The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/1726-0531.htm

Drivers for the implementation of circular economy in the Nigerian AECO industry: a structural equation modelling approach

Abdulkabir Opeyemi Bello and Rasheed Babatunde Isa
Department of Building, Federal University of Technology, Minna, Nigeria
Oladayo Popoola Afolabi
Department of Architectural Engineering and Construction Management, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia
Suhaib Arogundade
School of Built Environment, Engineering and Computing, Leeds Beckett University, Leeds, UK, and
Ayaz Ahmad Khan
University of South Australia, UniSA Creative, IVE, Adelaide, Australia and Australian Centre for Interactive and Virtual Environments, Adelaide, Australia

Received 27 September 2023
Revised 1 November 2023
Accepted 27 November 2023

Abstract

Purpose – This study aims to investigate the drivers influencing the implementation of circular economy principles in the Nigerian architecture, engineering, construction and operation (AECO) industry across diverse regions of Nigeria.

Design/methodology/approach – A quantitative research approach was adopted, using a structured questionnaire distributed to AECO professionals across four selected regions (North Central, North West, South-South and South West) in Nigeria. The data were analysed using Kruskal–Wallis test and structural equation modelling (SEM).

Findings – The study findings show a robust consensus of opinions among the respondents across regions and professions. The SEM analysis establishes the significant influence of the hypothesized drivers, regulatory and institutional, supply chain collaboration, technological advancements, organizational support and business strategies on the successful implementation of circular economy principles in the Nigerian AECO industry.

Research limitations/implications – The study is limited to specific regions and professions within Nigeria. Further limitation is the quantitative orientation of this study, which collects data using only a questionnaire.

Practical implications – The findings imply that stakeholders can adopt a unified approach to promote circular economy principles in the AECO industry. By recognizing the common understanding of circular economy drivers, collaborative efforts can be streamlined to advance sustainability, resource efficiency and circularity in the industry.

Originality/value – This study contributes to the nascent field of circular economy implementation in the Nigerian AECO industry. It offers a unique perspective by exploring variations in stakeholder opinions, providing insights into the nuanced understanding of circular economy drivers.

Keywords Circular economy, Developing countries, Drivers, Sustainable development, AECO industry, Government policies

Paper type Research paper

Journal of Engineering, Design and Technology
© Emerald Publishing Limited
1726-0531
DOI 10.1108/JEDT-09-2023-0434

Introduction

The architecture, engineering, construction and operation (AECO) industry is recognized as a cornerstone of economic growth and development. It also wields a significant environmental footprint marked by excessive resource consumption and waste generation (Ajayi and Oyedele, 2018). The AECO industry has historically been characterized by its linear consumption patterns, accounting for 40% of the global energy consumption and greenhouse gas emissions (UNEP, 2021). Additionally, the industry contributes significantly to global waste generation, with approximately one-third generated from construction and demolition waste (Menegaki and Damigos, 2018). The circular economy (CE) provides a transformative strategy to reduce these environmental impacts, aligning with the UN Sustainable Development Goals (Urain *et al.*, 2022).

The global pursuit of sustainability has led to the emergence of the circular economy principles, which presents an alternative to the linear "take-make-dispose" economic model (Pomponi and Moncaster, 2017). The AECO industry's traditional linear production and consumption patterns are increasingly acknowledged as unsustainable, prompting a global shift towards a circular economy paradigm (Munaro *et al.*, 2020). Circular economy principles emphasize the regeneration of resources, reduction of waste and maximization of value retention throughout the product lifecycle (Ellen MacArthur Foundation, 2015). As industries globally seek to address the pressing challenges of resource scarcity, environmental degradation and climate change, the AECO industry stands out as a critical focus area due to its substantial resource consumption and waste generation (Liu *et al.*, 2021).

In the AECO industry, implementing circular economy principles offers multifaceted benefits, ranging from reduced resource depletion to curbing greenhouse gas emissions and minimizing waste (Gonz'alez *et al.*, 2021). Given the benefits, several countries are promoting the implementation of a circular economy in the construction industry, including Denmark, Japan, Hong Kong, the UK, Australia, Germany and Switzerland (García-Quevedo *et al.*, 2020; Kirchherr *et al.*, 2018).

The development of circular economy principles in the AECO industry is motivated by resource scarcity (Ghisellini *et al.*, 2016), waste reduction imperatives (Tura *et al.*, 2019), regulation and policies (Munaro *et al.*, 2020), cost savings through material reuse (Ghisellini *et al.*, 2018), climate change mitigation (Wuni and Shen, 2022), social responsibility (Oyinlola *et al.*, 2018), technological innovation and stakeholder demand (Giorgi *et al.*, 2022) and alignment with the sustainable development goals.

Developing countries, which often exhibit rapid urbanization and industrialization, confront unique challenges and opportunities in their pursuit of circularity (Bello *et al.*, 2023a; Oluleye *et al.*, 2022). The construction industry in these economies, characterized by exponential growth and substantial infrastructure demands, is central to the discourse on circularity (Torgautov *et al.*, 2021). While these nations contribute significantly to global resource consumption, they face heightened vulnerabilities due to limited resource availability and waste management infrastructure (Bello *et al.*, 2023b).

Nigeria, a major African economy and a rapidly urbanizing economy, exemplifies the complexities of implementing circular economy practices in a developing country. The Nigerian AECO industry has experienced remarkable growth due to population expansion, urban migration and infrastructural demands (Aboginije *et al.*, 2021). However, this growth has been accompanied by inefficient resource use, inadequate waste management and environmental degradation (Ojo *et al.*, 2021). The Nigerian Government has recognized the need for sustainable development and circular economy implementation, as evidenced by the Nigeria Circular Economy Working Group (NCEWG). The NCEWG framework promotes sustainable production and consumption patterns within the AECO industry.

However, the knowledge of circular economy principles is limited among professionals in developing countries, contributing to the slower transitioning and implementation of this sustainable and efficient approach. Moreover, while studies on circular economy implementation in developed countries are apparent (Giorgi *et al.*, 2022), there is a paucity of research that examines the factors that influence the implementation of circular economy in the African built environment industry (Mhlanga *et al.*, 2022). Idris and Bello (2023) further substantiated the prevalence of limited knowledge of the circular economy among Nigerian AECO professionals. These challenges necessitate the need to examine the drivers that could influence circular economy implementation in Nigeria.

Aslam *et al.* (2020), Paiho *et al.* (2020) and Mahpour (2018) demonstrated how government can drive and support circular economy implementation, while Hina *et al.* (2022) showed how technological application can drive the implementation of circular economy. Similarly, factors such as adequate research and development and financial system have been noted to drive the implementation of circular economy (Wuni, 2023; Adabre *et al.*, 2022; Agyemang *et al.*, 2019; Hart *et al.*, 2019; Adams *et al.*, 2017).

This study aims to bridge these gaps by using a structural equation modelling (SEM) approach to elucidate the impact and relationship between key drivers of circular economy implementation in the Nigerian AECO industry. As a robust statistical technique, SEM enables the assessment of direct and indirect relationships among various factors, thereby providing clarity on the complex interplay of variables (Hair *et al.*, 2019). The study introduction provides an overview of the study, while subsequent sections provide insights into the principles and drivers of circular economy, adopted methodological approach, presentation and discussion of results and conclusion of the study.

Review of related literature

This chapter provides an exploration of the principles and drivers underpinning the circular economy. The chapter underscores how the implementation of CE principles can lead to environmental protection, economic development and the creation of new business opportunities. The diverse range of drivers is presented in Table 1, showing a comprehensive overview of the multifaceted factors that contribute to the successful implementation of CE practices in the construction industry.

Principles of circular economy

Circular economy principles have gained significant attention in recent years as a sustainable approach to resource management and environmental conservation. The principles of a circular economy are centred around minimizing waste and maximizing the value of resources by promoting reuse, recycling and regeneration. The CE concepts are summarized in the 10Rs, which are as follows: R0 Refuse, R1 Rethink, R2 Reduce, R3 Reuse, R4 Repair, R5 Refurbish, R6 Remanufacture, R7 Repurpose, R8 Recover and R9 Recycle (Peiro *et al.*, 2020; Vermeulen *et al.*, 2019).

According to Geissdoerfer *et al.* (2017), the core principles of a circular economy include designing out waste and pollution, keeping products and materials in use and regenerating natural systems. This holistic approach emphasizes the importance of product design that enables easy disassembly and recycling, reducing the environmental impact of production processes. The work of Stahel (2016) highlights the significance of extending the lifespan of products through repair, refurbishment and remanufacturing, thereby reducing the need for continuous extraction of raw materials. Furthermore, the principles of a circular economy

Code	Category	Drivers	References
RIDR1	Regulatory and Institutional	Availability of government-level action circular vision and goals	Aslam *et al.* (2020)
RIDR2		Increasing landfill regulations and taxes	Bilal *et al.* (2020)
RIDR3		Penalties for non-compliance	Wuni (2023)
RIDR4		Tax increment on the usage of raw materials	Paiho *et al.* (2020)
RIDR5		Increased CE requirement in public procurement	Mahpour (2018)
RIDR6		Reward for CE requirements compliance	Ghisellini *et al.* (2018)
RIDR7		Availability of effective legal and regulatory framework	Witjes and Lozano (2016)
SCDR1	Supply chain	A collaborative culture within the supply chain network	Urbinati *et al.* (2021)
SCDR2		Market demand for circular materials, products and services	Burke *et al.* (2021)
SCDR3		Long-term relationships, collaboration and partnerships with supply	Kazancoglu *et al.* (2020)
SCDR4		Market-based incentives for circular construction supply chain	Tura *et al.* (2019)
SCDR5		Trust environment and information sharing between stakeholders	Wuni (2023)
SCDR6		Development of reverse logistics infrastructure and network	Agyemang *et al.* (2019)
SCDR7		Supply chain integration	Hina *et al.* (2022)
SCDR8		Supportive circular supply chain culture	Sousa-Zomer *et al.* (2018) Bilal *et al.* (2020)
TDR1	Technological	Availability of effective technological infrastructure and equipment	Wuni (2023)
TDR2		Incentive design for adaptability and disassembly using design tools	Hina *et al.* (2022)
TDR3		Technological innovations to enable closed loops in material flows	Aslam *et al.* (2020)
TDR4		Availability of tools for the assessment of building circularity	Chang and Hsieh (2019)
TDR5		Availability of technical solutions	Hart *et al.* (2019)
TDR6		Efficient information system to track materials in recycling supply chain drivers	Giorgi *et al.* (2022)
TDR7		Availability of effective and reliable ICT solutions	Ghisellini *et al.* (2018)
ODR1	Organizational	Research and development	Hart *et al.* (2019)
ODR2		Design for circular business models	Wuni (2023)
ODR3		Top management support	Adams *et al.* (2017)
ODR4		Good leadership	Kirchherr *et al.* (2018)
ODR5		Good organizational infrastructure	Konietzko *et al.* (2020)
ODR6		Alignment of CE with organizational vision, goals and strategies	Nogueira *et al.* (2020)
ODR7		Collaboration between organizational departments	Govindan and Hasanagic (2018)
BDR1	Business	Good market strategy	Hina *et al.* (2022)
BDR2		Green financial innovation	Wuni (2023)

(*continued*)

Table 1.
Drivers for the implementation of circular economy

Code	Category	Drivers	References
BDR3		Stability in business operations	Bilal *et al.* (2020), Adabre *et al.* (2022)
BDR4		Minimizing business reliance on virgin raw materials	Tura *et al.* (2019)
BDR5		Promotion of service-oriented business models	Wuni (2023)
BDR6		New revenue generation path	Tura *et al.* (2019)
BDR7		Cost reduction and savings	Wuni (2023)
BDR8		Clear business case and benefits of CE	Wuni (2023)
EVD1	Environmental	Efficient resource and management	Wuni (2023)
EVD2		Reduce the environmental footprint of organizations	Giorgi *et al.* (2022)
EVD3		Waste reduction	Bilal *et al.* (2020)
EVD4		Environmental protection	Smol *et al.* (2021)
EVD5		Energy savings	Ghisellini *et al.* (2018)
SO1	Social	Creation of employments	Tura *et al.* (2019)
SO2		Public health and wellness concerns	Wuni (2023)
SO3		Global pressure	Tura *et al.* (2019)
SO4		Awareness of CE	Patwa *et al.* (2020)
SO5		Cultural change among stakeholders	Wuni (2023)
ECO1	Economic	Development of new business	John *et al.* (2023)
ECO2		Increase long-term revenue generation	Wuni (2023)
ECO3			Giorgi *et al.* (2022)
		Material circularity marketplace	Smol *et al.* (2021)
ECO4		Recycling incentive programmes	Ilić and Nikolić (2016)
ECO5		Maximize data economy	Ghisellini *et al.* (2018)

Source: Authors' compilation

Table 1.

advocate for the use of renewable energy sources and the adoption of sustainable production practices to minimize the environmental footprint of industrial processes (Urain *et al.*, 2022).

By implementing these principles, companies can transition from the traditional linear model of "take, make, dispose" to a more sustainable and regenerative approach. This shift not only reduces the strain on natural resources but also promotes energy efficiency and fosters the development of a more resilient and environmentally friendly economy. As argued by Bocken *et al.* (2016), the adoption of circular economy principles can lead to increased resource productivity, cost savings through reduced material inputs and the creation of new business opportunities based on the development of innovative and sustainable products and services. Additionally, a circular economy can contribute to the mitigation of climate change by minimizing greenhouse gas emissions and reducing the overall environmental impact of industrial activities (Urain *et al.*, 2022). To conclude, the principles of the circular economy offer a comprehensive framework for achieving sustainable development goals while fostering economic growth and environmental stewardship.

Drivers of circular economy implementation in the architecture, engineering, construction and operation industry

In achieving a sustainable future, implementing circular economy practices is paramount, and regulatory and institutional drivers stand at the forefront of propelling this transformation. A comprehensive literature review shows that the availability of government-level action, circular vision and well-defined goals is pivotal in setting the stage for circular economy implementation. Aslam *et al.* (2020), Bilal *et al.* (2020) and Wuni (2023) emphasize that when governments take the lead by establishing clear circular economy objectives and strategies, it acts as a powerful impetus for businesses, industries and communities to align their operations and behaviours with circular principles. Paiho *et al.* (2020) and Mahpour (2018) underscore the significant impact of increasingly stringent landfill regulations and taxes on fostering circularity.

As elucidated in the work of Urbinati *et al.* (2021), Burke *et al.* (2021) and Kazancoglu *et al.* (2020), collaborative culture within the supply chain network stands out as a core driver which encourages knowledge exchange, innovation and the establishment of sustainable practices across the supply chain, paving the way for circularity.

Wuni (2023), Hina *et al.* (2022) and Aslam *et al.* (2020) emphasize the availability of adequate technology to drive the rapid and successful implementation of circular economy in the AECO industry. Moreover, adequate technological solutions streamline the monitoring and management of circular processes, promoting transparency and traceability (Giorgi *et al.*, 2022). Critical organizational-related drivers such as research and development, design for a circular business model and good organizational structure have been reported by extant literature, such as Wuni (2023), Konietzko *et al.* (2020) and Nogueira *et al.* (2020).

Effective business strategies are pivotal in adopting circular economy principles, aligning economic goals with sustainable practices. A good business strategy serves as a fundamental driver (Tura *et al.*, 2019; Hina *et al.*, 2022; Bilal *et al.*, 2020). This approach involves understanding and responding to market demands for environmentally responsible products and services, which fosters sustainability and positions businesses favourably in today's eco-conscious consumer landscape. The environmental drivers underscore efficient resource management, reduced environmental footprints and energy savings, as highlighted by Wuni (2023) and Giorgi *et al.* (2022). While social related drivers emphasize the creation of employment opportunities, public health concerns and cultural change, as discussed by Tura *et al.* (2019) and Patwa *et al.* (2020). Economic related drivers stress the development of new businesses, long-term revenue generation and the maximization of the data economy (John *et al.*, 2023; Giorgi *et al.*, 2022). The summary of the categorized drivers is presented in Table 1.

Research methodology

In conducting this research, a quantitative approach was adopted to systematically examine and quantify the relationships and drivers pertinent to implementing circular economy principles among selected AECO professionals in Nigeria. This technique allows for the precise measurement and analysis of attitudes, perceptions and factors influencing the circular economy adoption in this specific context (Saunders *et al.*, 2016).

The study's target population consists of selected AECO professionals, namely, architects, builders, civil engineers and quantity surveyors, operating in selected regions across Nigeria, namely, the North Central, North West, South-South and South West regions. These regions were chosen to ensure geographical diversity and representation of the Nigerian context, which is crucial for obtaining a comprehensive understanding of circular economy implementation in the Nigerian AECO industry. The professionals' categories were selected based on their leading roles and direct involvements in AECO activities in the Nigerian AECO industry. The other two regions (North East and South East) were excluded from the study due to the high insecurity rate, which has hampered the economic developments in the regions.

A snowball sampling technique was adopted to collect data from the population. This technique was chosen for its effectiveness in reaching professionals in a specific field and for generating a sample that reflects the diversity of the population (Bryman, 2016). The initial questionnaire was pilot tested to ensure wider respondents will not have difficulties in filling the questionnaire and also to exclude drivers that might be similar or have same meaning. Participants consented to participate in the study while their confidentiality and privacy are protected as research ethics demands. The questionnaire was distributed virtually using Google Forms. At the end of the survey, total of 208 valid responses were received and subsequently considered for the study. This sample size was considered adequate based on related studies in Nigeria that have used a similar sample size (Idris and Bello, 2023; Olanrewaju *et al.*, 2022).

Data collection was facilitated through a well-structured questionnaire. The questionnaire was designed to elicit responses related to the perceptions, attitudes and practices of AECO professionals regarding circular economy principles. A questionnaire survey was adopted because it is cost-effective and easy to reach wider respondents to participate in the study. Respondents were asked to rate their responses using a five-point Likert scale, a common approach for assessing levels of agreement or disagreement (Dawson, 2013). Subsequently, the data was subjected to a rigourous analytical process. To identify potential variations in responses across different regions and professions, the Kruskal–Wallis test, a non-parametric statistical test, was used. The non-parametric approach was chosen due to the ordinal nature of the collected data, ensuring the validity of the analysis within the context of the study. This test helps compare multiple groups and determine whether observed differences are statistically significant (Field, 2013).

Additionally, Smart partial least squares-structural equation modelling (PLS-SEM) version 4 was used to delve deeper into the complex relationships and dependencies within the data set. SEM is a robust and comprehensive statistical technique that allows for a more intricate analysis of the structural relationships between variables (Hair *et al.*, 2019).

By using these rigourous quantitative research methods, this study aimed to provide a detailed, data-driven analysis of the circular economy adoption among AECO professionals in Nigeria.

This study further develops eight hypotheses and a conceptual framework shown in Figure 1:

H1. Business drivers significantly influence the implementation of circular economy principles in the Nigeria AECO industry.

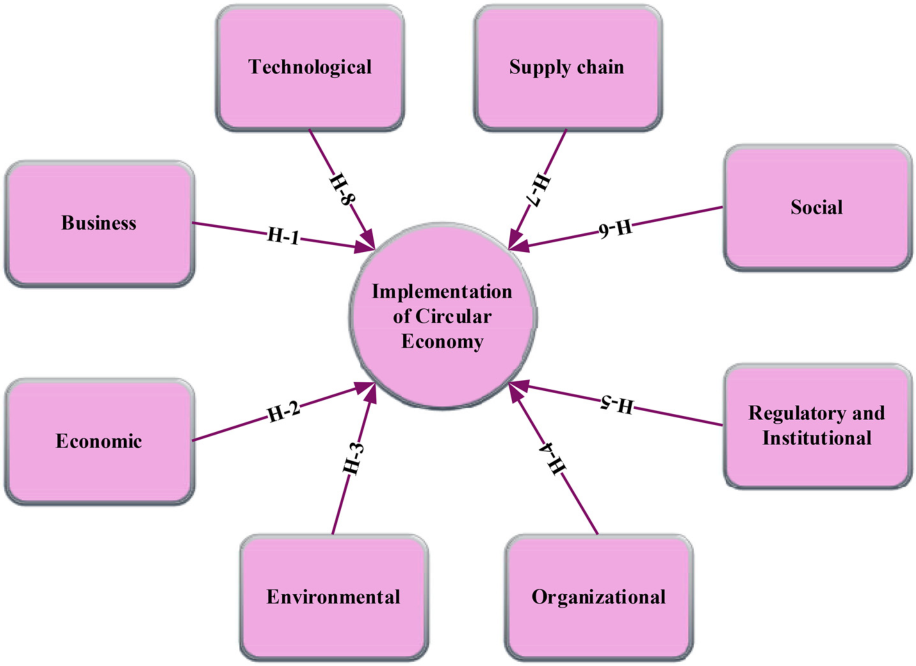
H2. Economic drivers significantly influence the implementation of circular economy principles in the Nigeria AECO industry.

H3. Environmental drivers significantly influence the implementation of circular economy principles in the Nigeria AECO industry.

H4. Organizational drivers significantly influence the implementation of circular economy principles in the Nigeria AECO industry.

H5. Regulatory and institutional drivers significantly influence the implementation of circular economy principles in the Nigeria AECO industry.

H6. Social drivers significantly influence the implementation of circular economy principles in the Nigeria AECO industry.



Source: Authors' concept

Figure 1. Conceptual framework

H7. Supply chain drivers significantly influence the implementation of circular economy principles in the Nigeria AECO industry.

H8. Technological drivers significantly influence the implementation of circular economy principles in the Nigeria AECO industry.

Results

Respondents information

The result provides an overview of the characteristics of the respondents (208) in the study representing AECO professionals in the Nigerian AECO industry. Engineers dominate the professional distribution, comprising 45.19% of the sample, highlighting their significant role in implementing circular economy principles. Architects, builders and quantity surveyors account for 16.35%, 25% and 13.46%, respectively, contributing adequately to the profession diversity. The majority hold bachelor's degrees (63.46%) as their highest academic qualification, 30.29% hold master's degrees and 6.25% hold doctorate degrees. Respondents with 11–20 years of working experience account for (46.15%), 0–5 years (14.9%), 6–10 years (30.29%) and 20 years above (8.65%). The regional distribution reveals the South West as the most represented region (42.79%), followed by the North Central (29.33%), North West (15.38%) and South-South (12.5%). Notably, most professionals work in small firms (10–49 employees) (70.19%), emphasizing the significance of smaller enterprises in the AECO industry, medium firms (50–249 employees) (20.67%) and large firms (250 employees above) (9.13%). Respondents were asked about the nature of construction works they engaged into between civil works such as roads and bridges, building constructions or combination of both. In total, 42.79% engaged in a combination of civil and building works, while 34.61% and 22.60% only work on building works and civil works, respectively.

Measurement model

A measurement model is a fundamental component of SEM used to assess the relationships between observed indicators (variables) and their underlying latent constructs. According to Hair *et al.* (2006), the validity of the measurement model is assessed based on its ability to demonstrate both convergent and discriminant validity.

Convergent validity is a critical aspect of measurement validation in SEM and assesses whether different indicators measuring the same latent construct converge (Hulland, 1999). High convergent validity indicates that multiple indicators effectively capture the same underlying concept. Convergent validity is examined using Cronbach alpha (α), composite reliability (ρc) and average variance extracted (AVE) (Fornell and Larcker, 1981).

Table 2 comprehensively assesses convergent validity for each identified cluster within the study. The high alpha (>0.70) coefficients indicate strong internal consistency within each construct, while the substantial composite reliability values emphasize the reliability of the measurement model. Furthermore, the AVE values, all surpassing the 0.5 threshold, established that a substantial portion of the variance in the indicators is attributed to their respective constructs.

Multicollinearity was assessed using the variance inflation factor (VIF) test. The VIF values for each construct were all below the acceptable threshold of 3.3, as recommended by Kock (2015). This suggests that common method bias is not present in the data. Consequently, the findings in Table 2 substantiate the absence of multicollinearity issues in the data. These robust measures collectively affirm the convergent validity of the measurement instruments for each essential domain, providing a solid foundation for subsequent structural analyses within the study.

Figures 2 and 3 show the initial and final loading measurements. According to Hair *et al.* (2017), a load value of 0.700 is considered adequate. However, if the study is exploratory then a value of 0.4 higher is adequate (Hulland, 1999). Hence, this study set a minimum benchmark of 0.6 load factor. Figure 2 shows 52 initial loaded items, while 34 items were later determined to have a load factor above 0.6 after loading three times as shown in Figure 3.

Components	α	ρc	AVE	VIF
Business	0.921	0.936	0.648	3.004
Economic	0.860	0.910	0.771	1.889
Environmental	0.851	0.910	0.770	3.075
Organizational	0.885	0.918	0.693	2.593
Regulatory and Institutional	0.783	0.824	0.547	1.392
Social	0.917	0.938	0.792	1.835
Supply chain	0.989	0.936	0.833	1.375
Technological	0.814	0.915	0.843	1.929

Notes: α = Cronbach's alpha; ρc = composite reliability; AVE = average variance extracted; VIF = variance inflation factor
Source: Authors' data analysis

Table 2.
Convergent validity

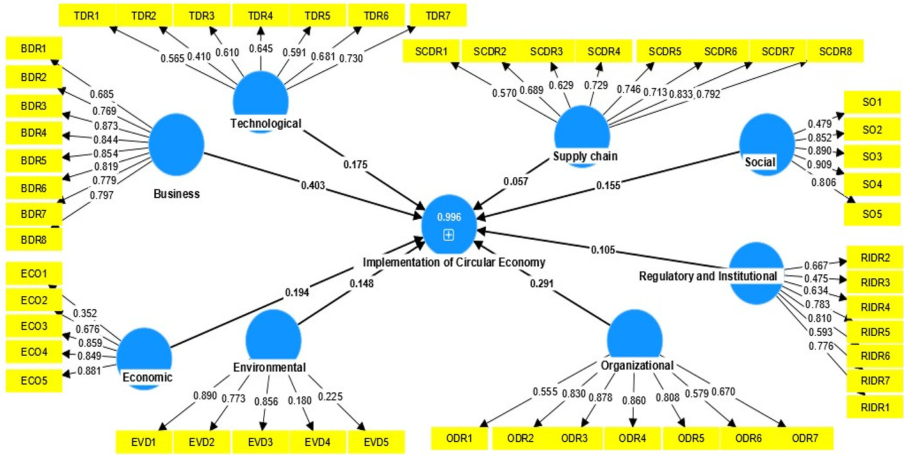


Figure 2.
Initial loading

Source: Authors' data analysis

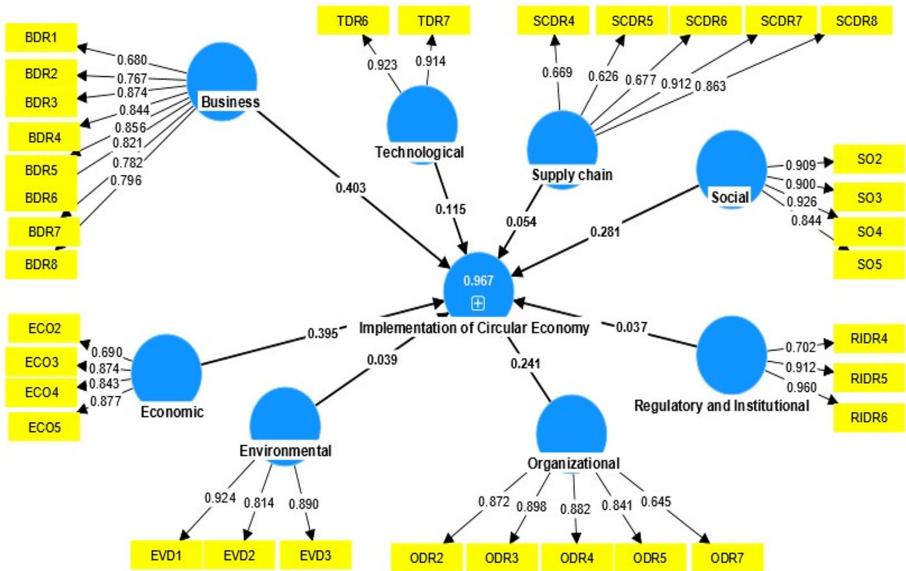


Figure 3.
Final loading

Source: Authors' data analysis

Discriminant validity aims to confirm that the measurement instruments effectively capture unique and separate concepts. To establish discriminant validity, examining the correlations (Fornell-Larcker) between constructs and ensuring that they are lower than the square root of the AVE for each construct is pertinent. When correlations are lower than the AVEs, it indicates that the constructs are distinct and do not measure the same underlying concept, reinforcing the validity of the measurement model.

The discriminant validity in this study was evaluated using the hetrotrait-monotrait ratio (HTMT) and the Fornell-Larcker criterion. Table 3 shows the results of the Fornell-Larcker criterion, which examines the relationship between the square root of AVE and the correlation between constructs. The correlation results indicate that the square root of AVE surpasses the inter-construct correlation for all the constructs. According to Kock (2015) if the square root of the AVE is greater than the correlation then the model discriminant validity is adequate. Table 3 also summarizes the HTMT analysis, which reveals that all the constructs have correlations that fall below the recommended threshold of 0.900, as suggested by Gold *et al.* (2001) and Henseler *et al.* (2015).

Path analysis (bootstrapping) and cross-validated predictive ability test

Path bootstrapping is a resampling technique commonly used in SEM to assess the significance and robustness of path coefficients in a model (Hair *et al.*, 2021; Kline, 2023). Examining path bootstrapping, the statistical significance of path coefficients, calculating confidence intervals (CIs) and assessing the model stability and reliability can be determined, enabling adequate hypotheses testing. In examining the validity of the hypotheses, the bootstrapping technique was applied by randomly resampling the original data set to create 5,000 new samples at a 95% CI, a commonly used maximum number of random samples. The standardized path coefficients (β) and p-values are shown in Table 4, indicating that all the hypotheses are significant.

Predictive evaluation is crucial as it enables researchers to determine whether their proposed model can outperform a naive baseline, a core predictive validity component (Sharma *et al.*, 2019; Shmueli and Koppius, 2011).

Prediction-oriented tools for PLS-SEM have been introduced to aid in these assessments, including $\text{PLS}_{\text{predict}}$ (Shmueli *et al.*, 2016) and $\text{CVPAT}_{\text{compareoverall}}$ (Liengaard *et al.*, 2021). Before conducting a cross-validated predictive ability test (CVPAT) analysis, it is essential to note that both alternative models meet the necessary measurement and structural evaluation criteria (Hair *et al.*, 2019). The evaluation of these models indicates that they meet the required benchmark (Hair *et al.*, 2022). For the models to possess predictive validity, their average loss must be significantly lower (higher predictive accuracy) than the benchmark of naïve indicator averages. If this is not the case, the models should be discarded (Shmueli *et al.*, 2016). Table 4 shows strong predictive validity (average loss difference $= -0.382$, $t = 19.194$, $p = 0.000$).

The study's results indicate seven of the eight hypotheses are significant. Firstly, the relationship between business factors and the implementation of the circular economy is strongly established ($\beta = 0.403$, $t = 12.659$, $p = 0.000$). Similarly, economic drivers significantly contribute to circular economy implementation ($\beta = 0.395$, $t = 8.193$, $p = 0.033$). Additionally, the organizational factors also have a substantial impact on the implementation of circular economy principles ($\beta = 0.241$, $t = 9.215$, $p = 0.000$). Furthermore, the environmental drivers show a moderate yet statistically significant influence on circular economy implementation ($\beta = 0.039$, $t = 6.064$, $p = 0.000$). Similarly, regulatory and institutional factors ($\beta = 0.037$, $t = 6.223$, $p = 0.002$), social factors ($\beta = 0.281$, $t = 9.433$, $p = 0.050$), supply chain factors ($\beta = 0.054$, $t = 7.32$, $p = 0.039$) and technological factors ($\beta = 0.115$, $t = 4.987$, $p = 0.067$) all exhibit significant contributions to the implementation of circular economy principles.

Kruskal–Wallis (analysis of variance)

The Kruskal–Wallis test results indicate no statistically significant ($p > 0.05$) variations in opinions across different regions and professions within the Nigerian AECO industry

Table 3. Heterotrait-monotrait ratio and Fornell-Larcker criterion (HTMT)

Category	Business	Economic	Environmental	Organizational	Regulatory and Institutional	Social	Supply chain	Technological
Heterotrait-monotrait ratio (HTMT)								
Business								
Economic	0.724							
Environmental	0.708	0.807						
Organizational	0.758	0.882	0.741					
Regulatory and Institutional	0.742	0.644	0.719	0.715				
Social	0.797	0.708	0.699	0.897	0.819			
Supply chain	0.866	0.835	0.649	0.804	0.849	0.803		
Technological	0.888	0.893	0.532	0.778	0.772	0.744	0.892	
Fornell-Larcker criterion								
Business	0.805							
Economic	0.866	0.878						
Environmental	0.814	0.964	0.878					
Organizational	0.795	0.799	0.768	0.833				
Regulatory and Institutional	0.711	0.912	0.811	0.816	0.740			
Social	0.819	0.944	0.847	0.757	0.813	0.890		
Supply chain	0.846	0.831	0.716	0.808	0.879	0.833	1.000	
Technological	0.799	0.709	0.854	0.767	0.818	0.861	0.902	0.918

Source: Authors' data analysis

Table 4. Bootstrapping and cross-validated predictive ability test

Path	β	SD	t	p	CI 2.50%	CI 97.50%
H1 - Business → Implementation of circular economy	0.403	0.042	12.659	0.000*	0.412	0.576
H2 - Economic → Implementation of circular economy	0.395	0.058	8.193	0.033*	0.115	0.519
H3 - Environmental → Implementation of circular economy	0.039	0.036	6.064	0.000*	0.122	0.565
H4 - Organizational → Implementation of circular economy	0.241	0.033	9.215	0.000*	0.211	0.742
H5 - Regulatory and institutional → Implementation of circular economy	0.037	0.078	6.223	0.002*	0.242	0.629
H6 - Social → Implementation of circular economy	0.281	0.076	9.433	0.016*	0.113	0.531
H7 - Supply chain → Implementation of circular economy	0.054	0.058	7.320	0.039*	0.118	0.401
H8 - Technological → Implementation of circular economy	0.115	0.021	4.987	0.008*	0.182	0.684
Cross-validated predictive ability test (CVPAT)						
				t		p
Implementation of circular economy		−0.382		19.194		0.000*
Overall		−0.382		19.194		0.000*

Notes: β = original sample; SD = standard deviation; t = t statistics; p = p-values; CI = confidence interval; significant at $p < 0.050$*
Source: Authors' data analysis

circular economy hypothesized drivers. This result provides a broad consensus among participants on the significance of these drivers, with no notable distinctions based on geographic regions or professional backgrounds. While some variations may exist, they did not reach statistical significance, implying a shared understanding of the relevance of these drivers in promoting circular economy principles. These results underscore the potential for a unified approach to circular economy in the Nigerian AECO industry, facilitating collaborative efforts among professionals and policymakers to advance sustainability and resource efficiency.

Discussion of results

This study critically examines the drivers towards the implementation of circular economy in the Nigerian AECO industry through the application of SEM to examine the impact and relationship between the drivers. The outcome of this study is consistent with prior research studies (Aslam *et al.*, 2020; Bilal *et al.*, 2020; Wuni, 2023; Paiho *et al.*, 2020; Mahpour, 2018; Ghisellini *et al.*, 2018; Witjes and Lozano, 2016), which has highlighted the importance of government-level actions, regulations, penalties and incentives in promoting circular economy initiatives. This factor underscores the significance of supportive policies, legal frameworks and governmental initiatives in fostering sustainability and circularity within the AECO industry. These drivers can influence business practices, encourage resource efficiency and drive the transition towards circular business models in AECO, aligning with global sustainability goals.

Similarly, the importance of collaborative supply chain practices, market demand for circular materials and the development of reverse logistics networks in advancing circularity was stretched in various studies (Urbinati *et al.*, 2021; Burke *et al.*, 2021; Kazancoglu *et al.*, 2020; Tura *et al.*, 2019). Collaborative cultures, market-based incentives and efficient information sharing within the supply chain can enhance resource efficiency and promote circular business models in AECO. This finding has practical implications for supply chain managers, AECO professionals and policymakers, emphasizing the need for collaborative supply chain practices to drive sustainability and circularity in the AECO industry, contributing to environmental and economic benefits.

Wuni (2023) and Hina *et al.* (2022) accentuate the significance of technological innovation, adequate information systems and technical solutions in increasing circularity. Adequate technological infrastructure and innovative solutions can enhance resource efficiency, promote sustainable materials management and enable the transition towards circular business models. In other studies, research and development, leadership support and cross-departmental collaboration in promoting circularity were demonstrated to promote organizational effort to implement circular economy (Konietzko *et al.*, 2020; Nogueira *et al.*, 2020). Organizational culture, leadership commitment and alignment with circular goals and strategies can foster a conducive environment for circularity and sustainable practices.

This findings of Hina *et al.* (2022), Bilal *et al.* (2020) and Adabre *et al.* (2022) emphasized the importance of market-oriented strategies, financial innovations and cost-saving initiatives in advancing circularity, which is in consistency with this study. Effective market strategies, financial innovation and transparent business cases can drive the adoption of circular business models and practices.

The drivers of environmental implementation are critical for promoting sustainable practices. Studies by Wuni (2023), Giorgi *et al.* (2022), Bilal *et al.* (2020) and Smol *et al.* (2021) underscore the importance of these drivers in minimizing the ecological impact of industrial operations and fostering sustainable resource management. Similarly, the social drivers, such as job creation (Tura *et al.*, 2019), public health concerns (Wuni, 2023), global pressure

(Tura *et al.*, 2019), awareness of circular economy (Patwa *et al.*, 2020) and cultural change among stakeholders (Wuni, 2023), are essential drivers for facilitating community engagement and fostering a more sustainable and inclusive society. Moreover, the economic focus, such as the development of new business models (John *et al.*, 2023; Wuni, 2023; Giorgi *et al.*, 2022; Smol *et al.*, 2021; Ilić and Nikolić, 2016; Ghisellini *et al.*, 2018), increasing long-term revenue generation, promoting material circularity marketplaces, initiating recycling incentive programmes and maximizing the data economy, are crucial for enhancing economic resilience and promoting sustainable growth. These dimensions collectively emphasize the necessity of integrating these drivers to establish a robust framework for implementing circular economy principles in the Nigeria AECO industry.

Conclusion

This study delved into the multifaceted landscape of circular economy implementation in the Nigerian AECO industry. Through rigourous quantitative research and SEM, the impact of eight key drivers was investigated: Business, Economic, Environmental, Organizational, Regulatory and Institutional, Social, Supply Chain and Technological. The findings of this study have illuminated the profound influence of these drivers on the successful implementation of circular economy principles in the Nigerian AECO industry. These insights hold significant implications for various stakeholders, including policymakers, industry practitioners and researchers. Consequently, the study further established that professionals have similar opinions on the drivers for implementing a circular economy irrespective of their profession or region of operation. This implies that the development of strategies or interventions might be universally applicable or accepted across different groups, simplifying the implementation process. This research has comprehensively espoused the interplay between various circular economy drivers and their influence on the Nigerian AECO industry.

Implications for the study

The implications derived from this study encompass practical, theoretical and managerial aspects, offering valuable guidance for various stakeholders in the Nigerian AECO industry. From a practical perspective, the study highlights the urgent need for policymakers to proactively shape and enforce regulatory frameworks that foster circular economy principles. This includes revisiting existing regulations to align them more effectively with circularity goals and providing incentives for sustainable construction practices. The elucidation of these drivers can provide the stakeholders with the requisite information to implement the circular economy in the Nigerian AECO industry. Further, it can provide guidance to policymakers in making informed decisions in the implementation of this novel approach.

This practical collaboration can accelerate the adoption of circular material flows and enhance resource efficiency in the industry. Theoretically, this study contributes to understanding circular economy implementation in the Nigerian AECO industry and enriches the literature by validating the impact of the various drivers. It paves the way for future research to explore the mechanisms behind policy implementation, assess the long-term sustainability implications of circular practices and examine the interactions and potential trade-offs among drivers.

Managerially, the insights generated can encourage AECO professionals and policymakers to strategically integrate circular economy principles into their decision-making processes, ensuring a more sustainable and environmentally responsible construction industry in Nigeria. The implication of this study can be extended to other developing and least developing economies.

Limitations

This study limitations include the exclusive use of a quantitative approach and the limited sample size. These can be effectively addressed in future research by incorporating qualitative methods to gain a more comprehensive understanding of these factors. Additionally, increasing the sample size and diversifying the demographic characteristics of respondents can enhance the generalizability of the findings.

References

Aboginije, A., Aigbavboa, C. and Thwala, W. (2021), "A holistic assessment of construction and demolition waste management in the Nigerian construction projects", *Sustainability*, Vol. 13 No. 11, p. 6241.

Adabre, M.A., Chan, A.P.C., Darko, A. and Hosseini, M.R. (2022), "Facilitating a transition to a circular economy in construction projects: intermediate theoretical models based on the theory of planned behaviour", *Building Research and Information*, Vol. 51 No. 1, pp. 85-104, doi: 10.1080/09613218.2022.2067111.

Adams, K.T., Osmani, M., Thorpe, T. and Thornback, J. (2017), "Circular economy in construction: current awareness, challenges and enablers", *Proceedings of the Institution of Civil Engineers – Waste and Resource Management*, Vol. 170 No. 1, pp. 15-24, doi: 10.1680/jwarm.16.00011.

Agyemang, M., Kusi-Sarpong, S., Khan, S.A., Mani, V., Rehman, S.T. and Kusi-Sarpong, H. (2019), "Drivers and barriers to circular economy implementation: an explorative study in Pakistan's automobile industry", *Management Decision*, Vol. 57 No. 4, pp. 971-994.

Ajayi, S.O. and Oyedele, L.O. (2018), "Waste-efficient materials procurement for construction projects: a structural equation modelling of critical success factors", *Waste Management*, Vol. 75, pp. 60-69.

Aslam, M.S., Huang, B. and Cui, L. (2020), "Review of construction and demolition waste management in China and USA", *Journal of Environmental Management*, Vol. 264, p. 110445.

Bello, A.O., Khan, A.A., Idris, A. and Awwal, H.M. (2023a), "Barriers to modular construction systems implementation in developing countries' architecture, engineering and construction industry", *Engineering, Construction and Architectural Management*.

Bello, A.O., Eje, D.O., Idris, A., Semiu, M.A. and Khan, A.A. (2023b), "Drivers for the implementation of modular construction systems in the AEC industry of developing countries", *Journal of Engineering, Design and Technology*.

Bilal, M., Khan, K.I.A., Thaheem, M.J. and Nasir, A.R. (2020), "Current state and barriers to the circular economy in the building sector: towards a mitigation framework", *Journal of Cleaner Production*, Vol. 276, p. 123250.

Bocken, N.M., De Pauw, I., Bakker, C. and Grinten, V.B. (2016), "Product design and business model strategies for a circular economy", *Journal of Industrial and Production Engineering*, Vol. 33 No. 5, pp. 308-320, doi: 10.1080/21681015.2016.1172124.

Bryman, A. (2016), *Social Research Methods*, Oxford University Press, Oxford.

Burke, H., Zhang, A. and Wang, J.X. (2021), "Integrating product design and supply chain management for a circular economy", *Production Planning and Control*, Vol. 34 No. 11, pp. 1097-1113.

Chang, Y.T. and Hsieh, S.H. (2019), "A preliminary case study on circular economy in Taiwan's construction", *In IOP Conference Series: Earth and Environmental Science*, Vol. 225, p. 012069.

Dawson, C. (2013), *Advanced Research Methods: A Practical Guide for Social Research Projects*, Hachette UK.

Ellen MacArthur Foundation (2015), “Towards a circular economy: business rationale for an accelerated transition”, Ellen MacArthur Foundation, available at: https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an

Field, A. (2013), *Discovering Statistics Using IBM SPSS Statistics*, Sage, London.

Fornell, C. and Larcker, D.F. (1981), “Evaluating structural equation models with unobservable variables and measurement error”, *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50, doi: 10.2307/3151312.

García-Quevedo, J., Jové-Llopis, E. and Martínez-Ros, E. (2020), “Barriers to the circular economy in European small and medium-sized firms”, *Business Strategy and the Environment*, Vol. 29 No. 6, pp. 2450-2464, doi: 10.1002/bse.2513.

Geissdoerfer, M., Savaget, P., Bocken, N.M. and Hultink, E.J. (2017), “The circular economy–a new sustainability paradigm?”, *Journal of Cleaner Production*, Vol. 143, pp. 757-768, doi: 10.1016/j.jclepro.2016.12.048.

Ghisellini, P., Cialani, C. and Ulgiati, S. (2016), “A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems”, *Journal of Cleaner Production*, Vol. 114, pp. 11-32.

Ghisellini, P., Ripa, M. and Ulgiati, S. (2018), “Exploring environmental and economic costs and benefits of a circular economy approach to the construction and demolition sector. A literature review”, *Journal of Cleaner Production*, Vol. 178, pp. 618-643.

Giorgi, S., Lavagna, M., Wang, K., Osmani, M., Liu, G. and Campioli, A. (2022), “Drivers and barriers towards circular economy in the building sector: Stakeholder interviews and analysis of five European countries policies and practices”, *Journal of Cleaner Production*, Vol. 336, p. 130395, doi: 10.1016/j.jclepro.2022.130395.

Gold, A.H., Malhotra, A. and Segars, A.H. (2001), “Knowledge management: an organisational capabilities perspective”, *Journal of Management Information Systems*, Vol. 18 No. 1, pp. 185-214.

Gonz’alez, A., Sendra, C., Herena, A., Rosquillas, M. and Vaz, D. (2021), “Methodology to assess the circularity in building construction and refurbishment activities”, *Resour. Conserv. Recycl. Adv*, Vol. 12, p. 200051.

Govindan, K. and Hasanagic, M. (2018), “A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective”, *International Journal of Production Research*, Vol. 56 Nos 1/2, pp. 1-34, doi: 10.1080/00207543.2017.1402141.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L. (2006), *Multivariate Data Analysis*, 7th-ed., Sage publications, London, Vol. 6.

Hair, J.F., Jr, Matthews, L.M., Matthews, R.L. and Sarstedt, M. (2017), “PLS-SEM or CB-SEM: updated guidelines on which method to use”, *International Journal of Multivariate Data Analysis*, Vol. 1 No. 2, pp. 107-123.

Hair, J.F., Risher, J.J., Sarstedt, M. and Ringle, C.M. (2019), “When to use and how to report the results of PLS-SEM”, *European Business Review*, Vol. 31 No. 1, pp. 2-24.

Hair, J., Jr, Hair, Jr, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2021), *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, Sage publications, London.

Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2022), *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 3rd ed., Sage, Thousand Oaks, CA.

Hart, J., Adams, K., Giesekam, J., Tingley, D.D. and Pomponi, F. (2019), “Barriers and drivers in a circular economy: the case of the built environment”, *Procedia CIRP*, Vol. 80, pp. 619-624.

Henseler, J., Ringle, C.M. and Sarstedt, M. (2015), “A new criterion for assessing discriminant validity in variance-based structural equation modeling”, *Journal of the Academy of Marketing Science*, Vol. 43 No. 1, pp. 115-135.

Hina, M., Chauhan, C., Kaur, P., Kraus, S. and Dhir, A. (2022), "Drivers and barriers of circular economy business models: where we are now, and where we are heading", *Journal of Cleaner Production*, Vol. 333, p. 130049.

Hulland, J. (1999), "Use of partial least squares (PLS) in strategic management research: a review of four recent studies", *Strategic Management Journal*, Vol. 20 No. 2, pp. 195-204.

Idris, A. and Bello, A.O. (2023), "Strategies for adoption of circular economy in the Nigeria construction industry", *Journal of Management Science and Engineering Research*, Vol. 6 No. 2, pp. 47-59, doi: 10.30564/jmser.v6i2.5846.

Ilić, M. and Nikolić, M. (2016), "Drivers for development of circular economy – a case study of Serbia", *Habitat International*, Vol. 56, pp. 191-200.

John, I.B., Adekunle, S.A. and Aigbavboa, C.O. (2023), "Adoption of circular economy by construction Industry SMEs: organisational growth transition study", *Sustainability*, Vol. 15 No. 7, p. 5929.

Kazancoglu, I., Kazancoglu, Y., Yarimoglu, E. and Kahraman, A. (2020), "A conceptual framework for barriers of circular supply chains for sustainability in the textile industry", *Sustainable Development*, Vol. 28 No. 5, pp. 1477-1492.

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A. and Hekkert, M. (2018), "Barriers to the circular economy: evidence from the European Union (EU)", *Ecological Economics*, Vol. 150, pp. 264-272, doi: 10.1016/j.ecolecon.2018.04.028.

Kline, R.B. (2023), *Principles and Practice of Structural Equation Modeling*, Guilford publications, New York, NY.

Kock, N. (2015), "Common method bias in PLS-SEM: a full collinearity assessment approach", *International Journal of e-Collaboration*, Vol. 11 No. 4, pp. 1-10.

Konietzko, J., Baldassarre, B., Brown, P., Bocken, N. and Hultink, E.J. (2020), "Circular business model experimentation: demystifying assumptions", *Journal of Cleaner Production*, Vol. 277, p. 122596.

Liengaard, B.D., Sharma, P.N., Hult, G.T.M., Jensen, M.B., Sarstedt, M., Hair, J.F. and Ringle, C.M. (2021), "Prediction: coveted, yet forsaken? Introducing a cross-validated predictive ability test in partial least squares path modeling", *Decision Sciences*, Vol. 52 No. 2, pp. 362-392.

Liu, J., Wu, P., Jiang, Y. and Wang, X. (2021), "Explore potential barriers of applying circular economy in construction and demolition waste recycling", *Journal of Cleaner Production*, Vol. 326, p. 129400.

Mahpour, A. (2018), "Prioritizing barriers to adopt circular economy in construction and demolition waste management", *Resources, Conservation and Recycling*, Vol. 134, pp. 216-227.

Menegaki, M. and Damigos, D. (2018), "A review on current situation and challenges of construction and demolition waste management", *Current Opinion in Green and Sustainable Chemistry*, Vol. 13, pp. 8-15.

Mhlanga, J., Haupt, T.C. and Loggia, C. (2022), "Shaping circular economy in the built environment in Africa. A bibliometric analysis", *Journal of Engineering, Design and Technology*, doi: 10.1108/JEDT-03-2022-0175.

Munaro, M.R., Tavares, S.F. and Bragança, L. (2020), "Towards circular and more sustainable buildings: a systematic literature review on the circular economy in the built environment", *Journal of Cleaner Production*, Vol. 260, p. 121134.

Nogueira, A., Ashton, W., Teixeira, C., Lyon, E. and Pereira, J. (2020), "Infrastructuring the circular economy", *Energies*, Vol. 13 No. 7, p. 1805.

Ojo, L.D., Oladinrin, O.T. and Obi, L. (2021), "Critical barriers to environmental management system implementation in the Nigerian construction industry", *Environmental Management*, Vol. 68 No. 2, pp. 147-159.

Olanrewaju, O.I., Kineber, A.F., Chileshe, N. and Edwards, D.J. (2022), "Modelling the relationship between building information modelling (BIM) implementation barriers, usage and awareness on building project lifecycle", *Building and Environment*, Vol. 207, p. 108556.

Oluleye, B.I., Chan, D.W., Olawumi, T.O. and Saka, A.B. (2022), "Assessment of symmetries and asymmetries on barriers to circular economy adoption in the construction industry towards zero waste: a survey of international experts", *Building and Environment*, Vol. 228, p. 109885.

Oyinlola, M., Whitehead, T., Abuzeinab, A., Ade, A., Akinola, Y., Anafi, F., Farukh, F., Jegede, O., Kandan, K., Kim, B. and Mosugu, E. (2018), "Bottle house: a case study of transdisciplinary research for tackling global challenges", *Habitat International*, Vol. 79, pp. 18-29.

Paiho, S., Mäki, E., Wessberg, N., Paavola, M., Tuominen, P., Antikainen, M., Heikkilä, J., Rozado, C.A. and Jung, N. (2020), "Towards circular cities—conceptualising core aspects", *Sustainable Cities and Society*, ISSN 2210-6707, Vol. 59, p. 102143, doi: 10.1016/j.scs.2020.102143.

Patwa, N., Sivarajah, U., Seetharaman, A., Sarkar, S., Maiti, K. and Hingorani, K. (2020), "Towards a circular economy: an emerging economies context", *Journal of Business Research*, Vol. 122, pp. 725-735, doi: 10.1016/j. jbusres.2020.05.015.

Peiro, L.T., Polverini, D., Ardente, F. and Mathieux, F. (2020), "Advances towards circular economy policies in the EU: the new ecodesign regulation of enterprise servers", *Resources, Conservation and Recycling*, Vol. 154, p. 104426, doi: 10.1016/j.resconrec.2019.104426.

Pomponi, F. and Moncaster, A. (2017), "Circular economy for the built environment: a research framework", *Journal of Cleaner Production*, Vol. 143, pp. 710-718.

Saunders, M., Lewis, P. and Thornhill, A. (2016), *Research Methods for Business Students*, Harlow Pearson, New York, NY.

Sharma, P., Sarstedt, M., Shmueli, G., Kim, K.H. and Thiele, K.O. (2019), "PLS-based model selection: the role of alternative explanations in information systems research", *Journal of the Association for Information Systems*, Vol. 20 No. 4, p. 4.

Shmueli, G. and Koppius, O.R. (2011), "Predictive analytics in information systems research", *MIS Quarterly*, Vol. 35 No. 3, pp. 553-572.

Shmueli, G., Ray, S., Estrada, J.M.V. and Chatla, S.B. (2016), "The elephant in the room: predictive performance of PLS models", *Journal of Business Research*, Vol. 69 No. 10, pp. 4552-4564.

Smol, M., Marcinek, P. and Koda, E. (2021), "Drivers and barriers for a circular economy (CE) implementation in Poland – a case study of raw materials recovery sector", *Energies*, Vol. 14 No. 8, p. 2219.

Sousa-Zomer, T.T., Magalhães, L., Zancul, E. and Cauchick-Miguel, P.A. (2018), "Exploring the challenges for circular business implementation in manufacturing companies: an empirical investigation of a pay-per-use service provider", *Resources, Conservation and Recycling*, Vol. 135, pp. 3-13.

Stahel, W.R. (2016), "The circular economy", *Nature*, Vol. 531 No. 7595, pp. 435-438, doi: 10.1038/531435a.

Torgautov, B., Zhanabayev, A., Tleuken, A., Turkyilmaz, A., Mustafa, M. and Karaca, F. (2021), "Circular economy: challenges and opportunities in the construction sector of Kazakhstan", *Buildings*, Vol. 11 No. 11, p. 501.

Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S. and Valkokari, P. (2019), "Unlocking circular business: a framework of barriers and drivers", *Journal of Cleaner Production*, Vol. 212, pp. 90-98.

UNEP (2021), "Global status report for buildings and construction, UNEP – United Nations Environment Programme", available at: www.unep.org/resources/report/2021-global-status-report-buildings-and-construction

Urain, I., Eguren, A. and Justel, D. (2022), "Development and validation of a tool for the integration of the circular economy in industrial companies: case study of 30 companies", *Journal of Cleaner Production*, Vol. 370, p. 133318, doi: 10.1016/j.jclepro.2022.133318.

Urbinati, A., Franzò, S. and Chiaroni, D. (2021), "Enablers and barriers for circular business models: an empirical analysis in the Italian automotive industry", *Sustainable Production and Consumption*, Vol. 27, pp. 551-566.

Vermeulen, W., Reike, D. and Witjes, S. (2019), "Circular economy 3.0 – solving confusion around new conceptions of circularity by synthesising and re-organising the 3R's concept into a 10R hierarchy", *Renewable Matter*, Vol. 27, pp. 12-15.

Witjes, S. and Lozano, R. (2016), "Towards a more circular economy: proposing a framework linking sustainable public procurement and sustainable business models", *Resources, Conservation and Recycling*, Vol. 112, pp. 37-44.

Wuni, I.Y. (2023), "Drivers of circular economy adoption in the construction industry: a systematic review and conceptual model", *Building Research and Information*, Vol. 51 No. 7, pp. 816-833, doi: 10.1080/09613218.2023.2211689.

Wuni, I.Y. and Shen, G.Q. (2022), "Developing critical success factors for integrating circular economy into modular construction projects in Hong Kong", *Sustainable Production and Consumption*, Vol. 29, pp. 574-587.

Further reading

Debrah, C., Chan, A.P.C. and Darko, A. (2022), "Automation in construction artificial intelligence in green building", *Automation in Construction*, Vol. 137, p. 104192, doi: 10.1016/j.autcon.2022.104192.

Gupta, S., Chen, H., Hazen, B.T., Kaur, S. and Gonzalez, E.D.S. (2019), "Circular economy and big data analytics: a stakeholder perspective", *Technological Forecasting and Social Change*, Vol. 144, pp. 466-474.

Harman, H.H. (1976), *Modern Factor Analysis*, University of Chicago Press, Chicago.

Corresponding author
Abdulkabir Opeyemi Bello can be contacted at: abdulkabiropeyemi@gmail.com