, on the other hand, is more efficient than the passive light collection system but also demands higher cost and maintenance. This system tracks the orientation of direct sunlight continuously throughout the day and year either by simple one-axis motion such as a 'Fresnel lens' that comes with daily solar angle variations or by two-axis motion such as a 'heliostat system' that uses a mirror to reflect sunlight daily or on a seasonal basis.

4.3.6. Solar Shading

Day-lighting system in buildings is anchored on several components which help to enhance its performance, such as façade openings and types of glazing materials used, which contribute to daylight distribution and energy consumption in buildings. However, glazed areas and windows permit solar gains, sometimes overheating and high internal temperature, especially in hot climates, creating the need for solar shading [22].

Solar shading is the strategy by which heat gains into the interior space are reduced by preventing solar radiation in the indoor environment. It is often regarded as the most simple, cost-effective, efficient passive strategy in dry climates.

According to [20], the Building Research Establishment (BRE) pamphlet 'Solar Shading of Buildings' stipulated some primary reasons for solar shading in buildings. These are: (1) to reduce sun glare experienced through the windows, (2) to reduce the effect of heat gain from the sun and (3) to provide privacy for building occupants.

Various types of solar shading are available with their different features, merits and demerits. Climatic conditions, building use and light source to be excluded determines the type, size and positioning of any chosen shading device. The types of solar shading are:

4.3.6.1. External shading

The external shading techniques include shutters, louvres, overhang and canopy, light-shelf, vertical fins and deep window reveal. The most commonly used of these is the louvre shading system. Studies have shown that the effective performance of louvre shading depends on the angle of inclination, the number of louvres and the window-to-wall ratio [23]. However, certain conditions must be observed in the choice of louvre shading techniques, including the climatic conditions of the building site, the architect's concept of the external appearance/elevation of the building and the durability/viability of the hardware involved. Studies have also attested to the advantages of external shading over internal shading as it prevents direct sun rays from entering interior spaces, which is a form of 'prevention is better than cure' arrangement but is more expensive to install and maintain [24].

4.3.6.2. Internal shading

These include curtains and blinds. The curtain is the most widely used internal shading device in residential buildings globally. When lined with reflective material, it can help reduce solar gain and is perfectly practicable in temperate regions. The blinds as a shading device offer more flexibility because of the varieties available. These include Venetian blind (which has the advantage of being adjustable to admit adequate daylight to suit one's comfort level), the vertical hung louvre blind (which rotates the louvre slats for better privacy) and roller blinds.

4.4. Appraisals of Buildings with Daylight Concept

The study also appraised some iconic buildings with outstanding daylight characteristics. The buildings selected cut across different housing categories, including commercial, residential, religious, office and institutional buildings. Although there are several examples of such buildings across the globe, especially in the developed nations, this study outlined a few of these buildings and gave a detailed appraisal of three with particular focus on the application of daylighting in the buildings.

Some of the buildings include The Exeter's Library, located in New Hampshire, The New York Times Headquarters, Maryland, United States, The Thermal Baths, Vals, National Parliament House, Bangladesh, Villa Savoye, Paris; Wah Fu Estate, Hong Kong, Church of the Light, Osaka Japan, Jewish Museum, Berlin, Tate Modern Museum, London, the Royal Mosque, Isfahan, The Cologne Cathedral, Koln, Germany, Nordea Bank Headquarters, Copenhagen, Denmark, National Renewable Energy Laboratory Research Support Facility (RSF), Colorado, The Bullitt Centre, Madison Street Seattle, WA 98122 USA, John & Frances Angelos Law Centre, Maryland, United States, New Acton Nishi, Canberra, ACT.

As opined by Konis, and Selkowitz [25], most of these buildings are aimed at low and zero net energy (ZNE), involving the application of daylighting with low energy concepts. The buildings were designed to allow daylight and air to penetrate the buildings for both lighting and ventilation of the interior to enable occupants to reflect on the environment and feel of nature, which is a departure from the typical deep-foot designs that alienate users from nature.

4.4.1. National Assembly Building, Bangladesh

This is one of the iconic buildings in the world that represents a fusion of modern architecture and vernacular architecture with an emphasis on daylighting. The building, completed in 1982 and located in Dhaka, Bangladesh, was designed by the renowned Architect Louise Kahn, who is one of the advocates of daylighting concepts in architecture. The geometric shapes enhance the composition of the building on different façades, creating a fusion of both old and new cultural identities of the Bangali culture. In addition, the geometric shape also served as light wells introducing the natural environment into the interior [26].

The main feature of the National Assembly Building concerning the application of the natural and daylighting concept is the design of the roof. Here, Louis Kahn introduced windows with semi-circular shapes all around the rooftop of the assembly chamber (Figure1). This help to introduce enough daylighting into the halls from different directions, thereby changing peoples' perception of the vertical space and making the building height look taller (Figure 2). Lastly, Louise Kahn placed the massive National Assembly building around an artificially created lake, which brings a feeling of nature in and around the building while acting as a natural insulator and cooling system and improving spatial and daylight conditions of the building [26].

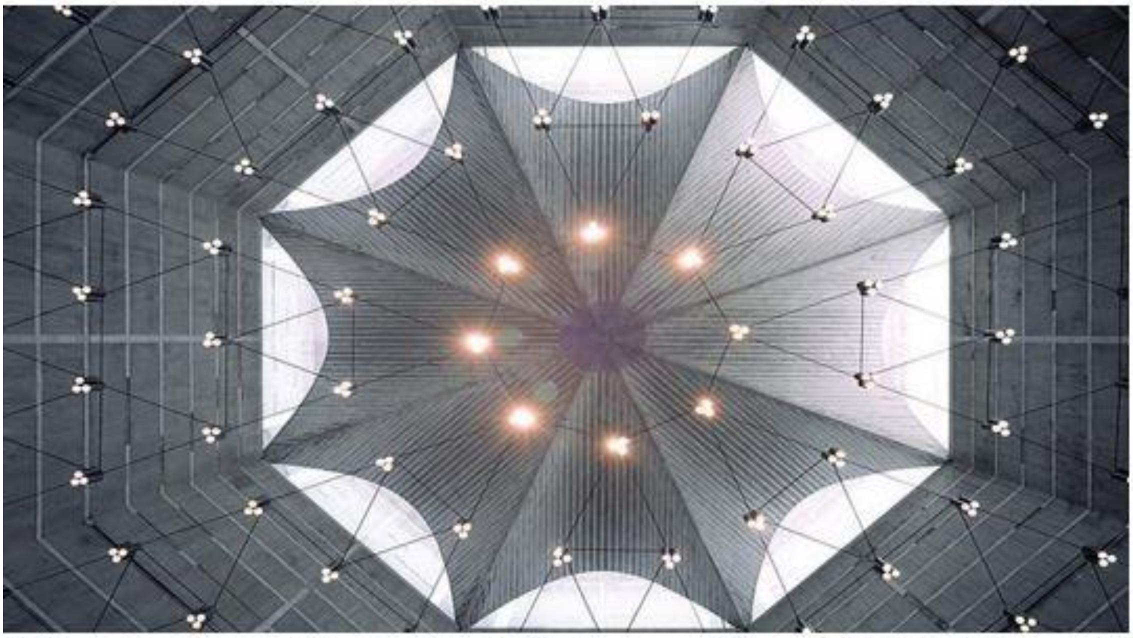

Figure 1. National Parliament House with roof light design [Source: www.rethinthinkingthefuture.com]

Figure 2. National Parliament House Interior Chamber being lit with rooftop light [Source: www.rethinthinkingthefuture.com]

Figure 3. National Parliament House with exterior view [Source: www.rethinthinkingthefuture.com]

4.4.2. Nordea Bank Headquarters, Copenhagen, Denmark

The Nordea Bank office building located in Copenhagen, Denmark was designed by Henning Larsen Architects, Denmark and was completed in 2016, with an occupancy capacity of 2200 employees. The Nordea Bank Office complex is another building which utilised daylighting concept with the major aim of providing the occupants with the opportunity of experiencing the natural environment through views of the outdoor and daylighting of the interior concerning daily and seasonal sunlight in addition to being a model of sustainable building design. The building has seven floors with a floor area of 40,000m2.

The design aspect centred on daylight application includes placing atriums at the centre of the building to spatially connect the various floors from the first floor to the seventh floor to create a sense of unity for the different work zones. In addition, the skylights give occupants a clear view of the exterior while exposing the central zones of the building to daily and seasonal natural lighting changes. Similarly, the work zones, meeting rooms and tea rooms are located close to the atriums, thereby serving as the source of ambient lighting [25].

In order to fulfil the objective of minimising the reliance and over-dependence on artificial lighting in the building during the day, the designers installed daylight dimming lighting control system devices. Furthermore, according to Konis, and Selkowitz [25], to satisfy the client's desire to have a visually transparent façade system, the design team developed a special façade concept in the form of a vertical box window-like modular construction for large spaces between the inner and outer glass casing forming a passive ventilation air cavity (Figure 4) This cavity is attached with an automated exterior fabric roller (Figure 5) which help to control direct sun penetration and solar heat gains to the workplace zones.

Figure 4. Nordea Bank Headquarters: Interior view showing visual transparency of the facade. [Source: Henning Larsen Architects]

Figure 5. Nordea Bank Headquarters: south-west view. [Source: Henning Larsen Architects]

4.4.3. Villa Savoye, Poissy, France

The Villa Savoye, located in Poissy, outskirt of Paris, France, is one of the best examples of buildings where daylight and nature are brought into a building for interactions with humans. The building owned and designed by the celebrated architect Le Corbusier in 1929 represents the very essence of the architectural philosophy of Le Corbusier, an architect known to be in love with nature. The building, representing the highest level of simplicity and modernity, remains an architectural piece worthy of study by new generation architects today.

The design of the Villa Savoye utilised the availability of sunlight to create interior spaces. Thus, Le Corbusier used daylight to differentiate between public and private spaces by placing the bedrooms along the north-east and south-east sides, making them fairly darker than the public areas during the day. The second-floor lobby brings daylight into the building through a roof light. There is a winding ramp that flows effortlessly from the entrance into the roof terrace outside and terminates in a 'curved solarium' capping the building from where occupants can access the exterior adorned with well-landscaped greenery for fresh, natural ventilation and sunshine intake, thus giving an indoor-outdoor integration (Figure 7).

Finally, in the Villa Savoye building, Le Corbusier employed his five' points of architecture' developed in 1926, namely: columns (used to raise the building above the ground level for air circulation), free plan (for free interior space manipulation), roof terrace (to admit nature into the building), ribbon windows (for natural lighting and ventilation) and free façade (for aesthetics). Combining the above elements makes the Villa Savoye a building that transcends all eras of architectural history and a simple, sophisticated example of a sustainable building.

Figure 6. Exterior view of Villa Savoye, Poissy, France. [Source: Renato, Saboya]

Figure 7. Interior view of Ramp and spiral staircase of Villa Savoye, Poissy, France [Source: Scarlet-green]

5. Conclusions

Day-light has always been one major consideration in architectural design from the beginning, which serve as the basis for accessing the creativity of architects. Although an attempt was made to jettison its inclusion as a factor in design due to the discovery of artificial lighting via electricity, today, the story is different with a global reawakening of daylight in building due to its numerous benefits. Currently, there is a growing concern about the health of occupants of a building and the building itself. Diseases from toxic emissions from building materials, low humidity and flicker from a fluorescent lamp, among others, result from the absence of daylight in buildings which causes much discomfort and result in the economic waste that can be avoided by daylight consideration in design.

The advancement in technology and innovations today has minimised the negative aspect of daylight, making it the best option for today and future design element as it has always been. It is very important to understand the right application of daylight principles, including the material combination that provides optimum comfort for occupants and users of buildings. Hence, the architects who are the designer must have a broad knowledge of the principles and workings of this nature-given gift of daylight for good designs and enhance architects' creativity. The paper recommends including daylighting requirements in the building approval processes by planning authorities in developing countries which is now a global trend.

Declaration of Competing Interest: The author declares that he has no conflict of interest.

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