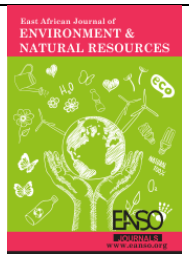

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Original Article

Architectural Preservation of Historic Buildings for Sustainable Built Environment

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ABSTRACT

Preservation of historic buildings plays a crucial role in promoting sustainable environment by serving as a model for climate-responsive designs and bridge between the past and the present architecture. This study focused on the need for architectural preservation of historic buildings in order to explore their unique features for energy efficiency that can benefit the environment in a sustainable manner. The study relied on case study methodology. Intrinsic approach to case selection is adopted because of historical relevance and significance to sustaining the typical tropical architecture design characteristics. The design of this case study is guided by the thermal comfort and energy efficiency theoretical developments of tropical architecture. The features of investigation center around the design characteristics and strategies that enhance the livability of a typical tropical building. Data for this research is primarily sourced through direct observation and photographs. Analysis of the data is done thematically. Findings reveal the investigated case building possesses design strategies and characteristics for the prevention and removal of solar heat gains in tropical buildings. These would enhance sustainable architectural practices within the tropical climate of Nigeria.

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INTRODUCTION

Architectural preservation of historic buildings is a dynamic method for developing resilient and sustainable communities which ultimately leads to cleaner built environment and ecosystem (Liang, et al., 2023). Various aspects of historical buildings could serve as examples and models to climate responsive and adaptive design strategies, the use of sustainable building materials and construction methods. All these could enhance new buildings' cooling energy demand and consumption if carefully implemented and optimised. Moreover, historical buildings have been able to showcase the way and manner in which human predecessors lived, and were able to wade through the challenges of climate impact on their existence (Armstrong and Kapp, 2022). The inherent significance of these historical buildings can last generations and serve as springboards for sustainable architectural practices through passive designs for climate adaptation to deliver energy-efficient buildings.

Development in the level of ingenuity of man and advancement in technology continuously shape the building styles and how the outdoor environment is planned. Modern and contemporary movements in architectural styles are overshadowing the legacy of sustainability offered by historic buildings, especially when there is a disregard for climate. There is minimal awareness of the architectural values of how human predecessors lived and survived the challenges of climate before innovations in advanced technology to provide cooling and heating aids for thermal comfort. This is because much emphasis is often laid on the preservation of historical buildings for cultural, history and heritage values of the society (Oldham, 2023; Okpalanzoe, & Adetunji, 2021; Omole, & Ogundiran, 2011).

Architectural preservation of historic buildings for the benefits of climate adaptation and responsive designs in tropical climates is necessary. This would promote the adoption of passive designs to reduce cooling energy demand and thereby deliver energy-efficient buildings for sustainable built environment. Developing sustainable built environment is one of the agenda of the United Nations Sustainable Development Goals (SDGs) (United Nations Environment Programme (UNEP), 2024). This is supported by the climate change action through clean energy and energy-efficient cities on decarbonisation to improve resilience and adaptation to future climate change (World Green Building Council (WGBC), 2023).

In Nigeria, researchers have established the purposes of preservation of historic buildings to include cultural, tourism, historical and economic benefits (Omole and Ogundiran, (2011); Okpalanzoe et al., (2021)), but preservation for the purpose of showcasing adaptation to climate parameters whereby indoor living condition is enhanced without dependence on artificial cooling methods was not considered. Previous documentation on the case study building, the Jaekel House, Lagos, preserves its history and heritage importance to Nigeria as a country such as enhancing tourism, boosting economy and recreation for psychological well-being. There is no research on preserving it for the architectural values on high adaptation to climate and how it can serve as a model for the tropical climate on thermal control, energy efficiency and overall sustainable built environment.

Historic buildings that consider local climate, building materials and methods of construction can contribute significantly to energy efficiency in buildings, this is fundamental to global climate change action (Jo et al., 2023). In light of the foregoing, this study will investigate the Jaekel House Lagos on its passive architectural characteristics and the significant climate adaptive role for energy-efficient buildings in the tropical climate of Nigeria. The study would explore the unique features present in the Jaekel house for climatic adaptation and responsiveness to hot environments. Intrinsic approach of case study methodology shall be adopted to gather primary data through direct observation and photography. The possessed passive design characteristics of the case study building would

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serve as a historic architectural example that makes Jaekel House Lagos worth preserving for generations and significantly contributing to sustainable environment.

LITERATURE REVIEW

Meaning and Significance of Architectural Preservation of Historic Buildings

Architectural preservation is an act of protection and maintenance of buildings, structures or any other physical elements within the built environment that have historical, cultural or architectural significance (Oldham, 2023; Archova, 2024). It usually includes identification, documentation and conservation processes to ensure durability and values for future generations (Okpalanzoe and Adetunji, 2021). Preservation of historic buildings starts from recognising the intrinsic and special values buildings have, which are of interest to the architectural history of a place and are therefore protected from damage, demolition and alteration. Architectural preservation of historic buildings encompasses efforts in the areas of addressing decay, deterioration and implementing adaptive reuse (Oldham, 2023).

Architectural preservation is highly significant to historic buildings in diverse ways, ensuring conservation, restoration and protection. Critical factors in determining architectural preservation merits of any historic building are the rich history of the past, unique architectural features, sense of community and urban sustainability, where identified buildings are eventually designated for protection (Oldham, 2023). The core of architectural preservation of historic buildings is the education about safeguarding the significant architectural landmarks and embracing their inherent unique characteristic. This would enhance learning about the past while shaping future sustainable developments (Adewumi, 2023).

Globally, numerous researches have addressed the preservation of historic buildings and the significance to cultural heritage, tourism, economy, education, sustainable environment. Jo et al., (2021) argues that historic buildings that consider the local climate, building materials and methods of construction can contribute to the energy efficiency and sustainability of buildings. Benefits of energy-efficient buildings include energy savings, emission reductions, low energy bills, improved indoor and outdoor air quality, comfortable and healthy buildings (Archova, 2024). Architectural preservation of historical buildings will safeguard against ruins and damage that can occur over the years through the action of weather, urbanisation and demolition.

Preserved historic buildings can serve as models on how to passively design buildings for climate responsiveness and adaptation for sustainable built environment. Since the time of Vitruvius, man has always thought about how to design buildings to suit the climate of a region (Gelder, 2018) for comfort and healthy living. According to Lechner (2014), passive designs in buildings is the first antidote against high energy consumption which leads to energy efficiency. Learning from the historic buildings' passive design strategies would in no little measure enhance comfortable habitation while cutting down on cooling needs of buildings. High level of thermal distress witnessed in the tropical climate of Nigeria makes it necessary to adopt building designs and construction methods that will prevent and remove heat gains at the surrounding microclimate and within the building interiors

Challenges in Architectural Preservation of Historic Buildings

Architectural preservation of historic buildings is faced with challenges that could hamper the realisation of the benefits of climate adaptiveness for energy efficiency, cultural values, history of place, tourism, economy and sustainable developments. One of these challenges is natural disasters and environmental decay such as floods, earthquakes, storms, termite invasions, fungi and mould growth (Okpalanzoe, & Adetunji, 2021; Archova, 2024). Omole and Ogundiran (2011) identified abandonment, lack of maintenance and poor governmental policy as some of the problems in the preservation of historic buildings.

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Moreover, sourcing accurate and authentic materials for repairs and restoration of historic buildings poses challenges Batistta, (2022)

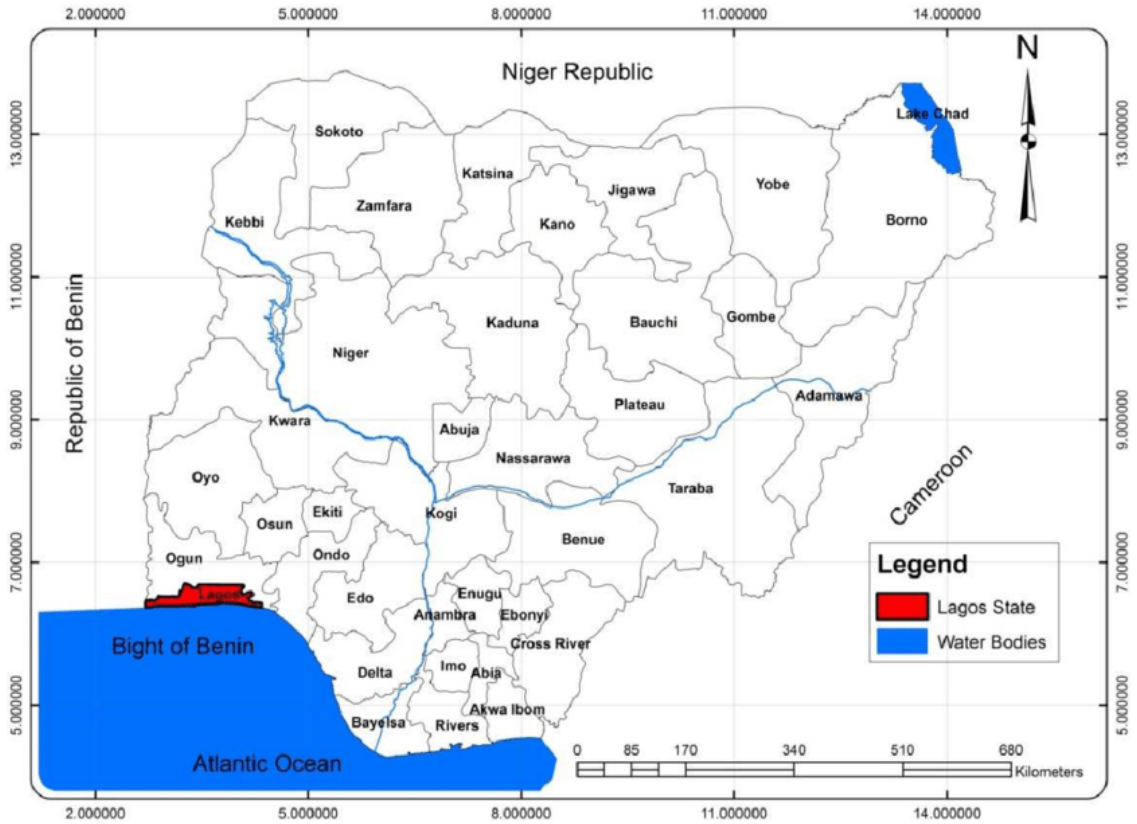
MATERIALS AND METHODS

Study Site and Climate Characteristics

The study site is at Ebute Meta, the headquarters of the Lagos Mainland Local Government Area which is situated at the center of Lagos and one of the most densely populated areas of Lagos (Figures 1 and 2). Lagos is a tropical city within the South-Western part of Nigeria and one of the fastest-growing commercial cities in the world (World City Culture Forum, 2023). It is situated along the Atlantic Coast in the Gulf of Guinea, stretching over 180 kilometres and made up of about 3,577 square kilometres, approximately 0.4 percent of Nigeria's landmass, with about 220.6 square kilometres covered with water bodies, mangrove swamps, and wetlands (Lagos State Government 2013).

Lagos lies between latitudes 6°22′ North to 6°42′ North and longitude 2°45′ East to 4°20′ East, at an altitude of 645 m above sea level (Sojobi et al.2015). The city has a warm-humid climate with the highest monthly average temperature of 29 Degrees Celsius occurring in February and March (Adebamowo et al. 2013). It experiences two climatic seasons; the rainy season from April to October which is characterised by wet and humid conditions and the dry season from November to March being characterised by dry and cold (harmattan) conditions. The annual average precipitation is 1000mm and the annual average temperature is 23-34 Degrees Celsius (Lagos State Government, 2013). The temperature and rainfall pattern are shown in Figure 3. It is of a wet equatorial climatic condition because of its proximity to the Gulf of Guinea along the Atlantic Ocean (Meteoblue, 2020). Lagos experiences high humidity throughout the year between 80-90%.

Figure 1: Map of Nigeria showing Lagos



Source: Adapted from Adeniran, Otokiti and Durojaye (2020)

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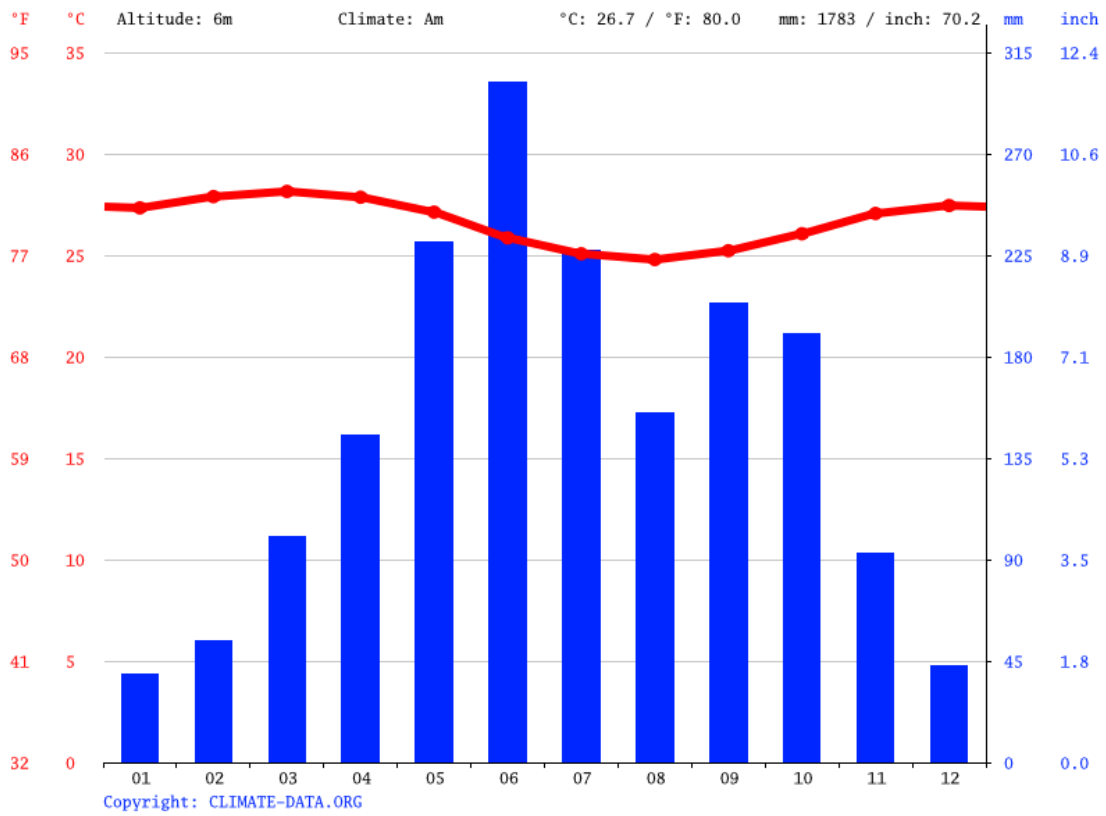
Figure 2: Part of Lagos showing Ebute Meta

Source: Map Data (2024)

Figure 3: Lagos Temperature and Rainfall Pattern



Source: Climate Data (2024)

Case Building Selection and Characteristics

The selection of the case building for this study was done purposefully. This is to ensure that the required information to achieve the objective of the research is obtained. The case for the investigation is the Jaekel House, Ebute Meta Lagos. The building was selected because of its historical relevance and significance to sustaining the typical tropical architecture design characteristics. Its architectural preservation for

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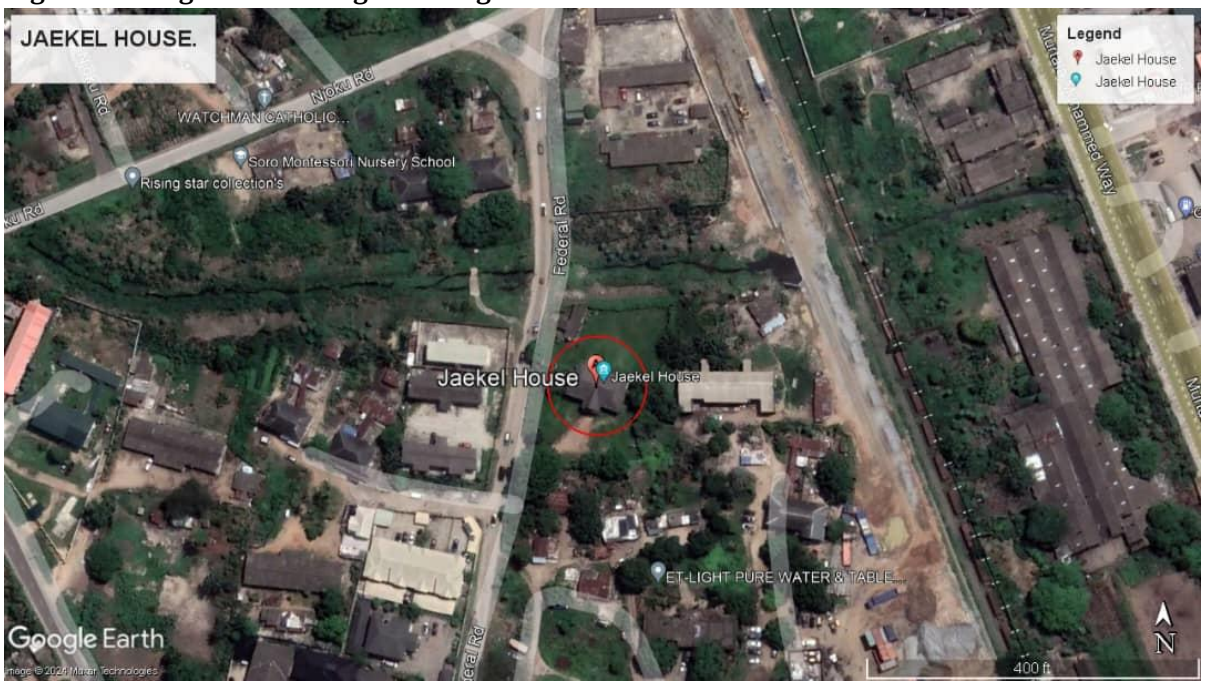
ages would enhance sustainable architectural practices and the environment within the tropical climate especially South-Western part of Nigeria.

Jaekel House is located at 17, Federal Road, Ebute Meta Lagos (Figure 4). It was built in 1898 by the Nigerian Railway Corporation as one of the first sets of residential structures for the top management staff. It was formerly named Quarter 17 but was later re-named after Late Francis Jaekel, a former superintendent of the Nigeria Railway Corporation. It used to be the residence of the general manager but was later converted to a senior staff rest house. The house had been standing for over 100 years before it was renovated and restored by Professor John Godwin in 2010. The Legacy1995 presently oversees and maintains Jaekel House to protect the history of Nigeria's first railway tracks, maintenance facilities, and storage buildings (British Council Nigeria, 2016).

Figure 4: Google Earth Image showing Jaekel House



The Jaekel House is an example of the colonial architectural style that was popular in Nigeria in the late nineteenth and early twentieth centuries known as "Brazilian style" The Portuguese, who brought Brazilian architecture to West Africa during the colonial period impacted the Brazilian style. The style is distinguished by symmetrical facades, intricate stucco work, arched windows and entrances that combine European and Brazilian elements. The use of native materials such as wood and corrugated iron, as well as louvered shutters to allow for natural ventilation, demonstrates this architectural influence (Sharma, 2023).

Jaekel House architecture considerably depicts tropical design to prevent and reduce heat transfer into the interior space. It is a two-storey building with dutch gable roof type which is most suitable for tropical climates. The height of the roof enhances the proper drain of water during rainfall and also prevents the conduction of heat into the interior spaces, thereby enhancing cooling. There is an overhang from the roof which shades the windows and the entire exterior walls of the house. Jaekel house form is rectangular with a veranda around it. It’s envelope is characterised by white coloured paint, brick walls and wooden framed windows with glass panels. The wooden louvered panels around the first floor achieve continuous air movements within the house (Figure 9). The interior of the house is also painted in white colour (Figure 9), this reduces heat gains within the interior and thus alleviates thermal distress. The outdoor space around the Jaekel

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House is natural with lush green vegetation, hardscape treatment was eliminated.

Methods

The study relied on case study methodology. Case study is a qualitative research approach whereby a contemporary case such as an individual, organisation, community, event or situation is comprehensively examined and analysed in its real-life context with a view to providing detailed understanding of the case being studied which can inform policy, best practices, develop new phenomenon or new research (Yin, 2018). According to Groat and Wang (2013), case study method is one of the architectural research methods where an empirical inquiry into a phenomenon or setting is carried out. The essence of case study strategy is the focus on investigating settings and phenomena embedded in its real-life contexts.

Intrinsic approach to case selection is adopted for the study. The case is selected because of its merits and uniqueness which is of interest to providing answers to the research question. The design of this case study is guided by the thermal comfort and energy efficiency theoretical developments of tropical architecture which could lead to sustainable environment. The features of investigation center around the design characteristics and strategies that enhance the livability of a typical tropical building. Data for this research is primarily sourced through direct observation and photographs. Data analysis is done thematically, while findings are presented descriptively.

Field Study

The field study consists of the actual assessment of the Jaekel House through direct onsite observation and photographs. Tropical building design strategies were analysed in the case building according to literature. The Jaekel House design characteristics, outdoor planning and building materials were assessed and analysed. The tropical design strategies observed and assessed are building orientation, use of shading devices, use of natural and cross ventilation, building thermal mass and use of reflective surfaces. The strategies are depicted by the building envelope characteristics for the prevention and removal of heat gain to optimise cooling for thermal comfort and reduced energy demand (Table 1). Thorough assessment was carried out of all the observed strategies and inferences were drawn. The images were produced with NIKON D750 camera.

Table 1: Jaekel House Investigated Design Characteristics

Building Design Strategies and Characteristics for Prevention of Heat Gain	Building Design Strategies and Characteristics for Removal of Heat Gain
Building orientation	Cross ventilation
Reflective light surface	Wooden louvered shading soleil
High pitched roof	
Wide roof overhang	
Wide veranda around the house	
Bricks for walling	
Wooden window, frame, door and Floor	
Outdoor shading using Tree, shrubs and grasses	
Clerestory	

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Figure 5: Front Elevation of Jaekel House

Source: Author 's Fieldwork, 2023.

Figure 6: Back Elevation of Jaekel House

Source: Author's Fieldwork, 2023.

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Figure 7: Right Side Elevation of Jaekel House

Source: Author's Fieldwork, 2023.

Figure 8: Left Side Elevation of Jaekel House

Source: Author's Fieldwork, 2023.

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Figure 9: Interior Space of Jaekel House

Source: Author's Fieldwork, 2023.

FINDINGS AND DISCUSSIONS

Jaekel House Design Strategies and Characteristics

Assessment of design characteristics of the Jaekel House was carried out through direct observation. Design strategies and principles for the tropical climate were investigated. Building design strategies and characteristics that prevent solar heat gains as well as strategies strategies that remove unwanted solar heat gains from interior space are presented.

Building Design Strategies and Characteristics for Prevention of Heat Gain

Building Orientation:

Assessment of the Jaekel House building orientation revealed that the building has a North-South orientation (Figure 4). The approach view of the house faces the south. This helps to minimise the exposure of the house to excessive solar radiation that could increase indoor air temperature and affect the thermal comfort of occupants. It is established in literature that appropriate building orientation in tropical climates prevents excessive solar heat gain and influences wind movements for natural ventilation (Lechner, 2014).

Reflective surface

The use of reflective surface principle for tropical building design was adopted in Jeakel House (Figures 5,7 & 9). The building was painted in white colour. The use of light colour on the building exterior has high reflectance and it lowers the surface temperature. This prevents heat transmittance into the building's interior space and thereby reduces cooling energy demand (Bulbaai, & Harman, 2021). Rawat and Singh (2022), achieve a 16% reduction in cooling energy demand during summer using light colour materials on building envelope in India. Yao et al., (2017) corroborate the use of reflective surfaces to reduce energy demand for cooling in tropical climate regions. This works on the principle that as reflectance increases absorption reduces. The effectiveness of reflection depends on the colour and material texture. Light-coloured and smooth surfaces offer greater reflectance or low absorption.

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High-Pitched Dutch Gable Roof with Welsh Roofing Slate

Dutch gable roof style of Jaekel House is a symbol of uniqueness (Figures 5,6 &7), characterising the show of elegance during the colonial era in Nigeria. The height of dutch gable roof has climatic advantage by enhancing roof ventilation to prevent quick transmission of heat into the interior spaces. The roof gable was vaulted creating a large space within the roof and introducing a window for ventilation in order to remove excess heat (Figure 9). High pitched roof also promotes quick flow of water from the roof surface during rainfall, since the tropical climate experiences high volume of rainfall. Higher stability is also provided by dutch gable than the ordinary gable roof.

Welsh slate roofing materials were used as the roof covering. It is very durable with its life span lasting hundreds of years. It has excellent insulation properties which reduces heat gain. This helps to achieve cooling within the house interior and ultimately improves thermal comfort of occupants (Neal, 2023). Welsh roofing slates used for the Jaekel House are sustainable, durable and aesthetically pleasing.

Wide Roof Overhang

Wide roof overhang design characteristics of the Jaekel house is a principle of shading the building from solar heat gain. The wide overhang shade the windows from direct solar heat absorption and thereby prevents indoor heat gain that could lead to thermal distress. Moreover, the roof overhang also prevents the building from driving rain.

Wide Veranda Around the House

The use of a wide veranda around the house especially east and west orientation is a significant solar heat gain prevention principle in tropical buildings. It also prevent glare and serves as a social space for different functions such as family gatherings. Jaekel House adopts this principle on three of its elevations to protect the building from unwanted solar heat gain that could lead to increase in indoor air temperature and consequently thermal discomfort of the occupant (Figures 5, 7 & 8). Traditional use of veranda is revealed in the indigenous Yoruba architecture from South-Western Nigeria. The space serves as a means to prevent heat transfer into the interior spaces as well as the social space to foster communication and engagement in various craft-making.

Bricks for Walling

External walls of the Jaekel House were made of bricks. Bricks are very versatile building materials that is sustainable because its readily available within the region and has excellent thermal performance whether in the warm or cold climate region of the world. The use of bricks in this historical building contributes to a comfortable indoor and sustainable environment.

Wooden Frame for Windows and Wooden Door

Jaekel House adopts wood for window frames, interior doors and floor for the first floor is also made of wood (Figures 5 & 9). Wood is a poor conductor of heat; this property made it a choice materials in Jaekel house to prevent heat gains within the interior spaces. Wood is a very sustainable building materials, it is readily available within the environment and renewable. It reduces solar heat transmittance into the building interiors and thereby maintains acceptable air temperature for thermal comfort.

Outdoor shading using Tree, shrubs and grasses

Jaekel House outdoor environment was well planned with vegetation around it (Figures 5, 6,7 & 8). This provides softness and contact with nature. Trees, shrubs and grasses provide shade and condition the outdoor environment from solar heat gain, this regulates outdoor microclimate around the house and thereby enhances cooling within the interior spaces. Vegetations in the environment prevent the accumulation of heat from solar radiation. Drivers of sustainable environment highlighted the role vegetation around buildings plays in achieving a reduction in energy consumption for thermal comfort (Brophy and Lewis, 2011)

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Clerestory

Clerestory windows were incorporated in Jaekel House on three of its' elevations; the front elevation, right side elevation and left side elevation (Figures 5, 7 & 8) for deep penetration of natural light and to make up for the amount of daylighting offset by the overhang shading the windows from direct solar heat gain. Clerestory are high-level windows allowing natural light to penetrate deeper and and increase light levels of interior spaces. Incorporating daylight into buildings is highly valued in contemporary architecture because it improves occupant well-being, lowers energy use, and produces visually beautiful areas.

Strategies and Design Characteristics for Removal of Solar Heat Gains

Cross Ventilation

An Array of wooden framed operable windows with glass panes were used to achieve cross ventilation in Jaekel House. Cross ventilation is essential for body cooling in the warm-humid tropical climate of Lagos, where there is high temperature and high relative humidity almost throughout the year. Wind-pressure-driven air movement is desirable through openings on opposite sides of walls in a space for body cooling and to cool the building fabrics. Air movement that results in cross ventilation is produced where a naturally ventilated building experiences pressure difference in wind and buoyancy (Stavrakakis et al, 2008).

Wooden Louvered

Jaekel House adopts wooden louver for a continuous air movement to eliminate heat from the interior space. The wooden louver was painted with white colour to reflect and prevent solar heat gain within the interior. The louvered can be adjusted to control the amount of air desired for cooling. Louver is a means of protecting interior space against heat and glare for a comfortable indoor experience (Sharma, 2023)

Jaekel House Outdoor Planning

The outdoor spaces surrounding the Jaekel House was planned with vegetative covers and natural ground walkway. The vegetative cover comprises of trees, shrubs and grasses, these are excellent means of conditioning the microclimate surrounding a building. Trees provide shade from the hot solar radiation which can affect the indoor comfort condition. Vegetation around buildings provides scenic beauty, contact with nature and promotes indoor thermal comfort.

Jaekel House Building Materials

Jaekel House made use of strong, durable, natural and locally available building materials. These prevent the impact of climatic variables on occupants' comfort. The extensive use of wood for the construction of the upper floor of Jaekel house has greatly benefited the house by reducing heat gains from solar radiation which can affect thermal comfort of users (Figure 5-8). Wood has been used for ages because of its availability within the locality and its' durability properties. Wood is a poor conductor of heat, it prevents heat gain within the interior space and thereby regulates indoor air temperature for occupants' thermal comfort.

In the Jaekel House, the use of welsh roofing materials enhances the cooling of the building, enhancing the durability of the roof and the entire building. The Welsh roofing material used to roof the Jaekel House was adopted because of its durability as it can last over one hundred years and its' adaptability for both cold and hot environments (Neal, 2023).

CONCLUSION

This paper investigated the Jaekel House, Ebute Meta Lagos, one of the historic buildings in Nigeria. The investigation was carried out on its passive architectural characteristics and the significant climate adaptive role for energy efficient buildings suitable for the tropical climate of Nigeria. It was found out that Jaekel House is an architectural epitome model for designing with climate to provide adequate thermal comfort with minimal dependence on active cooling methods. Preservation of the architectural characteristics of

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this aged historic building embodies an intersection of history, architecture, tourism and economic growth; this ultimately leads to sustainable environment when efficiently explored. Safeguarding historic buildings of this significance would preserve the heritage to explore and learn from for the contemporary development of sustainable communities.

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References

Adebamowo, M., Sangowawa, T. and Godwin, J., (2013). Low energy design of buildings in the tropics; the case of Lagos, Nigeria. *The International Journal of Engineering and Science* (IJES), 2(7), 01-08.

Adeniran, I.; Otokiti, P. & Durojaye, K. (2020). Climate change impacts in a rapidly growing urban region- A case study of Ikeja, Lagos, Nigeria. *International Journal of Environmental Planning and Management, l6 (1), 13-23.*

Adewumi, A., (2022). Built heritage and planning law in Africa: The Nigerian experience. *Built Heritage l 6* (7).

Archova, (2024). What is architectural preservation and its Importance. https://archovavisuals.com/architectural-preservation-and-its-importance/#historical-significance-of-architectural-preservation

Armstrong, P., J., & Kapp, P., H., (2022). Preserving the past or past preserving: sustaining the legacy of postmodern museum architecture. *Built Heritage*, 6(12).

Battista, G.; Vollaro, E. Oclon, P. & Vollaro R. (2022). Retrofit Analysis of a Historical Building in an Architectural Constrained area: A case study in Rome, Italy. *Applied Sciences, 12*, 12305. https://doi.org/10.3390/

British Council Nigeria, (2016). The Jaekel House.

https://www.britishcouncil.org.ng/events/jaekel-house

Brophy, V. & Lewis, J. (2011). A green vitruvius: *Principles and Practices of sustainable architectural design*. Earthscan, University college, Dublin.

Bulbaai, R., & Halman, J. (2021). Energy efficient building design for a tropical climate: Field study on the Caribean Island Curacao. *Sustainability*, 13(23), 13274;

https//doi.org/10.3390/su132313274

Climate Data, (2024). Lagos Temperature and Rainfall Pattern.

Gelder, J. (2018). Design with climate in ancient Rome: Vitruvius meets Olgyay. *52nd International Conference of the Architectural Science Association* (pp 745–752).

Groat, L., & Wang, D. (2013). *Architecture research methods.* Wiley and Sons. New Jersey.

Jo, H., Yuk, H., Kang, Y. & Kim, S. (2023). Conservation of architectural heritage: Innovative approaches to enhance thermal comfort and promote sustainable usage in historic buildings. *Case Study of Thermal Engineering*, *Elsivier* 51, 103500. https://doi.org/10.1016/j.csite.2023.103500Get rights and content

Lagos State Government, (2013). Lagos state development plan 2012–2025. Lagos, Nigeria

Lechner, R. (2014). *Heating cooling Ventilation: Sustainable principles for architects.* Willey & Sons.

Liang, W., Ahmad, Y., & Mohidin, H. (2023). The development of the concepts of architectural heritage conservation and its importance. *Built Heritage,* 7(21), 4738.

Meteoblue, (2020), Climate of Lagos

Article DOI: https://doi.org/10.37284/eajenr.7.1.2028

http://www.meteoblue.co/en/weather/historyclimate/climatemodelled/lagos_nigeria_2332459

Neal, O. (2023). Welsh roof slate. The reclaimed company

https://shop.thereclaimedcompany.co.uk/home/welsh-roof-slate

Oldham, T., (2023). Historical building restoration in the UK: Preserving our architectural legacy. *Construction UK*. https://ukconstructionblog.co.uk

Okpalanozie, O., E., & Adetunji, O., S., (2021). Architectural heritage conservation in Nigeria: The need for innovative techniques. *Heritage, l4(3),* 2124-2139. https://doi.org/10.3390/heritage4030120

Omole, F., K., & Ogundiran, A., (2011). Building conservation as a veritable tool for preservation of cultural heritage: A Case of a historic building in Calabar, Nigeria http://dx.doi.org/10.4314/fje.v6i2.7

Rawat, M., & Singh, R. (2022). Impact of light-colored paint materials on discomfort in building for hot-dry climate. *Materials Today*: Proceedings, *52*, Part 3, Pages 998-1005, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2021.10.470.

Sharma, M. (2023). Brazilian Architecture: The style feature and buildings https://simplykalaa.com/brazilian-architecture/

Sojobi, A., Balogun, I., Salami A. (2015), Climate change in Lagos State, Nigeria: what really changed? *Environment Monitoring Assessment*, 188(10), 556.

Stavrakakis, M., Koukou, M., Vrachopoulos, N., & Markatos (2008). Natural cross ventilation in buildings: Building-scale experiment and thermal comfort evaluation. *Energy and Buildings, 40*(9), 1666-1681.

https://doi.org/10.1016/j.enbuild.2008

United Nation on Environment Programme, (UNEP), 2024). Goal 11: Sustainable cities and communities. https://www.unep.org/explore-topics/sustainable-development-goals

World city culture forum (2023) https://worldcitiesculturefor um.com/city/lagos/

World Green Building Council (WGBC), (2023). Sustainable built environments & the UN's Sustainable Development Goals.

http://worldgbc.org/susutainable-environment-goals/

Yao, L., Li, R., Zhang, Z., & Zhang, J. (2017). Thermal and energy performance of a steel-bamboo composite wall structure. *Energy Build,* 156 (2017), pp. 225-237.

Yin, R. (2018). *Case Study Research and Applications Design and Methods.* (6th Ed.). Thousand Oaks, CA Sage

