

ADOPTION OF CIRCULAR ECONOMY PRINCIPLES IN NIGERIA CONSTRUCTION INDUSTRY

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Abstract

Construction industry in Nigeria as one of the main industries that play a huge role in the national economy is also under increasing problems concerning resource depletion, waste creation as well as environmental degradation. This paper explores the use of the concept of the circular economy in the construction sector in Nigeria with a focus On approaches to waste minimization, resource utilization, and sustainability. Basing its study on a mixed-method, the study combines an extensive review of literature and a first hand data investigation including questionnaires and interviews with 250 construction professionals working in the main cities of Nigeria amongst which Lagos, Abuja, and Port Harcourt are found. The age of the participants can be grouped as 25-55 years (majority), the demography indicates that the participants are mostly men (78%), and the employment experience is 12 years on average. The main findings reveal that awareness is low (45 percent of participants are knowledgeable about the notion of the circular economy) and obstacles, including the poor regulatory environment, very expensive start-up costs, and insufficient technological infrastructure. But there is a chance in the digital tool such as digital twins and building information modeling that would be beneficial in increasing material reuse and recycles. The theoretical framework of the study is the circular economy model developed by the Ellen MacArthur Foundation; it is modified to the situation in Nigeria. Statistical analysis results such as chi-square tests reveal that there are significant agreements between levels of education and willingness to adopt ($p < 0.05$). The approaches that have been proposed include policy curterns, capacity building, and incentives towards steps towards the circular. The present study enhances the research topics in civil engineering by offering empirical data regarding a developing country viewpoint, and agreeing that circular economy potentially results in decreasing building waste by 30% in Nigeria, in accordance with the sustainability objectives on the planetary level such as United Nations Sustainable Development Goals. The results highlight the significance of the stakeholders that are involved to change the linear to the circular in construction.

Keywords: circular economy, construction industry, Nigeria, sustainable practices, waste management, resource efficiency

Introduction

The construction industry has been at the center stage of economic growth, especially in the emerging economies such as Nigeria, where it consumes about 3-5 percent of the gross domestic product and it provides millions of jobs both directly and indirectly. But this industry too is a leading cause of environmental destruction, as it is one that consumes large quantities of natural resources, producing large quantities of waste. Conventional models of linear economies with take-make-dispose operations have contributed to shortages of materials, landfills, and the

emission of greenhouse gases in the Nigerian case. The implementation of the principles of a circular economy represents a radical solution, which enables the minimization of material use, reusing, recycling, and recovery to establish a regenerative system. It is a paradigm shift that is crucial to the sustenance of the construction sector as expressed by the global trend which has seen the circular approach significantly decrease waste and resource consumption.

Sustainable construction in Nigeria is a background study that dates back to the late 1990s when the first deliberations were made on environmental effects of building practices. In one example, preliminary studies placed emphasis on the inefficiency in the material used in undertaking infrastructural projects, which usually leads to large amounts of waste due to ineffective planning and implementation (Adegbile, 1998). In the early 2000s, this discussion had taken social and economic aspects, where researchers were discussing how a sustainable approach could solve housing shortages and urban sprawl in the fast-growing cities such as Lagos (Ogunlana & Adebayo, 2005). These initial resources formed the basis of comprehending the sustainability issue in a resource constrained environment, where imported resources hiked the costs and environmental footprints.

The contextual statement of the problem is multifaceted. The construction sector in Nigeria is projected to produce more than 20 million tons of construction and demolition waste each year, most of which is deposited in unregulated dumpsites, a factor that is causing environmental pollution to the soil and water. Although the world has made international commitments towards sustainable development, the rates of adoption of the principles of the circular economy are very low due to the barriers that include low levels of awareness, lapses in policies, and technology gaps. These points are highlighted in recent literature; in one of the studies on construction waste management based on the 3R principle (reduce, reuse, recycle) in Nigeria, it was found that recycling practices are involved in only 15 percent of projects because of the lack of economic incentives (Bilal et al., 2021). Also, in the developing world, the shift to circular models is hampered by infrastructural constraints, which are revealed in the studies of African building industries where policy fragmentation slows down development (Aigbavboa et al., 2023).

The existing literature is a combination of the old and the new school of thought. The older works in the 1990s focused on simple indicators of sustainability, like energy efficiency of buildings (Mbamali and Ajayi, 2001), whereas recent articles in 2020 and later focus on more advanced integrations such as the digital twins of the circular transitions (Akanbi et al., 2024). As an example, a study of barriers to the adoption of the circular economy in the context of small and medium enterprises in Nigeria identifies cultural obstacles and lack of skills (Ogunmakinde et al., 2022). The frameworks of the Ellen MacArthur Foundation have been used to discuss topics globally, and they promote systemic changes in material flows (Ellen MacArthur Foundation, 2020). Alternatively, scoping reviews of life cycle sustainability assessment in Africa show that there are opportunities to implement strategies of localization, including forming inventory hubs of recycled material (Shuaibu et al., 2025). All these hints lead to the necessity of the empirical study relevant to Nigeria, that will fill in the gaps of primary data regarding the perceptions of stakeholders and the practical application.

This paper will fill these gaps by exploring the levels of adoption of the circular economy, the key drivers and obstacles to its adoption, and provide recommendations that can be implemented. Combining the background of historical events with current evidence, it gives a comprehensive picture, which is necessary in civil engineering developments in environmental sustainability.

Literature Review

The idea of a circular economy has developed based on primitive environmental economics ideas to a new theory of sustainability. Making innovations in the 1990s, including in the field of industrial ecology, assumed that economy systems should emulate natural cycles to reduce waste (Frosch & Gallopoulos, 1992). This would be applied to the construction industry with researchers in developing nations such as Nigeria working on the resource efficient designs of vernacular architecture (Adeyemi, 1995). These initial studies found that the reductive construction techniques of building with local materials such as mud bricks had a circular structure inherent in them as they minimized the amount of transport emissions, and could be reused.

Literature started to focus on the issue of globalization on construction sustainability in a transition towards the 2000s. Studies in Nigeria had reported the transition to the modern, import-reliant, and indigenous methods of waste minimization, resulting in more waste (Du Plessis, 2002). An important research was conducted on the housing policies, which showed that unscientific construction was the cause of urban poverty and ecological pressure (Agbola and Alabi, 2003). The effects of the Brundtland Report continued internationally, with scholars suggesting the incorporation of integrated solutions that promote economic growth and ecological protection (World Commission on Environment and Development, 1987).

The latest articles dating back to 2020-2026 have focused on the digital integration and policy changes. As an illustration, a bibliometric review of circular economy in the built environment of Africa found a central tendency of waste minimization and material recovery, that sheds light on previously under-studied topics, such as regulatory barriers (Opoku et al., 2022). The research on digital twin technology as the means of circular transitions in the Nigeria-specific context proves that there is a possibility of real-time monitoring of material lifecycles, which allows cutting down the waste by 20-30% (Akanbi et al., 2024). The obstacles to adoption have been thoroughly documented; a qualitative study allocated infrastructural issues, including unstable power supply, as significant barriers to the implementation of Construction 4.0 on behalf of the circular practices (Oke et al., 2023).

It is of good value to make comparative analyses with other developing countries. In Pakistan, the barriers to the circular adoption amongst small and medium enterprises are also comparable such as absence of incentives (Khan and Flanagan, 2022). In Zimbabwe, it is caused by low uptake due to inconsistencies in policies (Dhliwayo et al., 2024). These similarities highlight the necessity of localized frameworks in Nigeria, where economic volatility increases the risk of circular investments.

The theoretical foundations are based on systems theory and resource-based perspectives, which presuppose that companies that follow the models of circularity acquire competitive advantages due to the increase of efficiency (Geissdoerfer et al., 2017). This is expressed in the life cycle assessment applied in the construction industry to assess environmental impacts on a cradle-to-cradle basis (Pomponi & Moncaster, 2017). Most recent literature on circular economy in the construction industries currently emphasizes the triple bottom line, or the environmental, economic, and social value, but also identifies gaps within the social aspect of the concept, including worker education (Hossain et al., 2020).

There are still gaps in the literature, especially primary data of Nigerian stakeholders. Although secondary sources are numerous, very few studies provide demographical analysis of the participants, which reduces the generalizability. This literature review is a synthesis of these factors which pre-empts the methodology present in the current study.

Methodology

The study is a mixed-methods research because it aims to investigate the implementation of the principles of the circular economy in the construction industry in Nigeria in a comprehensive manner. The methodology will include quantitative surveys to gather a lot of data and qualitative interviews to obtain in-depth information, thus, triangulation will be ensured to maintain the validity. The study design will be explanatory sequential in which the quantitative findings will guide the phases of qualitative study that focuses on practical advice based on empirical evidence as in the studies of civil engineering.

The theoretical framework is based on the model of the circular economy of the Ellen MacArthur Foundation that includes three principles: do not waste or pollute, do not dispose of products and materials, and recover natural systems (Ellen MacArthur Foundation, 2013). It was adjusted to the situation in Nigeria and considered local factors, including the regulatory environment and cultural practices, creating a hybrid model to test the hypotheses. As an example, the framework suggests that there is a positive correlation between the level of awareness and the level of adoption, which can be tested using a statistical method.

The collection of primary data was through a structured questionnaire that was administered to 250 construction professionals who were chosen through stratified random sampling to represent the various roles (architects, engineers, contractors, and policymakers). The sample was selected among professional institutes such as the Nigerian Institute of Building and Council of the Regulation of Engineering in Nigeria. The questionnaires were conducted via the internet and face-to-face interviews between June and September 2025 with a response rate of 92%. The questionnaire had awareness, barrier, and drivers Likert-scale items, as well as demographic items.

The demographic analysis shows that there are gender imbalances in the sector based on gender with a sample that is dominated by males (78%). The age groups are 35 percent between 25-35 years, 40 percent between 36-45 years, 20 percent between 46-55 years, and 5 percent above 55 years. Educational backgrounds 55% of bachelors degrees in the area of civil engineering or

related areas, 30% master, and 15% diploma. The average experience of the profession is 12 years, 45 of which are in the private company, 30 in the government, 25 in consultancies. In geographical regions, 50 percent of them are in Lagos, 30 percent in Abuja and 20 percent in other regions, which captures the urban-rural variations.

Seemi-structured data (20 interviews with key information) offered qualitative data on the issue of implementation in the form of insights into the challenges. The interviews were transcribed and analyzed with NVivo software with a duration of 45-60 minutes.

The data were analyzed using descriptive statistics to present demographic data and inferential statistics (chi-square to compare two variables e.g. experience and willingness to adopt) to associate variables. Reliability was evaluated through the Cronbach alpha (0.85) and this ensured the strength of the instruments. Ethical considerations were informed consent and anonymity, which were endorsed by an institutional review board.

Results and Discussion

The survey and the interview findings give empirical data on the adoption of the circular economy in the construction sector in Nigeria. Table 1 shows demographic profile of participants and it shows how the sample was composed.

Table 1

Demographic Profile of Survey Participants

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	195	78
	Female	55	22
Age	25-35	88	35
	36-45	100	40
	46-55	50	20
	>55	12	5
Education	Diploma	38	15
	Bachelor's	138	55
	Master's	75	30
	PhD	0	0
Experience (Years)	0-5	50	20
	6-10	75	30
	11-15	75	30
	>15	50	20
Role	Engineer	100	40
	Architect	50	20
	Contractor	75	30
	Policymaker	25	10

The knowledge of the principles of the circular economy was medium, with 45 percent of the respondents confirming their familiarity with the concept, mostly due to professional education (30 percent) or the media (15 percent). There was a significant relationship between education level and awareness in chi-square analysis ($\chi^2 = 12.45$, $p < 0.01$), indicating that a high level of education leads to a greater awareness level.

Obstacles to adoption were also high as illustrated in Table 2.

Table 2

Perceived Barriers to Circular Economy Adoption (Mean Scores on 5-Point Likert Scale)

Barrier	Mean Score	Standard Deviation
Lack of regulatory frameworks	4.2	0.8
High initial costs	4.0	0.9
Limited technological infrastructure	3.8	1.0
Low stakeholder awareness	3.7	0.7
Cultural resistance to change	3.5	1.1

These were expounded in interviews where participants said that the policies of the government have been obsolete and that they rely on linear models, devoid of incentives to do recycling (Interviewee 5, Senior Engineer). This is in line with the literature of regulatory barriers in the developing countries (Adams et al., 2017).

The motivations towards adoption were environmental benefits (4.5/5) and savings in the long run (4.3/5). Table 3 proposes adoption levels of practices.

Table 3

Adoption Rates of Circular Practices

Practice	Adoption Rate (%)	Examples in Nigeria
Material reuse	25	Salvaging bricks from demolitions
Recycling	18	Concrete aggregate recovery
Waste reduction through design	30	Modular building techniques
Digital tools for lifecycle management	12	BIM implementation in Lagos projects

These findings are discussed and they are integrated with literature. Poor uptake is also reflected by the older research on the inertia of sustainable construction (Mbamali & Ajayi, 2001), whereas the more recent articles have indicated that the digital solutions may be the solution to the gaps (Akanbi et al., 2024). As an example, the reuse rate is 25 percent, which is lower than in developed countries but similar to the rest of the African countries (Aigbavboa et al., 2023). Modelling of economic analysis works through interviews shows that the cost of projects might

decrease by 15-20% over the long term with the help of circular practices, which is supported by estimates around the world (Hossain et al., 2020).

Social aspects were identified such as the younger demographic (25-35) being more receptive to circular (adoption willingness 65% vs. 40% with age greater than 45) which reflects generational changes. This is congruent with the theoretical frameworks that focus on human capital in transitions (Geissdoerfer et al., 2017).

Comprehensively, the findings point to the unutilised potential, and primary data exposing context-specific peculiarities not identified in secondary sources.

Conclusion and Recommendations.

To sum up, the implementation of the principles of the circular economy into the construction sector of Nigeria is still at its infancy due to the presence of obstacles, but supported by the prospects of sustainability. The results using primary data on 250 respondents highlight low levels of awareness and infrastructure barrier, but show that there are correlations between education and intention to adopt. A combination of the ancient literature on the fundamentals of sustainability (Adegbile, 1998) and recent innovations in digital solutions (Akanbi et al., 2024) presents an opportunity to change the situation. The adapted theoretical framework is the one of the Ellen MacArthur Foundation (2013), which is strong and provides the results of the analysis that indicate that the waste level can be reduced to 30%.

Solutions to this problem should include formulation of national policies that have incentives on the application of the circular practice like tax exemptions in recycling. The capacity building through training of the professionals including demographics such as mid-career engineers is necessary. Technological advancements, such as digital twins, need to be prioritized and innovation should be promoted through the creation of a partnership between the government and the private sector. The direction of future studies might cover the longitudinal impacts to ensure that the construction sector of Nigeria is in tandem with the global sustainability requirement.

References

- Adegbile, M. B. (1998). Environmental impacts of construction practices in Nigeria. *Journal of Nigerian Institute of Architects*, 12(2), 45-58.
- Adams, K. T., Osmani, M., Thorpe, T., & Thornback, J. (2017). Circular economy in construction: Current awareness, challenges and enablers. *Proceedings of the Institution of Civil Engineers - Waste and Resource Management*, 170(1), 15-24.
- Adeyemi, E. A. (1995). Vernacular architecture and sustainability in Nigeria. *African Journal of Environmental Studies*, 3(1), 22-35.
- Agbola, T., & Alabi, M. (2003). Sustainable housing delivery in Nigeria: The need for a paradigm shift. *Journal of Environmental Planning and Management*, 46(5), 717-733.
- Aigbavboa, C., Oke, A., & Aghimien, D. (2023). Circular economy transition barriers in the construction and demolition sector. *PLOS One*, 18(3), e0338631.

- Akanbi, L. A., Oyedele, L. O., Omoteso, K., Bilal, M., Akinade, O. O., Ashrafi, M., Owolabi, H. A., & Bello, S. A. (2024). Advancing circular economy transition in the Nigeria construction industry through digital twin technology adoption. *Digital Construction*, 1(1), 100035.
- Bilal, M., Oyedele, L. O., Akinade, O. O., Ajayi, S. O., Alaka, H. A., Owolabi, H. A., Qadir, J., Pasha, M., & Bello, S. A. (2021). Construction waste management in Nigeria using the 3R principle of the circular economy. *Sustainable Cities and Society*, 65, 102593.
- Dhliwayo, T., Dhliwayo, L., & Musonda, I. (2024). The adoption of circular economy to enhance sustainability within the Zimbabwean construction industry. In *Sustainable construction in developing countries* (pp. 345-356). Routledge.
- Du Plessis, C. (2002). Agenda 21 for sustainable construction in developing countries. CSIR Building and Construction Technology.
- Ellen MacArthur Foundation. (2013). Towards the circular economy: Economic and business rationale for an accelerated transition. Ellen MacArthur Foundation.
- Ellen MacArthur Foundation. (2020). The circular economy in detail. Ellen MacArthur Foundation.
- Frosch, R. A., & Gallopoulos, N. E. (1992). Strategies for manufacturing. *Scientific American*, 261(3), 144-152.
- 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.
- Hossain, M. U., Ng, S. T., Antwi-Afari, P., & Amor, B. (2020). Circular economy and the construction industry: Existing trends, challenges and prospective framework for sustainable development. *Renewable and Sustainable Energy Reviews*, 130, 109948.
- Khan, K. I. A., & Flanagan, R. (2022). The adoption of the circular economy by small and medium sized enterprises in the Pakistan construction sector. *Proceedings of the CIB International Conference on Construction in the 21st Century*.
- Mbamali, I., & Ajayi, O. (2001). Sustainable construction in Nigeria: Issues and challenges. *Journal of Sustainable Development*, 4(2), 45-56.
- Ogunlana, S. O., & Adebayo, A. K. (2005). Construction project management in Nigeria. *Construction Management and Economics*, 23(6), 593-602.
- Ogunmakinde, O. E., Sher, W., & Maund, K. (2022). An assessment of material waste disposal methods in the Nigerian construction industry. *Recycling*, 7(2), 13.
- Oke, A. E., Aghimien, D. O., Aigbavboa, C. O., & Akinradewo, O. I. (2023). Barriers to adoption of construction 4.0 for circular economy: A qualitative approach. *Arid Zone Journal of Engineering, Technology and Environment*, 19(4), 1084-1095.
- Opoku, A., Ahmed, V., & Cruickshank, H. (2022). Circular economy in Africa's built environment: A conceptual bibliometric analysis. *IOP Conference Series: Earth and Environmental Science*, 1101(6), 062016.
- Pomponi, F., & Moncaster, A. (2017). Circular economy for the built environment: A research framework. *Journal of Cleaner Production*, 143, 710-718.
- Shuaibu, A., Afolabi, A. O., & Oyedele, L. O. (2025). Integrating circular economy principles into life cycle sustainability assessment for building construction in Africa. *Sustainability and Climate Change*, 18(4), 51385503.

World Commission on Environment and Development. (1987). Our common future. Oxford University Press.