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Benefits of Circular Design Adoption in the Nigerian Building Industry

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Abstract: Circular economy (CE) is hinged upon resource optimisation as a more viable and sustainable approach against the extractivist linear economic model that has resulted in resource scarcity, affordability issues, and environmental degradation. Design plays a critical role as the foundation of the circular approach, however, limited studies have examined the inherent benefits of circular design (CD) adoption from the building design firms' (BDFs) perspectives, more importantly, none exist in Nigeria to the best of the author's knowledge. This study assesses the benefits of CD adoption in the Nigerian building industry (NBI). Primary data were collected from 216 architectural and engineering design firms domiciled in Lagos using a questionnaire survey. The findings indicated the top five benefits which include reduction in energy use by efficient utilization through design, development of new skill sets in circularity by design teams, reduction in pollution through reduced burning of fossil fuel, reduction of construction/demolition waste generation, improvement of public health by preserving local biodiversity. While increasing competitiveness amongst BDFs and resource security through optimisation and dematerialisation were ranked the least. The outcome can be ascribed to the fact that Nigeria currently faces an energy crisis with efforts being made in developing energy-efficient buildings and the need to minimize the environmental impact of construction practices. It was suggested that BDFs need to invest in CD expertise development through training and education, voluntary stewardship, and providing the requisite technologies to aid CD implementation. This study provided the basis for the needed debates on the relative benefits of CD adoption in the NBI.

Keywords: Building design firms, Circular design, Circular economy, Lagos-Nigeria, Benefits

Introduction

The concept of circular economy (CE) is currently a topic of discussion across different sectors around the world regarding sustainability. İts benefits include reducing the impact of resource extraction and optimising efficiency (Ezema et al., 2023). CE aims to establish waste-free systems by utilising regenerative and restorative approaches through thoughtful design and implementation according to the Ellen MacArthur Foundation in 2017. The architecture, engineering, construction, and operations (AECO) sector is recognised for its high usage of resources, consuming around 40% of environmental resources, producing 40% of global carbon emissions (Naneva, 2022), utilising 43% of global energy, and producing 40% of global waste (Al-Hamrani et al., 2021; Hasheminasab et al., 2022). İn addition, the AECO sector is recognised for its use of the linear economy (LE) model, where resources are taken, made into products, and disposed of at the end of their life cycle (Al-Hamrani *et al.*, 2021). This type of economy is often referred to as an extractivist economy (Hentges et al., 2022). If we continue consuming resources at our current rate, global production will need to increase twofold by 2030 and triple by 2050 to keep up with the growing population's demands (Ezeudu et al., 2021; Okafor et al., 2021).

However, this will also result in a substantial amount of waste generated from production processes and infrastructure development for human activities (Adewuyi & Adewuyi, 2020; Tongo et al., 2021). The concept of CE has been considered an expansion of sustainable practices due to its ability to achieve optimal utilization of resources.

The emergence of CE in the AECO industry has influenced various stages of the building procurement process (Çimen, 2021; Ellen MacArthur Foundation [EMF], 2017; Ezeudu & Ezeudu, 2019; Mboli et al., 2020), particularly in the design stage (Al-Hamrani et al., 2021; Kayacetin et al., 2022). The design stage has been identified as the most efficient and effective phase of sustainable construction for implementing CE strategies (Dewagoda et al., 2022). Circular design strategies have made it feasible to integrate CE into the design stage, providing a range of advantages. Nonetheless, it has been observed that differences exist in the adoption of circular design (CD) between developed and developing economies due to variations in geographical location, sectoral, organisational, technological, and economic differences (Guerra & Leite, 2021; Hart et al., 2019). While CD benefits have been extensively researched in developed economies (Adams et al., 2017), there have been few studies investigating the potential benefits of CD adoption in the Global South (Bilal et al., 2020; Hossain & Khatun, 2021), specifically from the viewpoint of building design firms (BDFs). To the best of our knowledge, no such study has been conducted in Nigeria. Therefore, this research aims to evaluate the advantages of implementing CD in the Nigerian building industry (NBI).

Adoption of Circular Design Strategies: Salient Benefits

Circular design strategies (CDS) are a set of resource optimisation techniques employed during the building development's design stage. These methods aim to ensure that materials are continually used and reused at their highest value, thus slowing down the resource loop. CDS also involves designing out waste to narrow the resource loop and promote the regeneration of materials in both the technical and biological cycles, ultimately closing the resource loop. CE embraces a design philosophy that focuses on restoring and regenerating resources to promote maximum efficiency. This is accomplished by employing various strategies such as modular design, design for deconstruction and disassembly, design for flexibility and adaptation, design for excellence, whole systems design, design in layers, and design for reuse (Çimen, 2021; Ezeudu & Ezeudu, 2019) among other techniques. Most of the previous CE research conducted in the NBI has centered on life-cycle assessment, end-of-life, materials, and waste valorization, with little emphasis placed on the significance of the design stage (Osobajo et al., 2020), which has been identified as the most effective stage for implementing CE (Dewagoda et al., 2022). Nevertheless, there are significant benefits to be gained from adopting CD in building development, particularly in addressing environmental degradation, affordability challenges, and resource scarcity.

Table 1. Benefits of circular design adoption

Code	Benefits	References
BN1	Relieve on the global ecosystem/ resource consumption	Guerra and Leite (2021)
BN2	Circular design supports climate change mitigation	Cruz Rios et al. (2021)
BN3	Reduction of construction/demolition waste generation	Guerra and Leite (2021)
BN4	Reduces energy use by efficient utilization through design	Ghisellini et al. (2018)
BN5	Protecting underground/surface waterways from contamination	Purchase et al. (2021)
BN6	Increased use of recycled materials (Upcycling/downcycling)	Purchase et al. (2021)
BN7	Improving public health by preserving local biodiversity	Guerra and Leite (2021)
BN8	Reduce pollution through reduced burning of fossil fuel	Purchase et al. (2021)
BN9	Mitigate the demand-driven materials price volatility risks	Guerra and Leite (2021)
BN10	Building components reuse for reduced building cost and time	Minunno et al. (2020)
BN11	New market for reusable/reclaimed components and elements	Minunno et al. (2020)
BN12	Potential reduction in operating cost of building maintenance	Minunno et al. (2020)
BN13	Increases competitiveness amongst building design firms	Adams et al. (2017)
BN14	Resource security through optimization and dematerialization	Adams et al. (2017)
BN15	New horizon for eco-innovations in the building market/sector	Minunno et al. (2020)
BN16	Development of new skill sets in circularity by design teams	Purchase et al. (2021)
BN17	Scraping of dump sites for more quality land for developments	Laurea, (2020)
BN18	Government creating means of achieving sustainability goals	Purchase et al. (2021)
BN19	Regulations on the certification of reclaimed components	Minunno et al. (2020)
BN20	Corporate social responsibility practices by design firms	Laurea (2020)

Hartwell et al. (2021) have highlighted that promoting recycling and reusing resources at the end-of-life stage is crucial in achieving reduction in carbon emission and minimizing waste generation. Additionally, Ritzen et al. (2019) found that incorporating component reuse in new dwellings could potentially result in a 90% reduction in embodied carbon emissions. According to Ghisellini et al. (2018), CE revolutionizes the entire value chain process by transforming the linear end-of-life approach to a multi-cycle approach that enhances efficiency and optimisation in resource utilization. The environmental impact and economic value of salvaged materials are influenced by factors such as the availability of secondary-use material markets, shorter transportation distances, and the process and method of deconstruction. Ghisellini et al. (2018) have identified that refurbishing offers a more sustainable option than demolition or new construction, and it has a shorter payback period for achieving a return on investment. Purchase et al. (2021) conducted a review on the impact of CE on construction and demolition waste management, and the study found that circularity strategies in buildings offer several benefits. These benefits include meeting sustainability goals, improving public health, reducing pollutants and greenhouse gas emissions, providing quality land to meet the demand for housing, conserving and preserving biodiversity, and creating job opportunities. Minunno et al. (2020) conducted a comparative study between a circular modular building designed for disassembly and secondary-use steel structures and a conventional linear modular building. The aim was to assess the environmental benefits of incorporating secondary-use materials through a life cycle assessment method. According to the study conducted by Minunno et al. (2020), the circular modular building designed for disassembly and secondary-use steel structures showed significant environmental benefits. These included an 88% reduction in greenhouse gas emissions and eutrophication, and an 87% reduction in acidification potentials. Additionally, the study found that circular buildings offered other benefits, such as savings on land used for landfills, component reuse, and the establishment of a market for reusable building components. Hentges et al. (2022) identified the benefits of CD adoption in the Brazilian construction sector, including the creation of CD guidelines, the adoption of Green Building Information Modelling (GreenBIM), and the implementation of circularity stewardship programmes. Furthermore, Hartwell et al. (2021) highlighted the environmental opportunities available in Europe, America, and Asia, due to the implementation of CE regulations and economic incentives that encourage pro-environmental innovations. The adoption of circularity strategies could also foster innovation in the building sector. Table 1 presents the benefits identified from the reviewed literature.

Method

The study's participants were architectural, civil/structural engineering, and building services engineering firms registered with their respective national regulatory bodies and based in Lagos, Nigeria. Lagos was chosen as the study area because it accounts for two-thirds of the construction activities ongoing in Nigeria. Moreover, Lagos is home to over 70% of the BDFs and head offices of construction companies in Nigeria (Ogunmakinde, 2019). To account for the varying characteristics and attributes of the study population, the study employed a quota random sampling method. Primary data was collected through a questionnaire survey administered to the BDFs, which sought responses on the firms' demographics, awareness of CD, and benefits of CD adoption. The questionnaires were distributed through two means: hand-delivered and electronically, using Google Forms sent via email and WhatsApp. Before conducting the main study, a pilot study was conducted. The responses from the pilot study were subjected to a Cronbach's Alpha reliability test to ensure that the questionnaire survey design measured the constructs appropriately and achieved internal consistency, as recommended by Robson & McCartan (2017). The Cronbach's Alpha reliability test yielded a score of 0.975 for the 20 benefits, which was higher than the threshold of 0.70 (Ogunmakinde, 2019). A total of 307 questionnaires were distributed, and 216 of them were fully completed by the respondents. The respondents were asked to rate the level of importance on a five-point Likert scale, ranging from 1 (very low importance) to 5 (very high importance). Statistical Products and Service Solutions version 21 was used for data analysis, management, and coding. The Shapiro-Wilk test was conducted to test for normality in the data distribution, which revealed that the survey data was distribution-free. The analyses conducted on the data included mean score ranking, standard deviation, and the Kruskal-Wallis Test, which was used to determine if there was a statistically significant difference in the responses.

Results and Discussion

Firms' Demography

According to Figure 1, BDFs exist in different forms depending on the services they provide. The majority of the respondents (158, 73.1%) were BDFs that offer architectural design services, while civil/structural engineering design service (31, 14.4%), electrical engineering design service (15, 6.9%), and mechanical engineering design service (12, 5.6%) were less common. The reason for this could be attributed to the fact that there are three times more registered architectural design firms than engineering design firms with their respective national regulatory bodies in the study area. When it comes to the age distribution of the firms, 59 (27.3%) of them have been in existence for one to five years, 52 (24.1%) for six to ten years, 41 (19.0%) for over 25 years, 37 (17.1%) for 11 to 15years, and 11 (5.1%) of the firms have been around for 21 to 25years. The majority of BDFs observed were relatively new start-up organisations that have been in operation for less than six years. This is likely due to the abundance of market opportunities in the building sector, as there are many building construction projects currently taking place in Lagos. This is second to none in the country, as mentioned by Ogunmakinde (2019), and is also due to the rate of urbanization in the state. Another factor to consider is the number of staff that BDFs have. The majority (71.8%) of these firms are small in size, with less than eleven staff members. This can be attributed to the ownership structure of these firms, with half (50.5%) being owned by sole proprietors, followed by partnership-owned (32.9%), and consortium-owned firms being the least common type among the respondents. The study found that the majority of BDFs (118, 54.6%) are aware of circular design. Meanwhile, 79 (36.6%) of respondents indicated that they have not heard of it, and 19 (8.8%) were unsure. It is noteworthy that more than half of the BDFs are familiar with CD. This finding is consistent with Bilal et al. (2020) research, which reported a 58% overall level of awareness of CE in the building sector of developing countries. Likewise, this discovery is in line with previous research conducted by Liu & Bai (2014) and Masi et al. (2018), albeit slightly lower. The disparity could be due to the limited number of studies on CD at the BDF level in the NBI. However, this study shed light on the significant benefits that laced the adoption of CD in the NBI as seen from the BDFs' perspective.

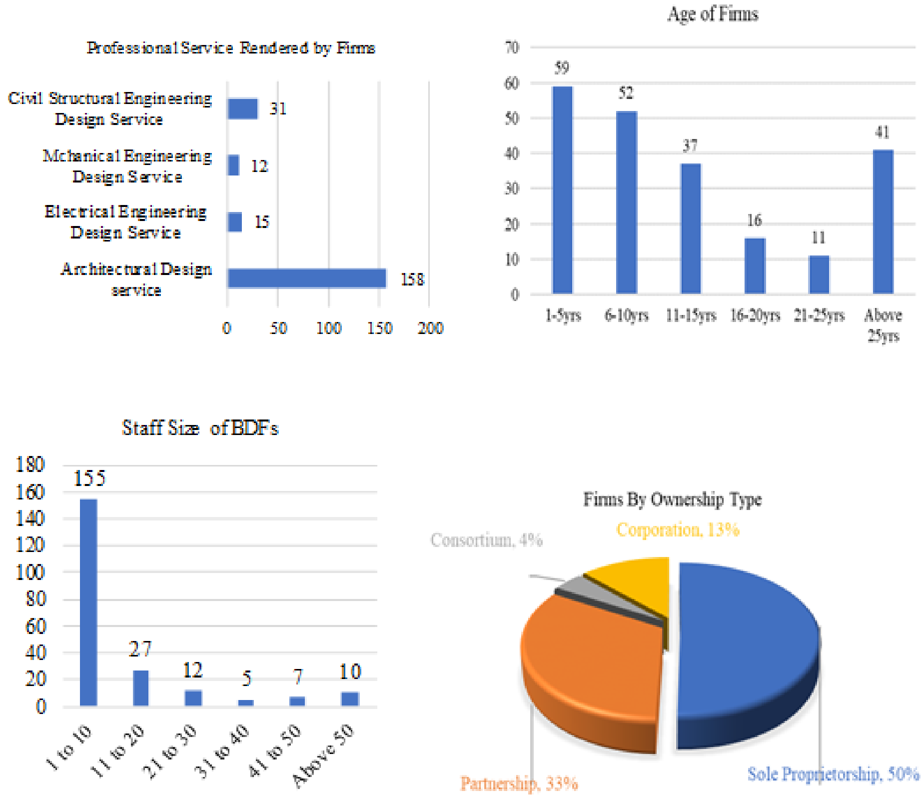

Figure 1. Distribution of firms by demographic characteristics

Benefits of CD Adoption in the NBI

The study evaluated the significance of the advantages of CD adoption in the NBI. Table 2 displays the mean scores and rankings of these benefits, with all of them above 3.50, as suggested by Wuni & Shen, (2022), indicating their importance. BN4, which is "reduction in energy use by efficient utilization through design," was ranked the most significant. Gupta (2019) reported that the implementation of CD could lead to a 64% reduction in energy operating costs in India. Nigeria is currently grappling with an energy crisis. In 2016, the Federal Ministry of Power, Works, and Housing in Nigeria conducted an analysis revealing the construction industry's high energy consumption and the necessity to create energy-efficient structures. Hence, the call for a need for energy-effcient building design strategies as argued by Sholanke et al. (2022). Minunno et al. (2020) pointed out that adopting CD can help achieve savings on operating costs and foster openness to innovative practices in

Australia. Gupta (2019) suggests that passive cooling and heating design approaches can help reduce operating costs and optimise energy consumption. While Akande et al. (2021) argued that the adoption of low-impact materials such as clay, hemp, and compressed stabilised bricks can significantly reduce the energy demand in housing delivery in the NBI. However, they strongly recommended the need for adequate public awareness and societal enlightenment. This would require the involvement of professionals with the necessary technical abilities in energy-efficient design as noted by Akhimien & Latif (2019). The second most significant benefit is the development of new skill sets in circularity by design teams (BN16). van Bueren et al. (2019) discovered that collaborations among design teams, both locally and internationally, can accelerate the development of new design capacities and skills while also contributing to knowledge acquisition, new technologies, and policy formulation. Given the limited CD knowledge among BDFs, they need to acquire new technical expertise in building design that incorporates CE principles. Professional training programmes such as workshops and seminars on circular building design can help BDFs equip their employees with the necessary knowledge for seamless implementation. According to Purchase et al. (2021), governments can play a significant role in organizing professional training in the form of educational workshops, seminars, and formal education in the NBI.

Table 2. Benefits of circular design adoption: Inter-group comparisons

Code	Archi. Firm		Electrical Eng. Firm		Mech. Eng. Firm		Civil/Struct. Eng. Fiirm		Overall			Kruskal-Wallis Test	
	Mean	*Rk*	Mean	*Rk*	Mean	*Rk*	Mean	*Rk*	Mean	*StD*	*Rk*	χ^2	*Sig.*
BN1	3.82	9TH	3.93	16TH	3.58	11TH	3.71	12TH	3.81	.997	9TH	1.080	.782
BN2	3.77	12TH	4.00	8TH	3.67	6TH	3.77	6TH	3.76	.976	12TH	1.597	.660
BN3	3.89	3RD	4.13	5TH	3.50	18TH	3.58	19TH	3.88	.997	4TH	4.471	.215
BN4	3.96	1ST	4.20	3RD	3.58	12TH	3.94	1ST	3.93	.900	1ST	6.455	.091
BN5	3.65	18TH	4.00	9TH	3.58	13TH	3.74	8TH	3.67	1.015	17TH	1.938	.585
BN6	3.84	7TH	3.87	18TH	3.75	1ST	3.71	13TH	3.82	1.030	7TH	.561	.905
BN7	3.85	5TH	4.00	10TH	3.50	19TH	3.71	14TH	3.84	1.013	5TH	1.279	.734
BN8	3.90	2ND	4.27	1ST	3.58	14TH	3.52	20TH	3.89	1.017	3RD	5.368	.147
BN9	3.65	19TH	4.00	11TH	3.58	15TH	3.74	9TH	3.67	1.002	18TH	2.114	.549
BN10	3.77	13TH	3.73	20TH	3.58	16TH	3.81	4TH	3.74	1.006	14TH	.953	.813
BN11	3.80	11TH	3.80	19TH	3.67	7TH	3.68	15TH	3.80	.928	11TH	.252	.969
BN12	3.70	15TH	4.27	2ND	3.67	8TH	3.68	16TH	3.75	.967	13TH	6.074	.108
BN13	3.66	17TH	3.93	17TH	3.58	17TH	3.81	5TH	3.67	1.012	19TH	2.145	.543
BN14	3.62	20TH	4.07	6TH	3.67	9TH	3.84	3RD	3.65	.962	20TH	3.096	.377
BN15	3.83	8TH	4.07	7TH	3.75	2ND	3.74	10TH	3.81	.974	10TH	1.818	.611
BN16	3.81	10TH	4.00	12TH	3.67	10TH	3.65	18TH	3.90	.957	2ND	1.371	.712
BN17	3.88	4TH	4.20	4TH	3.75	3RD	3.77	7TH	3.68	1.050	16TH	2.371	.499
BN18	3.68	16TH	4.00	13TH	3.50	20TH	3.87	2ND	3.84	.937	6TH	1.909	.592
BN19	3.85	6TH	4.00	14TH	3.75	4TH	3.68	17TH	3.74	.964	15TH	.713	.870
BN20	3.72	14TH	4.00	15TH	3.75	5TH	3.74	11TH	3.82	.918	8TH	1.222	.748

*Archi – Architectural; Eng. – Engineering; Struct. – Structural; Rk – Rank; StD – Standard Deviation; χ^2- Chi Square Value; Sig. – *p*-value

The third most significant benefit, as ranked by BDFs, was the "reduction in pollution through reduced burning of fossil fuel" (BN8). Minunno et al. (2020) stated that designing structures for disassembly and component reuse can reduce the global warming potential, GHG by 88%, waste to landfill, and eutrophication and acidification potential of the environment. This approach can also save the potential depletion of the ozone layer and abiotic by 5% and 23%, respectively. The fourth most significant benefit, as identified by BDFs, is the "reduction of construction/demolition waste generation" (BN3). Aboginije et al. (2021) indicated that waste management approaches utilized in Nigerian construction projects, specifically at the design phase are still not sustainable. Akanbi et al. (2018) and Olanrewaju and Ogunmakinde (2020) emphasized that the implementation of CD can help minimize the generation of construction and demolition waste. Purchase et al. (2021) noted that reusing construction waste onsite and reducing the amount of waste transported to landfills can lower carbon emissions. This will assist the NBI to move towards decarbonisation and clean production processes. The fifth most significant benefit of CD adoption in the NBI, as ranked by BDFs, is "improving public health by preserving local biodiversity" (BN7). According to Gupta (2019), implementing CD in public infrastructure developed to provide waste services, sanitation, and water can support material cycles and active urban nutrients that enhance public health. According to Guerra & Leite (2021) and Purchase et al. (2021), the implementation of CD can provide protection against uncontrollable material price escalation risks in the supply chain, ensure resource sufficiency, improve public health and well-being, and create employment opportunities.

Other benefits identified in the study are also of advantage to the NBI. Even though Nigeria has not yet established regulations and financial incentives that specifically promote CE in the building sector, BDFs in the country are still conscious of the environment. They have shown interest in protecting the environment amid the ongoing global campaign for preserving and conserving natural resources, waste management, pollution control, and reduction of carbon emissions. Tirado et al. (2022) highlighted that the environmental opportunities associated with CE can lead to the creation of local jobs and boost the economy. Guerra & Leite (2021) added that the transition to the circular building sector can also bring various environmental benefits, such as stakeholder engagement through public-private partnerships on case projects, policy amendments in national building codes and regulations, and voluntary stewardship for building circularity. Tirado et al. (2022) stated that the environmental opportunities associated with CE can lead to the creation of local employment and economic growth. This will be favourable to the umemployment level estimated at above 40% at the same time creating stability in the local economy in Nigeria. Similarly, the implementation of CD can enhance the competitiveness of BDFs in the built environment (Adams et al., 2017) and promote risk management as a corporate social responsibility by reducing practices that lead to environmental pollution (Laurea & Rivato, 2020)

İt can be deduced from the outcome of this study that environmental and technical benefits are the most significant to CD adoption in the NBI. This finding is consistent with previous research conducted by Guerra & Leite (2021) in the US, Gupta (2019) in India, Tirado et al. (2022) in France, among others. Gupta (2019) and Tirado et al. (2022) identified environmental opportunities as being the most significant in the building sector in France and India, respectively, due to the need to reduce the ecological footprint in the areas of sustainability and resilience. The consistency in findings could be as a result of the fact that the issues of climate change as a consequence of over exploitation of environmental resources has become top among the current global debates. Similarly, this may be because many BDFs view CD primarily from the perspective of efficient resource utilization, the 3R principle (reduce, reuse, and recycle), and sustainability. However, there is not much focus on environmental conservation in the design by BDFs in the NBI, as environmental impact assessments are rarely conducted for such designs. Architects and engineers should receive training that emphasizes environmental protection and awareness of climate change mitigation on a global scale (Ezema & Maha, 2022). However, the results of this study are not consistent with some previous research, such as Torgautov et al. (2021) in the construction sector in Kazakhstan. This study identified economic benefits as being the most significant due to the financial savings achieved through the reuse or recycling of construction materials, which serves as the primary motivation for stakeholders. The difference in findings could be attributed to the scope of the present study and previous studies. The current research focused on CD adoption at the level of BDFs, whose professional ethics prioritize resource security and responsibility toward delivering a healthy environment. Adopting CD can result in economic benefits, such as promoting eco-innovation in the building sector, creating a market for reused components, mitigating price volatility, reducing the cost of operation and maintenance, minimizing construction time, and addressing resource scarcity (Minunno et al., 2020). The NBI has been challenged with the investment cost in building development as well as the concerns boardering on foreign exchange rate associated with the importation market. Research has shown that there are significant opportunities for adopting CD (Minunno et al., 2020) in developing economies in Africa (Dabaieh et al., 2021), particularly in Nigeria (Ogunmakinde, 2019), as the innovation is relatively new in the region. The significance of circular industrial activities in bringing about sustainable development in Nigeria was stressed by Ogunsanwo & Ayo-Balogun (2020). The studies asserted that promoting the reuse and recycling of resources has become essential, specifically in the NBI. Onogwu (2014) acknowledged the significance of certain essential incentives, including robust institutions, government funding and interventions, and the adoption of circular programmes, in the implementation of CE in Nigeria. The practical implication of these findings is that BDFs must take on an effective leadership role in promoting CD awareness and its associated benefits among stakeholders throughout the value chain. To achieve the environmental goals of CD, BDFs should foster technical skills in CD via knowledge sharing and exchange, as well as invest in GreenBIM. To better respond to environmental challenges, design optimisation software should be integrated into design workflows and processes to enable the early assessment and evaluation of design options. These findings can help BDFs develop guidelines and tools for designing that facilitate the implementation of CD more easily.

Conclusion

CE has been a prevalent topic of discussion in the built environment globally, but the adoption of CE varies between countries due to their unique geographical and economic circumstances and the associated benefits. This study examined the benefits of CD adoption in the NBI, from the perspective of BDFs, using empirical evidence. The results of this study suggest that environmental and technical benefits are more significant to CD adoption in the NBI, while organisational benefits are less significant. These findings highlight the importance of debating the relative benefits of CD adoption in the NBI. BDFs should incorporate circular design thinking into design workflows and processes to manage and allocate resources in building developments. To operate in the new circular building procurement system, BDFs should employ circular project management approaches and stages that differ from conventional project management systems, based on circular business models. Additionally, it was suggested that BDFs adopt new methods of design, materials, and components sourcing by implementing design for availability. To achieve this, a new technical and technological infrastructure needs to be established. BDFs should create an assessment mechanism to evaluate affordability and stakeholders' willingness to invest in circular building projects. Additionally, there is a need for increased awareness and adoption of BIM among BDFs because it can significantly contribute to CD output through material passport and digital tracking throughout the building lifecycle.

Recommendations

According to the results of this study, BDFs should invest in developing CD technical expertise through training, continuous professional development programmes, and workshops. Moreover, they should raise awareness by collaborating with other firms and stakeholders, government making concerted efforts in launching voluntary stewardships, and providing necessary technologies to facilitate CD implementation in building developments. The government should create CE policies to facilitate a top-down approach and provide incentives and awards to encourage bottom-up CD adoption. Additionally, the government should take the lead by investing in case/pilot projects for future developments. To promote resource optimisation and other environmentally-friendly solutions, sustainability and circularity should be included in the curriculla of architecture and engineering courses at higher institutions of learning. additionally, if strategic actions are put in place, government policies and regulations could also drive the systemic shift.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the authors.

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