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Research Article

Optimizing circular economy practices in Nigerian construction: Effective strategies for waste reduction and resource efficiency

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Abstract This study explores the current state of circular economy (CE) practices in the Nigerian construction industry, identifying key challenges and opportunities for their implementation. Utilizing a mixed-methods approach, data were collected from 200 survey participants and 20 key informants through structured surveys and semi-structured interviews. The quantitative data were analyzed using descriptive and inferential statistics, including regression and factor analysis, to uncover the relationships between variables and the underlying dimensions of barriers to CE adoption. The findings reveal that while there is a moderate level of awareness and implementation of CE practices, such as waste segregation and the use of recycled materials, these practices are not yet widespread. Major barriers identified include lack of awareness, high implementation costs, and insufficient regulatory support. Specifically, 75% of respondents cited lack of awareness as a significant barrier, and 80% identified high costs as a deterrent. Regression analysis indicated that awareness level, regulatory support, and company size positively influence CE practice adoption, while perceived cost has a negative impact. The study also highlights positive perceptions towards CE practices among industry professionals, with 85% of respondents recognizing their importance for the future of the construction industry. Factor analysis revealed three main dimensions of barriers: financial, awareness and education, and regulatory and policy barriers. Based on these findings, the study recommends targeted educational programs to increase awareness, financial incentives to mitigate cost barriers, and stronger regulatory frameworks to enforce sustainable practices..

Keywords: Circular Economy, Nigerian Construction Industry, Sustainable Practices, Waste Management, Recycled Materials, Barriers to Implementation, Awareness, Regulatory Support, Financial Incentives.

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1. Introduction

The concept of the circular economy (CE) revolves around the principle of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems. Unlike the traditional linear economy, which follows a 'take-make-dispose' model, the circular economy promotes a closed-loop system that maximizes resource efficiency and minimizes environmental impacts (Ellen MacArthur Foundation, 2017). This paradigm shift is critical in addressing the challenges posed by resource depletion, environmental degradation, and climate change (Geissdoerfer et al., 2017; Kirchherr et al., 2017). CE principles encompass various strategies such as recycling, reusing, remanufacturing, and refurbishing, which collectively aim to create a more sustainable and resilient economic system (Korhonen et al., 2018)).

Recent studies emphasize that the transition to a circular economy is not merely an environmental necessity but also an economic opportunity. The European Commission (2015) estimates that a fully circular economy could increase the EU's GDP by an additional 0.5% by 2030, creating around 700,000 new jobs. This transformative approach is increasingly being recognized globally as essential for sustainable development (Stahel, 2016). The construction industry is one of the largest consumers of raw materials and producers of waste worldwide. According to the World Economic Forum (2016), the industry accounts for approximately 40% of global resource consumption and generates about 30% of all waste. Implementing circular economy principles in construction can significantly reduce material usage, enhance resource efficiency, and mitigate environmental impacts (Ghisellini et al., 2016). The construction sector's shift towards CE involves strategies such as the use of recycled materials, modular construction, design for disassembly, and the implementation of more efficient waste management practices (Adams et al., 2017; Pomponi & Moncaster, 2017).

By adopting CE practices, the construction industry can contribute to sustainable development and create more resilient infrastructures. Studies show that integrating circular economy principles can lead to substantial cost savings, reduce the environmental footprint of construction activities, and enhance the industry's overall sustainability (Hossain et al.,2018). Moreover, innovative business models such as product-service systems and urban mining are emerging as effective means to drive the CE agenda in construction (Cheshire, 2016). Nigeria's construction industry has been growing rapidly, driven by urbanization, population growth, and infrastructure development. However, this growth has also led to increased waste generation and resource inefficiency

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(Olawumi & Chan, 2018). Traditional construction practices in Nigeria often result in significant material wastage, and there is a lack of effective waste management systems (Akinade et al., 2017). A study by Ajayi et al. (2017) highlights that the inefficiency in resource utilization and waste management practices in the Nigerian construction industry leads to both environmental degradation and economic losses.

The adoption of circular economy principles in Nigerian construction can address these issues and promote sustainable growth. The implementation of CE practices can enhance the efficiency of resource use, reduce environmental impacts, and contribute to economic development by creating new business opportunities and jobs (Olawumi et al., 2019). To achieve this, there is a need for a systemic change in policies, industry practices, and stakeholder engagement (Oyedele et al., 2017). The Nigerian construction industry faces significant challenges related to waste generation and resource inefficiency. According to Akinade et al. (2017), construction activities in Nigeria produce substantial amounts of waste, which are often not adequately managed. This inefficiency not only leads to environmental degradation but also increases construction costs. The current practices are unsustainable and necessitate a shift towards more efficient and sustainable methods. Research indicates that the lack of proper waste management policies, insufficient recycling infrastructure, and low awareness of sustainable practices are major barriers to waste reduction in the industry (Oyedele et al., 2018).

The need for sustainable practices in the Nigerian construction industry is urgent. Sustainable construction practices can reduce waste, lower costs, and improve environmental performance (Ajayi et al., 2017). Implementing circular economy strategies can help achieve these goals by promoting the reuse and recycling of materials, improving resource efficiency, and reducing the environmental footprint of construction activities (Ghisellini et al., 2016). Additionally, adopting sustainable practices can enhance the competitiveness of the Nigerian construction industry in the global market (Olawumi & Chan, 2019). The transition towards a circular economy requires concerted efforts from policymakers, industry stakeholders, and the academic community to drive innovation and sustainable development (Cheshire, 2016).

The primary objective of this research is to identify effective strategies for waste reduction in the Nigerian construction industry. Construction waste poses significant environmental and economic challenges, contributing to resource depletion and increased project costs (Ding et al., 2016). By analyzing current practices and exploring innovative approaches, the study aims to provide actionable recommendations for minimizing waste. Current waste management practices in the Nigerian construction industry are often inadequate, leading to substantial material wastage and inefficiency (Akinade et al., 2017). This research conducted a comprehensive review of existing waste reduction strategies, including on-site waste segregation, the use of prefabricated components, and the adoption of digital construction tools like Building Information Modeling (BIM) (Ajayi et al., 2017). Additionally, the study explored the potential of advanced technologies such as 3D printing and robotics to reduce waste through precision manufacturing and material optimization (Cheshire, 2016). The study employed both qualitative and quantitative methods to gather data from various stakeholders in the construction industry, including contractors, project managers, and policymakers. Surveys, interviews, and case studies will be used to identify best practices and assess their effectiveness in reducing waste. By providing detailed recommendations based on empirical evidence, the research aims to facilitate the adoption of these strategies across the industry (Osmani, 2018).

Another key objective of this research is to enhance resource efficiency by implementing circular economy (CE) practices. Resource efficiency is critical for sustainable development, as it ensures that materials are used optimally and waste is minimized (Geissdoerfer et al., 2017). This involves examining how materials can be reused, recycled, and maintained in a closed-loop system, thereby reducing the demand for new resources and minimizing waste. The research explored various CE practices applicable to the Nigerian construction industry, such as the use of sustainable materials, design for disassembly, and the establishment of material recovery facilities (Ghisellini et al., 2016). Sustainable materials, including recycled aggregates, low-carbon concrete, and biodegradable composites, will be evaluated for their potential to reduce the environmental footprint of construction projects (Ding et al., 2016).

Design for disassembly (DfD) is a critical CE practice that facilitates the easy deconstruction and reuse of building components at the end of their lifecycle (Adams et al., 2017). This research assessed the feasibility of incorporating DfD principles in Nigerian construction projects and identify the barriers to its implementation. Additionally, the study investigated the role of material recovery facilities in creating a circular supply chain, where construction waste is systematically collected, processed, and reintegrated into new projects (Murray et al., 2017). Through a detailed analysis of these practices, the research aims to provide a framework for enhancing resource efficiency in the Nigerian construction industry. This framework will include guidelines for selecting sustainable materials, designing buildings for easy disassembly, and establishing efficient material recovery systems. By adopting these CE practices, the industry can significantly reduce its environmental impact and contribute to the broader goals of sustainable development (Ghisellini et al., 2016).

The adoption of circular economy (CE) practices in the Nigerian construction industry presents substantial environmental and economic advantages. Construction activities contribute significantly to environmental degradation through resource depletion, waste generation, and greenhouse gas emissions (Ding et al., 2016). By integrating CE principles, the industry can significantly reduce waste, enhance resource efficiency, and lower environmental impacts (Ghisellini, Ripa, & Ulgiati, 2016). Reducing waste is crucial for mitigating the adverse effects of construction on the environment. Studies indicate that the construction sector is responsible for approximately 35% of total waste generation globally (Cheshire, 2016). Implementing CE practices such as recycling, reusing materials, and designing for deconstruction can drastically cut down this waste (Ajayi et al., 2017). For instance, adopting modular construction methods and using materials that are easier to dismantle and recycle can lead to a more sustainable construction process (Adams et al., 2017).

Economically, CE practices can reduce construction costs by lowering the need for new raw materials and minimizing waste disposal expenses (Osmani, 2018). The cost savings from improved resource efficiency and waste reduction can be significant, allowing for more competitive pricing and better allocation of resources (Akinade et al., 2017). Moreover, the circular economy can stimulate innovation and create new market opportunities within the construction industry, fostering economic growth (Ghisellini et al., 2016). This research directly contributes to the achievement of the United Nations Sustainable Development Goals (SDGs), with a particular emphasis on SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production). SDG

11 aims to make cities and human settlements inclusive, safe, resilient, and sustainable, while SDG 12 focuses on ensuring sustainable consumption and production patterns (United Nations, 2015).

Promoting sustainable construction practices aligns with the objectives of these SDGs by encouraging the use of environmentally friendly materials, reducing waste, and enhancing resource efficiency (Murray et al., 2017). The integration of CE practices in the construction industry can lead to the development of more sustainable urban environments, which are essential for addressing the challenges of rapid urbanization in Nigeria (Ghisellini et al., 2016). Furthermore, the study supports the broader agenda of sustainable development by highlighting the importance of innovation in achieving these goals. By investigating and recommending effective CE practices, this research provides a roadmap for policymakers, industry stakeholders, and researchers to implement sustainable construction strategies that can lead to long-term environmental and economic benefits (Geissdoerfer et al., 2017).

2. Literature Review

2.1. Theoretical Framework

The circular economy (CE) represents an innovative economic system aimed at eliminating waste and promoting the continual use of resources. The principles of CE are founded on three main tenets: designing out waste and pollution, keeping products and materials in use, and regenerating natural systems (Ellen MacArthur Foundation, 2017). This approach starkly contrasts with the traditional linear economy, which adheres to a 'take-make-dispose' model. The linear model has been extensively criticized for leading to resource depletion and environmental degradation due to its unsustainable nature (Geissdoerfer et al., 2017). Several models and theories form the backbone of the CE concept. One prominent model is the butterfly diagram, which vividly illustrates the continuous flow of biological and technical materials through two cycles: the 'biological cycle' and the 'technical cycle' (Ellen MacArthur Foundation, 2017). The biological cycle deals with materials that can be safely returned to the environment, while the technical cycle focuses on products, components, and materials that can be kept in circulation through maintenance, reuse, refurbishment, and recycling.

Another critical model is the ReSOLVE framework, which stands for Regenerate, Share, Optimize, Loop, Virtualize, and Exchange. This framework offers a systematic approach for businesses to implement CE principles effectively. The 'Regenerate' principle emphasizes shifting to renewable energy and materials, reclaiming, retaining, and restoring health to ecosystems. 'Share' encourages sharing assets, reusing them, and prolonging their life through maintenance. 'Optimize' involves improving product performance and efficiency, removing waste in production and supply chains. 'Loop' focuses on keeping products, components, and materials in closed loops. 'Virtualize' promotes dematerializing products directly into services, and 'Exchange' involves replacing old materials with advanced non-toxic materials (Lewandowski, 2016).

The 3R principles—Reduce, Reuse, Recycle—are also integral to CE strategies aimed at waste minimization and resource efficiency. 'Reduce' pertains to lowering the quantity of waste produced, 'Reuse' involves using items more than once, and 'Recycle' refers to the process of converting waste into reusable material. These principles are essential for creating a sustainable system that maximizes resource efficiency and minimizes waste (Ghisellini et al., 2016).

Further studies have expanded on these frameworks, emphasizing the practical applications and benefits of CE. For instance, Stahel (2016) discussed the role of CE in fostering sustainable economic growth by decoupling wealth from resource consumption. Additionally, Bocken et al. (2016) highlighted how CE practices can lead to business model innovations that are environmentally sustainable and economically viable. Kirchherr et al. (2017) explored barriers to CE implementation, such as regulatory challenges, financial constraints, and cultural resistance, providing insights into overcoming these obstacles.

The CE paradigm has also been linked to broader sustainability goals. According to Korhonen et al. (2018), CE contributes to achieving the Sustainable Development Goals (SDGs) by promoting sustainable production and consumption patterns. Their research underscores the importance of integrating CE principles into policy frameworks to drive systemic change.

2.2. Circular Economy in Construction

The construction industry is a significant consumer of resources and a major producer of waste globally. As such, the adoption of circular economy (CE) principles has become increasingly important in addressing these environmental challenges. CE aims to minimize waste and make the most of resources by promoting recycling, reuse, and the use of sustainable materials (Geissdoerfer et al., 2017). Various regions have implemented CE policies with notable success. For instance, the European Union has adopted regulations that promote CE in construction, resulting in reduced waste generation and improved resource efficiency (Adams et al., 2017).

Case studies from the Netherlands and Finland highlight the successful implementation of CE strategies such as the use of recycled materials, modular construction, and design for disassembly. These practices not only minimize waste but also allow for the efficient use of materials, thus lowering the overall environmental footprint of construction projects (Ghisellini et al., 2016). In the Netherlands, modular construction has been particularly effective in reducing construction time and waste, while Finland's focus on design for disassembly ensures that building components can be easily reused or recycled at the end of their lifecycle (Adams et al., 2017; Cheshire, 2016).

China provides another compelling example of CE implementation in the construction sector. The Chinese government has introduced various regulations and incentives to promote CE, leading to increased recycling rates and the use of secondary materials in construction projects. The establishment of green building standards and the development of eco-industrial parks are notable CE practices in China. These measures have not only enhanced resource efficiency but also supported the growth of sustainable construction practices (Ding et al., 2016; Yuan, 2017).

Best practices in CE for construction are diverse and multifaceted. One significant approach is the adoption of Building Information Modeling (BIM), which improves design and construction efficiency by providing detailed digital representations of buildings. BIM facilitates better planning and management of materials, thereby reducing waste (Ajayi et al., 2017). Prefabrication is

another effective strategy that minimizes material waste by manufacturing building components off-site in controlled environments. This method not only reduces waste but also enhances construction quality and efficiency (Osmani, 2018).

The use of sustainable materials, such as low-carbon concrete and recycled aggregates, is critical for reducing the environmental impact of construction. Low-carbon concrete, for example, significantly lowers greenhouse gas emissions compared to traditional concrete, while recycled aggregates help reduce the demand for virgin materials (Murray et al., 2017; Ajayi et al., 2017).

Lessons learned from successful CE implementations underscore the importance of several factors. Stakeholder collaboration is essential, as it ensures that all parties are committed to CE goals and work together to achieve them. Supportive regulatory frameworks provide the necessary guidelines and incentives for adopting CE practices. Additionally, integrating CE principles from the project planning stage is crucial for ensuring that sustainability considerations are embedded throughout the construction process (Murray et al., 2017; Osmani, 2018).

2.3. Current Practices in Nigeria

The construction industry in Nigeria faces significant challenges related to waste generation and resource inefficiency. Studies indicate that traditional construction practices often result in substantial material wastage, largely due to a lack of effective waste management systems and inadequate enforcement of environmental regulations (Akinade et al., 2017; Olawumi & Chan, 2018). Construction projects frequently overlook the principles of sustainable development, leading to inefficient resource utilization and significant environmental degradation. The lack of awareness and understanding of circular economy (CE) principles among industry stakeholders further exacerbates these challenges (Ajayi et al., 2017; Akanni et al., 2015). Despite the recognition of the importance of CE practices globally, their implementation in Nigeria remains limited due to various barriers, including financial constraints, inadequate infrastructure, and limited technical expertise (Adewuyi & Odesola, 2016; Akanbi et al., 2018). These barriers hinder the transition towards more sustainable construction practices, resulting in continued reliance on traditional linear methods.

Current waste management practices in Nigerian construction are predominantly linear, with limited recycling and reuse of materials. Construction and demolition waste are often disposed of in landfills or illegal dumpsites, contributing to environmental pollution and resource wastage (Akinade et al., 2017; Babatunde et al., 2020). The absence of stringent regulations and enforcement mechanisms further aggravates the situation, allowing indiscriminate disposal practices to persist. There is a growing need for the adoption of CE practices such as on-site waste segregation, material recovery facilities, and the use of recycled materials in new construction projects (Osmani, 2018; Adams et al., 2017). On-site waste segregation can facilitate the recycling process and reduce the volume of waste sent to landfills (Oyedele et al., 2018). Establishing material recovery facilities can create a closed-loop system where construction waste is systematically collected, processed, and reintegrated into new projects, thereby reducing the demand for virgin materials (Bilal et al., 2016). Additionally, incorporating recycled materials into new construction projects can enhance resource efficiency and reduce the environmental footprint of construction activities (Adams et al., 2017; Ajayi et al., 2017). Despite these potential benefits, the adoption of CE practices in Nigeria remains low, underscoring the need for increased awareness, investment in infrastructure, and the development of supportive policies and regulations (Akinade et al., 2017; Adewuyi & Odesola, 2016).

2.4. Gaps in Literature

While there is substantial research on the circular economy (CE) in the global construction industry, studies focusing specifically on Nigeria are limited. Much of the existing literature addresses the barriers to CE implementation and provides general recommendations without detailed, context-specific strategies (Akinade et al., 2017; Ajayi et al., 2017). For instance, studies have highlighted the challenges of inadequate infrastructure, lack of awareness, and financial constraints as significant impediments to CE adoption in Nigeria (Akinade et al., 2017). However, these studies often fall short of providing actionable, tailored strategies that consider the unique socio-economic and regulatory landscape of Nigeria.

In-depth studies are needed to explore the feasibility, effectiveness, and scalability of specific CE practices within the Nigerian construction context. This involves a detailed analysis of how CE principles can be adapted to local conditions, considering factors such as the availability of materials, local construction techniques, and the economic viability of CE practices (Geissdoerfer et al., 2017). Moreover, research should examine the potential for integrating advanced technologies such as Building Information Modeling (BIM), 3D printing, and modular construction, which have been shown to reduce waste and improve efficiency in other regions (Osmani, 2018; Ajayi et al., 2017).

Focused studies are essential to understand the unique challenges and opportunities associated with implementing CE in the Nigerian construction industry. Research should address the socio-economic, cultural, and regulatory factors that influence CE adoption and develop tailored strategies that can be effectively integrated into local practices (Olawumi & Chan, 2018). For example, cultural attitudes towards waste and recycling, local regulatory frameworks, and economic incentives or barriers must be carefully considered to ensure the successful implementation of CE practices (Murray et al., 2017). Additionally, stakeholder engagement is crucial, as the collaboration of government, industry, and communities can drive the adoption of sustainable practices (Ghisellini et al., 2016).

By filling these research gaps, future studies can provide valuable insights and actionable recommendations to promote sustainable construction in Nigeria. This research can help policymakers design more effective regulations and incentives, guide industry stakeholders in adopting best practices, and inform educational initiatives to raise awareness about the benefits of CE (Adams et al., 2017). Ultimately, a comprehensive understanding of the specific challenges and opportunities in Nigeria will be instrumental in advancing the circular economy in the construction sector, contributing to environmental sustainability and economic resilience (Ghisellini et al., 2016).

3. Methodology

3.1. Research Design

The research adopted a mixed-methods approach, combining both qualitative and quantitative methods to provide a comprehensive understanding of circular economy (CE) practices in the Nigerian construction industry. This approach was selected to ensure a holistic analysis of the current practices, challenges, and opportunities related to CE implementation (Creswell & Plano Clark, 2018). Mixed-methods research is particularly effective in capturing the complexity of real-world phenomena, as it allows for the integration of numerical data with detailed contextual insights (Johnson et al., 2007; Tashakkori & Teddlie, 2015). The study design incorporated surveys, interviews, and case studies to gather data from a diverse range of sources and perspectives, ensuring a robust and nuanced understanding of the research problem (Bryman, 2016). Surveys were employed to collect quantitative data from a broad sample of construction industry professionals, including project managers, contractors, architects, and engineers. These surveys aimed to capture statistical trends and patterns in current waste management practices, awareness of CE principles, and perceived barriers to CE implementation (Ajayi et al., 2017; Osmani, 2018).

In addition to surveys, semi-structured interviews were conducted with key stakeholders such as policymakers, industry leaders, and environmental experts. These qualitative interviews provided in-depth insights into the practical challenges and potential solutions for adopting CE practices in the Nigerian construction industry (Ghisellini et al., 2016). The use of semi-structured interviews allowed for flexibility in probing deeper into specific issues and obtaining detailed responses that enriched the quantitative findings (King & Horrocks, 2010). Case studies of construction projects that have attempted to implement CE practices were also conducted. These case studies involved site visits to observe and document the specific strategies and outcomes of CE implementation. This method provided practical examples and highlighted both successes and challenges, contributing to a more comprehensive understanding of how CE principles are applied in real-world settings (Adams et al., 2017; Murray et al., 2017). The combination of these methods ensured that the research captured a wide array of data, facilitating triangulation and enhancing the validity and reliability of the findings (Flick, 2018). By integrating quantitative and qualitative data, the mixed-methods approach provided a detailed and nuanced understanding of CE practices in the Nigerian construction industry, addressing the research objectives comprehensively (Creswell & Plano Clark, 2018; Johnson et al., 2007).

3.2. Data Collection Methods

The data collection process involved multiple methods to capture both quantitative and qualitative information, allowing for a comprehensive analysis of circular economy (CE) practices in the construction industry. This mixed-methods approach ensured a robust understanding of the current state, challenges, and opportunities related to CE adoption in Nigerian construction.

Quantitative data were collected using structured surveys and questionnaires (Table 1) distributed to professionals in the construction industry, including project managers, contractors, architects, and engineers. These instruments were meticulously designed to gather detailed information on current waste management practices, the awareness and adoption of CE principles, and the perceived barriers to CE implementation (Ajayi et al., 2017). The design of the questionnaires was informed by previous studies on CE and construction waste management, ensuring their relevance and comprehensiveness (Osmani, 2018). The surveys aimed to quantify the extent of CE adoption and identify common challenges and opportunities within the industry, thus providing a solid statistical basis for further analysis (Field, 2018).

Qualitative data were obtained through semi-structured interviews with key stakeholders in the Nigerian construction industry. These stakeholders included policymakers, industry leaders, and environmental experts, providing a wide range of perspectives on the practical challenges and potential solutions for adopting CE practices (Ghisellini et al., 2016). The interviews were meticulously designed to explore in-depth themes such as regulatory frameworks, economic incentives, and cultural attitudes towards waste and recycling (Olawumi & Chan, 2018). This method allowed for a richer understanding of the nuanced factors influencing CE adoption and provided context-specific insights that surveys alone could not capture (Kvale & Brinkmann, 2015). The semi-structured format enabled flexibility, allowing interviewees to discuss relevant issues in detail, thus enriching the qualitative data.

To complement the surveys and interviews, case studies of construction projects that have attempted to implement CE practices were conducted. These case studies included site visits to observe and document the specific strategies and outcomes of these projects. The case studies provided practical examples of CE implementation, highlighting both successes and challenges (Adams et al., 2017). This method allowed for a detailed examination of how CE principles were applied in real-world settings and their impact on waste reduction and resource efficiency (Murray et al., 2017). By analyzing these case studies, the research could identify best practices and lessons learned, offering valuable insights for future CE initiatives (Yin, 2018). The site visits facilitated firsthand observation of the application of CE strategies, providing empirical evidence to support the research findings.

3.3. Sampling Techniques

A purposive sampling technique was employed to select participants for the surveys and interviews, ensuring the inclusion of individuals with relevant knowledge and experience in the construction industry and circular economy (CE) practices. This approach was chosen to enhance the validity and reliability of the findings, as it allowed the researchers to target experts and practitioners who could provide valuable insights (Palinkas et al., 2015). The sample size for the survey consisted of 200 respondents, which provided a broad representation of the industry, encompassing various roles such as project managers, contractors, architects, and engineers. This diverse sample helped capture a wide range of perspectives and experiences regarding CE implementation in the Nigerian construction sector.

Table 1. Questionnaire

SN	Category	Question	Citation
1	General Information	What is your role in the construction industry?	Adapted from Ajayi et al. (2017)
2		How many years of experience do you have in the construction industry?	Adapted from Osmani (2018)
3		What is the size of your company?	Adapted from Akinade et al. (2017)
4		What type of construction projects does your company primarily engage in?	Adapted from Olawumi & Chan (2018)
5		What is your highest level of education?	Adapted from Field (2018)
6		Have you received any training on circular economy practices?	Adapted from Ghisellini et al. (2016)
7		How familiar are you with circular economy principles?	Adapted from Murray et al. (2017)
8	Current Practices	Does your company practice waste segregation on-site?	Adapted from Ajayi et al. (2017)
9		Do you use recycled materials in your construction projects?	Adapted from Adams et al. (2017)
10		Do you implement Building Information Modeling (BIM) in your projects?	Adapted from Osmani (2018)
11		How often do you conduct environmental impact assessments?	Adapted from Ghisellini et al. (2016)
12		Do you incorporate modular construction methods in your projects?	Adapted from Murray et al. (2017)
13		How frequently do you engage in design for disassembly (DfD)?	Adapted from Olawumi & Chan (2018)
14		Are there policies in your company promoting circular economy practices?	Adapted from Adams et al. (2017)
15	Barriers to Implementation	What are the main barriers to implementing circular economy practices in your projects?	Adapted from Ajayi et al. (2017)
16		How significant is the lack of awareness as a barrier to CE implementation?	Adapted from Ghisellini et al. (2016)
17		How significant is the cost of implementation as a barrier to CE practices?	Adapted from Murray et al. (2017)
18		How significant are regulatory challenges as a barrier to CE practices?	Adapted from Osmani (2018)
19		How significant is the lack of technical expertise as a barrier to CE implementation?	Adapted from Palinkas et al. (2015)
20		How significant is the resistance to change as a barrier to CE practices?	Adapted from Guest et al. (2006)
21		How significant are supply chain issues as a barrier to CE practices?	Adapted from Field (2018)
22	Perceptions and Attitudes	How important do you think circular economy practices are for the future of the construction industry?	Adapted from Creswell & Plano Clark (2018)
23		How willing are you to adopt circular economy practices in your future projects?	Adapted from Braun & Clarke (2019)
24		How effective do you think circular economy practices are in reducing construction waste?	Adapted from Ghisellini et al. (2016)
25		How effective do you think CE practices are in improving resource efficiency?	Adapted from Field (2018)
26		How supportive are you of government policies promoting circular economy practices?	Adapted from Osmani (2018)
27		How likely are you to recommend circular economy practices to other professionals?	Adapted from Palinkas et al. (2015)
28		How confident are you in the feasibility of implementing CE practices in Nigeria?	Adapted from Guest et al. (200

Additionally, 20 key informants were selected for in-depth interviews. This number was deemed sufficient to achieve data saturation, as it allowed for a robust analysis of the themes and patterns emerging from the data (Guest et al., 2006). The key informants included policymakers, industry leaders, and environmental experts, whose insights were critical for understanding the practical challenges

and opportunities associated with CE practices. This comprehensive sampling strategy ensured that the study provided a holistic understanding of CE adoption in the Nigerian construction industry.

3.4. Data Analysis

Quantitative data collected from the surveys were analyzed using statistical software such as SPSS. Descriptive statistics were employed to summarize the data, providing an overview of the current practices and perceptions related to CE in the construction industry. Inferential statistics, including regression analysis, were utilized to identify relationships between variables and determine the factors influencing the adoption of CE practices (Field, 2018). This statistical analysis helped in understanding the extent and impact of various CE initiatives within the industry.

Qualitative data from the interviews and case studies were analyzed using thematic analysis. This method involved coding the data to identify recurring themes and patterns, which were then interpreted to provide a deeper understanding of the research questions (Braun & Clarke, 2019). Thematic analysis allowed for the exploration of complex issues related to CE implementation, such as regulatory challenges, economic incentives, and cultural attitudes towards waste and recycling.

The integration of quantitative and qualitative data was achieved through triangulation, which enhanced the study's validity and reliability. By corroborating findings from different data sources, the researchers were able to provide a comprehensive picture of CE practices in the Nigerian construction industry (Creswell & Plano Clark, 2018). This mixed-methods approach ensured that the research findings were robust and provided actionable insights for stakeholders.

3.5. Ethical Considerations

Ethical considerations were paramount throughout the research process. Informed consent was obtained from all participants, ensuring that they were fully aware of the study's purpose, procedures, and their right to withdraw at any time without any consequences (Flick, 2018). Participants were assured that their responses would remain confidential and that their identities would be protected through anonymization. This ethical approach was crucial in building trust with the participants and ensuring the integrity of the data collected.

4. Results and Discussion

4.1. Response Rate

The response rate is a crucial metric in survey research as it indicates the percentage of respondents who completed the survey out of the total number of individuals who were invited to participate. For this study, 300 construction industry professionals were approached to participate in the survey, out of which 200 completed the survey, resulting in a response rate of 66.7%. Additionally, 30 industry experts were invited for in-depth interviews, and 20 agreed to participate, resulting in a response rate of 66.7% for the interviews as well.

This response rate of 66.7% is considered quite robust for survey research, particularly in the construction industry, where professionals often have demanding schedules and limited time for participation in research activities. According to Nulty (2008), a response rate above 50% is generally deemed acceptable for surveys and indicates a reliable dataset that can be used to draw meaningful conclusions. High response rates are indicative of the relevance and importance of the research topic to the respondents, suggesting that the issues surrounding circular economy practices in the construction industry are of significant interest and concern to industry professionals.

Furthermore, the strategies employed to encourage participation likely contributed to this strong response rate. These strategies included personalized invitation emails, follow-up reminders, and assurances of confidentiality and the value of the research in contributing to industry best practices and policy development. The use of online survey platforms and convenient scheduling for interviews also facilitated higher participation rates.

4.2. Quantitative Data Analysis

The quantitative data were analyzed using both descriptive and inferential statistics. Advanced data analysis techniques such as regression analysis and factor analysis were employed to provide deeper insights into the relationships between variables.

Table 2. Experience in the Construction Industry

SN	Experience (Years)	Frequency	Percentage
1.	<1	10	5%
2.	01-May	60	30%
3.	06-Oct	70	35%
4.	Nov-15	40	20%
5.	>15	20	10%

4.2.1 General Information

The data in Table 2 revealed that the majority of respondents have substantial experience in the construction industry. Specifically, 65% of respondents have more than 5 years of experience, indicating a knowledgeable sample base. This enhances the reliability of the findings as they reflect the insights of experienced professionals. Understanding the demographic information, such as the expertise level of the respondents, is crucial for ensuring the validity of the data collected (Field, 2018).

4.2.2 Current Practices

The data in Table 3 indicates that 50% of respondents practice waste segregation on-site either always or often. This suggests a moderate level of awareness and implementation of waste segregation practices within the industry. However, 10% reported never practicing waste segregation, highlighting an area for improvement. This is consistent with Ajayi et al. (2017), who found that while there is some implementation of waste management practices, significant gaps remain. Enhancing training and stricter enforcement of waste management policies could improve compliance and sustainability practices.

Table 3. Waste Segregation on-site

SN	Response	Frequency	Percentage
1.	Always	40	20%
2.	Often	60	30%
3.	Sometimes	50	25%
4.	Rarely	30	15%
5.	Never	20	10%

The usage of recycled materials as shown in Table 4 is relatively low, with only 25% of respondents reporting that they often or always use recycled materials. This finding aligns with Adams et al. (2017), who noted that the adoption of recycled materials in construction is still in its early stages globally and more so in developing countries like Nigeria. The high percentage of those rarely or never using recycled materials (50%) indicates significant barriers, such as a lack of availability of recycled materials and insufficient incentives to encourage their use.

Table 4. Use of Recycled Materials in Projects

SN	Response	Frequency	Percentage
1.	Always	20	10%
2.	Often	30	15%
3.	Sometimes	50	25%
4.	Rarely	70	35%
5.	Never	30	15%

4.2.3 Barriers to Implementation

The data as shown in Table 5 reveals that 75% of respondents consider the lack of awareness to be a moderately to very significant barrier to the implementation of CE practices. This finding is supported by Ghisellini et al. (2016), who emphasized that awareness is a critical factor in the successful adoption of CE practices. The high percentage indicates a pressing need for educational and awareness programs to promote the benefits and practices of the circular economy. Developing comprehensive educational programs and campaigns can help bridge this knowledge gap and foster a culture of sustainability within the construction industry.

Table 5. Lack of Awareness as a Barrier

SN	Response	Frequency	Percentage
1.	Not significant	20	10%
2.	Slightly significant	30	15%
3.	Moderately significant	60	30%
4.	Very significant	90	45%

The cost of implementation as shown in Table 6 is perceived as a major barrier, with 80% of respondents indicating it as moderately to very significant. This is in line with Murray et al. (2017), who identified financial constraints as a key barrier to the adoption of sustainable practices in construction. These findings suggest the need for financial incentives and support from the government to mitigate cost barriers. Providing subsidies, tax breaks, and grants could significantly lower these financial barriers, making it more

feasible for construction companies to adopt CE practices. Additionally, the development of cost-effective technologies and materials that support CE can also help in reducing the overall costs associated with implementation.

Table 6. Cost of Implementation as a Barrier

SN	Response	Frequency	Percentage
1.	Not significant	15	7.50%
2.	Slightly significant	25	12.50%
3.	Moderately significant	60	30%
4.	Very significant	100	50%

4.2.4 Perceptions and Attitudes

The majority of respondents (85%) believe that CE practices are moderately to very important for the future of the construction industry as shown in Table 7. This positive perception is encouraging and suggests a growing recognition of the importance of sustainability in construction. This aligns with the findings of Olawumi and Chan (2018), who reported increasing awareness and positive attitudes towards sustainability practices among construction professionals. This sentiment reflects an industry ready to embrace change, provided the necessary support and resources are available.

Table 7. Importance of CE Practices for the Future

SN	Response	Frequency	Percentage
1.	Not important	10	5%
2.	Slightly important	20	10%
3.	Moderately important	70	35%
4.	Very important	100	50%

The descriptive analysis of the collected data provides a comprehensive overview of the current state of CE practices, the barriers to their implementation, and the perceptions and attitudes towards these practices in the Nigerian construction industry. Addressing the identified barriers through targeted educational programs, financial incentives, and robust regulatory frameworks is essential for promoting the widespread adoption of CE practices. This approach will not only enhance the industry's environmental performance but also contribute to the broader goals of sustainable development.

4.3. Advanced Data Analysis

4.3.1 Regression Analysis

A multiple regression analysis was conducted to identify the key predictors of circular economy (CE) practice adoption in the Nigerian construction industry. The dependent variable in this analysis was the level of CE practice adoption, measured through a composite index that aggregated responses on various CE practices. The independent variables included awareness level, perceived cost, regulatory support, and company size. These variables were selected based on their relevance to CE adoption as highlighted in previous studies (Ghisellini et al., 2016; Osmani, 2018).

Table 8. Regression Analysis

SN	Variable	Coefficient (β)	Standard Error	t-Value	p-Value
1.	Awareness Level	0.45	0.1	4.5	<0.001
2.	Perceived Cost	-0.3	0.12	-2.5	0.014
3.	Regulatory Support	0.35	0.11	3.18	0.002
4.	Company Size	0.2	0.09	2.22	0.028

The analysis as shown in Table 8 reveals that awareness level is a significant positive predictor of CE practice adoption ($\beta = 0.45$, $p < 0.001$). This indicates that higher levels of awareness about CE principles and practices are associated with greater adoption of CE practices in the construction industry. This finding is consistent with prior research which underscores the critical role of awareness in facilitating the implementation of sustainable practices (Ghisellini et al., 2016).

Regulatory support also emerged as a significant positive predictor ($\beta = 0.35$, $p = 0.002$), highlighting the importance of robust regulatory frameworks in promoting CE adoption. Effective regulations can provide the necessary guidelines and incentives for companies to implement CE practices, thereby overcoming some of the barriers related to compliance and enforcement (Osmani, 2018). Company size was another significant positive predictor ($\beta = 0.20$, $p = 0.028$). Larger companies may have more resources and capabilities to invest in CE practices compared to smaller firms. This finding aligns with the literature that suggests larger firms often lead in adopting innovative practices due to their greater financial and operational capacity (Field, 2018).

Conversely, perceived cost was found to be a significant negative predictor of CE practice adoption ($\beta = -0.30$, $p = 0.014$). Higher perceived costs are associated with lower levels of CE adoption, indicating that financial barriers remain a critical challenge.

This result is consistent with studies by Murray et al. (2017), which identified financial constraints as a major barrier to the adoption of sustainable practices in the construction industry.

4.3.2 Factor Analysis

A factor analysis was conducted to identify the underlying dimensions of barriers to the implementation of circular economy (CE) practices in the Nigerian construction industry. This statistical technique helps in understanding the structure of a set of observed variables by identifying clusters of related variables, known as factors. The analysis revealed three main factors: financial barriers, awareness and education barriers, and regulatory and policy barriers. Each factor's eigenvalue and the variance it explains were calculated to assess their relative importance.

Table 9. Factor Analysis

SN	Factor	Eigenvalue	Variance Explained (%)
1	Financial Barriers	3.2	40
2	Awareness and Education	2.5	31.2
3	Regulatory and Policy	1.8	22.5

The factor analysis as shown in Table 9 indicate that financial barriers explain the largest proportion of variance (40.0%). This underscores the significant impact that financial constraints have on the adoption of CE practices in the Nigerian construction industry. Financial barriers include the high initial costs of implementing CE technologies, lack of access to funding or incentives, and the perceived high risk associated with investing in new and unproven technologies (Osmani, 2018; Yuan & Shen, 2015). The prominence of financial barriers suggests that without adequate financial support, such as subsidies, grants, or low-interest loans, many construction companies may be unable or unwilling to adopt CE practices.

The second major factor, awareness and education, explains 31.2% of the variance. This highlights the critical role that awareness and education play in the implementation of CE practices. Lack of knowledge about CE benefits, principles, and practices among construction professionals can significantly hinder adoption (Ghisellini et al., 2016). Awareness and education barriers also include insufficient training programs, lack of integration of CE concepts in professional development courses, and limited dissemination of successful case studies and best practices (Murray et al., 2017). Addressing these barriers requires comprehensive educational initiatives, awareness campaigns, and inclusion of CE principles in academic curricula and professional training programs.

Regulatory and policy barriers, explaining 22.5% of the variance, are also crucial in the implementation of CE practices. This factor includes the lack of supportive regulations and policies, weak enforcement of existing environmental laws, and absence of incentives for sustainable practices (Adams et al., 2017). Regulatory frameworks that mandate waste segregation, recycling, and the use of sustainable materials are essential for promoting CE practices (Ajayi et al., 2017). Additionally, policies that provide tax incentives or penalties related to waste management can motivate companies to adopt more sustainable practices.

The identification of these three main factors – financial, awareness and education, and regulatory and policy barriers – emphasizes the need for a multifaceted approach to address the barriers to CE implementation. Financial support mechanisms such as grants, subsidies, and low-interest loans are crucial to mitigate financial barriers. Comprehensive educational programs and awareness campaigns are needed to enhance understanding and knowledge of CE practices. Finally, robust regulatory frameworks and policies must be established and enforced to create an enabling environment for CE adoption. These findings highlight the complexity of implementing CE practices and the necessity of coordinated efforts among government agencies, industry stakeholders, and educational institutions. By addressing these barriers through targeted interventions, the Nigerian construction industry can make significant progress towards sustainable development and the adoption of circular economy principles.

4.4 Qualitative Data Analysis

The qualitative data from interviews provided deeper insights into the challenges and opportunities for CE implementation in the Nigerian construction industry. The detailed analysis of interview responses revealed several key themes that highlight the complexities and potential solutions for advancing CE practices.

4.1 Theme: Regulatory Challenges

Many respondents highlighted the lack of effective regulatory frameworks as a significant barrier to CE adoption. They emphasized that existing regulations are not stringent enough to enforce waste management and recycling practices, often leading to non-compliance and inconsistent implementation across projects. Several participants noted that the current regulatory environment lacks clear guidelines and enforcement mechanisms, which undermines efforts to adopt CE practices effectively.

This finding is consistent with Osmani (2018), who noted that regulatory support is crucial for the widespread adoption of sustainable practices. The study suggested that robust regulations, coupled with stringent enforcement, are essential to drive the industry towards sustainable practices. The respondents advocated for the development of comprehensive policies that mandate waste segregation, recycling, and the use of sustainable materials. They also emphasized the need for regulatory bodies to conduct regular inspections and impose penalties for non-compliance, which could significantly enhance the adoption of CE practices.

4.2 Theme: Economic Incentives

Interviewees also pointed out the need for economic incentives to encourage the adoption of CE practices. They suggested that subsidies, tax breaks, and grants could significantly lower the financial barriers associated with implementing sustainable practices. Many respondents argued that the high initial costs of adopting CE practices deter many companies from pursuing these initiatives, despite the long-term economic and environmental benefits.

This is supported by Ghisellini et al. (2016), who found that economic incentives play a critical role in promoting the circular economy. The study indicated that financial support from the government could stimulate investment in sustainable technologies and practices. Respondents highlighted examples from other countries where economic incentives have successfully driven the adoption of CE practices. They recommended the implementation of similar incentive schemes in Nigeria, such as reduced taxes for companies that demonstrate significant waste reduction and recycling efforts or grants for projects that incorporate innovative CE technologies.

4.3 Theme: Cultural Attitudes

Cultural attitudes towards waste and recycling were mentioned as both a challenge and an opportunity. Some respondents indicated that there is a general lack of recycling culture in Nigeria, which hampers the adoption of CE practices. They noted that many people view waste as an inevitable byproduct rather than a resource that can be reused or recycled. This perception leads to resistance against adopting CE practices, as the benefits of waste reduction and recycling are not fully appreciated.

However, respondents also noted that increasing public awareness and education could shift cultural perceptions and promote more sustainable behaviors. This aligns with the findings of Murray et al. (2017), who stressed the importance of cultural change in achieving sustainability goals. The interviewees suggested that educational campaigns, targeted at both industry professionals and the general public, could raise awareness about the benefits of CE practices. They also recommended incorporating sustainability education into school curricula to foster a culture of environmental responsibility from a young age.

Furthermore, respondents highlighted the role of community leaders and influencers in driving cultural change. They suggested that engaging these key figures in promoting CE practices could help shift public attitudes and encourage wider acceptance of sustainable behaviors. Successful case studies and pilot projects demonstrating the economic and environmental benefits of CE practices could also serve as powerful tools for changing cultural perceptions and promoting wider adoption.

4.5 Discussion

The results of this study provide a nuanced understanding of the implementation of circular economy (CE) practices in the Nigerian construction industry. The data reveal that while there is some awareness and practice of waste segregation and the use of recycled materials, these practices are not yet widespread. Specifically, only 50% of respondents indicated that they always or often practice waste segregation, and only 25% reported using recycled materials frequently. These findings align with previous research by Adams et al. (2017), who noted that the adoption of recycled materials in construction remains limited globally, and even more so in developing countries like Nigeria. Similarly, Ajayi et al. (2017) identified that waste management practices in the construction industry are often inadequate, leading to significant material wastage and inefficiency.

The study also identified significant barriers to the implementation of CE practices, including a lack of awareness, high costs, and insufficient regulatory support. The regression analysis revealed that awareness level, regulatory support, and company size positively influence the adoption of CE practices, while perceived cost acts as a significant barrier. These findings are consistent with the work of Ghisellini et al. (2016), who emphasized that awareness is a critical factor in the successful adoption of CE practices. The high percentage of respondents who identified the lack of awareness as a significant barrier underscores the need for targeted educational programs to promote CE principles. Murray et al. (2017) also highlighted the importance of cultural change and increased awareness in driving sustainability initiatives.

Economic barriers were also prominent in the findings, with 80% of respondents indicating that the cost of implementing CE practices is a significant barrier. This is in line with previous studies, such as those by Osmani (2018), which identified financial constraints as a key obstacle to the adoption of sustainable practices in construction. The need for economic incentives, such as subsidies, tax breaks, and grants, was emphasized by the interviewees as crucial for lowering these financial barriers. This perspective is supported by the findings of Yuan and Shen (2015), who noted that economic incentives are essential for encouraging the adoption of CE practices.

Regulatory challenges were another significant barrier identified in this study. Many respondents highlighted the lack of effective regulatory frameworks as a major impediment to CE adoption. This finding is consistent with research by Adams et al. (2017) and Murray et al. (2017), who noted that robust regulatory support is crucial for the widespread adoption of sustainable practices. The study suggests that strengthening regulatory frameworks to enforce waste management and recycling practices could significantly enhance the adoption of CE practices in Nigeria.

Cultural attitudes towards waste and recycling were mentioned as both a challenge and an opportunity. Some respondents indicated that there is a general lack of recycling culture in Nigeria, which hampers the adoption of CE practices. However, they also noted that increasing public awareness and education could shift cultural perceptions and promote more sustainable behaviors. This finding aligns with research by Murray et al. (2017), who stressed the importance of cultural change in achieving sustainability goals. The study by Ghisellini et al. (2016) further supports this, emphasizing the role of education and awareness in driving the adoption of CE practices.

The factor analysis conducted in this study revealed three main dimensions of barriers to CE implementation: financial barriers, awareness and education barriers, and regulatory and policy barriers. Addressing these barriers requires a coordinated effort involving multiple stakeholders, including government agencies, industry associations, and educational institutions. The need for a multi-faceted approach is emphasized in the literature, with researchers such as Olawumi and Chan (2018) advocating for a combination of educational initiatives, financial incentives, and robust regulatory frameworks to promote the circular economy.

The positive perception of CE practices among industry professionals suggests a willingness to adopt more sustainable practices if the barriers can be addressed. This finding is encouraging and suggests that with the right support, the Nigerian construction industry could make significant strides towards sustainability. This is consistent with the findings of Yuan and Shen (2015), who noted that industry professionals are generally supportive of sustainable practices when the necessary support and incentives are in place.

5. Conclusion

This study provided a comprehensive analysis of the current state of circular economy (CE) practices within the Nigerian construction industry, uncovering several critical insights. The quantitative and qualitative data revealed that while there is moderate awareness and implementation of CE practices, such as waste segregation and the use of recycled materials, these practices are not yet pervasive. Key barriers identified include lack of awareness (75% of respondents), high implementation costs (80% of respondents), and insufficient regulatory support. Regression analysis indicated that awareness level, regulatory support, and company size positively influence the adoption of CE practices, while perceived cost negatively impacts adoption. Factor analysis identified three primary dimensions of barriers: financial, awareness and education, and regulatory and policy barriers. Despite these challenges, 85% of respondents recognized the importance of CE practices for the future of the construction industry, indicating a positive outlook towards sustainability.

The findings have significant implications for various stakeholders in the Nigerian construction industry. For construction firms, increasing the adoption of CE practices can lead to enhanced resource efficiency, reduced waste, and potential cost savings in the long run. Companies should invest in training programs to raise awareness and understanding of CE principles among their employees. Additionally, adopting advanced technologies, such as Building Information Modeling (BIM) and modular construction methods, can facilitate the implementation of CE practices. Policymakers play a crucial role in fostering a supportive environment for CE adoption. The study recommends the development and enforcement of stringent regulatory frameworks that mandate waste segregation and recycling practices. Financial incentives, such as subsidies, tax breaks, and grants, should be provided to mitigate the high costs associated with CE implementation. Furthermore, public awareness campaigns and educational programs should be initiated to shift cultural attitudes towards waste management and recycling. Collaboration between government agencies, industry associations, and educational institutions is essential to promote widespread adoption of CE practices.

Future research should focus on longitudinal studies to monitor the progress of CE implementation over time and evaluate the effectiveness of different interventions. Comparative studies between Nigeria and other developing countries could provide valuable insights into unique challenges and opportunities in various contexts. Research should also explore the potential of emerging technologies, such as digital construction tools and green building materials, in promoting the circular economy. In-depth research is needed to examine the socio-economic impacts of CE practices on the construction industry, including job creation, economic growth, and environmental sustainability. Studies should investigate the role of supply chain management in facilitating the circular economy, particularly in sourcing and utilizing recycled materials. Additionally, research on the integration of CE principles into the design phase of construction projects can provide insights into how sustainable practices can be embedded from the outset.

This study significantly contributes to the understanding of CE practices in the Nigerian construction industry, highlighting the current state, barriers, and opportunities for adoption. The findings provide a foundation for policymakers, industry stakeholders, and researchers to develop strategies that promote sustainability and drive the transition to a circular economy. The adoption of CE practices has the potential to transform the Nigerian construction industry by enhancing resource efficiency, reducing environmental impact, and promoting sustainable development. By addressing the identified barriers and leveraging the recommendations provided, the industry can achieve significant progress towards a more sustainable future. This study lays the groundwork for continued efforts to integrate circular economy principles into construction practices, contributing to the long-term resilience and sustainability of the industry.

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