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To cite this article: Anthony Sholanke *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **665** 012008

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240th ECS Meeting ORLANDO, FL

Orange County Convention Center Oct 10-14, 2021



Abstract submission due: April 9

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The Role of Artificial Lighting in Architectural Design: A Literature Review

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Abstract. Artificial lighting design is an integral part of the building design process. However, little or no emphasis is usually placed on its importance in the initial design process, as lighting is often understood as merely the idea of illuminating spaces. This paper investigated the evolved variety of roles artificial lighting plays in architectural designs in the context of psychology and communication. Data was compiled from existing knowledge on artificial lighting techniques, tools and practices to develop a literature for better understanding of the greater capabilities of artificial lighting within the urban context. The study focused mainly on the use of artificial lighting in the 21st century, in a bid to capture the diverse roles artificial lighting plays in the built environment in recent times. The study is a qualitative research that relied strictly on data from secondary sources. A total of twenty-eight relevant publications were sourced using Google search engine via the internet. The data were content analysed, grouped in themes and presented using descriptive approach. The study revealed that artificial lighting plays important roles in delineating spaces, beautifying environments, improving workers' productivity level, as well as serving as a tool for navigation and communication in the urban environment. The paper concluded that over the years, artificial lighting has evolved beyond spatial illumination, but now functions as a tool for passive non-verbal communication. Therefore, planning for artificial lighting should be introduced early in the design process to avoid incurring unnecessary cost and time wasting usually associated with late decision making in the building industry.

Keywords: Artificial Lighting, Luminaires, Illumination, Literature Review and Architectural Design.

1. Introduction

Lighting or illumination is a thoughtful usage of light to achieve functional or appealing effect which could be realised by natural or artificial means [1]. Lighting refers to the description of the manner a space or location becomes visible to the human eye by natural or artificial means. Lighting enables light to create a variety of effects based on the need of a space [2]. Lighting is important in architectural design as it helps to change the mood of a space as well as the perceived size of an enclosed area. Lighting is a significant component in interior design due to its ability to enhance aesthetic value and create the feeling and ambiance of a livable space [3].

The term "artificial lighting" is generally used to refer to light originating from an electrically powered source such as a lamp, bulb or tube, which can be manipulated to achieve the needed end effect. Such light can be decreased, increased, focused, directed or coloured, depending on what is required [2]. Light has four controllable qualities which are: intensity, colour, direction and movement. Each of these qualities can be manipulated to influence mood, selective focus, modelling and visibility which are the four key functions of stage lighting [4].

Artificial lighting cuts across more than just placing bulbs and increasing the quantity and size of luminaires in a space. Artificial lighting can also be used to systematically delineate spaces, create a sense of ambience and affect the psychology of users of a particular space or environment [5]. There are three main categories of artificial lighting in relation to architectural designs. They include:



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ambient lighting (overall illumination in a space); task lighting (for accomplishing a task such as reading); and accent lighting (for highlighting a feature) [2].

Besides its functional role in architectural designs, lighting helps to create visually dynamic spaces. It can also be used to enhance or reduce the ambiance of a space. Therefore, appropriate lighting is an essential component of achieving an aesthetically pleasing environment [3]. However, it is observed that in Nigeria, lighting is seen as a mere afterthought, which is quite unfortunate, because lighting is an aspect in building design that should take high priority from the onset due to its interactive role with architecture [6]. Application of lighting in architectural designs in Nigeria, largely focuses on the use of light for the sake of brightening or illuminating a space. Whereas, artificial lighting offers a variety of purposes and functions that aid the non-verbal communication as well as the psychological aspects of exterior and interior of building and space design.

Due to the importance of lighting in the built environment, studies were found to have been conducted in the field of Architecture relating to lighting. Majority of such studies considered artificial lighting and its significance in the areas of thermal efficiency, energy consumption and new technology. Some of such studies are those of [7], [8], [9], [10] & [11]. Some studies were also found to have considered the role of artificial lighting as a tool for psychological communication in some specific areas of the built environment [12, 13, 14, 15 & 16]. However, no study was found to have aggregated the various evolving concepts and often overlooked perspectives on artificial lighting as a non-verbal communication tool as used in architectural designs of different areas within the built environment, which is the gap this study was conducted to fill.

Based on the foregoing, the study investigated the range of possibilities artificial lighting possesses as a psychological tool for communication within buildings and the urban environments to develop a literature for better understanding of the capabilities of artificial lighting within the urban context of the 21st century. The study was carried out to achieve the following objectives: to examine artificial lighting fixtures and uses; to examine guidelines in lighting design; to probe how artificial lighting can be used as a tool for communication and navigation within the built environment; to examine the effects of artificial lighting on workspaces and urban environments; and to examine how artificial lighting affects human psychology and impulse.

The study adds to existing body of knowledge by providing a systematic empirical data base on the role of artificial lighting in architectural design developed from a review of relevant literatures. The study is justified in that it provides a platform for better understand of the roles artificial lighting plays in the design of buildings and environments that meet users' satisfaction level, as well as the architects and lighting designers' intents. The study provides an insight on lighting techniques, purposes, functionality, fixtures, fittings and how all these various components can be used to improve patterns of communication in the built environment. The study also provides information on how to invoke certain emotions and psychological reactions from users of certain spaces with artificial lighting. The outcome of the study is a useful resource material for architects, urban designers, educators and students, on issues relating to artificial lighting services as a tool for psychological communication within the built environment.

2. Methodology

The research was designed as a literature review study. Thus, qualitative research methodology was used to conduct the research. A six step procedure was employed to carry out the study. First, the specific research problem was noted from a gap identified in literature as explained in the fifth paragraph of the introduction. Subsequently the purpose of the research was decided and the research focus set, as earlier stated in the aim of the study. Second, five objectives were appropriately formulated to tackle the research problem as itemised in the sixth paragraph of the introduction.

Third, being a literature review study, secondary documents were relied upon to gather data. The literature search was randomly conducted using Google scholar search engine on the internet. The Google search engine was employed because it is one of the most popular and widely used internet search tools. The keywords used for the search are: artificial lighting in architectural designs, luminaries and illumination in buildings. The literature search was largely limited to open access documents that were published in the last twenty years in order to capture the trend of the role artificial lighting is playing in the field of architecture in recent times. Based on these selection criteria, forty documents whose focus centred mainly around "Artificial lighting" were first selected. After a close examination of the documents, twenty-eight of them found to relate to the purpose and objectives of the study, were chosen for further scrutiny. The chosen documents are publications relating to artificial lighting and luminaires as a means of communication and influencing users' experience within the built environment.

Fourth, the selected documents were carefully examined. Their texts were analysed and information considered related to achieving the objectives of the research were sieved out. Fifth, the data gathered were then content analysed and synthesised. Sixth, the findings were descriptively explained, discussed and a conclusion made.

3. The Role of Artificial Lighting in Architectural Design

3.1. Sources of light

The origin of light can be traced back to the beginning of the events that led to the creation of the world as recorded in the bible. The holy book records that in the beginning when God created heaven and earth, the earth was completely filled with blackness and was without form and void. However, with the statement “let there be light” God commanded light to appear in the mist of the darkness which He later separated from the light. He named the light day and the darkness night. He then made two lights, the sun and the moon. The sun which is the greater light was created to appear and provide light on earth during the day, whereas the moon which is the lesser light was made to appear to provide the needed light at night. The entrance of light on earth became the starting point of a series of events that led to the creation of other essential components of the world such as water, land, plants, animals and humans [17]. This suggests why light is usually needed to accomplish a task.

Light sources can be subdivided into two categories namely: natural and artificial. Natural light sources include the sun, moon and stars. Buildings are usually designed to optimise capturing natural daylight from the sun [2]. The use of direct sunlight to illuminate spaces in buildings, helps to reduce the amount of energy needed for such purpose by non-natural means. Light is also essential to grow plants, as it is an important ingredient in photosynthesis. Though sunlight (natural light) is best suited to grow most plants, some plants can still be grown successfully with the use of artificial light only [18]. Light is important to both plant and animal life. Hence, some plants and animals such as mushrooms and jellyfish create their own light known as bioluminescence.

In contrast, artificial light is manmade. Its sources include fire, gaslight, candlelight and lamps powered by electric means. Artificial light, as against natural light connotes any source of light produced electrically. Artificial light has various types of applications which include its use in homes and for commercial purposes [18]. In modern times, various artificial light sources have been presented for use in the built environment. Among these light sources are incandescent lamps (hot filament wire within a glass bulb), which use electric current passed along wire to cause heat and emit light radiation. The length of the wire determines how much energy it consumes. Another artificial light source is the fluorescent discharge lamp which contains mercury vapour with extremely low pressure and are lit with electrons to cause excitation in the mercury to produce visible light. Compact fluorescent lamp with low luminous efficacy is also another source of artificial light in use. High intensity discharge lamps with a high power density are also in use [19].

Luminaires are also artificial light source. They are complete lighting units consisting of one or more light sources with mechanical and optical components. They are designed to hold and protect lamps and also connect them to a power source. Luminaires function in conjunction with the finished materials of a space. It is important for lighting designers to ensure they satisfy all photometric requirements (luminous intensity, luminous flux, luminaire efficiency and luminance distribution), as well as cost control and functionality requirements in selecting the type of artificial light source needed for a space [19].

3.2. Lighting design

Man uses his eyesight to navigate himself about the built and natural environment, therefore the role of lighting and the proper design of it cannot be overlooked as a design tool, particularly as 80% of information to man comes visually. According to [13] light does not only serve for vision and navigation, it also influences our wellbeing and our mood greatly. The effective application of lighting depends upon a definition of light that captures the full range of wavelengths to which the human retina is sensitive [12]. Therefore, lighting should be designed to seamlessly produce appropriate brightness for a space, as well as to save energy costs.

A lighting designer ought to gather as much information from the client as possible, regarding the use of a space, materials present and the number of users of the space. After gathering all necessary information, [13] advanced that a lighting designer should proceed with some objectives in mind, which include: having visual guides to create subtle differences in brightness to provide cues to guide users through a space, either internally or externally. For instance, traffic zones as well as long corridors can be structured in proper ways such that important areas like intersections are accentuated

with a high level of luminance. Also a hierarchy of visual focus should be installed. Designing darker areas can also be helpful. The brightness perceived by users depends on the reflective properties of a space and can affect the perceived functionality of the luminaries situated in the space.

In addition, architectural characteristics can be highlighted, emphasised or extenuated depending on the kind of luminaires and illumination. For instance, certain points of a building or façade can be called into focus and a room can look a lot larger depending on the illumination of the ceilings and walls. Different lamps produce different colour characteristics and temperatures which affect the visual perception of spaces. This can be used to tell users if a space is private or public, safe or unsafe. The physical style of luminaires themselves, as well as their lighting characteristics can help in the interior décor of a space and can either make it look more technical or more stately. The way a facility is illuminated has a big influence on its image. By means of different kinds of illumination, a space can be made to look more inviting or more forbidding. Glare, luminaire type, colour, intensity and distribution modify the look of a space and thus affect the image [13].

Also, designing task lighting for office spaces, substantial differences in the luminance levels within the users' field of view should be avoided as that disrupts visual performance and can affect their well-being. Generally, artificial lighting can be used non-verbally to aid in navigation and better understanding of the purpose of spaces. Various lighting techniques can be used to produce different moods and reactions. Thus, it is important for lighting designers to have a good understanding of how to properly make use of luminance to enhance users' satisfaction and avoid the negative psychological effects associated with improper lighting design on users [13].

3.3. Effects of artificial lighting on visual comfort and energy consumption

In looking into the psychological implications of artificial lighting on users, the area of visual comfort cannot be overlooked. Some studies have shown a significant correlation between the luminance levels of spaces and their effects on the visual comfort of users of such spaces. In a study conducted on offices in Seoul, South Korea, [20] carried out the study to understand the significance of this correlation. The study aimed at revealing the factors that determine lighting energy used and consumed in open plan office spaces. Emphasising on the roles of occupant adaptive actions, the three core parameters under observation in the study were vertical and horizontal luminance, the visual comfort of users and how they use lighting. The study established that there is actually a significant direct relationship between the comfort illuminance (the level of luminance that occupants consider as neither dim nor bright) and the prevailing indoor luminance levels. Also implying that occupants tend to adapt themselves to given visual environments and can be affected by past environmental luminance. However, the study only presented results from two office plans in the summer which is considered a limitation, as such results may vary based on seasonal, climatic and geographical regional changes.

[21] discovered in a survey that users of residential spaces found lighting and electrical installations to be the highest source of user satisfaction in residential buildings. This shows the importance in the relationship between proper artificial lighting levels and users' satisfaction. Pohl & [19] also explained the limitation of glare on the visual comfort of users in a space, separating it into direct and indirect forms. Direct being glare coming from the luminaires that are either too bright for a space or improperly shaded, or indirect, that is, coming from reflected surfaces. Both of these forms of glare occur outside the field of view of users of a space to pose a distraction and affect their visual comfort. The research showed that users of a space are likely to adapt to the visual conditions of a space and attain greater visual comfort and productivity when they are able to adequately adjust the lighting conditions of the space to suit their needs. This can be attained by luminaires which allow the lighting output to be adjusted. The use of such luminaires also help to conserve energy levels as the users of a space can adjust lighting to their taste as opposed to just leaving the light on throughout. However, the study did not reveal methods of controlling luminance levels in a space if cases of direct or indirect glare are prevalent, hence there is a need for further studies in this regard.

[22] also discovered that artificially lighting buildings in Covenant University, in Ota, Nigeria, accounted for about 29% of total energy consumption, which, besides cooling which is 29%, was the highest cost of energy in building maintenance. In a related study by [23], the authors found that the annual cost savings in the replacement of fluorescent lights and incandescent bulbs with compact fluorescent lamps in academic hostels and staff residences in Covenant University, were about 394MWh, equivalent to N4.8 million (\$30,000) and 644MWh, N7.9 million (\$49,375) respectively. The study concluded that properly planned energy efficiency policies on lighting and cooling can result in annual electricity savings of about 16%. This goes to show that an understanding of artificial

lighting and how it can be effectively managed is essential for achieving a reasonable building maintenance and urban life cycle cost in the development of the built environment.

3.4. Effects of artificial lighting on emotion

Artificial lighting is an important consideration in the wellbeing of users of a particular space as it affects mood, emotion and mental alertness. It can also support and affect circadian rhythms and influence peoples physiological and psychological states [14]. Therefore, artificial lighting methods are usually adopted for the purpose of creating varying kinds of environments or inducing certain emotional states. It is a powerful tool of passive communication. Examples of this can be seen in spaces like theatres, stadiums or plays where certain emotional states are evoked from the audience. Artificial lighting plays a key role in this regard.

According to [25], an improvement in the type, sources, quality and levels of artificial lighting in learning spaces such as schools, help to improve the rates of mental alertness and productivity for both students and teachers. In their research where they evaluated the opinions students held over LEDs and fluorescent lamps on their productivity, the result showed that students responded more to LED lights than they did to fluorescent, stating that it was more comfortable, attractive and stimulating. This implies that not only does artificial lighting evoke both emotion and stimulation, but the kinds of luminaires used to produce light have a direct effect on the kind of results generated and the effect it has on the end users.

3.5. Effects of ambient lighting on approach motivation

Lighting has a long lasting effect on individuals and how they relate with others and as such should be correctly utilised in order to maximise its effects in this regard. A research by [13] on the effects of ambient lighting, discovered that people reported less approach motivation in a dark room as against a bright room. The study investigated the influence of lighting over the psychological motivation of users to enter or engage with a certain space. As a result of the impression that a dark space is more likely to lack an activity, the study posited that darker environments are more likely to lower approach motivation as against brighter atmospheres [26]. Some other studies also revealed similar findings [13].

3.6. Architectural lighting in workspaces

In a research on the application of artificial lighting in office spaces [14] conducted a study on how artificial lighting is used as a tool for non-verbal communication within the building envelope. The author noted that intelligent lighting solutions help to increase peoples sense of wellbeing to create identity and at the same time cut energy costs. The researcher also advanced that lighting spaces that can be adjusted to the personal preference of users by variable colour temperature and quantity of light, increase employee satisfaction and create identity. High quality product design that maximises illumination, aesthetics and reduce maintenance costs also play a role in this.

In order to favour concentrated, creative and communicative tasks of an office space, rather than uniform and general lighting design, modern workspaces favour lighting that splits spaces into zones and therefore accommodates various types of use, as well as the needs of individual employees where every employee is enabled to individually adjust the brightness and color temperature assigned to them. In the context of 'light creating identity' the right use of colors in a space help to convey the truth of activities performed in the space. Therefore, spaces that appear open or closed, private or public, safe or unsafe are created. To create a sense of identity using light, lighting design and features should be incorporated along with the intended users of that space, building or environment [14].

Nonetheless, while the study of [14] dealt deeply on the psychological and communication implications of artificial lighting in the workspace, it did not provide deep insight into how exactly artificial light can be manipulated to create specific feeling or induce specific kinds of non-verbal communication. The ideas projected in the research are only pivotal for understanding how artificial lighting functions as a tool for both active and passive communication with users of a particular space.

3.7. Architectural lighting and its implications on the urban landscape

Looking outside the building envelope briefly, artificial lighting also provides a wide array of uses and possibilities. One of the applications of lighting in the urban scape include security control as lit spaces naturally invoke openness and serve as a passive deterrent to criminal activity. It also highlights a more defined cityscape and helps to drastically reduce the rate of accidents through guidance and navigation [27].

Lighting design also serves a role of defining portions of a particular region. While it helps in achieving proper understanding of the cityscape as a whole, lighting design should also be able to delineate and specify urban zones on a wider scale. The application of artificial lighting in highlighting urban furniture helps users understand which spaces are categorised as public open spaces and which are seen as closed. Residents or tourists therefore know where to sit, where to walk, as well as places that are out of bounds. Lighting master plans are also crucial in identifying Lynch's five concepts in city development which are: paths, landmarks, nodes, districts and edges [16].

In an investigation by [28] on artificial lighting in future cities and how architecture can be created through the physics of light, the researcher advanced that artificial lighting is a vital component of urban design and should be recognized as such. Like natural lighting, artificial lighting also contributes to the material and spiritual growth of cities and humans. However, as there is no universal or central lighting scheme that covers a wide area on an urban scale, he submitted that linear lighting with varying colours should be used in isolated city areas as a means of directing the population to specific areas and eliminating inner city challenges such as delayed time or cases of violence. The researcher also looked into separating functional areas of a city by the colour of luminaries used in external lighting and suggested that pathways (roads) to a certain functional area bear the same colour of that functional area in order to create order, beauty, security and avoid time wasting in navigation. Planting similar coloured light bands in hospitals to guide clients to relevant areas and spaces was also recommended. The author concluded that artificial light has become a tool for enhancing public comfort, health and safety and that spatial visibility can be improved by lighting.

In general, the studies reviewed in this section clearly indicate that the language of artificial lighting can be translated in the urban environment to mean a tool for navigation and specification of spaces as well as urban zones and areas. Nonetheless, a lighting concept on an urban scale is yet to be widely implemented.

3.8. Summary of Key Findings from Literature Reviewed

The following table provides a general summary of key issues from the major literature reviewed.

Table 1: Summary of Key Findings from Literature Reviewed

SN	Author/Date	Topics	Paradigm/Method	Purpose	Findings	Gaps
1	Designing Buildings Limited (2020).	Artificial Lighting.	Qualitative	The study discussed artificial light sources, and types of artificial lighting	Artificial light sources include; incandescent, fluorescent and light emitting diode. Types of artificial lighting include; Ambient, task and accent lighting	Does not consider the levels of efficiency of these types and sources, as well as their effects on users.
2	Anj (2020).	Giving Life to Ideas: The Next Wave.	Qualitative	The study examined the influence of artificial lighting in interior design	The way in which you incorporate lighting into your home interiors defines the mood of the user of the space as it has a great impact on the perception. Good interior	Only considers the influence of interior lighting features and excludes exterior.

					lighting design can increase the brightness of a space and create ideal mood sets.	
3	Rea, M. S. (2018).	Lighting Simply Made Better: Providing a Full Range of Benefits without much Fuss.	Mixed Method	The study revealed the human retina is sensitive to a wide range of wavelengths. This research has also elucidated the spectral and the absolute sensitivities of these different neural channels	Light can evoke important <i>non</i> -visual responses, such as circadian regulation. Proposed herein is a new, unbiased “universal luminous efficiency function” [U(λ)]	Focuses on the technical qualities of efficient lighting without addressing what methods of lighting can evoke specific required responses.
4	Veenstra, L., & Koole, S. L. (2018).	Disarming Darkness: Effects of Ambient Lighting on Approach Motivation and State Anger Among People with Varying Trait Anger.	Qualitative	The present research examined the influence of ambient lighting on approach-oriented motivation and emotion. Because darkness is associated with inactivity, the authors hypothesized that dark (vs. bright) environments would lower approach motivation.	People reported less approach motivation in a dark (vs. bright) room. People high (vs. low) on trait anger were less prone to become angry at a dark (vs. bright) site. The effects of ambient lighting fit with modern theories of situated emotion regulation.	Limited in sample size and population, and did not consider varying cultures and age groups.
5	Wikibooks (2018).	Technical Theatre/Lighting/Introduction.	Qualitative	Discussed the controllable qualities and the functions of light in theatres	Qualities include; intensity, colour, direction & movement. Functions include, visibility, focus	Does not consider the new roles of artificial lighting but focuses on properties

					and mood	
6	Zumbotel. (2017).	Light for Offices and Communication.	Qualitative	A handbook examining lighting fixtures and their role in the interior office environment	Results show the variety of ways lighting can serve as a means of communication within the office environment, especially in the areas of activity and delineation of private and public spaces.	Future studies can verify results obtained through more quantitative data analysis.
7	Kuijsters, A., Redi, J., Ruyter, B. d., & Heynderick X, I. (2015).	Lighting to Make You Feel Better: Improving the Mood of Elderly People with Affective Ambiences.	Qualitative	The study hypothesized that ambiances with a clearly recognizable, positive affective meaning could be used to effectively mitigate negative mood in elderly.	In line with the hypothesis it found that the activating ambience was physiologically more arousing than the neutral ambience. The cozy ambience was more effective in calming anxious elderly than the neutral ambience, as reflected by both the self-reported and physiological measurements.	Future studies can replicate the analysis carried out on other age groups besides the elderly to see if results tally.
8	Oyedepo, S. O., Olayinka, S., Adekeye, T., Leramo, R., Kilanko, O. & Babalola, P. (2015).	A Study of Energy Demand and Consumption in Covenant University, Ota, Nigeria.	Quantitative	The purpose of the study was to conduct an energy audit was conducted at Covenant University in Nigeria looking for ways to reduce energy costs.	Results showed that a well-articulated and vigorously pursued energy efficiency policy measures in the university can result in an estimated annual savings in electricity consumption of about 16%.	The case study can be replicated in multiple institutions and building typologies.
9	Oluwunmi, A. O. & Izobo-Martins, O. (2012).	User's Satisfaction with Residential Facilities in Nigerian Private	Mixed method	This study aimed at ascertaining the satisfaction derived by residents of	Findings showed that the inhabitants of the university staff quarters were majorly satisfied with	The case study can be replicated in multiple institutions and

		Universities: A Study of Covenant University.		the staff residential estate of a Nigerian private university from its facilities with a view of ensuring the functionality and optimal performance of facilities in Universities.	the services of five out of the eight principal university facilities maintained by the Physical Planning and Development (PPD) unit.	building typologies.
10	Talebian, K. (2012).	Day for Night - The Role of Artificial Lighting in Returning People to Urban Public Spaces.	Qualitative	The purpose of this research was to understand how planning, developing and revitalizing of appropriate lighting design for urban space supports bringing people back to the public spaces of the city.	Current dissertation pointed out; in order to be able to attract people to urban public spaces, set of rules and guidelines has to be applied to the lighting of public spaces which calls Lighting Master Plan, and recommended 13 factor89ys for evaluating lighting consumption in a region.	Studies in the future can be carried out using this framework in multiple cities of varying cultures and population sizes.
11	YoungYun, G., HyoinKim, & TaiKim, J. (2012).	Effects of occupancy and lighting use patterns on lighting energy consumption.	Mixed Method	Reported survey results from a monitoring campaign of four offices in Korea, which was conducted from February to June 2010 with an aim to reveal occupancy patterns, occupant use of lighting systems	The results indicate that there are no statistically significant relationships between external illumi nance and lighting use patterns, but there is a clear time of day effects (i.e. a strong tendency of turning on lighting on worker's first arrival in the morning).	The paper uncovered the influence of occupancy patterns on lighting use. Further research can be done to understand how certain lighting practices affect occupancy patterns, and by extension , lighting

						usage.
12	Yun, G. Y., Kong, H. J., Kim, H. & Kim, J. T. (2011).	A Field Survey of Visual Comfort and Energy Consumption in Open Plan Offices.	Qualitative	This study aimed to reveal the factors in determining lighting energy consumption of open plan offices with the emphasis on the roles of occupant adaptive actions.	Results reveal that there were close relationships between prevailing illuminance levels on the work plane and luminous comfort.	Future studies can be carried out using other office layouts and formats.
13	Al-Ashwal, N. T. & Budaiwi, I. M. (2011).	Energy Savings due to Daylight and Artificial Lighting Integration in Office Buildings in Hot Climate	Mixed Method	Investigated the energy performance of office buildings resulting from daylight and artificial lighting integration in hot climates	Results have shown that as much as 35% reduction in lighting energy consumption and 13% reduction in total energy consumption can be obtained when proper daylighting and artificial lighting integration is achieved.	Further research can be done to understand the results of the utilisation of artificial lighting alone.
14	Krarti, M., Erickson, P. M. & Himan, T. C. (2005).	A Simplified Method to Estimate Energy Savings of Artificial Lighting use from Daylighting.	Quantitative	Provided a simplified analysis method to evaluate the potential of daylighting to save energy associated with electric lighting use.	A direct correlation was established between window transmittance and window area on annual lighting reductions.	Focuses on the relationship between artificial lighting and daylighting in energy, not in terms of human psychological influence
15	Ghisi, E., & Tinker, J. A. (2005).	An Ideal Window area Concept for Energy Injtegration of Daylight and Artificial Light in Buildings.	Quantitative	This paper presented a methodology to predict the potential for energy savings on lighting using an Ideal Window	It was observed that the potential for energy savings on lighting in Leeds ranged from 10.8% to 44.0% over all room sizes and room ratios for an external illuminance	Future studies can identify how to achieve proper illumination levels with artificial lighting alone

4. Discussion

The study was conducted to investigate the variety of roles illumination plays in architectural designs of the 21st century to provide insight for better understanding of the applications of artificial lighting within the urban context in recent times. The review of studies relating to artificial lighting indicates that artificial lighting has a wide range of uses that goes beyond just illuminating a space or improving visibility. Artificial lighting is now a useful tool for navigation, beautification, delineation of spaces, emphasising features, as well as influencing user's mood and psychology within an environment. Luminaires are now fixtures employed to put a finishing touch to the design of environments. To achieve users' satisfaction in a functional space, it is important to choose the right luminaires that will help achieve the desired result. Issues such as luminous intensity, luminous flux, luminaire efficiency, luminance distribution and cost efficiency, are all important aspects to also consider.

In determining the right lighting design for a space, guidelines such as the use of the space, number of users designed for, finishing materials, size and physical attributes of luminaires, are all important factors for architects and lighting designers to consider, in order to achieve a desired outcome. Through the use of bright and dark areas, spaces can be viewed as more or less active respectively. In floors, roads and walkways design, certain luminaires can be used to direct users through building and urban spaces. This shows the application of artificial lighting as a tool for human navigation. With the use of a variety of colours, light intensity and accessibility, artificial lighting can also influence the moods and levels of engagement of workers or users in a space. If properly utilised, it can help architects in ensuring proper use of spaces as intended. Active or inactive spaces can also be made more active or inactive depending on what is desired with the correct application of artificial lighting principles.

5. Conclusion

Artificial lighting has evolved beyond spatial illumination over the years to become a tool for passive non-verbal communication that can evoke emotion and affect people psychologically. It is recommended that architects should take advantage of the numerous potentials artificial lighting presents to explore more possible ways of using illumination to enhance users' comfort, experience and satisfaction in the development of the built environment. Artificial lighting design is an integral part of the design process. Therefore, planning for it should be introduced early in the design stage to avoid incurring unnecessary cost and time wasting associated with late decision making in the construction industry.

This study has compiled and analysed in one place, various literature that showcased the evolving role of artificial lighting as a tool for non-verbal communication in specific areas of the built environment. The study's contribution is that it has provided a new platform that sheds more light on the potential applications of artificial lighting as a tool for human, non-verbal communication in the architectural profession. The paper is also a reference material for architectural professionals, scholars and students to better and more conveniently understand the new roles of artificial lighting in architectural designs and how they can be practically applied in the field to enhance users experience and evoke certain emotions in people, as intended by designers. In addition, the study establishes a new scientific base for further research on the topic.

The study was conducted as a literature review. This implies that, only secondary data were collected, analysed and presented. This did not allow for new discoveries to be made, but rather provided a systematic information on existing knowledge for better understanding. Further studies could examine users experience and satisfaction with various lighting types, as well as the effectiveness of different kinds of lighting in meeting designers' intentions and users' specific needs. Such studies will involve the collection of raw primary field data that may likely lead to new discoveries towards possible improvement in the design of artificial lighting fittings and fixtures. Similar literature review studies can also be conducted using wider scope for the literature search, as the authors recognise that the literature search scope utilised for this research constitutes a limitation for the study. Such investigation can extend beyond how artificial lighting was used before the 21st century.

6. Credit

The credit for this research goes to the author, SHOLANKE Anthony and Co-authors FADESERE Oladimeji and ELENDU Daniel. The following table shows the contributions of each of the authors.

Table 2: Authors' Status and Contributions

SN	Name	Status	Contributions
1.	Sholanke Anthony	Author	Conceptualisation, Formal Analysis, Funding Acquisition, Methodology, Project Administration, Resources, Supervision, Validation, Visualisation and Writing (review & editing).
2.	Fadesere Oladimeji	Co-author	Conceptualisation, Data Curation, Formal Analysis, Investigation, Visualisation and Writing (original draft).
3.	Elendu Daniel	Co-author	Data Curation, Investigation and Writing (original draft).

7. Acknowledgements

The authors appreciate Covenant University for providing the resources and enabling environment to conduct this study, as well as researchers whose works were used as reference materials. Such works were duly cited appropriately in the body of this paper and referenced in the next section.

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