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Integration of Green Architecture Principles for Occupants Thermal Comfort in a University Students' Hostel, Nigeria

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ABSTRACT
Occupants comfort is fundamental in assessing the benefits to be derived from occupying a building. This in no small measure is attributed to the fact that it has a direct bearing on the health and performance. Anecdotal evidence shows that university hostels lack the required comfort needed to improve and /or boost students' academic performance. It is against this backdrop, that this study seeks to investigate green architecture principles for Student's thermal comfort in university Hostels. The methodology of the paper consists of a desktop systematic review of literatures. It adopts peer-reviewed articles from high academic database in gaining insights on green architecture and thermal comfort of users. Emerging findings suggests the need to adopt the culture of green architecture approach to designing university hostels for student's thermal comfort and improved academic performance.

Key words: Green Architecture, Green Architecture Principles, Thermal Comfort of users, Buildings

INTRODUCTION
Considering the fact that buildings account for about 40% of the amount of global energy consumption with an accompanying 30% CO2 emission, it is noteworthy to emphasize that a significant portion of this energy is used for thermal comfort in buildings (Lavy et al., 2014; Yang et al., 2014; Huang et al., 2015). However, the prevalence of efficient and effective cooling systems that meets occupant's cooling requirements and health needs is another dimension that is deeply rooted in the philosophy of green architecture. It is generally perceived that, since human beings spend about 80-90 % of their day indoor, a green architecture that provides sufficient comfort is very fundamental (Zuo & Zhao, 2014; Park & Nagy, 2018).

According to Akande (2010), buildings meant to serve as accommodations are design without giving the necessary consideration to factors that are responsible to enabling thermal comfort without much dependence on energy use. In addition, providing adequate comfort in buildings is equivalent to disease prevention by allowing proper ventilation which guarantees the comfort of occupants. Nonetheless, there has been a burgeoning interest in the philosophy of green architecture with emphasis currently been directed towards building ratings or assessment system which in itself is a tool for rating building performance with respect to some specified set of criteria including site, water, material, energy and indoor environment quality and other attributes of sustainable design (Gou et al., 2014).

A close examination of the Nigerian built environment, suggests that whilst the practitioners and designers have constantly made efforts to integrate the philosophy of green architecture that would permit for enhanced or improved user's comfort, a lot still has to be done in cascading the ideals of eco designs. From global statistics, Heating, Ventilation and Air Conditioning (HVAC) accounts for over 40% of energy usage in buildings particularly institutional building and overly above 60% in laboratories (Gou, 2014; Lobaccaro & Acero, 2015; Hamzah, 2016). The figure above shows that the amount of heat expended needs both an urgent attention and an immediate regulation. Based on the forgoing, it is pertinent to provide a holistic perspective that would be modelled as an approach towards the integration of green

architecture principles for user's thermal comfort that would then be adopted in students' hostel, for Kaduna state university. The overall objective of this study is to provide a general view about green building assessment systems with indicators revealing key characteristics of important subsystems and elements of concern.

METHODOLOGY

This study adopts a conceptual analysis framework using a systematic review of literature methodology design to gain scholarly insights on how to encourage the integration of green architecture principle for user's thermal comfort in buildings. In achieving this, 30 peer-reviewed journal articles were sourced from 12 distinct (Sage, Emerald, Cambridge Journal, Elsevier, Wiley, Taylor & Francis, Inderscience, Heinonline, Eric, Jstor, Oxford, Springer) and highly academic databases from 2014-2018 using the search combinations: Green architecture principles + Thermal Comfort of Users all in advanced search title from Google Scholar Search engine. The same process was repeated multiple times in sourcing for the articles. This methodology was found to be very academic, accurate, reliable and easily replicated, hence, the rationale for its usage.

Literature Review

This chapter reviews scholarly works in other to provide insights on the integration of green architectural principles for user's comfort. To achieve this perspective, the opinion of scholars are reviewed in order that policy planners and practitioners in the built environment will have a holistic perspective on the green architecture principles that will permit or allow for user's comfort in buildings.

Thermal Comfort and its Antecedents

Thermal Comfort is defined in ISO 7730:1995 standard as "That condition of mind which expresses satisfaction with the thermal environment" (ISO, 1995). This statement makes clear that thermal comfort is a product of people response to their thermal environment, which based on their personal condition (Hamzah, 2016).

First off, from the clear examination of scholarly definition of thermal comfort has been stressed by previous studies as one that cannot be discountenanced when assessing the performance of buildings with suppositions that residential buildings having more thermal comfort than public and commercial buildings (Adunola & Ajibola, 2016).From their perspective, thermal conditions and fluctuations are influenced by architectural space and materiality in relation to solar orientation, wind direction, and response to diurnal temperature fluctuation. What is more, is the fact that thermal comfort is in part a psychological phenomenon open to influence by variables other than thermal. Nonetheless, buildings are naturally supposed to have responsive filters that condition a building to be thermally comfortable in the light of environmental conditions. In addition, to achieve this objective, the building must provide for an acceptable thermal functionality that is quite suitable for occupants

Contrary to the findings of Adunola and Ajibola (2016), it is pertinent to also note that adverse effect of high levels of tropical urban air temperature is a deciding factor in planning for an occupant's satisfaction in buildings. To this end, it is fundamental to note that in Nigeria the environmental conditions does not always allow for user's comfort. This in part is attributed to the location of the country and the tropical distribution and geographical characteristics of our climate. Nevertheless, these anomalies can be mitigated or curbed using green architecture designs and inclinations bearing in mind, the region's specific characteristics, and the town's landscape that should be considered in design thermally comfortable buildings. From the perspective of the scholars here, it suggests that understanding the environmental aspects of architecture and the way they align or interact with the needs of people (occupants) is a fundamental step in defining the appropriate green principles that would be integrated in the building design. This suggests that buildings meets an array of environmental diversity that defines a realistic spectrum of criteria, it also

seeks to contribute to a more detailed and distinctive design in a thermal environment.

More importantly, scholars have opined that the significance of behaviour, context, and culture can never be displaced when issue of architectural thermal comfort is to be discussed or examined. In emphasizing this, a psychological dimension is adopted to stress the presence of certain physical parameters of an environment to the thermal state of the occupant's physiology and health, occupant's experience of thermal comfort(as it will explain in detail the occupant's experience level of comfort given the prevailing environmental conditions or attributes. In another sense, spatio-structural elements in buildings has been identified as quite fundamental for building occupants to adapt naturally to the thermal conditions of their building (Shin & Miller, 2014). More so, these factors allows for other variables such as the socioeconomic, educational level, intellectual exposure, cultural and traditional dispositions to values amongst others. Anyhow, in determining the green architecture principles for occupant's building, Raghab (2016) emphasized the occupants, the adaptation process, the spatial characteristics of the building, the locational attributes or features, and the climate as key in assessing the thermal condition of buildings.

From the perspective of Adunola (2014), indoor and outdoor measurements of air temperature and other relevant climatic elements with certain variation of temperature across residential densities is very integral and affects indoor thermal comfort. However, the microclimate is also very key as it impacts the indoor comfort of residents.

Fundamentally, the concept of adaptive thermal comfort is the basis of the thermal experience in the urban spatial environment. The adaptive nature of thermal comfort has been expressed as being a means of extending the comfort conditions within spaces as occupants utilize the adaptive opportunities available to them with emphasis on the parameters to consider are the outdoor temperature at different intervals of the day and indoor temperatures during different periods. (Adunola, 2014). This was closely corroborated by Rupp et al. (2015) but with some modification and extension of the parameters or variables to include naturally ventilated, air-conditioned and mixed mode buildings, personalized conditioning systems, influence of demographic factors and their accompanying history and other variables attributed to environmental properties such as humidity, air movement, and layout among others.

Yang et al. (2014), further stressing the understanding of thermal comfort and energy conservation in buildings, in their opinion, factors such as future climate scenario using HVAC applications, fuel mix and other associated energy plans in adjusting to heating and cooling requirements due to climate change.

Manzano-Agugliaro et al. (2015), suggests certain bioclimatic architecture strategies that have been adopted in specific countries to be exported to other areas with similar climates in that it allows for a good functional design strategy fosters large energy saving measures (each in its corresponding climate) related to s(K, 2010) solar protection and humidification.

Conversely, Taleb and Taleb (2014), propose alternatives for various orientations that relative to wind and sun, their effects on the temperature and other wind readings would complement adequate thermal comfort levels. Nevertheless, from their perspective, setting up regulations regarding the planning of desert areas should be on the basis of early assessment of designs (Scognamiglio & Garde, 2016).

Furthermore, integrating an atrium into a Dutch terraced dwelling will facilitate the reduction of heating demand and increase the number of discomfort hours during the summer (Taleghani et al., 2014; Shin, 2016). Anyhow, regardless of the performance of energy and other climatic factors, an optimal balance is achieved between energy use and summer comfort for the severest climatic situations.

Next, despite the subjective nature in the modelling of thermal comfort for practical applications, option of using standardized thermostat settings is necessary in some

instances (Pritoni et al., 2017). In using HVAC systems, the thermal comfort assessments of occupants in the control strategies of such systems would determine their improved efficiency. Different measures towards the control of this systems have birthed the use of open-loop systems is directly integrated into HVAC controls, but still, closed –loop control systems exists. Principally, employing a control algorithm which is seated on a reconciliation of use, as proxy for thermal comfort would permit a real –time assessment or feedback.

Also, devising an appropriate combination of housing preferences is quite necessary on one hand, and on the other hand, it requires a great deal of commitment to bridge the complexes of the underlying factors. These are attributed to the fact that, multiple decision making has its relative importance in that better defines structural attributes of housing preferences. Fulfilling the above needs enables potential occupants or buyers of buildings prioritize the different elements of a house design (Mohammad et al., 2014; Moghimia & Jusan, 2017, Kalutara et al., 2017).

The opinion of Azizi and Fassman (2015), further pinpointed the behaviour of people when they are too hot or too cold. Bearing this in mind, they suggested three coping mechanism were tested

(i) environmental adjustment,
(ii) personal adjustment and
(iii) psychological adjustment.

This explains why occupants in "green buildings engaged more in personal adjustments, less environmental adjustment, and more in psychological adjustment compared to conventional buildings, while in response to being hot, these coping mechanisms were less apparent" (Azizi & Fassman, 2015 p.5).

Worthy of mention is the fact that environmental conditions partly in line with the nature of plant adaptations, design mapping have been suggested to be imbibed from biological principles to architectural resources in order to permit the opening of new perspective that would allow for new possible technical solutions and stressing the adaptation of plants to environmental conditions during a particular climate (Fekry et al., 2014; López et al., 2017).

Green Architecture Designs

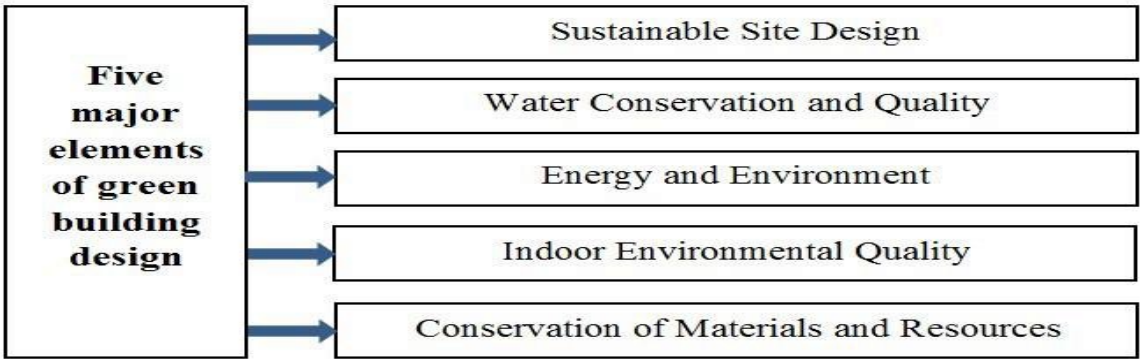
It is quite fundamental to emphasize that "the concept of "Green Architecture" also known as "sustainable architecture" or "green building," is the theory, science and style of buildings designed and constructed in accordance with environmentally friendly principles" (Ragheb et al., 2015 p.778).Whilst Green architecture strives to minimize the number of resources consumed in the building's construction, use and operation, as well as curtailing the harm done to the environment through the emission, pollution and waste of its components, there is an urgency to design, construct, operate and maintain buildings energy, water and new materials are utilized as well as amounts of waste causing negative effects to health and environment is generated (Ragheb eta l., 2015).

From the perspective of Burcu (2015) and USGBC (2002), Green architecture or eco-design, or eco-friendly architecture, stresses the following as the important criteria in achieving green architecture:

i. Ventilation systems designed for efficient heating and cooling
ii. Energy-efficient lighting and appliances
iii. Water-saving plumbing fixtures
iv. Landscapes planned to maximize passive solar energy
v. Minimal harm to the natural habitat
vi. Alternate power sources such as solar power or wind power
vii. Non-synthetic, non-toxic materials
viii. Locally-obtained woods and stone
ix. Responsibly-harvested woods
x. Adaptive reuse of older buildings
xi. Use of recycled architectural salvage
xii. Efficient use of space

While most green buildings do not have all of these features, the highest goal of green architecture is to be fully sustainable (USGBC, 2002).

From the above, the main principle of green building is summarized below:



Source: USGBC (2002)

Moving on, Gou et al (2014), differentiated green building certification systems at an international, national and local level using a cross contextualism theory that stems from the fundamental divergence on lifestyles, preferences, urban morphology besides climatic variations. The discussion is derived from a study of three green rating systems representing international, national and local systems with reference to intentions, mechanisms and benchmarks to facilitate objective assessments. For the case of Hong Kong, local challenges are identified and compared with counterparts at a national level. Two residential projects having certified by the 'modified, localized' national system is selected for a case study for synopsis with a view to explain the cause and effect of transferability versus non-transferability of assessment credits and protocols.

Consequently, Tharim and Samad (2016) highlighted the importance of adopting sustainable designs, stressing that it does not only advance the positives for the environment but also provides for the reduction of the overall life cycle cost of building in order to increase the occupant's comfort, which in turn helps in creating a sustainable community around us. Overall, green construction and sustainable construction is key in an effort to optimizing the occupant's comfort in a building. To this end, emphasis was made on building façade, indoor environment quality, thermal comfort, occupant's satisfaction and green building (Al-Rifaie et al., 2014; Ishak et al., 2017; Masood et al., 2017).

Subsequently, Gou (2016), green building for office interiors are a ramification of green building that refers to efficiently using resources and improving occupant health and productivity. Green building concept allows for green building standards and rating systems such as LEED (Leadership in Energy and Environmental Design), which helps government regulators, building professionals and consumers embrace green building. From Gou (2016), it is suggestive to say that green building rating system, is undeniable the standard or rating systems that will provide practical methods and guidelines for designing and assessing building performance through a user-friendly checklist.

However, He et al (2014), emphasized that for a better energy-saving effect, the performance-based architectural design method and the integration of Building Information Modelling (BIM) technology and architectural design for energy conservation must be advanced as most preferable methods in achieving high quality living spaces and energy conservation. This is particularly evident in China because of its application of digital technology in building energy conservation.

Green Building Benefits

Green building is not a simple development trend; it is an approach to building suited to the demands of its time, whose relevance and importance will only continue to increase (USGBC, 2002) Comfort: Because a well-designed passive solar home or building is highly energy efficient, it is free of drafts. Extra sunlight

from the south windows makes it more cheerful and pleasant in the winter than a conventional house.

Economy. If addressed at the design stage, passive solar construction doesn't have to cost more than conventional construction, and it can save money on fuel bills.

Aesthetics. Passive solar buildings can have a conventional appearance on the outside, and the passive solar features make them bright and pleasant inside.

Environmentally responsible. Passive solar homes can significantly cut use of heating fuel and electricity used for lighting. If passive cooling strategies are used in the design, summer air conditioning costs can be reduced as well.

RESULTS AND FINDINGS

From the review of literatures in the review section, the following consensus have been agreed on by scholars are predicates for ensuring the use of green architecture principles to achieve thermal comfort of users or occupants of buildings. Herein, they are presented as the results and major findings of the study.

An in-depth understanding of thermal comfort and energy conservation in buildings, with factors such as future climate scenario using HVAC applications, fuel mix and other associated energy plans is fundamental to heating and cooling requirements due to climate change.

Also, the occupants, the adaptation process, the spatial characteristics of the building, the locational attributes or features, and the climate as key in assessing the thermal condition of buildings.

In addition, behaviour, context, and culture can never be displaced when issue of architectural thermal comfort is to be discussed or examined.

The important criteria in achieving green architecture: Ventilation systems designed for efficient heating and cooling, Energy-efficient lighting and appliances ,Water-saving plumbing fixtures ,Landscapes planned to maximize passive solar energy , Minimal harm to the natural habitat , Alternate power sources such as solar power or wind power , Non-synthetic, non-toxic materials , Locally-obtained woods and stone , Responsibly-harvested woods , Adaptive reuse of older buildings , Use of recycled architectural salvage , Efficient use of space.

More importantly, bioclimatic architecture strategies that have been adopted in specific countries to be exported to other areas with similar climates in that they allow for a good functional design strategy that fosters a large energy saving measures (each in its corresponding climate) related to solar protection and humidification.

Again, the orientation relative to wind and sun, their effects on the temperature and other wind readings would complement adequate thermal comfort levels.

Subsequently, thermal comfort has been stressed as a psychological phenomenon open to influence by variables other than thermal.

Performance-based architectural design method and the integration of Building Information Modelling (BIM) technology and architectural design for energy conservation must be advanced as most preferable methods in achieving high quality living spaces and energy conservation.

Five major green architecture principles exist: sustainable site design, water construction and quality, energy and environment, indoor environment quality and conversation of material and resources.

DISCUSSION OF FINDINGS

From the results and findings presented earlier, this section provides discussions that would permit for the integration of green architecture principles for user's comfort into Hostel, in Kaduna State University.

Centrally, for any building or residential, the key components one should examine includes green architecture principles exists: sustainable site design, water construction and quality, energy and environment, indoor environment quality and conversation of material and resources. Integrating these features into buildings will not only enhance user's comfort but reduce the thermal level considerably whilst making efforts to attain green efficiency. It is then suggestive to state that buildings from the conceptualization

stages must have elements of sustainable design. By sustainable design, it implies that the building itself does have an eco-green design feature that will pose no threat to humans and the planet in general.

From our perspective we emphasize that for hostel buildings to imbibe the ideals of green architecture principles, the first step is a sustainable design with modifications and total quality management of other features that is added to the initial design.

RECOMMENDATIONS

Having emphasized the integration of green architecture principles and thermal comfort of user's, the following recommendations are put forward:

The ideals and philosophy of green architecture principles is one that is fundamental in ensuring thermal comfort of users and the conservation of our climate.

Whilst thermal comfort provided by HVAC is almost a must fit for buildings, it is recommended that with the amount of heat expended, the depletion it causes and the high energy consumption level, alternative means of heating buildings should be researched on and sourced for by designers and building practitioners.

Since emphasis has been made on the climatic factors particular to a given continent or location as being a critical factor to the thermal comfort at different intervals, this study therefore recommends the usage of location specific designs and resources that would address these concerns

Whilst the articles assessed in this paper is only a representative perspective of the myriad of literatures on green architecture principles and thermal comfort of users in buildings, it is therefore recommended that future researchers incorporate more papers and expand the databases for access to more journal publications.

CONCLUSION

This paper at first, initially sort out towards integrating green architecture principles and thermal comfort for building occupants. Through in-depth analysis a model perceived to have sustainable site design is very fundamental for designers. However, practitioners should be abreast with changing environmental conditions and constantly imbibe green initiatives in their conceptualization of designs with the human component given much consideration.

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