SUSTAINABLE BUILDING DESIGN FOR TROPICAL CLIMATES AS IT RELATES TO HOUSNG PROVISION IN BENIN CITY

BY

UMOGBAI FAVOUR OSHIONE

ENV2204823

FACULTY OF ENVIRONMENTAL SCIENCE

DEPARTMENT OF ARCHITECTURE

UNIVERSITY OF BENIN

EDO STATE

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A BACHELOR OF SCIENCES {BSCARC - B.SC. ARCHITECTURE} DEGREE,

IN THE FACULTY OF ENVIRONMENTAL SCIENCES, UNIVERSITY OF BENIN,

BENIN CITY, EDO STATE, NIGERIA.

FEBRUARY 2026

CERTIFICATION

This is to certify that the project titled **Sustainable Building Design for Tropical Climates as it Relates to Housing Provision in Benin City** was carried out by **Umogbai Favour Oshione**, a student of the Department of Architecture, Faculty of Environmental Sciences, University of Benin, in partial fulfillment of the requirements for the award of a Bachelor of Science (B.Sc.) degree in Architecture.

This work is original and has not been submitted elsewhere for any academic qualification.

_____. _____

Arc. Kunle Oyewole. Arc. Dr. Okafor

Project Supervisor **H.O.D, Department of Architecture**

DEDICATION

This work is dedicated to God Almighty for His grace, wisdom, and strength throughout this journey. I also dedicate it to my family, whose unwavering support and encouragement kept me going, and to all future architects committed to building a sustainable world for us to live in.

ACKNOWLEDGEMENT

I express my sincere gratitude to God for the wisdom and perseverance granted throughout the course of this project. My heartfelt appreciation goes to my supervisor, Arc. Kunle Oyewole, for the guidance, feedback, and encouragement that helped shape this work.

I also thank all my lecturers in the Department of Architecture, University of Benin, for their dedication and knowledge shared over the years. Special thanks to my family and friends for their moral support, and to the professionals and respondents who contributed valuable insights during my research.

I want to thank Ayodeji 'Wizkid' Ibrahim Balogun, whose music was the peaceful oasis I needed while writing this project. The songs from "Made in Lagos" and "Morayo" were always in the air during the writing of this project. I pray to achieve his level of consistency in my life as an architect.

Also want to appreciate my dear coursemates for their constructive input into my work, the person of Ogboumah Esseohen, Emede Onajite and Momoh Ehi Gloria. Their valued input makes this project a success for me and I really appreciate that. This achievement is ours.

ABSTRACT

The increasing environmental challenges and housing demand in tropical regions like Benin City necessitate the adoption of sustainable building practices. This project explores the integration of sustainable design principles in residential housing provision specific to

tropical climates. It examines passive cooling strategies, climate-responsive materials, and energy-efficient layouts tailored to the environmental context of Benin City.

Through field observations, interviews, and case studies, the research identifies key barriers to sustainable implementation and proposes practical design solutions. The study highlights how locally available resources and traditional knowledge can be harnessed to enhance building performance, thermal comfort, and affordability. Ultimately, the project advocates for policy support, public awareness, and stakeholder collaboration in creating sustainable housing systems for tropical regions.

TABLE OF CONTENTS

1.0 CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The increasing demand for housing in rapidly growing urban centers like Benin City has placed significant pressure on the built environment. As cities expand to accommodate growing populations, the need for housing that is not only affordable but also environmentally responsive has become a pressing concern. In tropical regions, where high

temperatures, intense rainfall, and humidity are dominant climatic features, conventional housing designs often fail to meet comfort requirements without heavy reliance on mechanical cooling systems, which in turn lead to high energy consumption and unsustainable living patterns.

Benin City, situated in the tropical rainforest zone of southern Nigeria, is experiencing a steady population increase, resulting in a surge in housing developments, most of which are constructed without sufficient regard for the local climate. These poorly designed structures often trap heat, increase indoor discomfort, and contribute to energy inefficiency. Additionally, many of the housing schemes disregard passive design strategies that could take advantage of natural ventilation, daylighting, shading, and rainwater management—all crucial elements in a tropical climate.

Sustainable building design offers a critical solution by promoting architectural responses that are energy-efficient, environmentally conscious, and economically viable. It incorporates locally available materials, passive cooling strategies, renewable energy sources, and efficient water use systems. Applying such strategies in the housing sector, especially in tropical environments like Benin City, ensures buildings perform better under local conditions while also reducing their ecological footprint.

This study seeks to bridge the gap between climatic realities and housing provision by exploring how sustainable design strategies can be integrated into residential architecture in Benin City. The research emphasizes that sustainability is not only about reducing environmental impact but also about creating livable, affordable, and resilient housing for present and future generations.

1.2 PROBLEM STATEMENT

In Benin City, the majority of residential buildings are developed with little to no consideration for the prevailing tropical climatic conditions. As a result, residents experience discomfort due to overheating, poor indoor air quality, and increased reliance on fans or air conditioners, which contribute to high energy bills and strain on the local power supply. Moreover, rapid urban growth has led to unplanned housing expansions that further degrade the environment and reduce the city's resilience to climate change impacts such as flooding and heatwaves.

Current housing designs largely neglect the use of passive design strategies that could significantly reduce energy consumption and improve comfort. There is also limited application of sustainable materials, green building technologies, and awareness among developers and homeowners about the benefits of climate-responsive architecture. This disconnect between housing provision and climatic adaptation continues to fuel the cycle of unsustainable development in the city.

The challenge, therefore, lies in rethinking how housing is designed and delivered in Benin City, with a strong emphasis on sustainability tailored to the local climate. The need for

affordable, durable, and environmentally responsive housing options has never been more urgent.

1.3 AIM OF THE STUDY

The aim of this research is to explore, analyze, and propose context-appropriate sustainable building design strategies that address the challenges of housing provision in tropical climates, using Benin City as a case study. The goal is to develop architectural solutions that not only respond effectively to the climatic conditions of the region but also enhance energy efficiency, environmental performance, and livability in residential buildings. This will be achieved by bridging the gap between design practices and climate-conscious approaches, promoting housing models that are adaptive, affordable, and sustainable for the long term.

1.4. OBJECTIVES OF THE STUDY

1. **To study and document the climatic characteristics of Benin City, i**ncluding temperature patterns, humidity levels, rainfall, and solar orientation—and analyze how these factors impact building performance, energy use, and indoor comfort in residential structures.

2. **To examine current housing typologies and construction practices in Benin City**, identifying the extent to which they incorporate or fail to incorporate climate-responsive and sustainable design elements such as passive ventilation, thermal insulation, orientation, and material choices.

3. **To investigate and compile a set of sustainable design principles and passive strategies** that are most effective in tropical climates, including the use of shading devices, cross-ventilation, green roofs, thermal mass, water harvesting systems, and the use of renewable energy technologies.

4. **To assess the socio-economic and cultural dimensions of housing provision** in Benin City, recognizing the barriers and opportunities for integrating sustainable design approaches in both low- and middle-income housing developments.

5. **To develop a sustainable housing design framework or prototype** that applies identified strategies in a practical and scalable way one that addresses climate adaptation, environmental responsibility, and occupant comfort without compromising affordability or local architectural identity.

6. **To evaluate the potential environmental and economic benefits** of integrating sustainable building strategies in residential development, including reduced operational energy, lower carbon emissions, improved health outcomes, and long-term cost savings for residents.

7. **To make policy and design recommendations** for architects, planners, and policymakers on promoting sustainable housing development practices that align with the city's urban growth, climate goals, and housing needs.

1.5 RESEARCH QUESTIONS

1. **What are the key climatic characteristics of Benin City that should influence sustainable housing design?**

Benin City experiences a **tropical monsoon climate**, characterized by high humidity, intense rainfall (especially between March and October), and average temperatures ranging from **24°C to 32°C**. The city receives heavy rainfall annually, and the dry season, although short, brings high solar radiation and heat buildup. These conditions demand buildings that:

- Promote **natural ventilation** to reduce heat buildup
- Use **shading devices** to prevent direct solar gain
- Incorporate **moisture-resistant materials** for longevity
- Control indoor temperatures without dependence on artificial cooling

2. **How do existing residential buildings in Benin City perform in terms of thermal comfort, energy efficiency, and environmental responsiveness?**

Most existing buildings in Benin City perform poorly in thermal comfort and energy efficiency. Many structures:

- Rely on **corrugated zinc roofing**, which absorbs and radiates heat
- Have **poor cross-ventilation** due to inadequate window placement
- Depend heavily on **mechanical cooling** (fans or air conditioners)
- Use **non-renewable materials** like cement blocks without consideration for insulation
- Lack proper **site orientation**, increasing heat gain and discomfort

This results in higher energy consumption, uncomfortable interiors, and increased environmental impact.-

3. **What passive design strategies and sustainable building materials are most suitable for housing in tropical climates like Benin City?**

Passive design strategies suitable for Benin City include:

- **Cross ventilation** through strategic window placement and open floor plans
- **Shading devices** like overhangs, louvers, verandas, and vegetation
- **Orientation** of buildings to reduce solar heat gain
- Use of **courtyards** and atriums to encourage airflow

- **High ceilings** to reduce heat buildup

Sustainable materials include:

- **Laterite blocks**: locally sourced and thermally stable

- Rammed earth: low carbon and breathable

- **Bamboo and treated timber**: renewable and lightweight

- **Reflective roofing materials** or cool roofs to reduce heat absorption-

4. **What are the limitations or barriers economic, cultural, or policy-related to adopting sustainable building designs in the city's housing sector?**

Barriers include:

- Economic constraints: Sustainable materials and design features may have higher upfront costs, deterring low-income homeowners or developers.

- **Lack of awareness**: Many homeowners and builders are unfamiliar with passive design benefits.

- **Cultural preferences**: People often prefer modern concrete blocks over natural materials, associating them with status and durability.

- **Policy gaps**: There's limited enforcement of sustainable design principles in local building codes and development plans.

- **Skilled labor shortage**: Artisans trained in sustainable techniques are few.-

5. **How can sustainable design solutions be made affordable and adaptable for low- and middle-income housing without compromising quality?**

- Promote **local material use** like stabilized earth blocks to cut transportation and material costs.

- Use **modular and incremental housing** strategies to allow homes to grow over time.

- Employ **standardized design templates** that include passive cooling, which reduces long-term energy costs.

- Encourage **government subsidies or incentives** for sustainable housing.

- Train local artisans to adopt sustainable construction techniques, reducing labor costs.

6. **What measurable environmental, social, and economic benefits can be derived from integrating sustainable design in housing developments in Benin City?**

- **Environmental**: Reduced carbon emissions, minimized heat island effects, and conservation of natural resources.

- **Social**: Healthier indoor environments, improved thermal comfort, and greater housing satisfaction.

- **Economic**: Lower energy bills, reduced maintenance costs, and improved housing durability.

1.6 JUSTIFICATION OF THE STUDY

Benin City, like many rapidly urbanizing cities in tropical regions, faces an increasing demand for affordable, livable, and environmentally responsible housing. However, most housing developments fail to respond adequately to the climatic conditions, leading to high energy consumption, poor indoor comfort, and increased environmental degradation.

This study is justified by the urgent need to align housing provision with sustainable practices that not only meet current demands but also ensure long-term resilience and environmental health. By focusing on Benin City's unique climate and urban context, the study offers a localized understanding of sustainable architecture bridging the gap between global sustainability goals and practical, context-driven design solutions.

Furthermore, as Nigeria moves toward sustainable development and climate resilience, research of this nature becomes essential in informing policy, guiding architectural education, and empowering developers, architects, and planners with tools to make meaningful, climate-conscious design decisions. The study also serves as a blueprint for similar tropical regions facing the dual challenge of housing shortage and climate stress.

1.7 SCOPE OF THE STUDY

This study focuses on examining how sustainable building principles can be integrated into housing design to suit the tropical climate of Benin City. It explores passive design strategies, local building materials, and environmentally responsive construction techniques that promote energy efficiency, thermal comfort, and long-term housing sustainability. The research is limited to **residential buildings,** especially low- and middle-income housing within **Benin City's urban and peri-urban areas.** It includes field observations, case studies of selected buildings, and interviews with architects, builders, and residents. The study also considers policy frameworks and their impact on sustainable housing implementation.

1.8 LIMITATIONS OF THE STUDY

- **Geographical Limitation**: The study is restricted to Benin City and may not fully represent other tropical regions with different microclimates.

- **Time Constraints**: The research is conducted within an academic timeframe, which limits long-term observation of building performance.

- **Data Accessibility:** Access to detailed energy consumption data or comprehensive records of material life cycles may be limited.

- **Respondent Bias**: Opinions from builders or occupants may reflect personal preferences rather than objective assessments.

- **Financial Constraints:** In-depth testing of building materials or performance simulations may be limited by available resources.

1.9 DELIMITATIONS OF THE STUDY

This study on sustainable building design as it relates to housing provisions in Benin City had several delimitations:

1. **Geographical Scope**

- The research focused on Benin City, Edo State, Nigeria. Findings might not apply to other cities or regions with different climatic, cultural, or economic contexts.

2. **Focus on Housing Provisions**

- The study concentrated on housing (residential buildings). Other building types (commercial, institutional) or infrastructure weren't covered.

3. **Sustainable Design Aspects**

- Emphasis was on circular economy strategies (Re-use, Reduce, Recycle, etc.) in building design. Other sustainability aspects like energy efficiency, water management, or green materials weren't deeply explored.

4. **Stakeholder Group**

- The research targeted built environment students' awareness at the University of Benin. Perspectives of practitioners, policymakers, or communities weren't included.

5. **Methodological Choices**

- Used questionnaires for quantitative data. Qualitative insights (interviews, case studies) or observational data on actual practices weren't part of the scope.

- Self-reported data on awareness and perceptions might differ from actual knowledge or behavior.

1.10 DEFINITION OF TERMS

- **Sustainable Building Design**: An approach to construction that meets present housing needs without compromising the ability of future generations to meet theirs, emphasizing energy efficiency, use of renewable materials, and minimal environmental impact.

- **Tropical Climate**: A climate typically found near the equator, characterized by high temperatures, high humidity, and heavy rainfall throughout the year.

- **Passive Design**: Architectural design strategies that use natural energy sources (like sunlight and wind) for heating, cooling, and lighting, reducing the need for mechanical systems.

- **Thermal Comfort**: The condition of mind that expresses satisfaction with the surrounding thermal environment, achieved through appropriate ventilation and insulation.

2.0 CHAPTER TWO: LITERATURE REVIEW

2.0.1 INTRODUCTION

The global shift toward sustainable development has significantly influenced architecture, particularly in regions experiencing rapid urban growth and environmental challenges. Sustainable building design, especially within tropical climates, has become a vital approach to reduce energy demand, improve indoor comfort, and preserve natural ecosystems. This chapter reviews existing literature on sustainable architecture, housing challenges in tropical cities, climate-responsive design, and its implications for residential development in Benin City.

2.0.2 THE CONCEPT OF SUSTAINABILITY IN ARCHITECTURE

Sustainability in architecture goes beyond environmental responsibility. It encompasses economic viability and social equity. According to the *Brundtland Report (1987),* sustainability is defined as “meeting the needs of the present without compromising the ability of future generations to meet their own needs.” In building design, this means reducing environmental impacts while maintaining function, comfort, and longevity.

2.0.3 CHARACTERISTICS OF TROPICAL CLIMATE

Tropical climates are characterized by high temperatures, high humidity, intense rainfall, and significant solar radiation. In cities like Benin City, these conditions demand that buildings respond appropriately to the environment to remain habitable and efficient. Design strategies such as cross-ventilation, shading devices, natural daylighting, and roof insulation are critical in such regions.

2.0.4 CLIMATE-RESPONSIVE DESIGN STRATEGIES

Many researchers emphasize passive design as a primary strategy in tropical architecture. These include orientation of buildings to capture wind and reduce solar gain, use of local and breathable materials, vegetation integration, and flexible spatial arrangements. *Olgyay (1963)* introduced the concept of bioclimatic design, stressing that architectural form should emerge from environmental context. Other studies highlight the success of vernacular architecture in responding to climate without mechanical systems.

2.0.5 HOUSING PROVISION AND SUSTAINABILITY IN NIGERIA

In Nigeria, housing demand continues to outpace supply, with over 17 million housing deficits reported. Sustainable design offers a long-term solution by improving durability, reducing lifecycle costs, and enhancing quality of life. However, literature notes challenges such as high initial costs, lack of awareness, limited policy enforcement, and inadequate technical capacity among professionals.

2.0.6 SUSTAINABLE MATERIALS AND CONSTRUCTION

Studies recommend the use of local, renewable, and low-embodied energy materials such as earth blocks, bamboo, and recycled timber. Green roofs, rainwater harvesting systems, and permeable paving have also been cited as effective methods for improving sustainability in dense urban settings.

2.0.7 CASE STUDIES AND BEST PRACTICES

Several global and local examples demonstrate the success of sustainable housing in tropical climates. Projects in Southeast Asia, East Africa, and southern Nigeria showcase innovative use of climate-responsive forms, modular layouts, and energy-efficient systems. These case studies reinforce the viability of sustainable housing for tropical urban environments.

2.1 OVERVIEW OF SUSTAINABLE ARCHITECTURE

Sustainable architecture is the design and construction of buildings in a way that reduces environmental impact while enhancing user well-being and economic performance. It integrates ecological principles into design thinking by considering energy efficiency, site orientation, resource conservation, and occupant comfort.

In tropical regions like Benin City, sustainable architecture prioritizes:

- **Thermal comfort** without mechanical cooling.

- **Water conservation t**hrough efficient plumbing and rain harvesting.

- **Renewable energy integration** like solar panels.

- **Use of local, climate-appropriate materials** such as adobe, timber, laterite, and stone.

The principles of sustainable architecture in tropical climates draw inspiration from traditional African architecture, which relied heavily on passive systems, courtyards, and adaptable spaces. However, modern challenges such as urban density, pollution, and unregulated development require updated solutions that balance modern technology with traditional wisdom.

Sustainable architecture also extends to social sustainability ensuring that housing is inclusive, affordable, and supportive of local communities. It encourages participatory planning, promotes local craftsmanship, and considers long-term maintenance in its design.

2.2 PRINCIPLES OF SUSTAINABLE BUILDING DESIGN

Sustainable building design focuses on minimizing the environmental footprint of construction while maximizing the efficiency, comfort, and longevity of a structure. The core principles guiding this approach, especially in tropical regions like Benin City, include:

1. **Energy Efficiency**: Buildings should be designed to reduce energy consumption through passive cooling, efficient lighting, and appliances. Orientation, shading devices, and natural ventilation reduce reliance on artificial systems.

2. **Passive Design**: This involves leveraging natural elements, sunlight, wind, vegetation for lighting, heating, and cooling. Proper window placement, roof insulation, and cross-ventilation help maintain thermal comfort.

3. **Water Efficiency:** Incorporating water-saving fixtures, greywater reuse systems, and rainwater harvesting helps reduce pressure on local water supplies and promotes sustainability.

4. **Sustainable Materials:** Choosing local, renewable, and low-embodied energy materials reduces the carbon footprint of a building. Examples include compressed earth blocks, bamboo, and recycled wood.

5. **Waste Reduction**: Design should allow for minimal construction waste, encourage material reuse, and include waste management systems in building use.

6. **Indoor Environmental Quality:** Ensuring good air quality, natural lighting, acoustic comfort, and non-toxic materials promotes occupant health and productivity.

7. **Adaptability and Resilience:** Buildings should be designed to adapt to changing needs and resist environmental stresses such as flooding, storms, and temperature extremes.

8. Site Sensitivity: Sustainable buildings work in harmony with their environmentpreserving natural landscapes, promoting biodiversity, and minimizing land disturbance.

2.3. CLIMATIC CONDITIONS IN TROPICAL REGIONS

Tropical regions, such as southern Nigeria where Benin City is located, are characterized by distinct climatic features that significantly influence building design. Understanding these conditions is key to creating sustainable and climate-responsive architecture.

1. **High Temperatures:** Average daily temperatures typically range between 25°C and 35°C. Without proper shading and ventilation, indoor spaces can become uncomfortable and require energy-intensive cooling.

2. **High Humidity:** Relative humidity often exceeds 70%, especially during the rainy season. This demands well-ventilated spaces to prevent mold growth and ensure comfort.

3. **Intense Solar Radiation:** Prolonged exposure to sunlight can heat up buildings quickly. Passive shading elements like overhangs, louvres, and vegetation help mitigate this effect.

4. **Seasonal Rainfall**: Tropical climates experience heavy rains for several months of the year. Roofing, drainage, and foundation designs must be optimized for water management to prevent structural damage.

5. **Light Winds**: Tropical regions may benefit from predictable wind patterns, making natural ventilation a viable strategy when building orientation and window placement are optimized.

6. **Daylight Availability**: Tropical zones typically receive ample daylight throughout the year. Proper use of daylight reduces artificial lighting needs and improves indoor quality.

In conclusion, climatic conditions in tropical regions pose both challenges and opportunities for sustainable design. By embracing passive strategies, local materials, and climate-aware planning, architects can create housing that is both environmentally responsible and comfortable for occupants.

2.4 HOUSING PROVISION IN DEVELOPING COUNTRIES

Housing conditions in many developing countries, including Nigeria, are often characterized by rapid urbanization, limited infrastructure, and widespread informal settlements. As urban populations continue to grow, the demand for affordable and adequate housing has outpaced supply, leading to several critical challenges:

1. **Overcrowding**: Many households live in small, poorly ventilated spaces with multiple occupants, often exceeding acceptable occupancy limits. This contributes to poor indoor air quality and increased health risks.

2. **Substandard Construction**: Due to poverty and lack of regulation, many homes are built with low-quality or makeshift materials, making them vulnerable to weather, fire, and structural collapse.

3. **Inadequate Infrastructure**: Basic services like potable water, sanitation, electricity, and waste disposal are often lacking or insufficient in low-income housing areas.

4. **Lack of Planning**: Informal settlements grow with little or no planning, resulting in congested layouts, lack of open space, and poor road access, which impedes emergency services and daily mobility.

5. **Environmental Degradation**: Deforestation, erosion, and flooding are exacerbated by unregulated building activities and a lack of climate-resilient design in housing.

6. **Affordability Gap**: The formal housing market is often inaccessible to the majority due to high costs, leaving most residents with no choice but to settle in slums or poorly constructed rental units.

Improving housing in developing countries requires a multi-faceted approach that combines policy reform, affordable design, infrastructure development, and community engagement.

2.5 SUSTAINABLE HOUSING IN TROPICAL CLIMATES

Sustainable housing in tropical regions is designed to respond to the specific environmental, social, and economic conditions of the tropics. The goal is to provide comfortable, affordable, and environmentally responsible dwellings that support long-term well-being. Key features include:

1. **Climate-Responsive Design**: Tropical housing should minimize heat gain and maximize cooling through orientation, shading devices, natural ventilation, and light-colored roofing materials that reflect solar radiation.

2**. Use of Local Materials**: Materials such as bamboo, mud blocks, timber, palm thatch, and laterite are sustainable and often more thermally efficient than concrete. They reduce embodied energy and promote cultural continuity.

3. **Passive Cooling Techniques**: Wide overhangs, verandas, inner courtyards, open floor plans, high ceilings, and cross-ventilation are essential for maintaining thermal comfort without mechanical cooling.

4. **Rainwater Harvesting and Water Efficiency**: Roof catchment systems and water-efficient fixtures help reduce dependence on unreliable municipal water supplies.

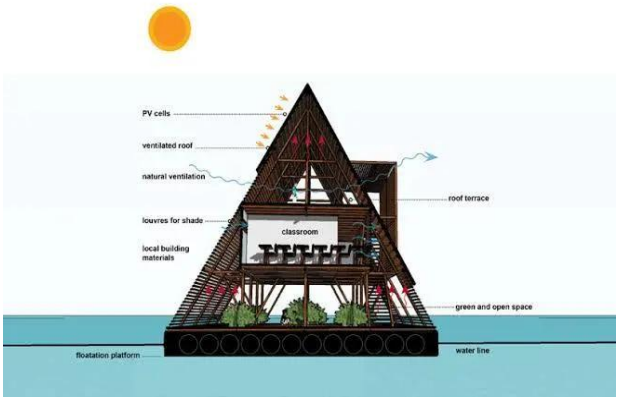
5. **Resilience to Climate Hazards**: Sustainable tropical housing must be structurally resilient to high rainfall, humidity, and occasional storms. Elevated floors, proper drainage, and durable roofing systems are essential.

6. **Affordability and Accessibility**: Sustainable housing solutions must be cost-effective and scalable to meet the needs of low- and middle-income populations in tropical cities.

7. **Community-Based Approaches**: Involving local communities in the planning, design, and building processes fosters ownership, relevance, and long-term maintenance of housing projects.

In essence, sustainable housing in tropical climates blends vernacular wisdom with modern environmental practices to create solutions that are not only eco-friendly but also socially inclusive and economically viable.

2.6 CASE STUDIES (LOCAL AND INTERNATIONAL)



- Local Case Studies (Nigeria)

Case Study 1: Makoko Floating School – Lagos, Nigeria

fig 1. Picture showing makoko floating school

fig 2. Picture showing a sectional view of makoko floating school.

- **Overview**: Designed by NLÉ Architects, this prototype was built to address flooding and housing inadequacies in the informal waterfront settlement of Makoko.

- **Sustainability Features**:

  - Built using locally sourced timber and recycled barrels for buoyancy.

  - Solar panels provide renewable energy.

  - Rainwater harvesting system in place.

  - Natural ventilation and lighting reduce energy use.

- **Relevance**: Though experimental, it represents a climate-resilient and cost-effective housing solution for vulnerable tropical communities.

Case Study 2: Prototype Housing by Federal Housing Authority – Abuja, Nigeria

- **Overview**: A pilot mass housing project targeting low and middle-income earners.

- **Sustainability Features:**

  - Use of compressed stabilized earth blocks (CSEB) to reduce embodied energy.

- Passive ventilation strategies.

- Site planning incorporates green space and stormwater control.

- **Relevance**: Demonstrates an attempt to scale sustainable housing within the constraints of Nigerian urban planning and government funding.

International Case Studies

Case Study 3: Green Village – Bali, Indonesia

- **Overview**: A residential and learning community built entirely from bamboo in a tropical rainforest environment.

- **Sustainability Features**:

- Bamboo architecture adapted to tropical climate.

- Natural ventilation, daylighting, and water recycling.

- Locally built with community labor and resources.

- **Relevance**: Exemplifies how sustainable tropical housing can blend modern aesthetics with indigenous materials and construction techniques.

fig 3. Picture showing a view of the green village in Bali, Indonesia.

Case Study 4: Quinta Monroy Housing – Iquique, Chile (by Elemental)

fig 4. Picture showing views of the quita monroy housing *fig 4. Picture showing views of the quita monroy housing*

- **Overview**: A social housing project providing incremental housing to low-income families.

- **Sustainability Features**:

- Core housing units designed to be expanded by users.

- Efficient use of space and services.

- Low-cost, climate-appropriate materials.

- **Relevance**: While not tropical, its adaptable, cost-efficient design offers lessons for scalable housing provision in Nigeria's urban areas.

2.7 SUMMARY OF LITERATURE REVIEW

The literature review explores the core principles and relevance of sustainable architecture, particularly within tropical climates such as Benin City, Nigeria. It begins by establishing that sustainable building design aims to minimize environmental impact while ensuring comfort, functionality, and affordability. In tropical regions, where high temperatures, humidity, and heavy rainfall dominate, passive design strategies such as natural ventilation, shading, thermal mass, and orientation are essential.

The review also examines the challenges of housing in developing countries including rapid urbanization, inadequate infrastructure, and poor-quality housing stock and emphasizes the need for climate-responsive, low-cost housing solutions. It evaluates the concept of sustainable housing as one that not only meets environmental goals but also aligns with cultural, social, and economic realities.

Case studies from both local and international contexts reinforce the practicality of sustainable strategies such as the use of local materials, modular design, and community participation. The literature highlights that while sustainable architecture in tropical climates is achievable, success depends on appropriate policy, education, affordability, and integration of traditional knowledge with modern technologies.

CHAPTER 3.0: RESEARCH METHODOLOGY

3.1 PREAMBLE

This chapter will describe the techniques used to collect study-related data. It will go over the research design, study area, study population, sample size, sampling approaches, data collection tools, and data collection and analysis procedures**.**

3.2 RESEARCH DESIGN

This study adopts a qualitative research design supported by quantitative analysis where applicable. The qualitative approach is suitable for exploring contextual factors such as climate responsiveness, building practices, sustainability principles, and user perception within Benin City's housing sector. It allows for an in-depth understanding of architectural practices, socio-economic dynamics, and environmental conditions influencing sustainable design.

Additionally, descriptive and exploratory research methods are employed to investigate existing housing conditions and evaluate sustainable design interventions. The study also uses case study analysis to examine local and international examples of sustainable housing developments in tropical regions, offering comparative insights into best practices and challenges

3.3 AREA OF STUDY

Benin City, the capital of Edo State in Southern Nigeria, serves as the study area for this research. It is one of Nigeria's oldest and historically significant cities, known for its cultural heritage and evolving urban landscape. The city lies approximately between latitude 6.33°N and longitude 5.62°E.

Benin City falls within the tropical rainforest climate zone, characterized by:

- High temperatures averaging 26°C to 32°C

- High humidity levels (often above 80%)

- Two major seasons, a rainy season (April to October) and a dry season (November to March)

- Heavy rainfall during wet months

This climatic condition makes Benin City a suitable site for examining sustainable building practices in tropical regions, especially those involving natural ventilation, sun shading, and rainwater management.

The city also features a mix of formal and informal housing, offering diverse examples of how residents adapt to climate and resource constraints in their building practices. Its

growing population, infrastructural pressures, and housing challenges make it a relevant case for exploring sustainable housing solutions in tropical urban settings

3.4 POPULATION OF THE STUDY

For the purpose of this research, the target population includes built environment students across various departments such as Architecture which has 279 Students, Quantity Survey has 176 students, Geo-informatics has 102 students, Estate students, Estate Management has 153 students, and Structural Engineering has 389 students. The total population of the study is 1099 which consists of all the undergraduate students across all levels in these departments

3.5 SAMPLE SIZE

The total sample size was determined based on the scope and resources available. At least 100 residents were targeted through questionnaire distribution, while 10−15 key informants were interviewed for in-depth perspectives

3.6 SAMPLING TECHNIQUE

For this study, a purposive sampling technique was adopted to select participants and locations that provide the most relevant data regarding sustainable housing practices in Benin City. This method allows the researcher to deliberately target specific groups or areas that reflect the research objectives, especially those demonstrating varying degrees of sustainable building design or housing conditions.

a. Selection of Respondents:

Respondents were selected from diverse neighborhoods ranging from low-income to middle and high-income residential zones. This ensured a wide range of data on building types, materials used, thermal comfort experiences, and levels of awareness of sustainable practices.

b. Selection of Professionals:

A subset of key stakeholders architects, engineers, housing developers, and officials from planning agencies were also sampled based on their expertise and involvement in housing development in the city. These professionals provided qualitative insights into the constraints and opportunities for sustainable housing..

3.7 INSTRUMENT FOR DATA COLLECTION

The methodology is structured to gather relevant data through a combination of primary and secondary sources:

a) Primary Data Collection

- Site Visits and Observations: Selected residential areas in Benin City are visited to assess existing housing designs, materials used, ventilation strategies, shading devices, and environmental integration.

- Structured Interviews: Key stakeholders such as architects, urban planners, housing developers, and residents are interviewed to gather expert and experiential insights.

- **Questionnaires**: Distributed to homeowners and occupants to assess user satisfaction, comfort levels, and awareness of sustainable practices in their homes.

b) Secondary Data Collection

- Literature Review: Academic journals, books, architectural reports, government policies, and international case studies on sustainable housing in tropical climates.

- Climate Data Analysis: Review of meteorological data (temperature, humidity, rainfall, wind direction) specific to Benin City to guide passive design considerations.

3.8 METHOD OF DATA COLLECTION

To ensure a comprehensive understanding of sustainable housing in Benin City, this study employs multiple data collection methods that capture both qualitative and quantitative data:

a. Field Observation

On-site visits were conducted in selected residential areas within Benin City. These visits allowed direct observation of building orientations, roofing types, shading techniques, ventilation methods, use of local materials, and general environmental integration of housing structures.

b. Structured Interviews

Interviews were held with architects, town planners, housing developers, and government officials involved in housing and urban development. These interviews provided insights into planning policies, architectural strategies, and challenges in implementing sustainable housing in tropical regions.

c. Questionnaire

Structured questionnaires were distributed to residents across different socio-economic classes in Benin City. Questions focused on housing satisfaction, thermal comfort, ventilation, lighting, awareness of sustainable practices, and willingness to adopt green features in their homes.

d. Secondary Sources

The study relied on existing literature such as government reports, academic papers, architectural documents, climate data, and sustainable housing case studies to strengthen the analysis and guide design recommendations.

3.9 METHOD OF DATA ANALYSIS

The data collected was analyzed using both qualitative and quantitative methods to provide a comprehensive understanding of sustainable housing in the study area.

a. Quantitative Analysis:

- Responses from questionnaires were coded and analyzed using statistical tools such as Microsoft Excel or SPSS.

- Frequency tables, percentages, and charts were used to summarize data on housing conditions, ventilation, lighting, and residents' comfort levels.

- Cross-tabulation was used to identify patterns and relationships, such as between income levels and sustainable housing adoption.

b. Qualitative Analysis:

- Data from interviews and field observations were transcribed and analyzed using thematic analysis. Recurring themes such as affordability, policy barriers, material sourcing, and environmental adaptation were identified and discussed.

- Descriptive narratives were developed to explain observed sustainable features in local housing, including orientation, shading, and ventilation strategies.

c. Integration of Findings:

The analysis integrated both data types to triangulate results—validating questionnaire data with interview responses and on-ground observations. This ensured a more reliable and insightful interpretation of the housing situation and informed the design recommendations.

3.10 LIMITATIONS OF METHODOLOGY

While this research was carefully planned and executed, several methodological limitations were encountered. These include:

a. Limited Sample Size:

Due to time and resource constraints, the number of respondents sampled may not fully represent the entire population of Benin City. A broader sample could have provided more generalizable findings.

b. Accessibility Issues:

Certain neighborhoods or settlements, especially those in informal or underserved areas, were difficult to access either due to poor road infrastructure, security concerns, or unwillingness of residents to participate.

c. Response Bias:

Some respondents may have provided socially desirable answers rather than accurate reflections of their housing conditions or knowledge of sustainability. This could skew results, particularly in areas related to energy usage or income disclosure.

d. Incomplete Responses:

Not all respondents answered every question on the questionnaire, resulting in gaps in some datasets. This sometimes made statistical analysis more challenging and reduced the robustness of certain findings.

e. Limited Availability of Local Records:

In gathering data on past housing projects or urban policies in Benin City, there was a lack of up-to-date and accessible records. This limited the ability to fully assess historical trends or previous interventions in sustainable housing.

f. Subjectivity in Qualitative Interpretation:

While thematic analysis provides rich insights, it can be influenced by the researcher's interpretation. Despite efforts to remain objective, some bias may have influenced the way certain responses or themes were categorized.

3.11ETHICS IN RESEARCH

All data collected are handled confidentially. Informed consent is obtained from interviewees and respondents, and all sources are duly acknowledged to avoid plagiarism

3.12 QUESTIONNAIRE

SECTION A: RESPONDENT'S PROFILE

1. What is your age range?

   - ( ) 18–25 ( ) 26–35 ( ) 36–45 ( ) 46+

2. What is your occupation?

   - ( ) Architect ( ) Builder ( ) Resident ( ) Developer ( ) Other: ____

3. How long have you lived/worked in Benin City?

   - ( ) Less than 5 years ( ) 5–10 years ( ) Over 10 years

4. What type of housing do you currently live in?

   - ( ) Detached ( ) Semi-detached ( ) Block of flats ( ) Bungalow

SECTION B: GENERAL HOUSING CONDITIONS

5. How would you rate the quality of housing in your area?

- ( ) Excellent ( ) Good ( ) Fair ( ) Poor

6. Are the houses in your area well adapted to Benin City's tropical climate?

- ( ) Yes ( ) No ( ) Not sure

7. What are the most common problems with buildings in your area?

- ( ) Poor ventilation ( ) Heat retention ( ) Water leakage ( ) Poor lighting ( ) Others

8. Do you think sustainable housing practices are being applied in Benin City?

- ( ) Yes ( ) No ( ) Not sure

SECTION C: CLIMATE-RESPONSIVE DESIGN

9. Do most buildings in your area use natural ventilation (windows, vents)?

- ( ) Yes ( ) No ( ) Somewhat

10. Are shade elements like verandahs or overhangs common in your area?

- ( ) Yes ( ) No

11. What type of roofing is most common in your neighborhood?

- ( ) Zinc/metal sheet ( ) Concrete slab ( ) Tiles ( ) Thatch

12. How effective is the roofing in protecting against heat and rainfall?

- ( ) Very effective ( ) Fair ( ) Poor

13. Do you believe building orientation impacts comfort in homes here?

- ( ) Yes ( ) No

SECTION D: SUSTAINABLE MATERIALS & TECHNOLOGIES

14. Are local building materials (e.g. mud blocks, laterite) still used?

- ( ) Often ( ) Sometimes ( ) Rarely ( ) Never

15. Would you prefer a house built with eco-friendly materials if affordable?

- ( ) Yes ( ) No

16. What sustainable features would you like in your home?

- ( ) Solar panels ( ) Rainwater harvesting ( ) Green roof ( ) Natural cooling design

17. Are sustainable buildings perceived as expensive by people here?

- ( ) Yes ( ) No ( ) Not sure

18. What do you think prevents people from adopting sustainable design?

- ( ) Cost ( ) Lack of awareness ( ) Lack of professionals ( ) Cultural factors

SECTION E: POLICY & DESIGN RECOMMENDATIONS

19. Do you think the government supports sustainable housing in Benin?

- ( ) Yes ( ) No ( ) Not aware

20. Should building codes enforce climate-responsive designs?

- ( ) Yes ( ) No ( ) Maybe

21. Are you aware of any housing project that uses sustainable practices?

- ( ) Yes ( ) No — If yes, name it: _____

22. Would you support a policy encouraging the use of sustainable designs?

- ( ) Yes ( ) No

23. Do you think sustainable housing can reduce energy costs long-term?

- ( ) Yes ( ) No

24. What role should architects play in promoting sustainable housing here?

- Open-ended

25. Suggest one way to improve housing design for Benin’s climate:

- Open-ended

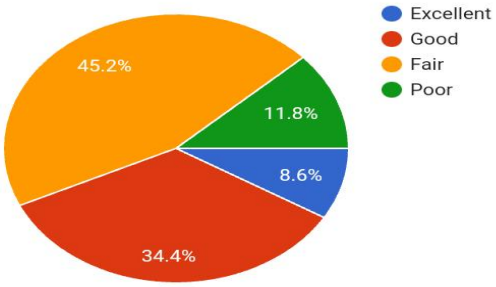
CHAPTER 4.0: DATA PRESENTATION, ANALYSIS AND DISCUSSION

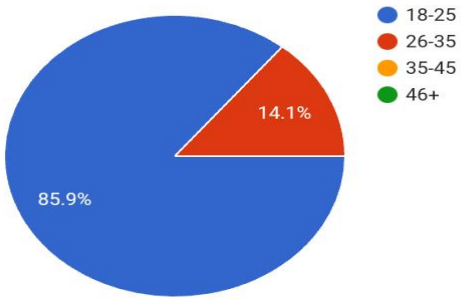
This chapter presents the analysis and discussion of data obtained from the questionnaire survey conducted in Ovia North-East Local Government Area, Edo State. A total of 93 questionnaires were successfully retrieved and analysed. The data are presented using tables and figures, while discussions are made in line with the objectives of the study

SECTION A: RESPONDENT'S PROFILE

5. How would you rate the quality of housing in your area?

93 responses

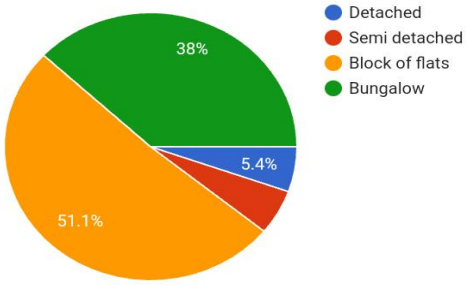




4. What kind of housing do you currently live in?

Copy chart

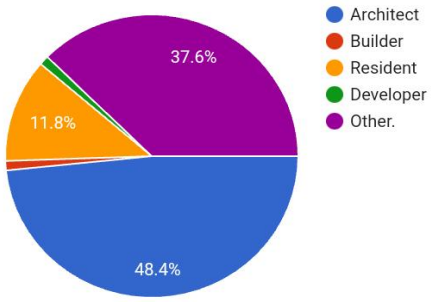
92 responses



2. What is your occupation?

Copy chart

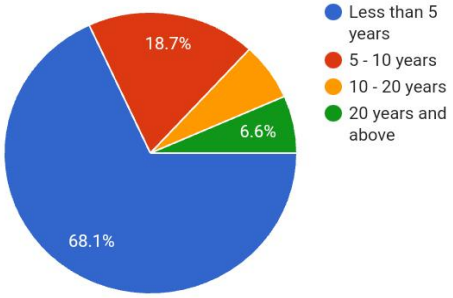
93 responses



3. How long have you worked/lived in Benin City?

Copy chart

91 responses



SECTION B: GENERAL HOUSING

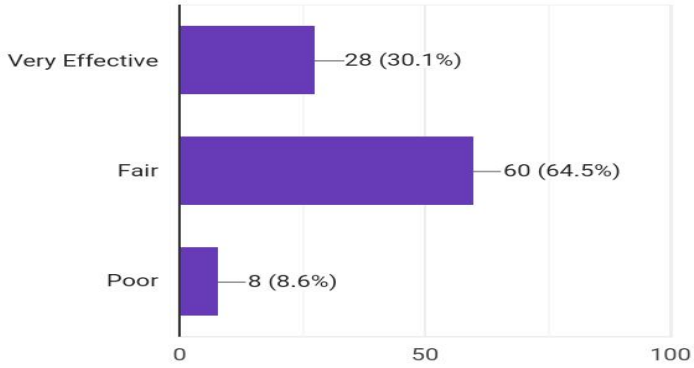
CONDITIONS

8. su pr ap 93

12. How effective is the roofing in protecting against heat and rainfall?

Copy chart

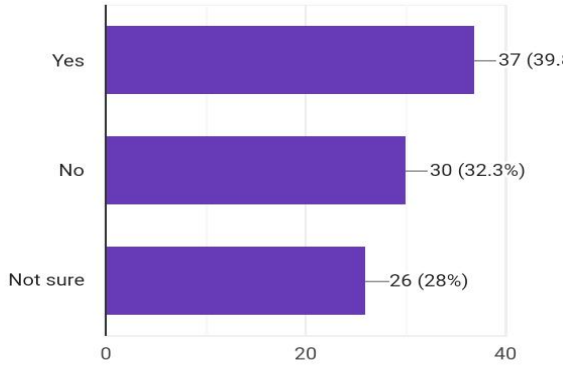
93 responses



6. Are the houses in your area well adapted to Benin's tropical climate?

Copy chart

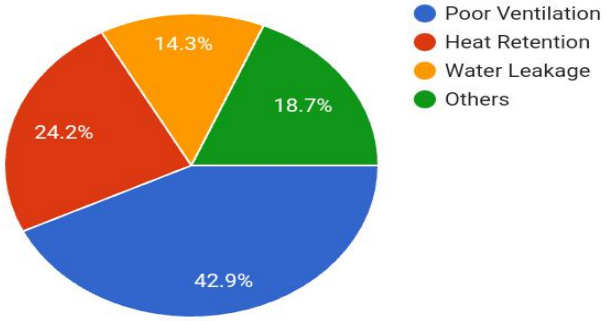
93 responses



7. What are the most common problems with buildings in your area?

Copy chart

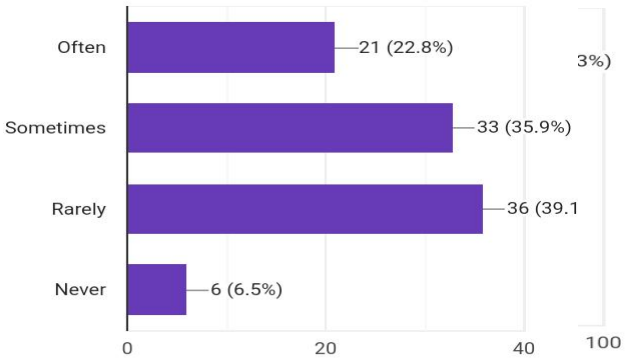
91 responses



SECTION C: CLIMATE-RESPONSIVE DESIGN

14. Are local building materials (e.g. mud blocks, laterite) still used?

92 responses

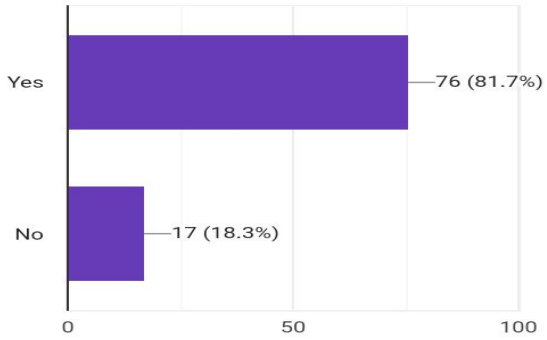


SECTION D: SUSTAINABLE

10. Are shade elements like verandahs or overhangs common in your area?

Copy chart

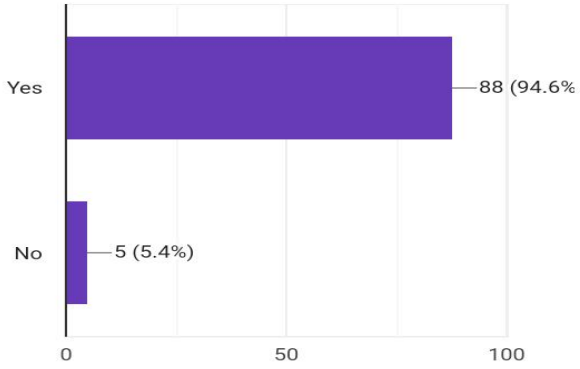
93 responses



13. Do you believe building orientation impacts comfort in homes here?

Copy chart

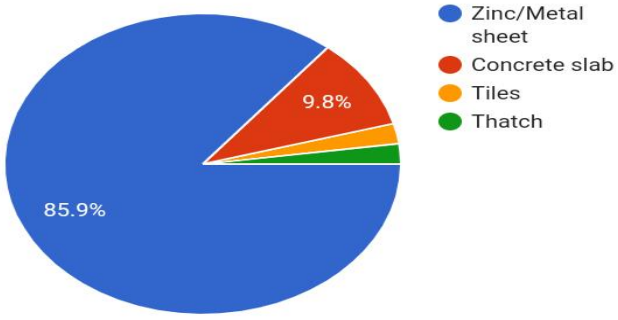
93 responses



11. What type of roofing is most common in your neighborhood?

Copy chart

92 responses

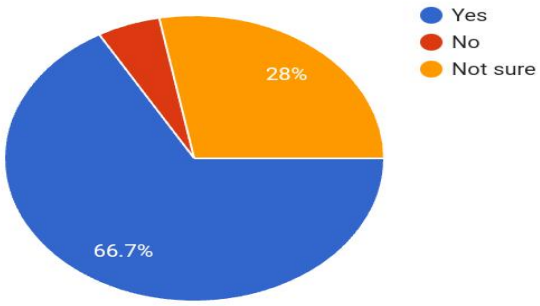


MATERIALS & TECHNOLOGIES

17. Are sustainable buildings perceived as expensive by people here

Copy chart

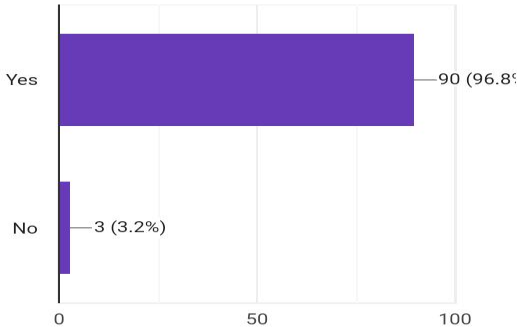
93 responses



15. Would you prefer a house built with eco-friendly materials if affordable?

Copy chart

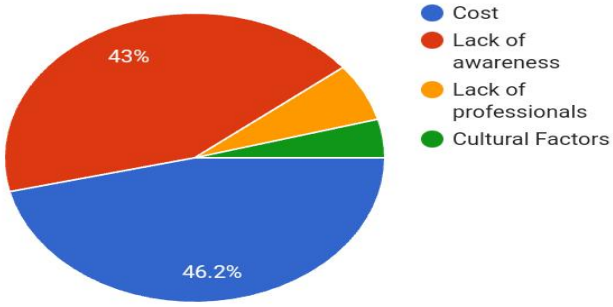
93 responses



18. What do you think prevents people from adopting sustainable design?

Copy chart

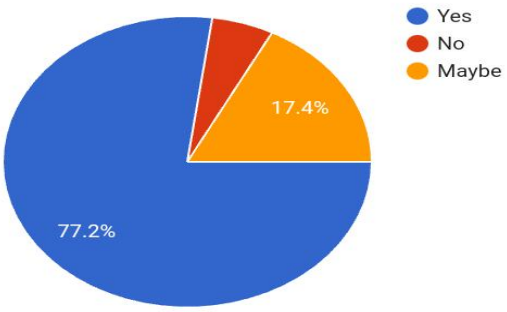
93 responses



20. Should building codes enforce climate-responsive designs?

Copy chart

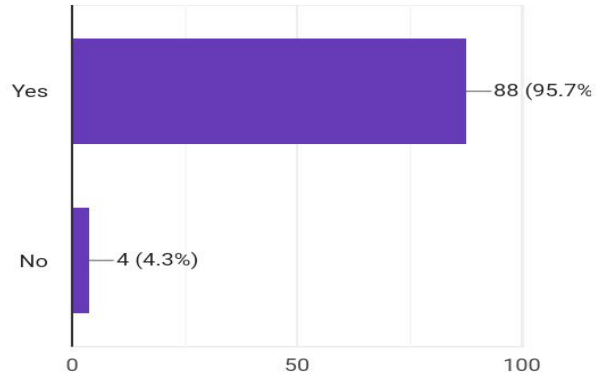
92 responses



23. Do you think sustainable housing can reduce energy costs long-term?

Copy chart

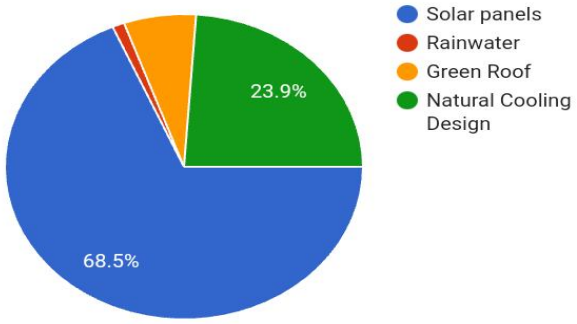
92 responses



16. What sustainable features would you like in your home?

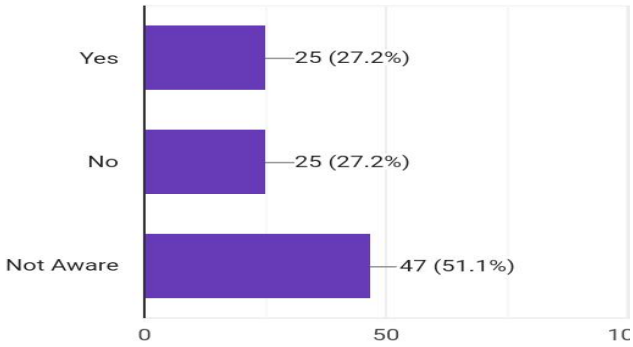
Copy chart

92 responses



19. Do you think the government supports sustainable housing in Benin?

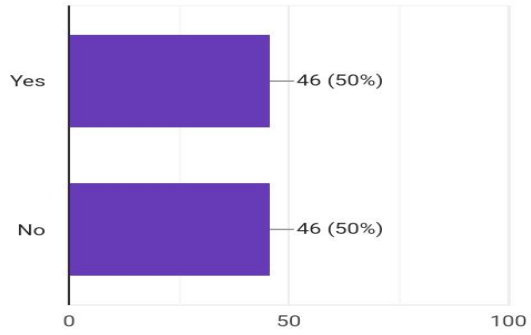
92 responses



21. Are you aware of any housing project that uses sustainable practices?

Copy chart

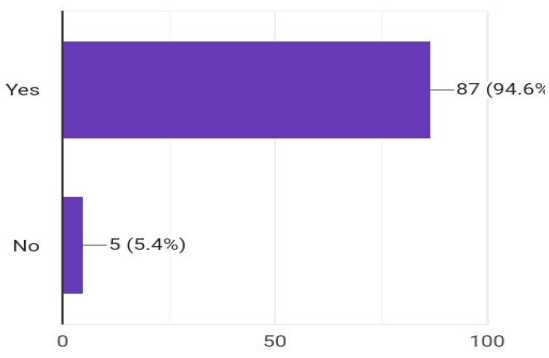
92 responses



22. Would you support a policy encouraging the use of sustainable designs?

Copy chart

92 responses



CHAPTER 5

SUMMARY, CONCLUSION, RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

This research set out to investigate how sustainable building design principles can be integrated into housing provision in Benin City, a tropical climate region, to address the pressing challenges of energy inefficiency, poor ventilation, thermal discomfort, high utility costs, and environmental degradation. From extensive fieldwork, literature review, case studies, and questionnaire analysis, several key findings emerged:

First, the research established that while the concept of sustainability is gaining traction globally, it is still underutilized in most local housing developments in Benin City. The majority of residential buildings are still constructed with conventional methods and materials that do not adequately respond to the tropical climate. The use of cement blocks, metal roofing sheets, poor insulation, and lack of passive cooling strategies result in buildings that are

thermally inefficient, leading to overdependence on mechanical ventilation and high energy bills.

Second, awareness and education levels regarding sustainable design principles are low among residents, and even among some professionals in the built environment sector. This knowledge gap significantly affects the demand for eco-conscious housing. However, there is a general willingness to adopt sustainable practices if these solutions are made affordable and accessible.

Third, while few existing buildings in Benin City demonstrate elements of sustainable design such as rainwater harvesting, solar energy use, natural ventilation, or use of local materials these examples are exceptions rather than the norm. Factors such as cost, lack of policy enforcement, inadequate technical know-how, and limited availability of eco-friendly materials were consistently cited as barriers to implementation.

The study also discovered that most government and private housing projects in the city have not integrated environmental impact assessments or green building benchmarks into their planning and construction processes. There is a lack of institutional frameworks that support or mandate sustainable building practices.

Despite these challenges, the research found several opportunities for advancing sustainable housing. These include the availability of local materials like laterite and timber, abundant sunlight for solar energy, and a youthful, growing population that can be educated on sustainable practices. Furthermore, global trends and climate change advocacy are increasingly pressuring local governments and professionals to align with sustainable development goals.

5.2 CONCLUSIONS

From the research findings, it is evident that sustainable building design is not just a desirable alternative, but a necessary approach to addressing the housing challenges faced by residents in tropical climates like Benin City. Climate-responsiveness in architecture must move from theoretical discourse to practical implementation.

The study concludes that the application of sustainable design principles including site-responsive planning, use of passive design strategies (natural ventilation, solar orientation, shading), incorporation of renewable energy sources, efficient water usage, and selection of local and durable materials can drastically improve housing quality in terms of comfort, energy efficiency, affordability, and environmental impact.

The low level of awareness among residents and some practitioners underscores the need for a multi-stakeholder educational approach that includes architects, developers, homeowners, students, and policymakers. Introducing sustainability-focused modules in architectural education, conducting workshops, and public awareness campaigns can help bridge the knowledge gap.

Furthermore, the study concludes that government policies and planning regulations must be revised to actively promote and enforce sustainable building standards. Financial incentives, subsidies for eco-friendly materials, and support for research and innovation in green technologies will catalyze the widespread adoption of sustainable practices.

In conclusion, sustainable building design in tropical regions is both a challenge and an opportunity. With the right interventions in policy, education, design practice, and community participation, cities like Benin can lead the way in building homes that are not only livable but also future-proof. The role of architects and other professionals is crucial in reimagining housing in ways that harmonize with the climate while addressing the socio-economic needs of the population.

5.3 RECOMMENDATIONS

Based on the findings and conclusions of this study, the following recommendations are made to support the integration of sustainable building design principles in housing provision in Benin City:

1. **Policy Enforcement and Government Support**

- The government should create and enforce building codes that mandate sustainability practices in housing design. These should include regulations for energy efficiency, passive design elements, and environmental impact assessments for new projects.

- Incentives such as tax relief, subsidies, or grants should be provided for developers and individuals who integrate sustainable technologies (e.g., solar panels, rainwater harvesting, green roofing).

2**. Public Awareness and Education**

- Awareness campaigns should be launched to educate the public about the long-term economic and health benefits of sustainable housing.

- Architecture schools and technical institutions should integrate sustainability-focused courses that are specific to tropical climates.

3. **Training for Professionals**

- Encourage micro-grid systems and solar street lighting in housing estates.

- Continuous professional development should be made available for architects, builders, and engineers to stay updated with sustainable technologies and techniques suited for tropical climates.

- Workshops and hands-on demonstrations should be encouraged to promote the adoption of local and eco-friendly building materials.

4. **Encourage Use of Local Materials**

- Builders should be encouraged to use locally sourced, durable, and climate-appropriate materials such as stabilized earth blocks, bamboo, or treated timber, which reduce transportation costs and environmental impact.

5**. Community Participation**

- Involve local communities in the design and development process. This fosters a sense of ownership and ensures that the designs align with users′ cultural and functional needs.

6. **Adoption of Passive Design Strategies**

- Architects and developers must prioritize passive ventilation, strategic orientation of buildings, shading devices, and thermal massing in building layouts to respond to the hot and humid conditions of Benin City.

7. **Integration of Renewable Energy**

- Solar energy systems should be actively promoted for residential use to reduce dependence on the national grid and fossil fuels.

8. **Monitoring and Evaluation**

- There should be an institutional framework to monitor the performance of sustainable housing over time and evaluate their efficiency in energy use, maintenance, and occupant satisfaction

5.4 CONTRIBUTION TO KNOWLEDGE

This research makes several meaningful contributions to academic and practical knowledge in the field of sustainable architecture:

1. **Contextual Application of Sustainability**

- The study bridges the gap between global sustainable design principles and their application within the specific climatic, economic, and cultural context of Benin City and similar tropical regions.

2. **User-Based Insights**

- It provides valuable insight into the perceptions, challenges, and needs of residents and professionals regarding sustainable housing. These findings can inform policy makers, developers, and educators.

3. **Model for Future Designs**

- The research proposes a conceptual framework and design approach that can be adapted by professionals when designing for tropical climates, emphasizing passive strategies, material efficiency, and community participation.

4. **Awareness and Advocacy**

- lBy identifying the limitations in current housing practices and proposing practical solutions, the study advocates for a shift toward environmentally conscious and people-centered design.

5. **Encouragement of Local Innovation**

- The research encourages further exploration of indigenous building techniques, local materials, and community-driven innovations as valid components of sustainable housing strategies.

In essence, this work adds to the growing body of research promoting climate-responsive design in the Global South and offers a pathway for future developments that are both environmentally responsible and socially inclusive.

5.5 SUGGESTIONS FOR FURTHER STUDIES

While this study has explored key aspects of sustainable building design in relation to housing provision in Benin City, there remains a wide scope for future exploration. The following areas are suggested for further research:

1**. Post-Occupancy Evaluation (POE) of Sustainable Housing Projects**

Future studies can focus on evaluating the performance of existing sustainable housing developments in Benin City or similar tropical regions. This will help assess whether the design strategies actually deliver the intended environmental, economic, and social benefits.

2**. Cost-Benefit Analysis of Sustainable Housing**

A deeper analysis comparing the initial investment, maintenance costs, and long-term savings of sustainable housing vs. conventional housing in Nigeria can provide financial justification to developers and homeowners.

3. **User Behaviour and Sustainability Practices**

Research can be conducted on how occupants interact with sustainable building features. Understanding user behavior can inform better design approaches and highlight areas where user education is needed.

4. **Adaptation of Vernacular Architecture**

Further investigation into how traditional Nigerian housing techniques and materials can be adapted with modern sustainable technologies will help in creating contextually appropriate housing solutions.

5. **Impact of Urban Policy on Sustainable Housing Development**

Exploring how government policy, land use regulation, and urban planning frameworks affect the adoption of sustainable housing in tropical cities could inform policy reform and advocacy.

6. **Integration of Smart Technologies in Sustainable Housing**

Research could explore the role of smart home systems such as energy management apps, water-saving devices, or solar monitoring in promoting sustainable living in low-income tropical regions.

REFERENCES

Adebayo, P., & Iweka, A. F. (2020). Sustainable construction materials and the future of affordable housing in Nigeria. Journal of Sustainable Development in Africa, 22(4), 45–58.

Adebayo, A., & Omoregie, E. (2021). Affordable housing in Edo State: Challenges and prospects. Nigerian Journal of Urban Studies, 12(1), 45–62.

Afolayan, J. O., & Oladapo, I. O. (2017). Performance of compressed stabilized earth blocks in Nigerian construction. Construction and Building Materials, 142, 15–22.

Akinwale, A. A. (2021). Assessing the viability of local building materials for sustainable housing delivery in Nigeria. International Journal of Built Environment Research, 9(2), 33–47.

Akinmoladun, O. I., & Oluwoye, J. (2022). Housing challenges in Nigeria and the need for sustainable construction. Journal of Urban Housing Studies, 14(2), 45–60.

Aribigbola, A. (2011). Housing affordability as a factor in the creation of sustainable environment in developing world: The example of Akure, Nigeria. Journal of Human Ecology, 35(2), 121–131.

Choguill, C. L. (2007). The search for policies to support sustainable housing. Habitat International, 31(1), 47–53.

Ebekozien, A., & Aigbavboa, C. (2019). Community-driven housing strategies in Nigeria's informal settlements. Journal of Construction in Developing Countries, 24(1), 45–60.

Ede, A. N., Akinde, E. J., & Odewumi, T. S. (2022). Potential of indigenous materials for sustainable housing delivery in Nigeria. Nigerian Journal of Construction Technology and Management, 5(1), 22–34.

Ibem, E. O., & Amole, D. (2010). Evaluation of public housing programmes in Nigeria: A theoretical and conceptual overview. The Built & Human Environment Review, 3(1), 88–117.

Ibem, E. O., & Azuh, D. (2020). Sustainable housing and low-income communities in Nigeria: A review of policies and practices. Habitat International, 98, 102–115.

Kolawole, O., & Adeniran, A. (2018). Alternative building materials for sustainable housing in developing countries. Journal of Environmental Science and Technology, 11(4), 150–167.

Nwosu, C. (2019). The performance of local building materials in low-cost housing delivery in Nigeria. African Journal of Environmental Management, 14(2), 67–80.

Olotuah, A. O. (2016). Housing development and environmental sustainability in Nigeria. Journal of Sustainable Architecture, 8(1), 25–37.

Olotuah, A. O., & Bobadoye, S. A. (2018). Affordable housing and sustainable development in Nigeria: A review. International Journal of Sustainable Built Environment, 7(1), 45–56.

Raji, O., & Adebayo, P. (2019). Cost benefits of alternative building materials in developing economies. Journal of Sustainable Construction Systems, 5(3), 61–72.

UN-Habitat. (2022). World Cities Report 2022: Envisioning the future of cities. United Nations Human Settlements Programme.

UN-Habitat. (2023). Housing and sustainable urban development in Africa. United Nations Human Settlements Programme.

World Bank. (2023). Housing affordability and urban development in Sub-Saharan Africa. Washington, DC