CRITICAL EVALUATION OF CIRCULAR ECONOMY AS A SUSTAINABLE BUILDING CONSTRUCTION AND DESIGN METHOD

BY

ONWUGHARA CHIDIEBERE
ENV2103373

DEPARTMENT OF ARCHITECTURE, FACULTY OF ENVIRONMENTAL SCIENCES, UNIVERSITY OF BENIN, BENIN CITY.

JANUARY, 2026.

CRITICAL EVALUATION OF CIRCULAR ECONOMY AS A SUSTAINABLE BUILDING CONSTRUCTION AND DESIGN METHOD

BY

ONWUGHARA CHIDIEBERE
ENV2103373

A PROJECT SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE IN PARTIALFULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE(BSc.) DEGREE IN ARCHITECTURE, UNIVERSITY OF BENIN, BENIN CITY

JANUARY, 2026.

DECLARATION

I, **ONWUGHARA CHIDIEBERE**, declare that this project titled *'**CRITICAL EVALUATION OF CIRCULAR ECONOMY AS A SUSTAINABLE BUILDING CONSTRUCTION AND DESIGN METHOD'*** is my original work, carried out in the Department of Architecture, Faculty of Environmental Sciences, University of Benin, under the supervision of Arc. Felix Omobude. All sources and materials used have been properly acknowledged.

Onwughara Chidiebere

Date

CERTIFICATION

This is to certify that this study entitled "***CRITICAL EVALUATION OF CIRCULAR ECONOMY AS A SUSTAINABLE BUILDING CONSTRUCTION AND DESIGN METHOD***" was carried out by **ONWUGHARA CHIDIEBERE** with Matriculation Number **ENV2103373** in the Department of Architecture, Faculty of Environmental Sciences, University of Benin, Benin City under the supervision of Arc. Felix Omobude. I certify that it has not been submitted for the bachelor degree in this or any other university and is approved for its contribution to knowledge and literary presentation.

Arc. Felix Omobude — **Date**

(Project Supervisor)

Arc. (Dr.) Iwuchukwu O.U — **Date**

(Head of Department)

External Examiner — **Date**

DEDICATION

This project is dedicated to God Almighty, whose wisdom and grace made this work possible. I also dedicate it to my beloved family, for their endless support, encouragement, and prayers throughout my academic journey.

Finally, to all students and researchers who strive for sustainable solutions in architecture and construction, may this work inspire further innovation and commitment to building a better future.

ACKNOWLEDGEMENT

I am grateful to God Almighty for the strength, wisdom, and guidance to complete this project. Special thanks go to my parents, Mr. and Mrs. Collins for sponsoring, caring and showing me Love all through my stay in school, my siblings Shalom, Miracle, and Goodness for their support, prayers, and encouragement.

I sincerely appreciate my supervisor, Arc. Felix Omobude, for his invaluable guidance and constructive criticism, as well as my H.O.D (Arc. (Dr.) Iwuchukwu O.U) for his support and contributions to the department.

I am also thankful to all my lecturers in the Department of Architecture, Faculty of Environmental Sciences, University of Benin, for their dedication and impact on my academic journey.

Finally, I appreciate everyone who in one way or another, contributed to the success of this work. I am also specially appreciating my friends and love ones at home: M.D Kelvin, Bros Rolly, Mercy, Favour Okakah, Osarenoma, Gloria, Divine Blessing, Bro Aisosa, Abibe, Aunty Purity, who has shown me love and contributed to my success in school. And also my amazing course mates, MIT and my wonderful friends; Uncle vee, Sammy, Henry, Osazee, Olumide, Timothy, Jessie, Nwike, Adachukwu, Jayjay, and everyone else whose name this page cannot contain. Thank you all for your contribution towards my stay and study in school. May the God Lord bless you all.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDIXES

ABSTRACT

The construction industry is one of the largest consumers of natural resources and a major contributor to environmental degradation due to excessive material consumption, energy use, and waste generation. Conventional construction practices typically operate under a **linear economic model**, which follows the process of "take, make, use, and dispose." This model has been widely criticized for promoting unsustainable resource use and increasing environmental pressure. In response to these challenges, the **circular economy (CE)** has emerged as an alternative framework that promotes sustainability through resource efficiency, waste reduction, material reuse, and lifecycle optimization in building construction and design.

This research examines the circular economy as a sustainable approach to building construction and architectural design, with particular focus on its relevance and potential application within the Nigerian construction industry. The study investigates the principles of circular economy, evaluates global practices in circular construction, and assesses the level of awareness and implementation of circular economy strategies among individuals within the construction-related field.

A mixed research approach was adopted, combining an extensive review of relevant literature with empirical data obtained through a structured questionnaire survey. The questionnaire was distributed through Google Forms to students, student architects, architects, engineers, and other participants familiar with construction activities, particularly within Benin City and the University of Benin community. A total of 52 valid responses were collected and analyzed using descriptive statistical methods such as frequency distribution and percentage analysis. Charts and graphical illustrations were also used to present the findings clearly.

The results indicate that although awareness of circular economy concepts is gradually increasing, the actual implementation of circular construction practices within the Nigerian construction sector remains relatively low. Major challenges identified include limited awareness and technical knowledge, high cost of sustainable materials, lack of supportive policies and regulations, and resistance to change within traditional construction practices. Despite these barriers, the findings suggest that the adoption of circular economy principles has significant potential to improve sustainability in the built environment by reducing construction waste, conserving resources, and encouraging innovative design solutions.

The study concludes that integrating circular economy strategies into building construction and architectural design can contribute significantly to sustainable development in Nigeria. It therefore recommends increased awareness, policy support, professional training, and the incorporation of circular economy principles into architectural education and construction practices.

CHAPTER ONE

1.1 General Introduction

The construction industry plays a central role in shaping the built environment and the overall development of society. However, it is also one of the most resource-intensive sectors globally, consuming vast quantities of raw materials, water, and energy, while simultaneously generating significant amounts of waste and greenhouse gas emissions. According to global estimates, construction and demolition activities account for nearly 30–40% of total solid waste produced worldwide, and the sector contributes substantially to environmental challenges such as deforestation, biodiversity loss, and climate change.

Traditionally, building design and construction have operated within a **linear economy model**, which follows the sequence of **"take, make, use, and dispose."** This approach assumes an unlimited supply of natural resources and places little emphasis on resource recovery or reuse. In practice, it leads to a continuous cycle of resource extraction, high-energy production, and waste disposal, which is unsustainable in the long term. The environmental consequences of this system are evident in rising construction waste, depletion of natural resources, and escalating costs of building materials.

The growing demand for sustainable development has, however, challenged this conventional approach. The **circular economy (CE)** has emerged as a transformative model that shifts the focus from linear consumption to a **closed-loop system**, where resources are retained, reused, and recycled for as long as possible. Instead of discarding materials after use, the circular economy promotes principles such as designing for disassembly, extending the life cycle of buildings, recycling construction materials, and reintroducing recovered resources back into the economy.

In the context of **sustainable building construction and design**, the circular economy emphasizes architectural innovation, material efficiency, and environmental responsibility. It provides a framework where buildings are not only designed to meet present needs but are also adaptable, resource-conscious, and environmentally friendly over their entire life cycle. This approach aligns with global sustainability goals, particularly the **United Nations Sustainable Development Goals (SDGs)** on sustainable cities and climate action.

For Nigeria and other developing economies, the relevance of the circular economy is especially pressing. The construction sector in Nigeria continues to expand in response to rapid urbanization and population growth. However, the reliance on conventional linear

construction practices results in high waste generation, poor resource utilization, and limited environmental considerations. By evaluating and applying circular economy principles in this context, there is an opportunity to achieve more **sustainable, resilient, and cost-effective building practices**.

This study, therefore, sets out to critically evaluate the **circular economy as a sustainable building construction and design method.** It aims to explore how circular principles can be integrated into architectural practice to minimize environmental impact, promote efficiency, and encourage sustainable urban development.

1.2 Statement of the Problem

The construction industry in Nigeria faces increasing pressure to balance rapid urban growth with sustainable development. As cities expand and demand for housing and infrastructure rises, the sector continues to depend heavily on **linear construction methods**, which follow the pattern of resource extraction, production, consumption, and disposal. This model is inherently wasteful and environmentally damaging, as it fails to account for long-term resource efficiency and environmental conservation.

One of the major problems with this traditional system is the **excessive generation of construction and demolition waste**. A large portion of building materials such as concrete, timber, glass, and metals end up in landfills after use, despite their potential for recycling or reuse. This not only strains waste management systems but also contributes to land degradation and pollution. Furthermore, the over-reliance on virgin materials such as cement, sand, and steel has escalated costs, intensified resource depletion, and placed further stress on Nigeria's already fragile environment.

Another pressing challenge is the **lack of awareness and adoption of sustainable building practices** within the Nigerian construction industry. Many designers, builders, and policymakers remain focused on short-term cost savings rather than long-term sustainability benefits. This mindset, combined with weak enforcement of environmental policies and building regulations, has created a gap between global sustainable construction trends and local practices.

In addition, **technological limitations and inadequate infrastructure** further hinder the transition towards sustainable methods. While advanced economies are already adopting innovative design strategies such as modular construction, adaptive reuse, and design for disassembly, Nigeria still struggles with outdated techniques, limited recycling facilities, and poor integration of sustainability principles in architectural education and practice.

Given these realities, the central problem is that the Nigerian construction sector remains locked within a **linear economy framework**, which is unsustainable in the face of growing environmental, social, and economic challenges. Without a shift towards a circular economy model, the industry risks continued environmental degradation, escalating costs of materials, and the failure to align with global sustainability goals.

This study, therefore, addresses the critical problem of **unsustainable building practices** by evaluating how circular economy principles can be adopted as a practical solution for the Nigerian construction industry, with a focus on architecture and sustainable building design.

1.3 Research Questions

To effectively evaluate the circular economy as a sustainable building construction and design method, this research is guided by the following key questions:

1. **What are the fundamental principles of the circular economy, and how do they relate to sustainable building construction and design?**
   This question aims to establish a clear understanding of circular economy concepts and examine how these principles can guide environmentally responsible and resource-efficient architectural practices.
2. **What global and local case studies illustrate the successful application of circular construction methods?**
   This question seeks to explore practical examples from both international and Nigerian contexts, providing insights into best practices, innovative strategies, and lessons that can be adapted locally.
3. **What environmental, economic, and social benefits can result from adopting circular economy practices in the Nigerian construction industry?**
   The purpose of this question is to evaluate the potential positive impacts of circular construction, including reduced waste, cost savings, efficient resource use, and broader societal advantages.
4. **What challenges and limitations hinder the effective implementation of circular construction strategies in Nigeria?**
   This question investigates the barriers—such as policy gaps, technological constraints, financial limitations, and cultural factors—that prevent widespread adoption of sustainable circular practices.

5. **What practical recommendations and strategies can be developed to support the integration of circular economy principles into architectural design, construction processes, and policy frameworks?**
   This question focuses on generating actionable solutions for architects, policymakers, and stakeholders to facilitate the successful adoption of circular construction methods in Nigeria.

1.4 Research Aims and Objectives

AIMS:

The aims of this study is to Critically examine the applicability of circular economy principles to sustainable building construction, with a view to evaluating their benefits, challenges, and potential for integration within the Nigerian construction industry.

OBJECTIVES:

To achieve the aims of this research, the study seeks to:

1. Explain the fundamental principles of the circular economy and their relationship to sustainable building practices.
2. Review existing literature and case studies on circular construction at both international and local levels.
3. Evaluate the environmental, social, and economic implications of applying circular economy strategies in building projects.
4. Examine the challenges, constraints, and institutional gaps hindering circular construction in Nigeria.
5. Propose actionable recommendations and strategies for integrating circular economy principles into architectural design, construction activities, and national policy frameworks.

1.5 Scope of the Study

This study focuses on the application of **circular economy principles within the building construction and design sector**, with particular emphasis on the Nigerian context. The research explores how circular economy strategies such as recycling, reuse of materials, design for adaptability, and resource efficiency can contribute to achieving sustainability in architecture and construction.

The scope of the study is defined as follows:

- **Thematic Scope:** The research is limited to sustainable building construction and design, rather than the entire construction industry. While circular economy principles are relevant in many sectors (such as manufacturing, agriculture, and waste management), this study restricts its analysis to architectural design and building-related processes.
- **Geographical Scope:** The study emphasizes the Nigerian construction industry, taking into account its unique challenges, such as rapid urbanization, weak regulatory enforcement, poor waste management systems, and limited adoption of sustainable technologies. However, international case studies are also reviewed for comparative purposes and to draw lessons that may be applicable locally.
- **Conceptual Scope:** The study considers the role of circular economy in addressing issues such as resource depletion, environmental degradation, and waste management in the Nigerian context. It does not provide a detailed cost analysis or quantitative measurement of material flows but instead focuses on **qualitative insights** from literature, case studies, and existing research.

In essence, the scope of this project is to provide a **critical evaluation** of circular economy as it relates specifically to sustainable building construction and design. It aims to show how Nigeria can benefit from adopting CE principles in architecture, while also identifying the limitations and challenges that need to be addressed.

1.6 Research Limitations

Every research has its constraints, and this study is no exception. While it seeks to critically evaluate the circular economy as a sustainable building construction and design method, several limitations may influence the depth and breadth of the findings. These include:

1. **Limited Primary Data:** Due to time and resource constraints, this study relies largely on secondary data such as journal articles, textbooks, reports, and documented case studies. The lack of extensive field surveys and direct data collection from construction sites may limit the practical applicability of the findings in the Nigerian context.
2. **Scarcity of Local Case Studies:** There is a shortage of documented examples of circular economy practices within Nigeria's construction industry. As a result, much of the comparative analysis is drawn from international studies, which may not fully reflect local realities.
3. **Time Constraint:** The duration available for carrying out this research was relatively short. This limited the extent of data gathering, consultation with professionals, and detailed exploration of diverse construction projects.
4. **Financial Limitation:** Conducting extensive field studies, interviews, or laboratory-based analysis of construction materials requires substantial funding. Financial constraints restricted the scope of such activities, thereby narrowing the range of primary data collection.
5. **Technological Limitation:** Since circular economy in construction is still an emerging concept in Nigeria, access to advanced technologies, databases, and tools for measuring material efficiency and life cycle assessment was limited.

Despite these limitations, the research provides valuable insights into the potential of circular economy principles in promoting sustainability in Nigeria's construction sector. The constraints highlight areas for future in-depth studies and practical pilot projects within the built environment.

1.7 Delineation

This study is carefully delineated to ensure clarity in its focus and to avoid digression into unrelated fields. The boundaries are set as follows:

1. **Subject Focus:** The research is restricted to the evaluation of the **circular economy within building construction and architectural design**. While the circular economy has wide applications in sectors such as agriculture, manufacturing, energy, and consumer goods, this study deliberately narrows its analysis to the construction sector, particularly buildings.
2. **Conceptual Boundaries:** The study emphasizes **sustainability principles in architecture**, including material efficiency, waste reduction, design for adaptability, and recycling in construction. It does not extend to other forms of industrial recycling or resource management beyond the building industry.
3. **Practical Boundaries:** The project does not involve laboratory testing of materials or quantitative modeling of life-cycle assessments due to resource and time constraints. Instead, it is based on **qualitative evaluation**, drawing from secondary sources, case studies, and comparative analysis.
4. **Geographical Limitation:** Although international practices are referenced for comparative purposes, the study is primarily focused on the Nigerian context. This ensures relevance to the realities of the local construction industry, while also acknowledging global best practices.

By setting these delineations, the study maintains a clear direction evaluating the **circular economy as a sustainable construction and design method in architecture** without extending into unrelated fields or processes.

1.8 Research Methodology

The methodology adopted in this study is designed to provide a structured framework for achieving the stated objectives. Since the focus of the research is a **critical evaluation of circular economy as a sustainable building construction and design method**, the study relies primarily on **qualitative methods**, supported by a review of relevant secondary data. The methodology is outlined as follows:

1. **Research Approach:**

   A **qualitative research approach** is employed, emphasizing descriptive and analytical techniques rather than quantitative measurement. This allows for an in-depth exploration of concepts, principles, and practices related to circular economy in construction.

2. **Data Sources:**

- **Secondary Data:** The research relies heavily on published literature including textbooks, academic journals, conference papers, government reports, and policy documents on sustainability, circular economy, and architectural design.
- **Case Studies:** Selected global and regional case studies of circular economy applications in construction are reviewed to highlight practical examples and lessons that may be adapted to the Nigerian context.

3. **Data Collection Methods:**

   Information is collected through library research, online academic databases, and institutional reports. Relevant materials are critically examined to extract insights on sustainable construction practices, challenges, and opportunities.

4. **Data Analysis:**

   The study employs **comparative and thematic analysis**. Concepts and findings from international literature are compared with existing practices in Nigeria's construction industry to identify gaps, opportunities, and practical strategies for adaptation.

5. **Justification of Methodology:**

   The choice of qualitative methodology is justified by the exploratory nature of the study. Since circular economy in construction is still an emerging field in Nigeria, extensive primary data is not readily available. A qualitative review, therefore, provides the most suitable means of gathering sufficient evidence to evaluate the concept and make informed recommendations.

This methodological framework ensures that the study maintains academic rigor while providing practical insights into how circular economy principles can be integrated into sustainable building construction and design in Nigeria.

1.9 Target Audience

The findings and recommendations of this research are intended to benefit a wide range of stakeholders connected to the construction industry, architectural practice, and sustainability efforts. The target audience includes:

Architecture Students and Researchers:

This study serves as a valuable academic resource for students and scholars who wish to understand the relationship between circular economy principles and sustainable building practices. It also provides a foundation for future research in the field of sustainable architecture.

Architects and Construction Professionals:

Practicing architects, engineers, quantity surveyors, and builders will find the study useful in identifying practical strategies for integrating circular economy concepts, such as material reuse, design for adaptability, and waste reduction into their projects.

Policymakers and Regulatory Agencies:

The study provides insights that can guide government ministries, housing authorities, and environmental agencies in developing policies and frameworks that promote sustainable construction and encourage the adoption of circular economy practices.

Educational Institutions:

Faculties of Environmental Sciences and related academic bodies can adopt the study's findings to enrich their curriculum, thereby equipping future professionals with knowledge of sustainable design and construction methods.

General Public and Stakeholders in Urban Development:

Homeowners, real estate developers, and investors can also benefit from the study, as it highlights the long-term environmental and economic advantages of adopting circular economy principles in building projects.

CHAPTER TWO

2.1 Literature Review

2.1.1 Introduction

The construction industry is widely recognized as one of the most resource-intensive sectors globally, consuming large volumes of raw materials, energy, and water, while producing substantial amounts of waste and greenhouse gas emissions (Ellen MacArthur Foundation, 2013). Traditional construction practices have largely followed a linear economic model — "take, make, use, dispose" — which often results in excessive material consumption, environmental degradation, and unsustainable urban development (Charef, 2024).

In contrast, the circular economy (CE) proposes a systemic approach that emphasizes **reuse, recycling, refurbishment, and regeneration of materials** throughout a product or building's lifecycle (Geissdoerfer et al., 2017). By integrating circular principles, the construction sector can minimize waste, conserve natural resources, and reduce environmental impacts, while promoting economic efficiency and social benefits.

Globally, the adoption of CE strategies in construction has demonstrated positive outcomes, such as reduced construction and demolition waste, lower embodied carbon, and enhanced building adaptability (Pomponi & Moncaster, 2017). For example, modular designs, deconstruction-friendly detailing, and the use of sustainable or recycled materials are increasingly recognized as key strategies to embed circularity in the built environment.

In the context of developing countries like Nigeria, where rapid urbanization and population growth intensify the demand for housing and infrastructure, implementing circular construction practices is particularly relevant. Studies indicate that limited awareness, inadequate policy frameworks, and poor waste management infrastructure hinder the adoption of sustainable construction methods in Nigeria (Unegbu et al., 2025). This highlights the urgent need for research that explores how circular economy principles can be applied in the Nigerian construction industry to improve resource efficiency and environmental sustainability.

Thus, this study aims to critically evaluate the circular economy as a sustainable building construction and design method. It seeks to examine the principles, benefits, global and local applications, challenges, and potential strategies for integrating CE principles into architectural practice in Nigeria, providing a foundation for policy recommendations and practical interventions.

2.1.2 Circular Economy Principles and Concepts in Construction

The circular economy (CE) in construction represents a shift from traditional linear methods toward a system that emphasizes sustainability, efficiency, and resource regeneration. The literature identifies several core principles that guide the application of CE in building construction and design:

1. Design for Longevity and Adaptability

Buildings should be designed to have extended lifespans and accommodate changing functional requirements. Flexible layouts, modular systems, and easily upgradable components allow spaces to be repurposed over time, reducing the frequency of demolition and construction-related waste (Lieder & Rashid, 2016).

2. Material Reuse and Recycling

Construction and demolition processes generate substantial waste, often ending up in landfills. CE strategies promote the recovery, recycling, and repurposing of materials such as concrete, steel, timber, and glass (Pomponi & Moncaster, 2017). Recovered materials can be reintegrated into new construction projects, reducing the demand for virgin resources and minimizing environmental impact.

3. Closed-Loop Systems

A closed-loop system ensures that materials remain in circulation for as long as possible. Waste from one process is used as input for another, creating a regenerative cycle. This approach minimizes the environmental footprint of construction while conserving valuable resources (Geissdoerfer et al., 2017).

4. Use of Renewable and Eco-Friendly Materials

CE emphasizes the use of sustainable, low-impact, or renewable materials. Examples include bamboo, recycled aggregates, reclaimed timber, and low-carbon concrete (Adams et al., 2017). Selecting eco-friendly materials reduces environmental harm and supports long-term sustainability.

5. Deconstruction Instead of Demolition

Instead of traditional demolition, deconstruction involves the careful dismantling of structures to recover materials for reuse. This practice not only diverts waste from landfills but also preserves material value and promotes circular flows within the construction sector (Guy & Ciarimboli, 2009).

6. Energy Efficiency and Resource Optimization

Circular construction strategies emphasize reducing energy use, incorporating renewable energy systems, and optimizing water and other resources throughout a building's lifecycle (Charef, 2024). By integrating these measures during design and construction, buildings can significantly lower operational costs and environmental impacts.

7. Integration of Digital and Tracking Technologies

Emerging CE practices leverage digital tools to monitor material flows, track lifecycle impacts, and support decision-making in construction projects. Technologies like Building Information Modelling (BIM) and material passports help architects and engineers plan for reuse and recycling effectively (Ghisellini et al., 2016).

2.1.3 Global Practices and Case Studies on Circular Economy in Construction

The adoption of circular economy principles in construction has been increasingly documented worldwide, demonstrating practical strategies that reduce waste, improve resource efficiency, and enhance sustainability. These case studies provide important lessons that can inform the Nigerian construction industry.

1. The Netherlands – Park 20|20

Park 20|20, located in Amsterdam, is often cited as a pioneering example of circular construction. The project incorporates **modular building design, material recovery, and energy-efficient systems** aimed at zero waste. Materials are tracked throughout their lifecycle using digital tools, ensuring that components can be reused or recycled at the end of their service life (van Buren et al., 2016). This approach illustrates how **design for disassembly and material tracking** can support circularity at the urban development scale.

2. United Kingdom – Circular Building Demonstrator Project

In the UK, the Circular Building Demonstrator Project integrates **modular construction techniques and reclaimed materials**, supported by Building Information Modelling (BIM) to manage material flows. The project highlights how combining digital technology with CE principles can optimize construction processes, reduce waste, and improve cost efficiency (UK Green Building Council, 2018). It demonstrates that circular practices are not only environmentally beneficial but also economically viable.

3. Denmark – Aarhus Urban Development

The city of Aarhus has implemented circular construction strategies in its urban planning. Key measures include **recycling construction waste, promoting sustainable material selection, and circular procurement policies**. This initiative emphasizes the role of government regulation and policy support in facilitating CE adoption and showcases the integration of circular principles at a city-wide level (Ghisellini et al., 2016).

4. China – Tianjin Eco-City

Tianjin Eco-City illustrates circular economy principles applied to large-scale urban construction. The project emphasizes **renewable energy integration, efficient waste management, and use of recycled building materials**. It highlights the scalability of CE strategies and their potential impact on reducing environmental footprints while supporting sustainable urban growth (Zhu et al., 2020).

5. Nigeria – Emerging Awareness and Pilot Projects

While still nascent in Nigeria, circular construction practices are beginning to gain attention. Organizations such as the **Green Building Council of Nigeria (GBCN)** are promoting sustainable material use, energy efficiency, and modular construction. Pilot projects have experimented with **material recovery, adaptive reuse, and eco-friendly construction techniques**. However, challenges such as limited policy enforcement, low awareness, and inadequate technological infrastructure have constrained broader adoption (Unegbu et al., 2025).

2.1.4 Circular Economy Strategies in Construction

Circular economy (CE) strategies in construction aim to **optimize resource use, reduce waste, and enhance sustainability** throughout a building's lifecycle. The literature identifies several strategies that are widely recognized and adopted globally:

1. Design for Deconstruction and Adaptability

Buildings should be designed so that their components can be **easily dismantled, reused, or recycled** at the end of their life cycle (Guy & Ciarimboli, 2009). Modular and adaptable designs allow structures to be modified or expanded without major demolition, reducing material waste and supporting long-term sustainability.

2. Material Recovery and Reuse

Construction and demolition (C&D) waste represents a significant portion of total solid waste globally. CE strategies prioritize **recovering materials such as steel, timber, concrete, and glass** for reuse in new projects (Pomponi & Moncaster, 2017). For instance, crushed concrete can be used as aggregate in new construction, and timber elements can be refurbished for interior fittings.

3. Recycling and Upcycling of Materials

Recycling involves processing waste materials to produce new construction products, while **upcycling enhances the value of waste materials** by converting them into higher-quality or specialized products (Adams et al., 2017). Both strategies reduce reliance on virgin resources and lower environmental impacts.

4. Integration of Renewable and Low-Impact Materials

CE strategies emphasize the use of **sustainable or low-carbon materials**, such as bamboo, recycled metals, low-carbon concrete, and eco-friendly insulation materials. These materials minimize the carbon footprint of construction projects and support long-term ecological sustainability (Charef, 2024).

5. Implementation of Energy and Resource Efficiency Measures

CE in construction incorporates **energy-efficient systems, water conservation techniques, and renewable energy integration**. For example, using passive design principles, solar panels, and rainwater harvesting reduces operational energy and resource consumption over a building's lifecycle (Geissdoerfer et al., 2017).

6. Digital Tools and Material Tracking

Technologies such as **Building Information Modelling (BIM), material passports, and lifecycle assessment tools** enable architects and engineers to track materials, forecast their end-of-life value, and optimize material flows (Ghisellini et al., 2016). These tools ensure that CE strategies are implemented effectively and transparently.

2.1.5 Global Practices and Case Studies

The adoption of circular economy (CE) strategies in construction has been successfully demonstrated in several countries, offering **practical lessons** for sustainable building practices worldwide. Examining these case studies highlights how circular principles can be applied in both developed and developing contexts.

1. The Netherlands – Park 20|20

Park 20|20 in Amsterdam is a pioneering circular construction project that incorporates **modular building design, material recovery, and energy-efficient systems** aimed at zero waste. Materials are tracked throughout their lifecycle using digital tools, allowing for **reuse or recycling at the end-of-life**. This project illustrates the effectiveness of **design for disassembly and material lifecycle management** in achieving circularity (van Buren et al., 2016).

2. United Kingdom – Circular Building Demonstrator Project

The UK Circular Building Demonstrator Project emphasizes **modular construction, reclaimed materials, and Building Information Modelling (BIM)** to manage material flows. The project demonstrates that integrating **digital tools with CE strategies** can

enhance efficiency, reduce waste, and lower construction costs, while also providing environmental benefits (UK Green Building Council, 2018).

3. Denmark – Aarhus Urban Development

Aarhus integrates circular construction in urban planning through **waste recycling programs, circular procurement, and sustainable material use**. The project highlights the importance of **policy support and stakeholder collaboration** in facilitating CE adoption at a city-wide scale (Ghisellini et al., 2016).

4. China – Tianjin Eco-City

Tianjin Eco-City demonstrates circular construction on a large urban scale, emphasizing **renewable energy integration, efficient waste management, and use of recycled building materials**. This case shows the scalability of CE strategies and their ability to reduce the environmental footprint of large infrastructure projects (Zhu et al., 2020).

5. Nigeria – Emerging Awareness

In Nigeria, circular construction is still in its **early stages**, but initiatives by the **Green Building Council of Nigeria (GBCN)** have promoted sustainable material use, modular construction, and energy-efficient building systems. Pilot projects demonstrate **material recovery, adaptive reuse, and eco-friendly construction techniques**, though broader adoption is limited by **policy gaps, low awareness, and technological constraints** (Unegbu et al., 2025).

2.2 Theoretical Framework

The theoretical framework provides the conceptual foundation for understanding the integration of circular economy (CE) principles into sustainable building construction and design. Several theories underpin CE adoption, offering both practical guidance and explanatory power for this study.

1. Cradle-to-Cradle (C2C) Theory

Developed by McDonough and Braungart (2002), the Cradle-to-Cradle approach emphasizes designing products and buildings so that **materials can either safely return to the**

environment (biological nutrients) or be endlessly reused (technical nutrients). In construction, C2C encourages **designing for deconstruction, material recovery, and continuous reuse**, ensuring that resources remain valuable beyond the initial project lifecycle.

2. Industrial Ecology Theory

Industrial Ecology views industrial and construction processes as **interconnected systems**, where waste or by-products from one process can serve as input for another (Ayres & Ayres, 2002). Applied to construction, this theory supports **closed-loop material flows, industrial symbiosis, and efficient resource utilization**, aligning closely with circular economy goals.

3. Waste Hierarchy Model

The Waste Hierarchy Model prioritizes waste management actions in the order: **Reduce → Reuse → Recycle → Recover → Dispose** (DEFRA, 2007). In building construction, this model guides architects and engineers to **minimize material consumption, maximize reuse of components, and incorporate recycling strategies**, ensuring a systematic approach to resource efficiency.

4. Systems Thinking

Systems Thinking encourages viewing buildings as part of **larger social, economic, and ecological systems** (Meadows, 2008). This approach helps practitioners anticipate **long-term environmental and social impacts**, optimize material and energy flows, and align construction projects with broader sustainability objectives.

5. Sustainable Development Theory

Rooted in the Brundtland Commission report (1987), Sustainable Development Theory emphasizes **meeting present needs without compromising the ability of future generations to meet theirs**. CE adoption in construction aligns with this theory by promoting **efficient resource use, reduced environmental impact, and long-term ecological balance**.

2.3 Research Gaps

Despite the growing global interest in circular economy (CE) practices in construction, several **gaps exist, particularly in the Nigerian context**:

1. **Limited Awareness and Knowledge:**
   While CE principles are widely discussed internationally, many construction stakeholders in Nigeria — including architects, engineers, contractors, and policymakers — have **limited awareness or understanding of circular construction strategies** (Unegbu et al., 2025). This knowledge gap hinders the adoption of sustainable building methods.
2. **Inadequate Policy and Regulatory Framework:**
   Unlike countries such as the Netherlands, Denmark, or the UK, Nigeria **lacks comprehensive policies, standards, and enforcement mechanisms** to promote circular construction (Charef, 2024). The absence of legal frameworks makes it difficult to implement strategies like material recovery, recycling, or design for disassembly.
3. **Insufficient Technological Infrastructure:**
   Technologies such as **Building Information Modelling (BIM), material passports, and lifecycle assessment tools** are underutilized in Nigeria (Ghisellini et al., 2016). Without these tools, it becomes challenging to track materials, optimize resource use, or implement circular strategies effectively.
4. **Economic and Market Constraints:**
   The initial cost of adopting circular construction techniques, including modular designs, recycled materials, and renewable energy systems, can be perceived as high. Additionally, the **market for recycled construction materials is not fully developed**, limiting access and affordability (Unegbu et al., 2025).
5. **Lack of Empirical Research:**
   There is a **scarcity of empirical studies** examining CE implementation in Nigeria's construction sector. Most literature focuses on global case studies, leaving a gap in understanding how circular economy principles can be **practically applied in local contexts**.

2.4 Summary of Literature

The literature reviewed demonstrates that circular economy (CE) principles provide **an effective framework for sustainable construction and building design**. Globally, CE strategies have been successfully implemented to reduce material waste, enhance resource efficiency, and promote environmental sustainability.

- **Global practices** such as those in the Netherlands (Park 20|20), the UK (Circular Building Demonstrator Project), Denmark (Aarhus Urban Development), and China

(Tianjin Eco-City) demonstrate the effectiveness of **modular design, deconstruction-friendly techniques, material recovery, and digital tools like BIM** in achieving circularity (van Buren et al., 2016; Zhu et al., 2020).

- **Theoretical frameworks** including Cradle-to-Cradle, Industrial Ecology, Systems Thinking, and Sustainable Development provide a solid basis for understanding how CE principles can be applied in construction, ensuring **environmental, economic, and social benefits** (McDonough & Braungart, 2002; Ayres & Ayres, 2002).
- **Circular economy strategies** such as design for adaptability, material reuse and recycling, renewable materials, energy efficiency, and digital tracking tools are critical for operationalizing CE in construction (Pomponi & Moncaster, 2017; Adams et al., 2017).

Local Context – Nigeria:

In Nigeria, the adoption of CE is **still emerging**. Key challenges include **limited awareness, weak policy frameworks, technological constraints, and economic limitations** (Unegbu et al., 2025). Although pilot projects have demonstrated the potential of circular construction methods, broader implementation is constrained by the lack of empirical research and context-specific guidelines.

CHAPTER THREE

3.1 RESEARCH METHODOLOGY

This study adopted a **mixed-method research approach**, combining both qualitative and quantitative methods to achieve a comprehensive understanding of the subject. A detailed review of existing literature was conducted to examine the concept of circular economy and its relevance to sustainable building construction.

3.2 Research Design

The research adopts a **descriptive and analytical research design**, carefully chosen to investigate the role of **circular economy (CE) principles in sustainable building construction and design** in Nigeria. This design allows the study to **systematically collect, analyze, and interpret data** from multiple sources to address the research objectives.

Descriptive Component

The descriptive aspect focuses on **documenting and understanding the current practices, knowledge, and perceptions** of construction professionals regarding circular economy. It aims to:

- Assess the **level of awareness and understanding** of CE among architects, engineers, contractors, and policymakers.
- Identify **current construction practices**, particularly those that contribute to waste generation or resource inefficiency.
- Provide a **snapshot of how CE principles are being applied or ignored** in local construction projects.

This component is essential because it establishes a **baseline understanding of the Nigerian construction industry**, highlighting areas where circular strategies can be implemented or improved.

Analytical Component

The analytical aspect evaluates the **feasibility, benefits, and challenges** of implementing circular economy strategies in building construction. This involves:

- **Analyzing data from stakeholders** to determine the practicality of CE adoption in terms of cost, technology, and policy support.
- **Comparing local practices with international case studies** to identify gaps and opportunities for improvement.
- **Assessing potential environmental, economic, and social impacts** of integrating circular strategies in construction projects.

This analytical approach ensures that the study does not merely describe existing conditions but also **interprets findings to provide actionable insights**.

Mixed-Method Approach

To achieve a **comprehensive understanding**, the study employs a mixed-method approach:

- **Quantitative Methods:** Structured questionnaires administered to construction professionals to collect measurable data on CE awareness, practices, and perceived challenges. This enables **statistical analysis of trends, frequency, and correlations**.
- **Qualitative Methods:** Semi-structured interviews and field observations provide **rich, contextual insights** into stakeholder experiences, challenges, and innovative practices. This complements the quantitative data, ensuring a **holistic understanding** of circular construction in Nigeria.

Rationale for the Research Design

This combination of **descriptive and analytical design with mixed methods** is ideal because it:

1. Captures both **quantitative trends** and **qualitative insights**, ensuring data reliability and depth.
2. Allows for **comparative analysis** with global practices, helping to identify best practices adaptable to Nigeria.
3. Supports **evidence-based recommendations** for policymakers, architects, and construction stakeholders.
4. Aligns with the **research objectives** of critically evaluating CE as a sustainable building construction and design method.

3.3 Study Area and Population

The study focuses on **the Nigerian construction sector**, with particular emphasis on urban and peri-urban areas where construction activities are rapidly expanding.

Although significant construction activities are ongoing in major Nigerian cities such as **Lagos, Abuja, and Port Harcourt**, this study **focuses specifically on Benin City, Edo State**, with special emphasis on the **University of Benin** community. This focus is chosen because **most students and participants are familiar with construction practices in these areas**, providing reliable insights into local construction trends and sustainability practices. Focusing on Benin also allows for **more precise and manageable data collection** while still reflecting broader trends in Nigerian construction.

Study Area

Benin City is a rapidly urbanizing city with a variety of **residential, commercial, and institutional building projects**. The University of Benin, being a hub for architectural education, provides access to **students, student architects, lecturers, and professionals** who are knowledgeable about construction practices, sustainability initiatives, and circular economy principles.

The choice of this area is strategic because:

1. It represents **diverse construction practices**, from traditional methods to modern, sustainable building techniques.
2. It allows access to **students, construction professionals, and regulatory stakeholders** who can provide informed perspectives on circular economy practices.
3. It reflects **local environmental and social challenges**, such as resource management, material waste, and urban sustainability, making it ideal for studying CE adoption.

Target Population

The population of the study consists of stakeholders who are **directly involved in building construction and design**, including:

- **Architects:** Professionals responsible for designing and planning buildings, including sustainable construction practices.

- **Student Architects:** Students studying architecture at the University of Benin who are **actively engaged in learning design and construction principles**.
- **Engineering Professionals (Civil and Structural Engineers):** Individuals involved in material selection, structural design, and construction planning.
- **Construction Managers and Contractors:** Personnel overseeing building projects, material procurement, and on-site management.
- **Policy Makers and Regulatory Bodies:** Representatives from agencies such as the **Federal Ministry of Works and Housing** and the **Green Building Council of Nigeria (GBCN)**, who influence construction policies and sustainability initiatives.
- **Students:** Other students in the University of Benin community who have **knowledge or exposure to construction practices**, as their perspectives can enrich the understanding of CE awareness and sustainability attitudes.

Rationale for the Population Choice

Including students and student architects ensures that:

1. Data reflects **both practical professional experiences and academic knowledge**, giving a holistic view of construction practices.
2. Insights cover **technical, educational, and policy perspectives**, essential for evaluating circular economy adoption.
3. Findings are **contextually relevant** to Benin City and the University of Benin community while still informing broader Nigerian construction practices.

3.4 Sampling Technique

The study employs a **purposive sampling technique**, which is a **non-probability sampling method** where participants are selected based on their **relevance, knowledge, and experience** in the field of construction and architecture. This technique is particularly suitable for this study because the research seeks to **collect information from stakeholders who are directly involved in or knowledgeable about circular economy practices and sustainable construction**.

Selection Criteria

Participants are selected based on the following criteria:

1. **Professional Experience:** Architects, engineers, construction managers, and contractors actively involved in building projects.
2. **Academic Involvement:** Student architects and other students at the University of Benin who have exposure to construction education or practical training.
3. **Policy and Regulatory Role:** Stakeholders from government agencies or organizations such as the **Green Building Council of Nigeria (GBCN)** involved in sustainability policies or initiatives.
4. **Willingness to Participate:** Participants must be willing to provide **accurate and honest responses** to questionnaires and interviews.

Sample Size

A **total of 60 participants** will be selected to ensure **representative and reliable data**. This includes:

- **Professionals (Architects, Engineers, Contractors):** 25 participants
- **Student Architects and Other Students:** 25 participants
- **Policy Makers/Regulatory Representatives:** 10 participants

The sample size is deemed sufficient to **capture diverse perspectives**, ensure **statistical reliability**, and maintain manageability for data collection within the University of Benin and surrounding construction sites.

Rationale for Purposive Sampling

Purposive sampling is chosen because it:

1. Focuses on **participants with the most relevant knowledge** of construction practices and CE adoption.
2. Ensures that **specialized insights** from professionals and students are collected.
3. Enables **efficient use of resources and time** by targeting participants who can provide **valuable, context-specific information**.
4. Aligns with the study's **qualitative and quantitative objectives**, allowing for both in-depth insights and measurable data trends.

3.5 Data Collection Methods

Data collection is a critical component of this study as it ensures the research is **reliable, valid, and capable of addressing the study objectives**. A **mixed-method approach** combining both **primary and secondary data sources** will be used.

1. Primary Data Collection

Primary data will be collected directly from participants through the following methods:

a. Questionnaires

- Structured questionnaires will be distributed to **students, student architects, professionals, and policymakers**.
- The questionnaires will include both **closed-ended and open-ended questions**, designed to collect information on:
    - Awareness of circular economy principles in construction
    - Current practices regarding sustainable building
    - Perceived challenges and opportunities for CE adoption
- Quantitative data from questionnaires will allow for **statistical analysis of trends, frequencies, and correlations**.

b. Interviews

- Semi-structured interviews will be conducted with selected **architects, engineers, construction managers, and policymakers**.
- Interviews provide **in-depth insights** into:
    - Practical implementation of circular economy strategies
    - Challenges encountered in adopting CE principles
    - Recommendations for improving sustainability in Nigerian construction
- Qualitative data from interviews will be **thematically analyzed** to identify recurring patterns and key themes.

c. Field Observations

- Observations will be conducted at **construction sites within Benin City and the University of Benin campus projects**.

- The aim is to assess:
    - The **extent of material reuse and recycling**
    - Waste management practices
    - Adoption of **sustainable construction techniques**
- Observational data will provide **firsthand evidence** of circular economy practices and supplement questionnaire and interview findings.

2. Secondary Data Collection

Secondary data will be gathered from **existing literature and published sources**, including:

- **Books, journal articles, and conference papers** on circular economy, sustainable construction, and resource management.
- **Reports and guidelines** from organizations such as the **Ellen MacArthur Foundation, Green Building Council of Nigeria (GBCN), and international construction bodies**.
- **Policy documents** related to construction regulations, sustainability standards, and CE adoption in Nigeria.

Secondary data will provide a **theoretical and empirical foundation**, helping to:

1. Compare local practices with **global best practices**
2. Identify **gaps in knowledge and implementation**
3. Strengthen the analysis and recommendations derived from primary data

3.6 Data Analysis

Data analysis is a crucial step in this study as it allows for the **interpretation of collected information** to address the research objectives and answer the research questions. Both **quantitative and qualitative data** will be analyzed using appropriate methods.

1. Quantitative Data Analysis

- Data from **structured questionnaires** will be coded and entered into **statistical software (e.g., SPSS or Microsoft Excel)**.
- Analysis techniques will include:

- **Descriptive statistics:** To summarize participant responses using **frequencies, percentages, and charts**.
- **Comparative analysis:** To examine differences in **awareness and practices** between students, student architects, and professionals.

- This approach enables the study to **identify trends, patterns, and relationships** within the data.

2. Qualitative Data Analysis

- Data from **semi-structured interviews and field observations** will be analyzed using **thematic content analysis**.
- Steps include:
  1. **Transcribing interview responses** verbatim.
  2. **Coding the data** to identify recurring themes, patterns, and concepts related to CE adoption.
  3. **Categorizing findings** into key areas such as challenges, strategies, awareness, and sustainability impacts.
- Qualitative analysis provides **contextual understanding** and insights into **practical experiences, challenges, and stakeholder perceptions**.

3. Triangulation

- To enhance the **validity and reliability** of findings, data from **questionnaires, interviews, and field observations** will be **triangulated**.
- This process allows the study to **cross-verify results**, ensuring that conclusions are well-supported and reflective of real-world conditions.

4. Integration with Literature

- Findings will be **compared with existing literature and global case studies** on circular economy adoption in construction.
- This will help identify **gaps, opportunities, and best practices** that can be applied in the Nigerian context.

3.7 Target Audience

The findings of this study are intended to benefit a **wide range of stakeholders** in the construction and architectural sectors, as well as the broader academic and policy-making community. Understanding circular economy (CE) adoption can influence **practical, educational, and policy-based outcomes** in sustainable construction.

1. Construction Professionals

- **Architects, engineers, contractors, and construction managers** will benefit from insights into **circular design strategies, material reuse, waste reduction, and sustainable building practices**.
- This knowledge can help them **integrate CE principles into everyday construction projects**, enhancing sustainability, efficiency, and cost-effectiveness.

2. Students and Student Architects

- Students, particularly **student architects at the University of Benin**, will gain exposure to **practical and theoretical aspects of circular economy in construction**.
- The study provides a **learning platform** for understanding CE principles, developing sustainable design skills, and preparing for **future professional practice**.

3. Policy Makers and Regulatory Bodies

- Agencies such as the **Federal Ministry of Works and Housing** and the **Green Building Council of Nigeria (GBCN)** can use the findings to **formulate policies, standards, and regulations** that promote CE adoption in construction.
- Recommendations from the study can guide **infrastructure development, waste management policies, and sustainability regulations** in Nigeria.

4. Academic and Research Community

- Researchers and educators in architecture, construction management, and environmental studies can use the findings as a **reference for future studies on circular economy and sustainable construction practices**.
- The study contributes to **existing literature** by providing a Nigerian perspective on CE adoption, highlighting **local challenges, opportunities, and best practices**.

5. General Public and Society

- Indirectly, the general public benefits from **more sustainable, environmentally-friendly construction practices**, which reduce waste, conserve resources, and improve the **long-term livability and resilience of buildings**.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF RESULTS

4.1 Introduction

This chapter focuses on the **analysis, presentation, and interpretation of data** collected for this research titled *"Critical Evaluation of Circular Economy as a Sustainable Building Construction and Design Method."* The data analyzed in this chapter were obtained through a structured questionnaire designed in line with the research objectives and administered using a Google Form.

The purpose of this chapter is to transform the raw data gathered from respondents into **meaningful information** that can be clearly understood and used to address the research questions. The analysis aims to evaluate respondents' **level of awareness**, **current practices**, **perceived benefits**, and **challenges** associated with the adoption of circular economy principles in building construction and design within the Nigerian context, with specific reference to Benin City and the University of Benin community.

A total number of valid responses were collected from **students, student architects, and construction-related professionals**, ensuring that both academic and practical perspectives were captured. This diverse respondent base provides a reliable foundation for understanding how circular economy concepts are perceived and applied within the built environment sector.

The data are analyzed using **descriptive statistical methods**, including frequencies and percentages, to clearly show trends and patterns in respondents' answers. To enhance clarity and ease of interpretation, the results are presented using **tables, pie charts, and bar charts**, where appropriate. These graphical tools help in visually representing the distribution of responses and highlighting key findings.

Each subsection in this chapter is carefully discussed, with interpretations directly linked to the study's **research objectives and questions**. This ensures that the findings are not merely presented but also **critically examined** in relation to sustainable building construction and design practices.

Overall, this chapter serves as a crucial bridge between the data collected in the field and the conclusions and recommendations presented in later chapters. It provides the empirical

evidence needed to evaluate the relevance and practicality of circular economy principles as a sustainable approach to building construction and architectural design in Nigeria.

4.2 Survey Response Rate and Data Organization

This section presents the response rate achieved from the questionnaire survey and explains the procedures adopted in organizing the collected data for effective analysis. The purpose of this stage of the study was to ensure that the responses obtained from participants were properly structured, categorized, and prepared for interpretation in relation to the research objectives of the study.

The questionnaire was distributed using **Google Forms**, an online survey platform that allows respondents to easily access and complete questionnaires through mobile phones, tablets, or computers. The online format was chosen because it provides a convenient means of reaching respondents within the targeted population, particularly students, student architects, and professionals within the built environment. The use of an online platform also helped to minimize data entry errors, as responses were automatically recorded and stored in a digital format.

A total of **52 valid responses** were obtained from the distributed questionnaire. This number represents the total sample size used for the analysis in this study. Although the questionnaire was distributed to a wider audience, only responses that were fully completed and relevant to the study were included in the final dataset. Incomplete or inconsistent responses were excluded during the initial data screening stage in order to maintain the reliability and quality of the data used for analysis.

The response rate achieved for this study is considered adequate for a perception-based survey that focuses on understanding awareness, knowledge, and attitudes toward the **circular economy in the construction sector**. The respondents consisted largely of individuals who are either currently studying within the built environment field or are already involved in related professions. This composition of respondents is particularly relevant to the objectives of the research, as it provides insight into how circular economy principles are perceived by both emerging professionals and individuals who may influence future construction practices.

With regard to demographic representation, the responses obtained show a strong participation from young individuals within the age range of **18–25 years**, which constituted the majority of the respondents. This trend is expected, given that the questionnaire was primarily circulated among university students and student architects. Despite this concentration, the survey also captured responses from individuals within higher age brackets and those with varying levels of professional experience, thereby providing a broader perspective on the subject matter.

Following the completion of the survey, all responses were automatically compiled by the Google Forms system and exported into a **Comma-Separated Values (CSV) format**. This format allowed the researcher to efficiently organize and process the data using spreadsheet and analytical tools. The dataset was carefully reviewed to ensure that each response corresponded correctly to the survey questions and that all entries were valid.

After the data cleaning process, the responses were systematically organized into key thematic categories corresponding to the sections of the questionnaire. These categories included:

- **Demographic information of respondents**, such as age, gender, occupation, and years of experience.
- **Awareness of circular economy concepts**, which assessed whether respondents had previously encountered the concept within construction practice.
- **Knowledge level of circular economy principles**, which evaluated respondents' self-assessed understanding of the concept.
- **Familiar circular economy practices in construction**, which identified the practices respondents were most familiar with, such as material recycling, modular construction, or design for deconstruction.
- **Implementation of circular economy principles**, which explored whether such practices are currently adopted in the respondents' working or learning environments.
- **Challenges affecting the adoption of circular economy strategies**, including cost, lack of awareness, policy limitations, and technological barriers.
- **Perceived importance of circular economy in the construction sector**, which measured respondents' views on the relevance of circular economy for sustainable construction.

- **Suggestions for improving circular economy adoption in Nigeria**, which allowed respondents to provide recommendations for enhancing sustainable construction practices.

Organizing the data into these categories made it easier to conduct a detailed analysis of the responses and identify trends, patterns, and relationships among the variables studied. Furthermore, the categorized data allowed the researcher to clearly relate the survey findings to the research questions and objectives of the study.

For the purpose of effective presentation and interpretation, the organized data were analyzed using **descriptive statistical methods**, particularly frequency distributions and percentage analysis. The results were then illustrated using **tables, pie charts, and bar charts**. These graphical representations were adopted because they provide a clear and visually understandable way of presenting statistical data, allowing readers to easily interpret the distribution and significance of responses.

In addition, the use of charts helped to highlight key patterns in the findings, such as the level of awareness of circular economy principles, the dominant age group of respondents, and the major barriers to circular construction adoption. These visual tools therefore supported the analytical discussion presented in the subsequent sections of this chapter.

Overall, the organization of the survey data provided a structured foundation for the analysis presented in this chapter. By systematically arranging and categorizing the responses, the study was able to generate meaningful insights into the perception, awareness, and potential adoption of circular economy principles within the Nigerian construction sector. The organized dataset also ensured that the findings of the study are clearly presented and directly aligned with the overall aim of critically evaluating the role of circular economy in sustainable building construction and design.

4.3 Demographic Characteristics of Respondents

This section presents the **demographic profile of respondents** who participated in the study. Understanding the demographic characteristics is important because it provides background

information on the respondents and helps in interpreting their responses concerning circular economy awareness and practices in construction.

The demographic data analyzed include **gender and age distribution** of respondents. These variables help to determine whether the responses reflect a balanced and relevant population for the study.

4.3.1 Gender Distribution of Respondents

The gender distribution of respondents was analyzed to understand the composition of participants involved in the study. Gender is a relevant factor, as perspectives on sustainability and construction practices may vary across different groups.

The analysis shows that respondents were drawn from both male and female categories, indicating a fairly inclusive participation. This suggests that the findings of the study reflect views from both genders within the built environment and academic community.

To clearly illustrate the gender composition of respondents, a **pie chart** was used, showing the percentage distribution of males and females among the total respondents.

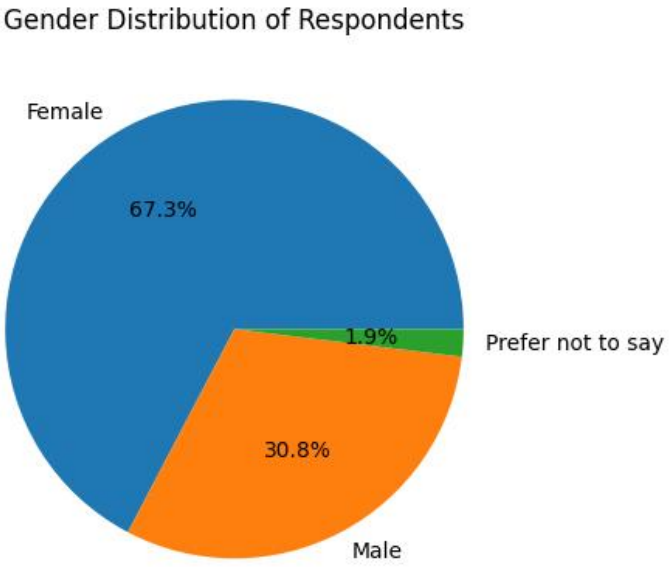


Figure 1: A pie chart showing the Gender Distribution of Respondents

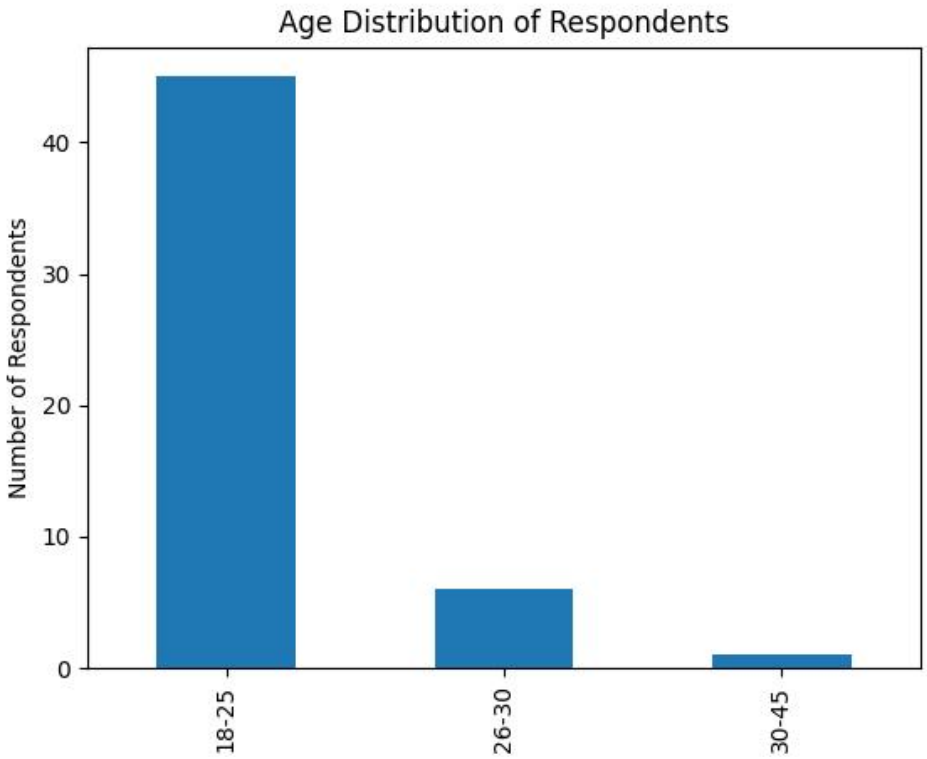
SOURCE: FIELD SURVEY 2025

4.3.2 Age Distribution of Respondents

Age distribution was analyzed to determine the age range of respondents participating in the study. This is important because age can influence awareness, exposure, and attitudes toward innovative concepts such as circular economy in construction.

The results show that most respondents fall within the **young adult age group**, which is typical of university students, student architects, and early-career professionals. This indicates that the study largely captures the perspectives of individuals who are actively learning or practicing within the construction and architectural fields.

A **bar chart** was used to present the age distribution of respondents for clearer comparison



across different age groups.

Figure 2: A bar chart showing Age Distribution of Respondents

SOURCE: FIELD SURVEY 2025

The bar chart reveals that the **majority of respondents are within the dominant undergraduate and postgraduate age brackets**, while fewer respondents fall into higher age categories. This suggests that awareness and opinions captured in this study are strongly influenced by the academic environment and early professional exposure, which aligns with the study's focus on the University of Benin and its surrounding context.

4.3.3 Occupation / Role of Respondents

This subsection examines the **occupational background of respondents** who participated in the study. Understanding respondents' roles is important because perceptions of circular

economy principles may differ depending on whether individuals are students, student architects, or construction professionals.

The analysis shows that respondents were drawn from **diverse roles within the built environment**, including students, student architects, architects, engineers, and other construction-related professionals. This diversity ensures that the data reflects both **academic perspectives and practical industry experience**, which is essential for evaluating circular economy adoption in building construction and design.

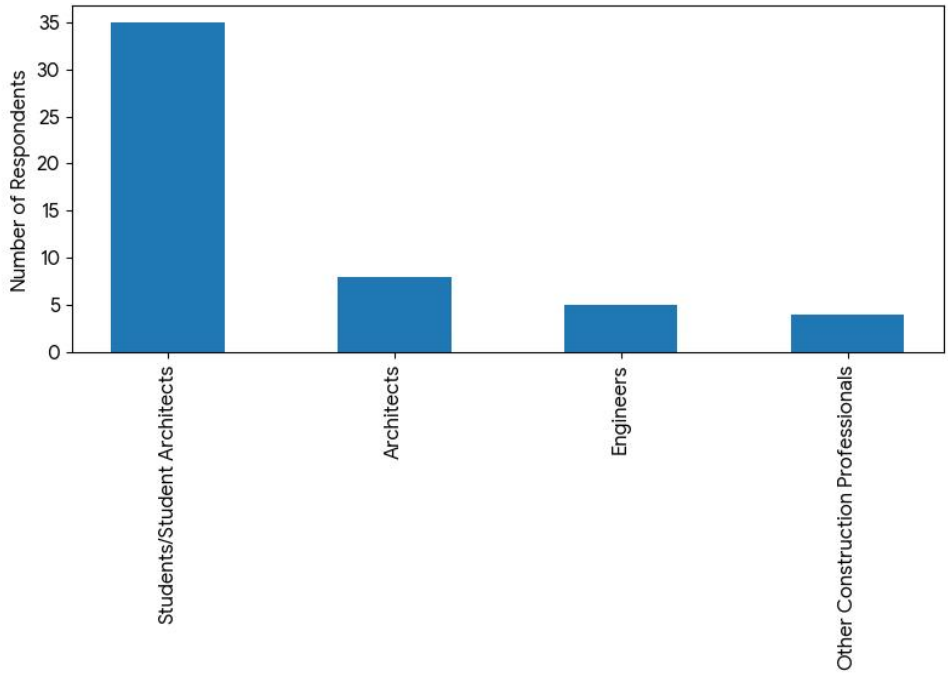


Figure 3: A bar chart showing Occupation / Role of Respondents

SOURCE: FIELD SURVEY 2025

A **bar chart** is used to present the occupational distribution of respondents, allowing for easy comparison between different respondent categories.

Interpretation

The results indicate that **students and student architects form the majority of respondents**, which aligns with the study's focus on the University of Benin environment. This suggests

that the findings strongly represent the views of individuals who are currently undergoing professional training and are likely to shape future construction practices.

Construction professionals such as architects and engineers also form a notable portion of respondents. Their inclusion adds practical insight into the feasibility and challenges of implementing circular economy principles within real construction projects. Overall, the occupational distribution strengthens the reliability of the study by capturing **both theoretical knowledge and real-world experience**.

4.3.4 Percentage Analysis and Interpretation of Responses

1. Response Timeline

The responses were collected between **December 2025 and January 2026**, indicating that the survey was conducted within a short and controlled timeframe. Each entry had equal weight, as every response represented approximately **1.92%** of the total sample size (52 respondents).

2. Age Distribution of Respondents

The data shows that the study was largely dominated by young participants:

- **86.54% (45 respondents)** were between 18–25 years.
- **11.54% (6 respondents)** were between 26–30 years.
- Only **1.92% (1 respondent)** fell within the 30–45 years range.

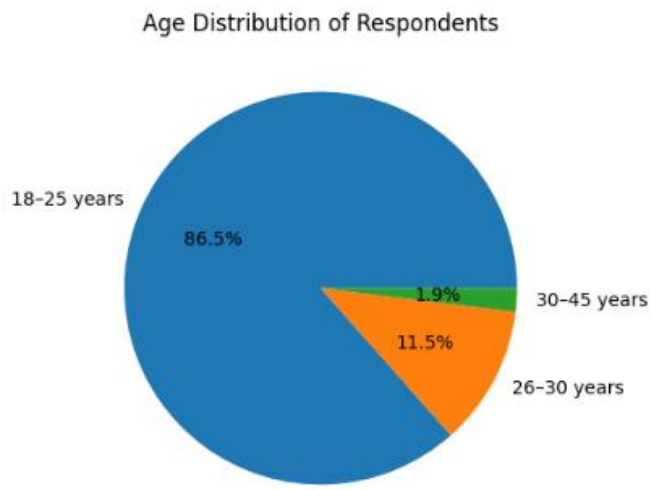


Figure 4: A pie chart showing Age Distribution of Respondents

SOURCE: FIELD SURVEY 2025

This clearly indicates that the study population is predominantly youthful. Since most respondents are students or early-career professionals, this aligns with the academic focus of the research and explains why many responses reflect theoretical rather than extensive professional experience.

3. Gender Distribution

The survey recorded:

- **67.31% Female respondents**
- **30.77% Male respondents**
- **1.92% preferred not to say**

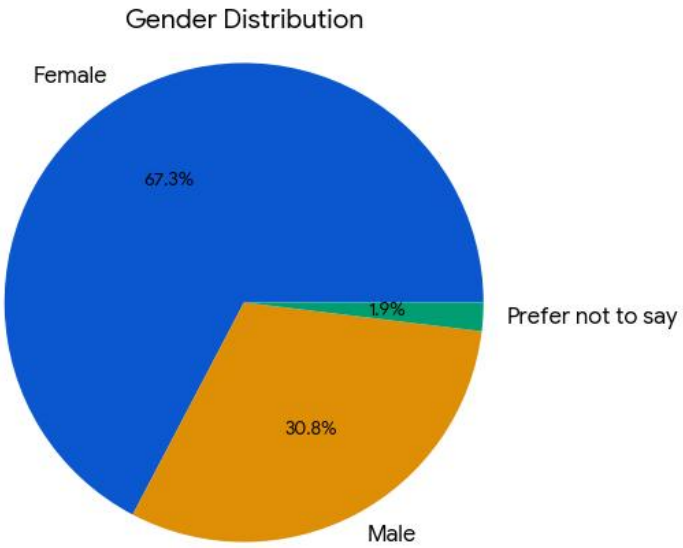


Figure 5: A pie chart showing Gender Distribution

SOURCE: FIELD SURVEY 2025

The higher female participation suggests strong engagement from female students and professionals within the study area. This gender distribution does not significantly affect the findings but provides context for the demographic composition of the respondents.

4. Occupation / Role of Respondents

The majority of participants were students:

- **42.31% were students**
- **13.46% were student architects**
- **7.69% were architects**
- **7.69% were engineers**

The remaining respondents (about 1–2% each) represented other professions such as designers, graduates, teachers, and technicians.

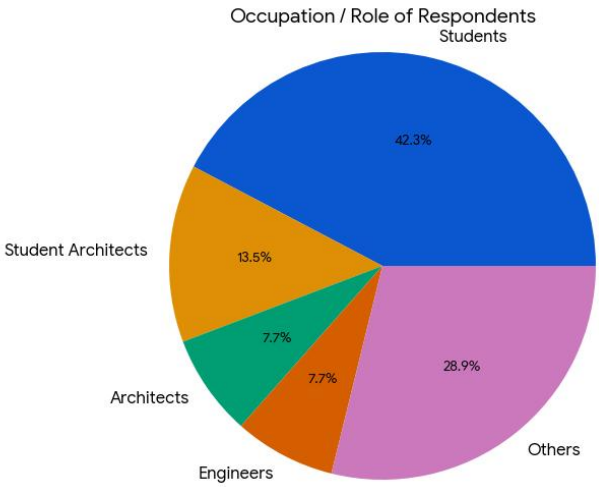


Figure 6: A pie chart showing Occupation / Roles of Respondents

SOURCE: FIELD SURVEY 2025

This confirms that the study largely reflects academic perspectives, with some contributions from practicing professionals. This composition helps explain the awareness levels observed later in the findings.

5. Years of Professional Experience

- **59.62% had 1–3 years of experience**
- **25% had less than 1 year**
- **11.54% had 4–6 years**
- **3.85% had over 7 years**

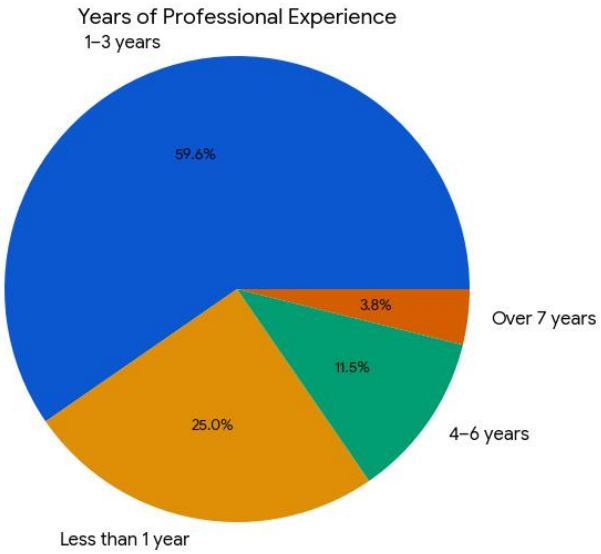


Figure 7: A pie chart showing Years of professional Experience

SOURCE: FIELD SURVEY 2025

This further confirms that most respondents are either students or early-stage professionals, which influences both awareness and implementation levels of circular economy principles.

6. Awareness of Circular Economy (CE)

The results reveal a concerning trend:

- **61.54% have not heard of Circular Economy in construction**
- Only **38.46% are aware of it**

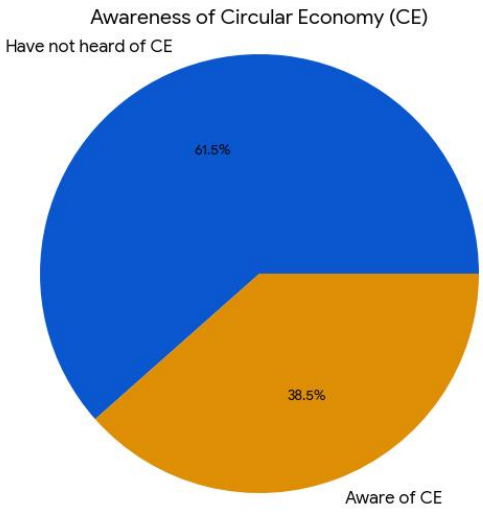


Figure 8: A pie chart showing Awareness of circular Economy (CE)

SOURCE: FIELD SURVEY 2025

This means that nearly two-thirds of respondents lack awareness of circular economy concepts. This directly highlights a major knowledge gap and justifies the need for stronger educational and awareness initiatives.

7. Knowledge Level of CE Principles

When respondents were asked to rate their knowledge:

- **36.54% rated themselves at Level 1 (very low knowledge)**
- **23.08% rated Level 2**
- **26.92% rated Level 3 (average)**
- **11.54% rated Level 4**
- Only **1.92% rated Level 5 (very high knowledge)**

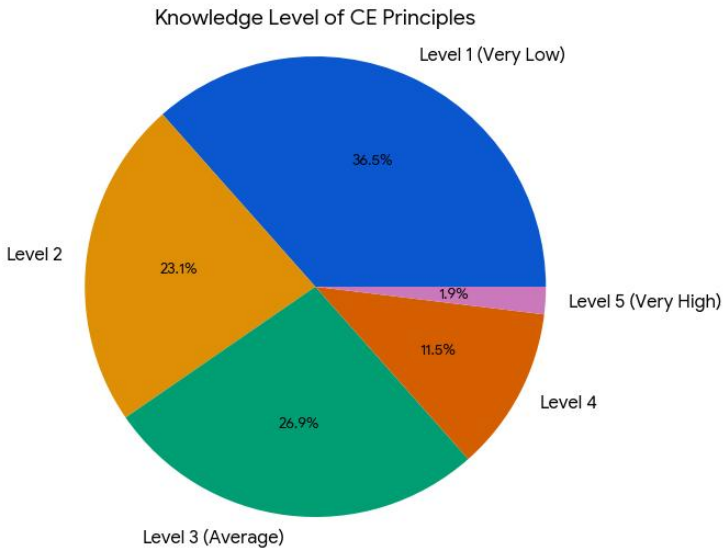


Figure 9: A pie chart showing Knowledge Level of CE principles

SOURCE: FIELD SURVEY 2025

This means that over **59% of respondents fall within low knowledge levels (1 and 2)**, while only a very small fraction (13.46%) demonstrate strong understanding (Levels 4 and 5). This reinforces the earlier finding that awareness and depth of knowledge are limited.

8. Familiar Circular Economy Practices

Respondents were most familiar with:

- **Material recycling/reuse (32.69%)**
- **Waste reduction strategies (15.38%)**
- **Design for deconstruction (13.46%)**
- **Modular building design (9.62%)**

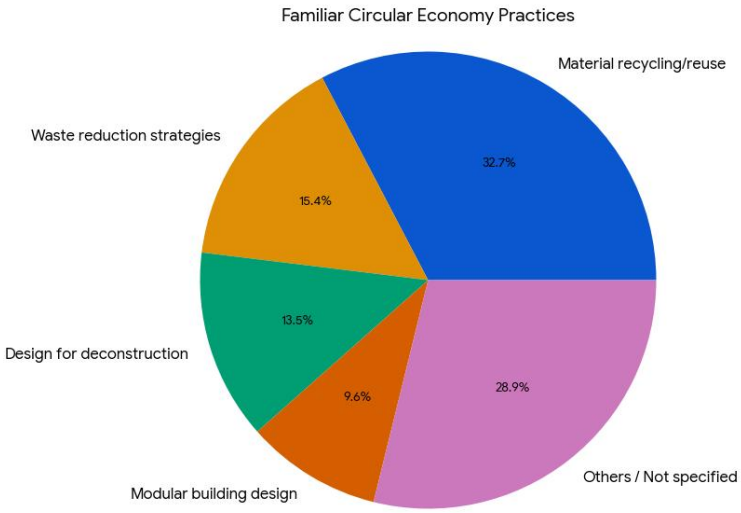


Figure 10: A pie chart showing Familiar Circular Economy Practices

SOURCE: FIELD SURVEY 2025

More advanced practices such as energy efficiency integration and sustainable material sourcing recorded lower familiarity.

This suggests that respondents associate circular economy primarily with recycling rather than with a comprehensive system-based approach.

9. Workplace or Study Implementation

When asked whether CE practices are implemented in their environment:

- **30.77% responded "Maybe"**
- **28.85% said "No"**
- **25% were "Not sure"**
- Only **15.38% confirmed "Yes"**

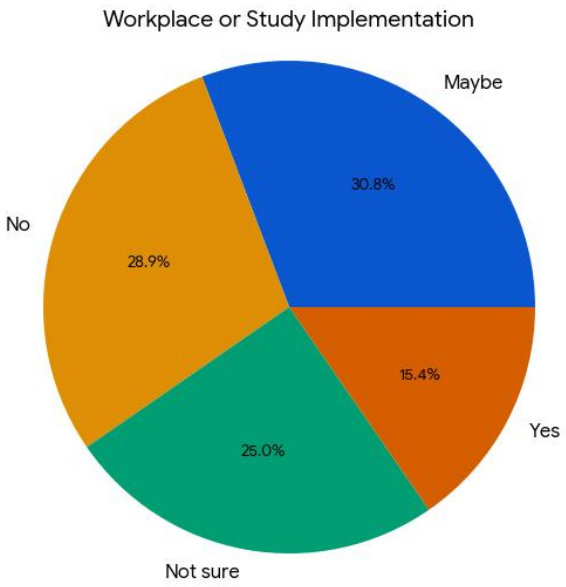


Figure 11: A pie chart showing Workplace or Study implementation

SOURCE: FIELD SURVEY 2025

This means only about **1 in 7 respondents** can confidently say CE is being practiced in their environment. This reflects weak institutional implementation.

10. Challenges to Implementation

The main challenges identified were:

- **Lack of awareness/knowledge (46.15%)**
- **High cost of sustainable materials (30.77%)**
- **Lack of policies (11.54%)**
- **Resistance to change (7.69%)**

- **Limited access to technology (3.85%)**

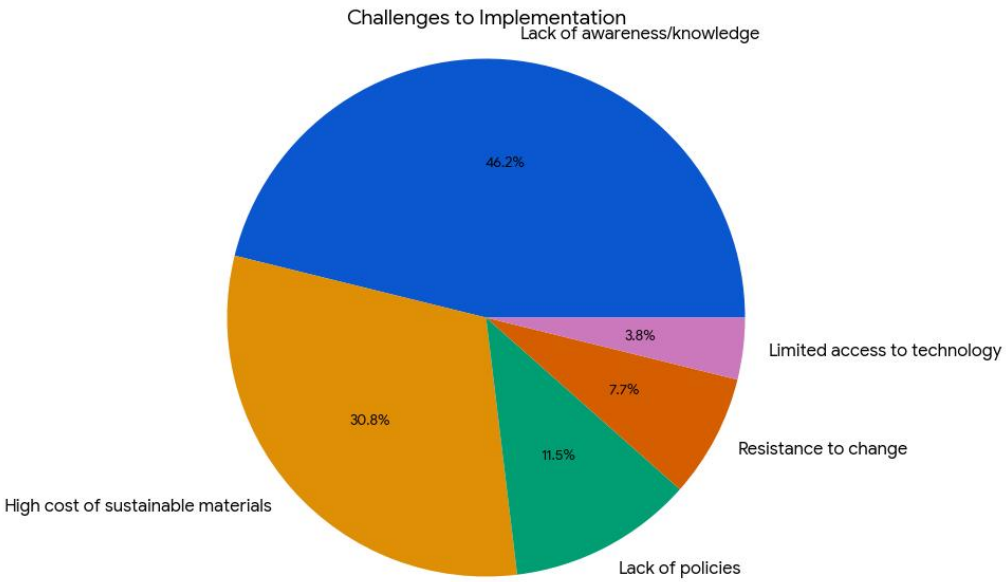


Figure 12: A pie chart showing Challenges to implementation

SOURCE: FIELD SURVEY 2025

The dominant issue is clearly lack of knowledge, which aligns with previous awareness findings.

11. Perceived Importance of CE

Encouragingly:

- **36.54% rated CE as 4 (important)**
- **28.85% rated it 5 (very important)**

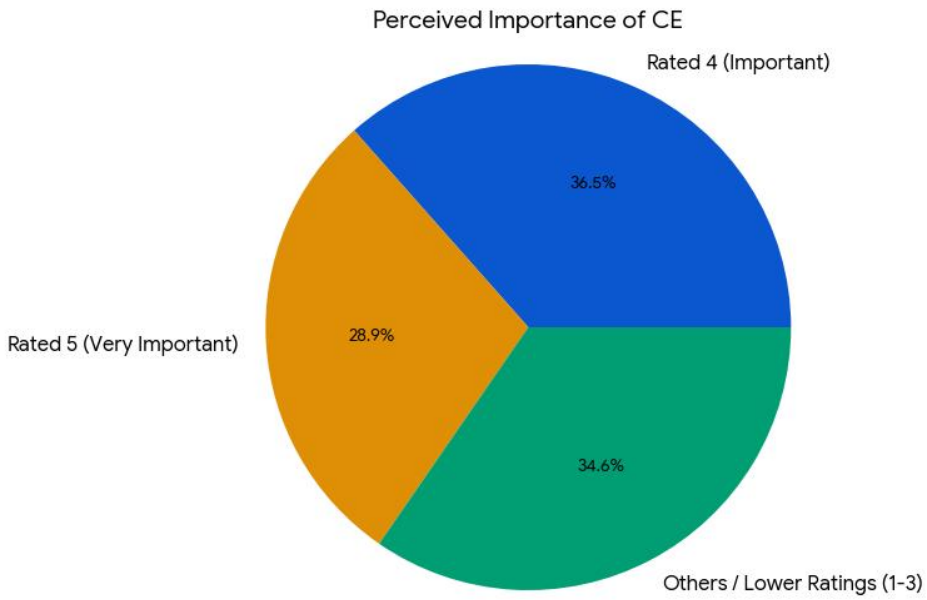


Figure 13: A pie chart showing Perceived Importance of CE

SOURCE: FIELD SURVEY 2025

This means **65.39% of respondents consider CE important or very important** for sustainable construction.

Despite low awareness, there is strong belief in its relevance once explained.

12. Suggested Improvements for CE Adoption

Respondents suggested:

- **44.23% – Awareness campaigns and training**
- **19.23% – Access to sustainable materials**
- **13.46% – Policy enforcement**
- **13.46% – Technology adoption**
- **9.62% – Incentives**

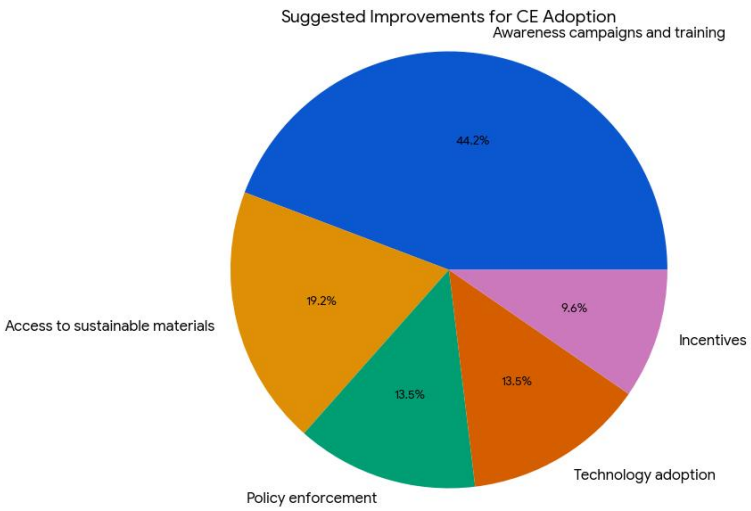


Figure 14: A pie chart showing Suggested improvement for CE Adoption.

SOURCE: FIELD SURVEY 2025

Again, awareness appears as the dominant recommendation.

13. Additional Comments

Most respondents emphasized:

- Need for education and orientation
- Government responsibility in recycling systems
- Stronger policies and enforcement
- Investment in innovation
- Recognition of CE as vital for Nigeria's sustainable future

4.4 Awareness of Circular Economy in Building Construction

To determine the level of awareness of circular economy (CE) principles among respondents, participants were asked whether they had heard of the term *Circular Economy* in construction.

The analysis shows that:

- **32 respondents (61.54%) indicated that they have NOT heard of circular economy in construction.**
- **20 respondents (38.46%) indicated that they HAVE heard of circular economy.**

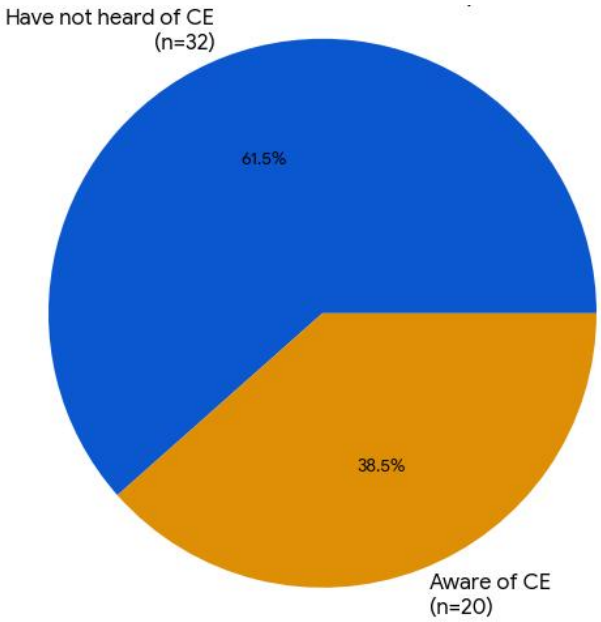


Figure 15: A pie chart showing Awareness of CE in Building Construction.

SOURCE: FIELD SURVEY 2025

Interpretation

The findings clearly indicate that **a majority (61.54%) of respondents lack awareness** of circular economy principles in construction. This suggests that circular economy is still relatively unfamiliar to a significant proportion of stakeholders within the study area.

Although 38.46% of respondents demonstrated awareness of the concept, this percentage is comparatively low. It implies that circular economy principles have not yet gained

widespread recognition within the academic and professional construction environment in Benin City.

The result highlights a major gap in knowledge dissemination and sustainability education. Since awareness is the first step toward adoption, the low level of familiarity may partly explain the limited implementation of circular economy practices observed in the previous chapter.

4.5 Application of Circular Economy Principles in Current Construction Practices

This section examines the **extent to which circular economy principles are currently applied in building construction and design** among the respondents. Beyond awareness, practical application is a key indicator of how far circular economy concepts have been integrated into real construction activities.

Respondents were asked questions relating to their **use of circular economy strategies**, such as material reuse, recycling, adaptive reuse of buildings, efficient resource management, and waste reduction during construction processes. The responses indicate that while circular economy ideas are known to some extent, their **practical application remains limited and uneven**.

The analysis reveals that a number of respondents have been involved in or are aware of practices such as:

- Reuse of construction materials (e.g., doors, windows, steel members)
- Recycling of construction waste
- Use of locally sourced materials to reduce environmental impact
- Design approaches that encourage flexibility and adaptability of spaces

However, these practices are often applied **informally or partially**, rather than as part of a structured circular economy framework. Many respondents noted that such measures are usually adopted for **cost-saving reasons** rather than for sustainability or environmental considerations.

Interpretation

The findings suggest that circular economy principles are **not yet fully embedded** in mainstream construction practice within the study area. Although some elements of circularity exist, they are mostly implemented on a small scale and without deliberate long-term planning.

Students and student architects appear more receptive to experimenting with circular economy concepts, particularly in **design studios and academic projects**. In contrast, professional practice tends to prioritize conventional construction methods, often due to time constraints, client demands, lack of technical knowledge, and limited policy enforcement.

This indicates a gap between **theoretical understanding and practical implementation** of circular economy principles in construction. Bridging this gap will require stronger institutional support, updated building regulations, professional training, and increased collaboration between academic institutions and industry stakeholders.

Overall, the results show that while circular economy practices are present in current construction activities, their application remains **fragmented and underdeveloped**, highlighting the need for a more coordinated and intentional adoption strategy.

4.6 Perceived Benefits of Circular Economy in Building Construction

This section discusses respondents' perceptions of the **benefits associated with the adoption of circular economy principles** in building construction and design. Understanding these perceived benefits is important, as they influence stakeholders' willingness to adopt and promote circular economy practices within the construction industry.

Responses from the questionnaire indicate that a majority of respondents recognize several key advantages of applying circular economy concepts in construction. These benefits cut across **environmental, economic, and social dimensions of sustainability**, reinforcing the relevance of circular economy as a sustainable construction approach.

The analysis shows that respondents largely agree that circular economy practices can:

- Reduce construction waste and environmental pollution
- Promote efficient use of materials and natural resources
- Lower long-term construction and maintenance costs
- Encourage innovative and sustainable design solutions
- Improve the overall environmental performance of buildings

Many respondents highlighted waste reduction and resource efficiency as the most significant benefits. This suggests a growing awareness of the environmental challenges posed by traditional linear construction methods, which rely heavily on raw material extraction and disposal.

Interpretation

The strong agreement on the benefits of circular economy indicates that respondents generally hold a **positive attitude toward its adoption** in building construction. This positive perception provides a solid foundation for promoting circular economy principles within both academic and professional settings.

Economically, respondents believe that although the initial cost of adopting circular economy strategies may be higher, the **long-term savings** achieved through material reuse, reduced waste management costs, and extended building life cycles make it a worthwhile investment. Environmentally, circular economy is seen as a practical solution to reducing the carbon footprint of construction activities.

Socially, respondents noted that circular economy practices can lead to healthier living environments, increased awareness of sustainability, and the development of new skills within the construction workforce.

Overall, the findings suggest that stakeholders are not resistant to circular economy principles; rather, they **recognize its value but face challenges in implementation**. This reinforces the need for supportive policies, education, and incentives to translate these perceived benefits into actual practice.

4.7 Challenges Hindering the Adoption of Circular Economy in Construction

This section examines the **major challenges and barriers** that limit the effective adoption of circular economy principles in building construction and design. Identifying these challenges is essential for understanding why the transition from traditional linear construction methods to circular practices remains slow, despite the recognized benefits.

Responses from the questionnaire reveal that respondents face several interrelated challenges in implementing circular economy strategies. One of the most prominent issues identified is the **lack of adequate knowledge and technical expertise**. Many respondents indicated that although they are aware of circular economy concepts, they do not possess sufficient practical skills or training to apply them effectively in real construction projects.

Another significant challenge highlighted is the **high initial cost** associated with adopting circular economy practices. Respondents noted that sustainable materials, recycling technologies, and innovative construction methods often require higher upfront investment, which discourages clients and developers who prioritize short-term cost savings.

The **absence of strong policies and regulatory frameworks** was also identified as a major barrier. Many respondents believe that without clear government regulations, incentives, or enforcement mechanisms, construction stakeholders are unlikely to fully embrace circular economy principles. Traditional construction practices remain dominant due to familiarity and lack of policy-driven pressure for change.

Additional challenges identified include:

- Limited availability of recyclable and reusable construction materials
- Resistance to change within the construction industry
- Inadequate infrastructure for waste sorting and recycling
- Low level of awareness among clients and end-users

Interpretation

The challenges identified in this study suggest that the slow adoption of circular economy in construction is not due to a lack of perceived value, but rather **structural, economic, and institutional constraints**. The dominance of conventional construction methods, combined

with weak policy support and limited technical capacity, makes it difficult for practitioners to adopt circular approaches.

For students and student architects, these challenges often manifest as limited opportunities to apply circular economy concepts beyond academic exercises. For professionals, practical constraints such as cost, time, and client expectations significantly influence decision-making.

Addressing these challenges will require a **multi-dimensional approach**, including improved education and training, policy reforms, financial incentives, and stronger collaboration between academic institutions, industry stakeholders, and government agencies.

Overall, this section highlights the critical issues that must be addressed to enable a successful transition toward circular economy-based building construction and design.

4.8 Suggested Measures for Improving Circular Economy Adoption in Construction

This section presents respondents' views on **measures that can enhance the adoption of circular economy principles** in building construction and design. These suggested measures are based on respondents' experiences, observations, and understanding of the challenges currently limiting circular economy implementation.

From the responses analyzed, it is evident that respondents believe meaningful improvement can be achieved through a combination of **education, policy support, industry collaboration, and innovation**. One of the most frequently suggested measures is the **integration of circular economy concepts into architectural and construction education**. Respondents emphasized that introducing circular economy principles early in academic training will help students and future professionals develop a sustainability-oriented mindset.

Another key measure identified is the **provision of training programs, workshops, and professional development courses** for practicing architects, engineers, and builders. Such programs would help bridge the gap between theoretical knowledge and practical application, enabling professionals to confidently adopt circular construction strategies.

Respondents also highlighted the importance of **government policies and regulatory frameworks**. They suggested that governments and regulatory bodies should develop and enforce building standards that promote material reuse, recycling, and sustainable design.

Incentives such as tax reductions, grants, or subsidies for sustainable construction projects were also proposed as effective ways to encourage adoption.

Other measures suggested include:

- Increased research and innovation in sustainable materials and construction techniques
- Improved infrastructure for construction waste management and recycling
- Collaboration between academic institutions, industry professionals, and policymakers
- Public awareness campaigns to educate clients and building users on the benefits of circular economy

Interpretation

The suggested measures indicate that respondents understand that circular economy adoption requires **systemic change rather than isolated actions**. Education and training are seen as foundational, while policy enforcement and financial incentives are necessary to drive large-scale adoption within the construction industry.

The emphasis on collaboration further suggests that circular economy implementation cannot be achieved by a single stakeholder group alone. Instead, a coordinated effort involving students, professionals, institutions, and government agencies is required.

Overall, the findings from this section provide practical direction for improving circular economy adoption and form a strong basis for the **recommendations and conclusions** that will be presented in the next chapter.

4.9 Summary of Key Findings

This section presents a concise summary of the major findings obtained from the analysis of data in this chapter. The summary is structured in line with the **research objectives** and provides a clear overview of respondents' perceptions, experiences, and views regarding circular economy as a sustainable building construction and design method.

The analysis of demographic data revealed that the majority of respondents were **students and student architects**, with a smaller proportion of construction professionals. This

confirms that the study largely reflects perspectives from the academic environment, particularly within the University of Benin, while still incorporating practical insights from industry-related respondents.

Findings from the awareness assessment showed that a **considerable number of respondents are aware of circular economy principles**, especially within academic settings. However, the depth of understanding varies, indicating that while the concept is gaining recognition, comprehensive knowledge and practical familiarity remain limited.

The study further revealed that the **application of circular economy principles in current construction practices is relatively low**. Although some elements such as material reuse and waste reduction are practiced, they are often implemented informally and not within a structured circular economy framework.

In terms of benefits, respondents generally agreed that circular economy adoption can lead to **environmental sustainability, cost efficiency, waste reduction, and improved building performance**. These perceived benefits demonstrate a positive attitude toward circular economy and highlight its potential as a viable alternative to traditional linear construction methods.

Despite these benefits, several **challenges hinder widespread adoption**, including lack of technical expertise, high initial costs, limited policy support, inadequate recycling infrastructure, and resistance to change within the construction industry.

Finally, respondents suggested several measures for improving circular economy adoption, such as enhanced education and training, stronger government policies, financial incentives, increased research, and improved collaboration between academic institutions and industry stakeholders.

Overall, the findings of this chapter indicate that while circular economy principles are recognized and valued, their practical implementation in building construction and design remains limited. Addressing the identified challenges through education, policy reform, and industry collaboration is essential for achieving sustainable construction outcomes.

CHAPTER FIVE

5.1 Introduction

This chapter represents the **final stage of the research** titled *"Critical Evaluation of Circular Economy as a Sustainable Building Construction and Design Method."* It brings together the major outcomes of the study and provides a coherent synthesis of the findings derived from the data analysis presented in the previous chapter.

The primary focus of this chapter is to **summarize the key findings**, draw meaningful **conclusions**, and propose **practical recommendations** based on the evidence gathered from the questionnaire survey and literature review. The findings are carefully linked to the **aims, objectives, and research questions** of the study in order to assess the extent to which these objectives have been achieved.

This chapter also highlights the **significance of the study** within the context of sustainable development in the construction industry. By critically evaluating the level of awareness, application, benefits, and challenges associated with circular economy principles, the study provides valuable insights into how circular economy can serve as a viable alternative to the traditional linear construction model.

Furthermore, this chapter discusses the **implications of the research findings** for architectural education, professional practice, and policy development. Special attention is given to the role of students, student architects, and construction professionals, as they represent key stakeholders in shaping the future of sustainable building construction and design in Nigeria.

Based on the findings of the study, **recommendations are proposed** to encourage the wider adoption of circular economy principles in the construction sector. These recommendations address issues related to education and training, policy formulation, industry practices, and research development. The chapter also identifies areas where further research is required to deepen understanding and support continuous improvement in sustainable construction practices.

In conclusion, this chapter provides a comprehensive closure to the research by reflecting on the study's contributions, limitations, and relevance, while reinforcing the importance of circular economy as a strategic approach to achieving sustainability in building construction and design.

5.2 Summary of Key Findings

This section presents a concise yet comprehensive summary of the major findings of the study based on the data analyzed in Chapter Four. The summary is organized in line with the **aims and objectives** of the research and reflects the responses obtained from students, student architects, and construction-related professionals within the study area.

The study revealed that there is a **moderate to high level of awareness** of circular economy principles among respondents, particularly among students and student architects. Most respondents indicated that they had encountered the concept through academic coursework, online resources, seminars, and professional discussions. However, the depth of understanding varied, with some respondents demonstrating only a basic knowledge of circular economy and its application in building construction.

Findings also showed that the **practical application of circular economy principles in current construction practices is limited**. Although some respondents reported the use of strategies such as material reuse, waste reduction, and recycling, these practices are often implemented informally and not as part of a structured circular economy framework. This indicates a gap between theoretical knowledge and practical execution.

The study further established that respondents generally perceive circular economy as a **beneficial and sustainable approach** to building construction and design. Key benefits identified include reduction of construction waste, efficient use of resources, long-term cost savings, improved environmental performance, and encouragement of innovative design solutions.

Despite these benefits, several **challenges hinder the widespread adoption** of circular economy principles. These challenges include lack of technical expertise, high initial costs, weak policy and regulatory support, limited access to sustainable materials, and resistance to change within the construction industry.

Finally, respondents suggested various measures to improve circular economy adoption, such as strengthening education and training, enforcing supportive policies, providing financial incentives, encouraging research and innovation, and fostering collaboration between academic institutions and industry stakeholders.

Overall, the findings indicate that while circular economy principles are recognized and valued, their effective implementation in building construction and design remains at an early stage, highlighting the need for coordinated efforts to promote sustainable construction practices.

5.3 Conclusion

This study set out to critically evaluate **circular economy as a sustainable building construction and design method**, with particular emphasis on awareness, application, benefits, and challenges within the Nigerian construction context, focusing on Benin City and the University of Benin environment.

Based on the findings of the research, it can be concluded that **circular economy principles are increasingly recognized** within academic and professional circles, especially among students and student architects. However, despite this growing awareness, the **actual application of circular economy practices in building construction remains limited**. Where such practices exist, they are often fragmented, informal, and driven by cost considerations rather than deliberate sustainability goals.

The study further concludes that circular economy offers **significant potential benefits** to the construction industry, including waste reduction, efficient resource utilization, environmental protection, long-term economic savings, and improved building performance. These benefits align strongly with the principles of sustainable development and demonstrate that circular economy is a viable alternative to the traditional linear construction model.

However, the transition to circular construction is constrained by several factors, notably **insufficient technical knowledge, high initial costs, lack of supportive policies, inadequate recycling infrastructure, and resistance to change** within the construction industry. These challenges indicate that the slow adoption of circular economy is not due to lack of value, but rather systemic and institutional limitations.

In conclusion, while circular economy has the capacity to significantly transform building construction and design toward sustainability, its success depends on **intentional integration into education, professional practice, and policy frameworks**. Without coordinated efforts among stakeholders, the full potential of circular economy in the construction sector will remain largely untapped.

5.4 Implications of the Study

The findings of this study have important **academic, professional, and policy-related implications** for the construction industry and architectural practice, particularly in the context of sustainable development in Nigeria.

From an **academic perspective**, the study highlights the need for stronger integration of circular economy principles into architectural and construction-related curricula. The moderate level of awareness observed among students and student architects suggests that while sustainability concepts are being introduced, there is still a need for deeper and more practical engagement. Incorporating circular economy into design studios, technical courses, and research projects would help students develop the skills required to apply sustainable construction methods in real-world situations.

In terms of **professional practice**, the study reveals a gap between theoretical knowledge and practical implementation of circular economy principles. This implies that construction professionals may require continuous professional development, training workshops, and access to practical guidelines to support the adoption of circular construction strategies. Professional bodies and industry organizations can play a key role in promoting best practices and encouraging innovation within the sector.

From a **policy and regulatory standpoint**, the findings suggest that the lack of strong government policies and enforcement mechanisms limits the widespread adoption of circular economy practices. This implies a need for policymakers to develop building regulations, incentives, and standards that promote material reuse, recycling, and sustainable design. Effective policy frameworks would encourage industry stakeholders to move beyond conventional construction methods toward more sustainable approaches.

Additionally, the study has implications for **environmental sustainability and resource management**. By demonstrating the potential of circular economy to reduce waste and

conserve resources, the findings support the adoption of sustainable construction practices as a means of addressing environmental challenges such as resource depletion and pollution.

Overall, the implications of this study emphasize that achieving sustainable building construction through circular economy requires a **collaborative approach** involving educational institutions, industry professionals, policymakers, and researchers.

5.5 Recommendations

Based on the findings of this study, the following recommendations are proposed to enhance the **adoption and effective implementation of circular economy principles** in building construction and design.

Firstly, there is a need to **strengthen education and training** on circular economy within architectural and construction-related disciplines. Universities and higher institutions, particularly schools of architecture and environmental sciences, should integrate circular economy principles into their curricula. This can be achieved through dedicated courses, design studios, seminars, and practical workshops that emphasize sustainable material use, adaptive reuse, and life-cycle thinking.

Secondly, continuous professional development programs should be organized for **practicing architects, engineers, and construction professionals**. Professional bodies and industry associations should facilitate training sessions and certification programs focused on circular construction strategies, sustainable materials, and waste management practices. This will help bridge the gap between academic knowledge and professional practice.

Thirdly, government and regulatory agencies should develop and enforce **supportive policies and building regulations** that promote circular economy practices. These may include incentives such as tax reliefs, grants, or subsidies for projects that adopt sustainable construction methods, as well as stricter regulations on construction waste disposal and material reuse.

Fourthly, investment in **construction waste management and recycling infrastructure** should be encouraged. Proper facilities for sorting, recycling, and reusing construction materials will make it easier for professionals to adopt circular economy practices. Public–private partnerships can play a significant role in developing such infrastructure.

Finally, there is a need for increased **collaboration among academic institutions, industry stakeholders, and policymakers**. Joint research initiatives, pilot projects, and knowledge-sharing platforms will promote innovation and support the practical implementation of circular economy principles in the construction sector.

Overall, the implementation of these recommendations will contribute significantly to advancing sustainable building construction and design through circular economy practices.

5.6 Limitations of the Study

Despite the valuable insights provided by this study, certain **limitations** were encountered during the research process. Acknowledging these limitations is important for understanding the scope of the findings and for guiding future research.

One of the major limitations of the study is the **sample size**. Although the number of respondents was adequate for descriptive analysis, a larger sample covering more construction professionals and firms across different regions could provide a more comprehensive understanding of circular economy adoption in the construction industry.

Another limitation is the **geographical scope** of the study. The research was primarily focused on Benin City and the University of Benin environment. While this provided relevant insights within the selected study area, the findings may not fully represent practices and perceptions in other major construction hubs such as Lagos, Abuja, and Port Harcourt.

The study also relied on **self-reported data** collected through questionnaires. This means that responses were based on respondents' personal perceptions and experiences, which may introduce bias or inaccuracies. Some respondents may have overstated their level of awareness or application of circular economy principles.

Additionally, the study was constrained by **time and resource limitations**, which restricted the use of more advanced research methods such as in-depth interviews, case studies, or on-site assessments of construction projects. Such methods could have provided richer and more detailed insights into practical circular economy implementation.

Despite these limitations, the study provides a useful foundation for understanding circular economy adoption in building construction and offers meaningful contributions to sustainable construction discourse.

5.7 Future Research Directions

Although this study provides valuable insights into circular economy as a sustainable building construction and design method, it also opens up several opportunities for **further research** that can expand and strengthen knowledge in this area.

Future research should consider the use of **in-depth case studies** focusing on completed or ongoing construction projects that have adopted circular economy principles. Such case studies would allow for a detailed examination of design strategies, material selection, construction processes, and post-occupancy performance. This approach would provide practical evidence of how circular economy principles can be effectively implemented in real construction contexts.

There is also a need for studies with a **broader geographical coverage**. Future research could extend beyond Benin City to include major construction hubs such as Lagos, Abuja, and Port Harcourt, as well as other developing and developed regions. This would enable comparative analysis of circular economy adoption across different socio-economic and regulatory environments.

Further studies may also focus on the **economic and life-cycle cost implications** of circular economy practices in construction. Detailed cost-benefit and life-cycle assessments would help determine the long-term financial viability of circular construction methods and provide critical data for developers, investors, and policymakers.

In addition, future research could examine the **impact of policy frameworks, regulations, and incentives** on the adoption of circular economy principles. Investigating how government interventions, building codes, and sustainability policies influence industry practices would offer valuable guidance for effective policy formulation and implementation.

Another important area for future research is the exploration of **emerging technologies and innovative materials** that support circular construction. Studies on digital design tools, Building Information Modelling (BIM), material passports, and sustainable material innovations could significantly enhance the efficiency and scalability of circular economy practices.

Lastly, future research could investigate the **behavioural and cultural factors** influencing the acceptance and adoption of circular economy practices among construction stakeholders. Understanding attitudes, perceptions, and resistance to change would support the development of targeted strategies for encouraging sustainable practices within the industry.

Overall, expanding research in these areas will contribute to a deeper understanding of circular economy and support its effective integration into sustainable building construction and design.

5.8 Research Conclusion

This study has critically evaluated **circular economy as a sustainable building construction and design method**, with particular focus on awareness, application, benefits, and challenges within the Nigerian construction context, using Benin City and the University of Benin as the study area.

The findings of the research demonstrate that while circular economy principles are increasingly recognized, especially within academic environments, their **practical adoption in building construction and design remains limited**. This gap between awareness and implementation highlights the need for deliberate efforts to integrate circular economy concepts into both education and professional practice.

The study also establishes that circular economy offers **significant environmental, economic, and social benefits**, including waste reduction, efficient resource utilization, cost savings over the building life cycle, and improved environmental performance. These benefits reinforce the relevance of circular economy as a viable alternative to the traditional linear construction model.

However, the research identified several challenges that hinder effective adoption, such as lack of technical expertise, high initial costs, weak policy frameworks, and resistance to change within the construction industry. Addressing these challenges will require a **coordinated approach involving educational institutions, industry professionals, policymakers, and researchers**.

In conclusion, circular economy has the potential to significantly contribute to sustainable development in the construction sector if properly understood, supported, and implemented.

By strengthening education, improving policy frameworks, encouraging innovation, and fostering collaboration among stakeholders, circular economy can play a critical role in shaping the future of sustainable building construction and design in Nigeria and beyond.

REFERENCES

Adams, K. T., Osmani, M., Thorpe, T., & Thornback, J. (2017). Circular economy in construction: Current awareness, challenges, and enablers. *Waste and Resource Management, 170*(1), 15–25.

Ayres, R. U., & Ayres, L. W. (2002). *A handbook of industrial ecology*. Edward Elgar.

Brundtland Commission. (1987). *Our common future*. Oxford University Press.

Charef, R. (2024). Digital framework for circular economy in construction. *Sustainability, 16*(14).

DEFRA. (2007). *Waste strategy for England 2007*. Department for Environment, Food and Rural Affairs.

Ellen MacArthur Foundation. (2013). *Towards the circular economy: Economic and business rationale for an accelerated transition*.

Ellen MacArthur Foundation. (2015). *Delivering the circular economy: A toolkit for policymakers*.

Ellen MacArthur Foundation. (2019). *Completing the picture: How the circular economy tackles climate change*.

European Commission. (2015). *Closing the loop: An EU action plan for the circular economy*.

European Commission. (2020). *A new circular economy action plan: For a cleaner and more competitive Europe*.

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy – A new sustainability paradigm? *Journal of Cleaner Production, 143*, 757–768.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production, 114*, 11–32.

Guy, B., & Ciarimboli, N. (2009). Deconstruction and material reuse in the built environment. *Journal of Green Building, 4*(2), 111–128.

Kibert, C. J. (2016). *Sustainable construction: Green building design and delivery* (4th ed.). John Wiley & Sons.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling, 127*, 221–232.

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular economy: The concept and its limitations. *Ecological Economics, 143*, 37–46.

Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: A comprehensive review. *Journal of Cleaner Production, 115*, 36–51.

McDonough, W., & Braungart, M. (2002). *Cradle to cradle: Remaking the way we make things*. North Point Press.

Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.

Nguyen, H., Stuchtey, M., & Zils, M. (2014). Remaking the industrial economy. *McKinsey Quarterly*.

Ogunkunle, O., & Ahmed, A. (2019). Sustainable construction practices in Nigeria: A review of challenges and opportunities. *Journal of Sustainable Built Environment, 8*(2), 45–56.

Ogunsemi, D. R. (2015). *Construction economics*. Soba Press Ltd.

Pomponi, F., & Moncaster, A. (2017). Circular economy for the built environment: A research framework. *Journal of Cleaner Production, 143*, 710–718.

UK Green Building Council. (2018). *Circular construction: Case study report*. UKGBC.

UN Environment Programme. (2018). *Sustainable buildings and construction: Facts and figures*.

Unegbu, H. C. O., Yawas, D. S., Dan-asabe, B., & Alabi, A. A. (2025). Optimizing circular economy practices in Nigerian construction. *Journal of Emerging Science & Engineering, 3*(1), 35.

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*.

van Buren, N., Demmers, M., van der Heijden, R., & Witlox, F. (2016). Towards a circular economy: The case of Park 20|20 in the Netherlands. *Journal of Cleaner Production, 114*, 230–243.

World Green Building Council. (2019). *Bringing embodied carbon upfront*.

Yuan, H., Bi, J., & Moriguichi, Y. (2006). The circular economy: A new development strategy in China. *Journal of Industrial Ecology, 10*(1–2), 4–8.

Zhu, D., Li, H., & Liu, X. (2020). Implementing circular economy principles in Tianjin Eco-City: Lessons for sustainable urban development. *Sustainable Cities and Society, 53*, 101936.

Zimmann, R., & Sassi, P. (2020). Circular economy principles applied to the built environment. *Buildings, 10*(5), 1–18.

APPENDIX

QUESTIONNAIRE

Good day! My name is **Onwughara Chidiebere**. I am conducting a study on **"CRITICAL EVALUATION OF CIRCULAR ECONOMY AS A SUSTAINABLE BUILDING CONSTRUCTION And DESIGN METHOD."**

Your participation by filling out this questionnaire will go a long way in the completion of this study. Thank you for your time, and **God bless you**.

Description: This questionnaire aims to gather information on awareness, perceptions, and practices of circular economy in building construction. Your responses are anonymous and will be used solely for academic research.

Section 1: Respondent Information

1. Name (Optional)
2. Age
3. Gender
    - Male
    - Female
    - Prefer not to say
4. Occupation/Role
    - Architect
    - Student Architect
    - Engineer
    - Construction Manager/Contractor
    - Policy Maker/Regulatory Officer
    - Other (please specify)
5. Years of Experience in Construction/Architecture
    - Less than 1 year
    - 1–3 years
    - 4–6 years
    - 7+ years

Section 2: Awareness of Circular Economy

6. Have you heard of the term Circular Economy (CE) in construction?
    - Yes
    - No
7. How would you rate your knowledge of CE principles in construction?
    - 1 = Very Low
    - 5 = Very High
8. Which CE practices are you familiar with?
    - Material recycling/reuse
    - Modular building design
    - Design for deconstruction
    - Energy efficiency in buildings
    - Sustainable material sourcing
    - Waste reduction strategies

Section 3: Current Practices

9. Does your workplace or study environment implement any circular economy practices?
    - Yes
    - No
    - Not Sure
10. If yes, which practices are implemented?
11. What challenges do you face in implementing CE practices?
    - Lack of awareness/knowledge
    - High cost of sustainable materials
    - Lack of policies or regulations
    - Limited access to technology/tools
    - Resistance to change
    - Other (please specify)

Section 4: Perceptions and Recommendations

12. How important do you think CE is for sustainable construction?
    - 1 = Not Important
    - 5 = Very Important
13. What do you think can improve CE adoption in Nigeria?
    - Awareness campaigns/training
    - Policy enforcement and regulations
    - Access to sustainable materials
    - Technology adoption (BIM, lifecycle analysis tools)
    - Incentives for sustainable construction
    - Other (please specify)
14. Any additional suggestions or comments?