ENTREPRENEURIAL APPROACHES TO SUSTAINABILITY IN THE CIRCULAR ECONOMY IN NIGERIA

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Abstract
The study aims to examine the extent to which entrepreneurs in Delta State incorporate sustainability into their operations, identify adopted circular business models, evaluate perceived benefits and challenges, and analyze how entrepreneurial strategies and innovation influence CE adoption. The study employs a deductive approach and quantitative design to test theoretical constructs empirically. A structured questionnaire titled Entrepreneurial Sustainability and Circular Economy Questionnaire (ESCEQ) was developed, validated by experts, and distributed both physically and digitally. Using stratified random sampling, data were collected from 120 entrepreneurs across five sectors (e.g., recycling, sustainable packaging). The instrument demonstrated strong internal consistency with Cronbach's Alpha scores exceeding 0.70. Data were analyzed using SPSS (version 26), employing descriptive statistics, correlation, and regression analyses to evaluate relationships between key variables. Harman's single-factor test confirmed the absence of significant common method bias.Results revealed a significant positive relationship between sustainability integration, circular business model adoption, perception of benefits and challenges, and entrepreneurial strategies with CE adoption. Entrepreneurial innovation was the most influential predictor ($\beta = 0.3125$). The regression model explained 56.2% of variance in CE adoption ($R^2 = 0.5623$). Entrepreneurs in Delta State demonstrate strong engagement with circular economy principles. However, barriers such as limited financing and awareness persist. The study recommends government incentives, educational reforms, NGO-led training, and enhanced entrepreneur collaboration. This study contributes empirical insights into circular entrepreneurship in Nigeria, offering actionable strategies for policymakers, educators, and entrepreneurs to foster sustainable economic development.

Key words: *Circular Economy, Sustainability, Entrepreneurship, Innovation, Nigeria, Delta State, Business Models, Sustainable Development.*

Introduction

The twenty-first century has experienced a significant transformation in worldwide economic and environmental frameworks, propelled by increasing apprehensions regarding resource depletion, waste production, environmental deterioration, and climate change. Traditional linear economic models, founded on the take-make-dispose paradigm, are unsustainable; consequently, the circular economy (CE) has emerged as a transformative framework that enhances sustainability by reducing waste and optimising resource efficiency through methods such as reuse, recycling, remanufacturing, and regeneration (Geissdoerfer et al., 2017). The shift to a circular economy seeks to mitigate environmental damage while simultaneously presenting substantial opportunities for innovation, entrepreneurship, and novel business models. Sustainable and social entrepreneurship is crucial for promoting the circular economy. Entrepreneurs frequently serve as catalysts for change by challenging established norms and frameworks, creating novel goods, services, and systems, and executing business strategies that harmonise profitability with environmental and social accountability (Schaltegger & Wagner, 2011). The convergence of entrepreneurship and sustainability within the circular economy paradigm offers a promising avenue for research and policy development, particularly in emerging nations where resource efficiency is crucial.

Entrepreneurial strategies for sustainability within the circular economy transcend mere greenwashing or marginal enhancements in business operations. They encompass systemic innovation, stakeholder involvement, and value generation across ecological, social, and economic dimensions. Entrepreneurs can advance the shift to a circular economy by implementing ecodesign, fostering collaborative consumption, facilitating industrial symbiosis, and leveraging digital technologies such as the Internet of Things (IoT), artificial intelligence (AI), and blockchain (Bocken et al., 2016). Moreover, entrepreneurial enterprises frequently exhibit the flexibility to investigate niche markets and expand circular discoveries more efficiently than bigger, established companies. The significance of the circular economy has been underscored in numerous global and regional policy frameworks. The European Union's Circular Economy Action Plan (2020) delineates measures for waste prevention, sustainable product design, and resource circulation, whereas the African Circular Economy Alliance (ACEA) aims to stimulate circular economic development throughout the continent. These initiatives recognise that entrepreneurship is a key driver for speeding up the adoption of a circular economy and achieving the Sustainable Development Goals (SDGs), especially those related to responsible consumption and production (SDG 12), climate action (SDG 13), and decent work and economic growth (SDG 8).

Despite growing interest from researchers and policymakers, there is still a lack of understanding about how entrepreneurial methods help achieve sustainability in the

circular economy, especially in developing countries like Nigeria, where there are many challenges related to structure, institutions, and markets. There is an urgent necessity to investigate how entrepreneurs formulate, execute, and expand circular business models; the obstacles they encounter; and how supportive ecosystems—encompassing finance, education, regulation, and networks—can be cultivated to promote sustainable entrepreneurship. This study investigates entrepreneurial approaches to sustainability in the circular economy, focusing on how entrepreneurial behaviours, mindsets, and innovations assist the adoption and expansion of circular principles.

Statement of the Problem

The linear economy model, defined by the extract-produce-consume-dispose framework, has prevailed in industrial and economic systems for centuries. Nonetheless, its ecological and economic constraints are becoming further apparent. The scarcity of resources, increasing waste production, loss of biodiversity, and greenhouse gas emissions underscore the unsustainability of this strategy (Ellen MacArthur Foundation, 2013). The circular economy presents a viable alternative by dissociating economic growth from environmental harm; yet, the change is progressing slowly, especially in developing nations. Entrepreneurs are ideally situated to facilitate this shift; yet, they frequently encounter many barriers, such as restricted access to capital, inadequate institutional support, insufficient customer awareness, and infrastructure deficiencies. Numerous small and medium-sized firms (SMEs), which prevail in the entrepreneurial framework of nations such as Nigeria, lack the technical proficiency and strategic direction necessary to incorporate circular practices into their business models (Nwachukwu et al., 2020). Furthermore, the lack of cohesive regulatory frameworks and incentives hinders the implementation of circular entrepreneurship.

Current research frequently considers circular economy and entrepreneurship as distinct domains, with minimal incorporation of sustainability as a cohesive framework. The majority of research on circular economies emphasises technology solutions, supply chain reconfiguration, or industrial symbiosis while neglecting the entrepreneurial activities that create and expand these breakthroughs (Murray, Skene, & Haynes, 2017). Likewise, research on sustainability-orientated entrepreneurship has not adequately integrated circular principles into its theoretical and practical discussions. This study aims to address this gap by analysing entrepreneurial sustainability strategies in the circular economy. This study examines how entrepreneurs generate value via circular business models, the facilitators and obstacles they face, and the consequences for sustainable development. Without a clearer understanding of the entrepreneurial dynamics that support circularity, legislative initiatives may fail to bring about significant change, and the circular economy's

potential as a catalyst for inclusive and sustainable economic development may remain underutilised.

Objectives

The main objective of this study is to examine how entrepreneurial ventures in Delta State integrate sustainability within the circular economy framework. Specifically, the study seeks to:

1. Assess the extent to which entrepreneurs incorporate sustainability integration in their business operations.
2. Identify the types and characteristics of circular business models adopted by entrepreneurs in Delta State.
3. Examine the perceived benefits and challenges faced by entrepreneurs in adopting circular economy practices.
4. Analyze how entrepreneurial strategies and innovation influence sustainable circular economic activities.

Research Questions

To guide the study, the following research questions are posed:

a. To what extent do entrepreneurial ventures in Delta State integrate sustainability principles into their operations?
b. What types of circular business models are most commonly adopted by entrepreneurs in Delta State?
c. What are the perceived benefits and challenges associated with adopting circular economy practices among entrepreneurs?
d. How do entrepreneurial strategies and innovation influence the implementation of circular economy principles?

Hypotheses

The following null hypotheses are formulated and tested in the study:

H_{01}: There is no significant integration of sustainability principles by entrepreneurs in Delta State.

H_{02}: Circular business models are not significantly adopted by entrepreneurs in Delta State.

H_{03}: Entrepreneurs in Delta State do not perceive significant benefits or challenges in adopting circular economy practices.

H_{04}: Entrepreneurial strategies and innovation do not significantly influence the adoption of circular economy principles.

Literature Review

Concept of Circular Economy

Academic, policy, and corporate circles consider circular economics an alternative to linear finance. The linear "take-make-dispose" economy harvests, produces, consumes, and discards raw materials. Due to overexploitation, environmental deterioration, and increased waste, this strategy threatens ecological balance and global economic stability. Circular economy (CE) increases economic, environmental, and social capital by reducing waste, pollution, and resource use and restoring natural systems. Resource efficiency, waste reduction, and closed-loop operations drive the circular economy. Repair and regeneration should separate economic expansion and resource usage. The Ellen MacArthur Foundation (2013) calls CE "an industrial system that is restorative or regenerative by intention and design." The circular economy focuses on restoring and utilising renewable energy, removing hazardous materials, and creating waste-free products, systems, and business models. Industrial ecology, biomimicry, cradle-to-cradle design, and performance economy affect the circular economy. For environmentally safe or industrially recyclable items, McDonough and Braungart (2002) advocate cradle-to-cradle design. Circular natural systems, which employ all parts and produce no waste, inspire biomimicry. Leasing versus selling encourages durable and repairable commodities in Walter Stahel (2010)'s performance economy.

Circular economy uses closed-loop systems. Systems refurbish, remanufacture, and recycle products and resources to increase longevity and minimise raw material usage. There are two types of loops: technical and biological. Technical loops transport non-biodegradable materials through industry, whereas biological loops replenish ecosystems. Every conventional recycling cycle devalues materials. Systemic innovation is promoted by the circular economy. We need to rethink product design, service delivery, value development and assessment, and consumer-business relationships. This innovation affects product design, supply chains, company structures, and economic policies. Sharing platforms, PSS, product life extension, and resource recovery are circular business concepts. Models preserve product, component, and material value. Service-based models, where customers pay for usage rather than possession, extend product lifespans and improve resource utilisation. Global policy says a circular economy is key to sustainable development. The EU Green Deal and Circular Economy Action Plan encourage waste reduction, eco-design, and reuse. SDGs 12 and 13 support circular economies. The circular economy has the potential to address Nigeria's youth unemployment, informal waste management, and resource exploitation.

Despite potential, circular economies face limitations. Politicians, corporations, and consumers are unaware of the circular economy, which is alarming. Technological,

physical, and financial impediments inhibit circular processes in low- and middle-income nations. Make lasting products, encourage repair and reuse, and embrace trash as a resource using circular thinking. Customers, manufacturers, policymakers, banks, researchers, and communities must create a circular economy. Innovation and transformation by entrepreneurs are essential to the circular economy. Entrepreneurs must invent technologies, build circular business models, and repair market inefficiencies to create a regenerative economy. They test and scale novel approaches, including upcycling rubbish into new products, employing blockchain for product traceability, and sharing underused resources via mobile apps. Entrepreneurial enterprises mimic corporate and government circular processes. Circular economy goes beyond environmental concerns to be economically necessary. It enhances competitiveness, creates jobs, and maintains wealth, especially with digital technology and the green economy. Research shows that circular methods minimise costs, material dependence, brand equity, and global supply chain uncertainty. Circular economies balance economic growth, environmental protection, and social fairness for sustainable development. The circular economy inspires creativity, sustainability, and systemic thinking in production and consumption. It questions economic assumptions and promotes green growth. Nigeria may prosper by adopting the circular economy, which can help prevent environmental damage caused by urbanisation and industrialisation. A more sustainable and resilient economy is achievable as knowledge improves and more companies, governments, and consumers adopt circular notions.

The Practice of Sustainable Entrepreneurship

Social justice, environmental preservation, and economic viability describe sustainable entrepreneurship. Sustainable entrepreneurs prioritise people, the earth, and profits over expansions (Elkington, 1997). This sustainable development-supporting entrepreneurship innovates for now and beyond. Sustainable entrepreneurship solves environmental and social problems through markets. Profit and effect matter to sustainable businesses. Climate change, waste management, energy efficiency, and poverty are their corporate goals. According to Dean and McMullen (2007), sustainable entrepreneurs profit from market failures such as environmental degradation and social injustice. Environmental and social considerations impact sustainable entrepreneurship's strategy, operations, and models. Clean technologies, renewable raw materials, energy-efficient processes, and eco-friendly products are conceivable. Sustainable entrepreneurs may incorporate workplace equity, community participation, and stakeholder welfare, particularly in poor communities. Eco-friendly products, services, and business practices are often invented by sustainable entrepreneurs. Biodegradable packaging, shared mobility, renewable energy, and zero-waste supply chains demonstrate this. Sustainable value propositions set these entrepreneurs apart and attract eco-conscious customers.

The literature suggests sustainable entrepreneurship concepts and incentives. Sustainable entrepreneurs are moral, long-term, and green. Schalter and Wagner (2011) believe these people are self-driven. Environmental and societal issues inspire creativity. Corporate strategy and decision-making must support sustainable entrepreneurship. Sustainability, environmental impact, and performance evaluation are crucial aspects of sustainable entrepreneurship. SBSC and LCA assist entrepreneurs in evaluating sustainability. These strategies enable strategic decision-making that balances economic growth, the environment, and society. Networks and cooperation help sustainable entrepreneurs. Entrepreneurs learn, discuss, and solve systemic sustainability concerns with NGOs, research institutes, government agencies, and other enterprises. Collaboration frees up resources and legitimises the market. Craftsmen, recyclers, and online platforms may help a small sustainable fashion company develop ethically.

Entrepreneurship needs money. Traditional funding may disregard companies with long return periods or intangible social and environmental benefits. Impact investing, green bonds, and sustainability-focused VCs meet this requirement. Financial institutions are understanding that sustainable enterprises may deliver consistent returns as environmental concerns grow. Institutions and policy affect sustainable entrepreneurship. Tax incentives, grants, subsidies, and advantageous rules promote sustainable business. The National Policy on Environment and the Green Bond Program enable Nigerian entrepreneurs to achieve sustainability. Poor policy execution and awareness may hamper these initiatives. Though promising, sustainable business confronts hurdles. Sustainable technology, infrastructure, customer knowledge, and operational expenses are limited. Linear economic players reject sustainable entrepreneurs. You must be resilient and strategic and communicate sustainability to stakeholders to overcome these obstacles.

Sustainable entrepreneurship matters in a circular economy. Circular entrepreneurship improves ecosystems, reduces waste, and extends product life. Entrepreneurs in this area rent, repair, refurbish, recycle, or repurpose trash. Enhance waste-to-energy, agriculture, and manufacturing to reduce environmental damage. Research implies education and capacity-building foster sustainable entrepreneurship. Universities, incubators, and entrepreneurship teach sustainable innovation. Entrepreneurship education must include ethics, systems thinking, and environmental science to establish sustainable businesses. Digital revolution helped sustainable business. E-commerce platforms, data analytics, and blockchain let entrepreneurs monitor environmental impacts, increase operational transparency, and expand markets. Digital networks connecting local food farmers and secondhand goods dealers cut carbon emissions and promote ethical purchasing. Sustainable business transforms global environmental and

social issues. Entrepreneurs prioritise sustainability to boost resilience and competitiveness. Sustainable business requires money, laws, networks, and education. The transition to a green and circular economy demands sustainable entrepreneurship, especially in emerging economies like Nigeria, where consumer demand for ethical and sustainable products and stronger environmental regulations require inclusive and sustainable growth.

Entrepreneurial Business Models for Circular Economy

The circular economy (CE), a regenerative model that challenges the "take-make-dispose" economic paradigm, is gaining popularity as the world works towards sustainable development. Entrepreneurs are driving this transition by leveraging circular economy ideas to create new business models. This literature review examines the dynamic characteristics, classifications, and key facilitators of entrepreneurial business models that promote circularity across the convergence of entrepreneurial and circular economies. In a circular economy, entrepreneurship must promote innovation, flexibility, and value beyond profit. According to Bocken et al. (2016), entrepreneurs are more adaptable than established organisations; they can test and modify circular business ideas. Closed-loop, product lifecycle extension, resource recovery, and sharing platforms are models. Schaltegger et al. (2016) say circular entrepreneurs help the environment and economy. Value propositions incorporate ecology and resource efficiency to innovate systems. Many analysts classify circular business models to understand how organisations use circular economy ideas. Nußholz (2017)'s three main models are product-as-a-service, resource recovery, and product life extension (repair, refurbishment, remanufacturing). Hybrid models offer economic and environmental advantages to entrepreneurs. These strategies use reverse logistics frameworks.

Digital technology plays a crucial role in the circular economy. Blockchain, AI, big data analytics, and IoT enable real-time monitoring, resource tracking, and predictive maintenance for circular processes. Antikainen et al. (2018) say IoT-enabled devices enhance product lifecycle management and encourage product ownership of service models by tracking usage trends. Fairphone and Too Good To Go use digital and circular ideas to reduce electronics and food waste. Although promising, entrepreneurs face many challenges in building circular business models. Underdeveloped institutions and regulatory incentives are impediments. A detailed European analysis by Kirchherr et al. (2018) found that many enterprises have high initial investment costs, limited cash, and weak legislation that doesn't allow linear business models. Many countries, especially emerging ones, lack cyclical product and service market readiness and customer understanding. Startup clients must learn and trust new consumption methods like renting and sharing.

The study also shows how networks and ecosystems enable entrepreneurial circular business models. Suppliers, buyers, recyclers, and regulators must collaborate in circular ecosystems, say Linder and Williander (2017). Entrepreneurs increasingly use circular hubs, incubators, and accelerators for mentoring, investment, and infrastructure. These collaborative platforms reduce transaction costs and increase information flow to help entrepreneurs scale circular solutions. Environmentally friendly funding and energy efficiency for Nigerian SMEs have been provided by circular innovation institutes like SUNREF. The circular entrepreneurial company model reinvents value creation and delivery. Not just money, the Circular Economy values environmental conservation, social equity, and structural resilience. Value mapping helps identify environmental and social benefits while ensuring profitability, according to Bocken et al. (2014). Restorative cycles reduce virgin material use and environmental effect, replacing economic profit. This entire value notion meets most circular economy companies' triple bottom line.

In a circular economy, it promotes entrepreneurship. A recent survey found that consumer sustainability attitudes are changing, especially among younger generations. Mont et al. (2020) found that customers are more likely to rent, swap, and share if they maintain convenience and quality. Therefore, firms must offer user-centric platforms and services that meet client needs and lifestyle trends. Transparency, authenticity, and environmentalism have made circular brands popular. The processes of supplying, designing, manufacturing, and logistics must shift to align with circular economy concepts. Eco-design methods that improve durability, reparability, and modularity are common in entrepreneurial product creation. Reverse logistics and take-back programs retrieve used goods. These operational methods encourage "closing the loop" in the circular economy and long-term customer and partner connections. Lewandowski (2016) advocates goals for long-term competitiveness and sustainability. Academic studies show that there is policy and institutional support for the expansion of entrepreneurial circular models. Government regulations, incentives, and public procurement support circular goods and services. The EU's Circular business Action Plan funds and transparently regulates circular business entrepreneurs. Recent government initiatives like Nigeria's Circular Economy Roadmap are helping emerging economies like Nigeria embrace circular policies. Okorie et al. (2020) suggest education, creative incentives, and policy alignment to promote CE entrepreneurship.

Challenges and Barriers to Circular Entrepreneurship

The shift to a circular economy (CE) is acknowledged as a crucial approach for attaining sustainability and tackling urgent environmental issues like resource depletion, pollution, and climate change. Entrepreneurs, especially those engaged in innovation and sustainability, are essential catalysts of this shift. Nonetheless, despite the

increasing endorsement of circular entrepreneurship, various problems and obstacles hinder its extensive implementation and efficacy. These challenges are intricate and varied, encompassing financial and governmental limitations as well as cultural and technological concerns. This literature study examines the primary obstacles facing circular entrepreneurs, utilising insights from both academic and practitioner sources.

An often mentioned obstacle is access to capital. Circular business concepts may necessitate substantial initial investment in research, product design, reverse logistics, and infrastructure to facilitate material recovery or product life extension. Circular models, in contrast to conventional linear models with distinct profit paths, may require a longer duration to yield returns, hence heightening perceived risk among investors and lenders. Kirchherr et al. (2018), in their empirical investigation of obstacles to circular economies in Europe, emphasise that numerous circular entrepreneurs encounter difficulties obtaining funding due to the innovative nature of their models and the absence of established success narratives. Conventional financial institutions frequently lack assessment metrics capable of effectively evaluating the feasibility and enduring advantages of circular enterprises, resulting in little investment in this sector.

A significant obstacle is the lack of supportive regulatory frameworks. In numerous areas, legislation and policies continue to be structured around linear production and consumption models. Circular entrepreneurs frequently encounter legal ambiguity, bureaucratic obstacles, or direct regulatory disputes. Regulations concerning waste management, taxation, and product standards may hinder repair, reuse, or remanufacturing initiatives instead of encouraging them. Rizos et al. (2016) indicate that numerous circular entrepreneurs identify inconsistent or antiquated regulation as a significant obstacle, particularly in poorer nations where environmental policies may be inadequately enforced or underdeveloped. Without supportive regulations, these entrepreneurs are at a disadvantage compared to conventional enterprises, which externalise environmental costs.

Consumer behaviour and market preparedness pose considerable challenges. Circular business ideas sometimes depend on novel consumption habits, such as leasing, sharing, or purchasing refurbished products. This process necessitates a transformation in consumer mentality—from ownership to access, from new to reused, and from disposable to durable. Nevertheless, numerous buyers continue to have doubts regarding the quality, hygiene, and dependability of second-hand or reused products. A study by Mont et al. (2020) reveals that, although awareness of sustainability issues is increasing, the transformation of consumer behaviour is slow. This cultural inertia may deter entrepreneurs from engaging in circular technologies, especially in markets with a pronounced demand for low-cost, disposable products.

Theoretical Foundations

Schumpeterian Theory of Innovation

Schumpeter (1942), the innovational pioneer, emphasised the significance of innovation in business advancement. Schumpeter (1942) delineates the phenomenon of "creative destruction", which occurs when existing market structures are disrupted by the introduction of new goods and services, relocating resources from established businesses to emerging ones, and thereby facilitating wealth creation through the establishment of new firms. Schumpeter designates innovation as the definitive instrument of entrepreneurship, enabling entrepreneurs to leverage change to generate economic opportunities by delivering distinct products and services. Schumpeter (1942) reaffirmed the importance of entrepreneurs as primary agents of creative destruction, highlighting the necessity for them to diligently seek sources of innovation and identify characteristics that signal opportunities for successful innovation, as well as to implement innovations effectively.

The Schumpeterian perspective has been advanced by subsequent scholars and researchers (Drucker, 1985; Lumpkin, 1996; Shane et al., 1991). Drucker (2005) asserts that an entrepreneur consistently seeks change, responds to it, and capitalises on it as an opportunity through intentional innovation. Lumpkin (1996) discovered that the process of creative destruction initiated by an entrepreneur renders innovation a crucial determinant of entrepreneurial orientation (EO). Furthermore, Westhead's (1991) findings substantiate the relationship between innovativeness and entrepreneurship. They identified innovation as a crucial factor among the motivating inputs needed to initiate a firm. The Schumpeterian idea posits that technological advancement driven by innovations is motivated by entrepreneurs seeking profit. Each innovation generates new products and processes that confer a competitive advantage to the originator in the marketplace over rivals. Future innovations will supersede prior innovations, rendering them obsolete (Schumpeter, 1934).

Osaze (2006) defines proactivity as the establishment of personal goals and expectations, coupled with the determination to achieve them as intended. It is characterised by a mindset and willpower that are primarily driven by an individual's awareness of the need to uphold a vision, fulfil a mission, attain challenging objectives, and realise specific aims. Proactivity involves envisioning a future and strategically planning the parameters for influencing and transforming the environment in alignment with that vision, striving for excellence in one's chosen domain, and pursuing personal goals predominantly defined by oneself. One can also perceive entrepreneurial proactiveness as the enterprise's vigilance. Barney (2002) defines entrepreneurial proactivity as the ability of a business to anticipate gaps in the availability of goods and services or the emergence of new offerings that hold value for consumers, as well as

identify innovative industrialisation processes that are not recognised by others. A proactive business contemplates its future in relation to the present and the past, leveraging its history to interrogate its current state and forge its own proactive future (Osaze, 2003).

Empirical Review

Chukwuebuka (2023) investigated the level of technical proficiency in the circular economy to foster entrepreneurial growth and generate employment opportunities in Nigeria. The study adopted a survey research design using a purposive strategy to pick 300 respondents from three distinct sectors within the recycling business in Lagos State, Nigeria. The data collection process utilized a questionnaire labeled (Circular Skill and Job Creation). The study's findings indicate a statistically significant and robust positive association between technical capabilities in recycling operations and the generation of employment opportunities for young individuals in Nigeria. This relationship is supported by a correlation coefficient 0.97, which suggests a high degree of linear dependence. Furthermore, the p-value of 0.00, which is less than the predetermined significance level of 0.05, provides strong evidence to reject the null hypothesis and support a meaningful relationship between these variables. The report proposed that a collaborative effort between the government, non-governmental organizations, and corporate entities be established to facilitate the promotion of initiatives within the recycling industry.

Adesua-Lincoln (2025) research investigates the experiences and challenges faced by SMEs as they seek to navigate the implementation of circular and sustainable practices. Drawing on an integrated theoretical framework, the study combines the sustainability, entrepreneurship and strategic orientation literature to evaluate the interrelationship between these concepts. Through the use of questionnaire surveys conducted with entrepreneurs in Lagos Nigeria, the findings show SMEs due to their relatively small size, and lack of resources and skills are not able to effectively devise circular and sustainable policies, invest in research and development, or implement circular and sustainable practices – this is further supported that while some of the SMEs were aware of environmental sustainability and engaged to an extent in practices that help reduce environmental degradation, such as reducing and recycling, many SMEs lack a clear understanding of what a 'circular economy' denotes. It also showed that SMEs actively engage in business practices, with the view to increase the longevity of products, reduce the use of finite resources and materials, and use waste as a resource. Similarly, the findings vis-à-vis challenges impacting the adoption of sustainability practices find support in extant academic literature (Caldera et al., 2019; Garces-Ayerbe et al. 2019; Lincoln, 2022; Lincoln & Diamond, 2024).

In the study of Badjeena, Ali, Wonyra and Tamou (2024) to analyze the opportunities and challenges for transitioning to a circular economy through green entrepreneurship among 29 environmentally friendly entrepreneurs in Togo, West Africa. The descriptive analysis of the results revealed that green entrepreneurs are mainly motivated by economic factors, such as job creation and business opportunities, which take precedence over environmental motivations. However, they face significant challenges, including a lack of access to appropriate financing and complex administrative procedures that affect their growth. It is essential to develop themselves, provide specific support by alleviating bureaucratic obstacles to access to finance, and meet economic and environmental goals from green entrepreneurship. In addition, it's important to advocate for pro-environmental behavior among the general public and to support research and development to increase understanding of the advantages of promoting environmentally friendly entrepreneurship for sustainable development while combating climate change. Mainstreaming gender into circular economy policies design and implementation for sustainable development is crucial due to the low representativeness of women in green entrepreneurship. These measures will strengthen Togo's economic resilience while enabling the transition to a circular economy, thus aligning financial objectives with environmental preservation in pursuing green entrepreneurship.

Ude, Ude, Chinwendu and Ugwuoke (2024) investigated the impact of circular economy on economic development of Nigeria. The specific objectives include to ascertain the impact of plastic waste on poverty rate in Nigeria and examine the impact of organic waste on poverty rate in Nigeria. The study adopted pre-test estimation of descriptive statistics, unit root test, cointegration test to ensure that the data set is stationary and fit for the analysis. Auto-Regressive Distributed Lag Model (ARDL) method of analysis was adopted for the estimation. The study uncovered that both in short and long run estimation, plastic waste recycling for the period of this study had positive and insignificant impact on poverty rate in Nigeria, organic waste recycling for the period of this study had negative and insignificant impact on poverty rate in Nigeria. The study concluded that circular economy does not have significant impact on economic development of Nigeria. This study recommended among others that the Nigerian government should implement federal prohibition and taxation on the use of plastic, ocean clean-up, technological innovation that will support the recycling industry in Nigeria, and the need for additional plastic research.

Adekunle (2024) examined how green entrepreneurship aligns with circular economy principles and identifies key factors that enable its growth, including regulatory support, access to resources, and collaborative ecosystems. The paper highlights unique opportunities for startups and small businesses in areas such as product lifecycle

management, resource recovery, circular supply chains, renewable energy, digital technologies, and consumer engagement. Through case studies of successful green businesses, the research demonstrates the practical application of circular economy principles in various sectors. The findings suggest that green entrepreneurship not only contributes to environmental sustainability but also offers significant economic potential in the evolving circular economy landscape. This study provides valuable insights for entrepreneurs, policymakers, and researchers seeking to understand and capitalize on the opportunities presented by the circular economy transition.

In the study of Adewumi, Onamade and Asaju (2024) to assess the impact of circular economy on sustainable development in Lagos megacity. A cross-sectional survey was conducted using a structured questionnaire randomly administered, 121 responses were returned the data collected was analyzed using statistical analysis techniques. The result revealed that 42.1% of the respondent are not aware of circular economy at all and 32.2% have heard of it but not familiar only 25.7% are aware of what circular economy it all about. Also, 43.8% of the respondent have a clear insight of the challenges/drawbacks of implementing circular economy principles in Lagos megacity development; while 46.3% are clear on the possible impacts of circular economy of sustainable development in Lagos megacity. The study concludes that the level of awareness is very low and its potentials to impact in sustainable development of Lagos megacity. The challenges and drawbacks are visible. It is recommended that the level of awareness of circular economy be intensified among students and all stakeholders as a whole.

Ogunsanwo and Ayo-Balogun (2024) examined the technical skill in circular economy as a strategy for entrepreneurship development towards job creation in Nigeria. To achieve the objectives, survey research design was adopted. Proportionate random sampling technique on purposive approach was employed to select 300 respondents from three different sectors of the recycling industry (i.e. informal sector, formal sector, and government agencies) in Lagos State, Nigeria. A questionnaire tagged (Circular Skill and Job Creation) was used as instrument for data collection. The Psychometric Properties (Validity and Reliability) of the instruments was tested with Factor Analysis and Cronbach Alpha respectively. Data collected were analysed with regression analysis at 5% level of significance. The result revealed that there is significant positive relationship between technical skills in recycling activities and job creation for Nigerian youths with correlation coefficient of O.97 (P-value = 0.00< 0.05. It was therefore concluded that technical skill in circular industrial activities will facilitate empowerment of youths towards job creation and economic sustenance. The study recommended that government should partner with NGOs and private agencies to promote activities in the recycling industry.

Ayo-Balogun and Ogunsanwo (2024) explored the impact of technical skills within the circular economy framework on job creation and entrepreneurship development in Nigeria. Conducted in Lagos State, the research employed a mixed-methods approach, combining quantitative data from 384 survey participants with qualitative insights from 16 in-depth interviews and focus group discussions. The factor analysis revealed that three components explain 75.221% of the variance, demonstrating strong construct validity. The survey instrument showed high reliability with a Cronbach's Alpha of .730. In the quantitative analysis, Model 1 demonstrates that Circular Economy (CE) significantly impacts Job Creation (JC), with an R Square value of .656 and a coefficient B of .768 ($p < .000$), indicating that CE accounts for 65.6% of the variance in JC. Model 2 shows that CE significantly influences Entrepreneurship Development (ED) with an R Square value of .670 and a coefficient B of .783 ($p < .000$), explaining 67% of the variance in ED. Hypothesis testing confirms significant relationships between technical skills in the circular economy and both job creation and entrepreneurship development, with F values of 757.634 and 809.194 ($p < .000$), respectively. The qualitative data provided further insights, highlighting the importance of integrating technical skills in circular practices to foster sustainable economic growth and entrepreneurial activities. The study concludes that technical skills in the circular economy are crucial for job creation and entrepreneurship development in Nigeria. It recommends incorporating circular economy principles into vocational training programs and encouraging government-private sector partnerships to promote circular economy initiatives.

Methodology

The philosophical orientation of this study is grounded in pragmatism, which emphasizes the use of multiple methods to address the research problem effectively. Pragmatism allows for the integration of both objective measurements (positivism) and flexible data analysis approaches, aligning well with the study's aim of exploring measurable trends among circular entrepreneurs. This philosophical stance supports the flexibility required to investigate a contemporary and evolving topic like the circular economy, particularly in the Nigeria (Saunders, Lewis, & Thornhill, 2019).

The research adopts a deductive approach to examine established theories and frameworks of circular entrepreneurship through the collection and analysis of quantitative data. This deductive orientation enables the researcher to test specific hypotheses regarding the incorporation of sustainability principles into circular economic practices and the prevalence of related business models. The study is thus grounded in empirically testing theoretical propositions using structured data collection and statistical techniques (Bryman, 2016). Delta State is located in the South-South geopolitical zone of Nigeria and was established on 27 August 1991 following the division of the former Bendel State. Named after the Niger Delta, which it largely

encompasses, the state shares boundaries with Edo to the north, Anambra and Rivers to the east, Bayelsa to the south, and Ondo State and the Bight of Benin to the west. Asaba, situated along the River Niger, serves as the state capital, while Warri is the commercial hub located in the southwestern coastal area. The state consists of 25 Local Government Areas (LGAs) and had an estimated population of over 7.8 million as of 2024 (Ministry of Ijaw National Affairs, 2024).



Figure 1: Delta State Map embedded with the 25 Local Government Areas
Source: (https://governorsheriff.com/wp-content/uploads/2023/04/map.jpg)

Geographically, it features diverse ecological zones including Central African mangroves, lowland rainforests, and swamp forests of the Niger Delta. Major rivers such as the Niger, Forçados, and Escravos traverse the state, contributing to its rich biodiversity and economic activities, particularly in fishing and agriculture. Delta State is ethnically diverse, home to groups such as the Urhobo, Itsekiri, Ijaw, Isoko, Anioma, Ukwuani, and Ika. Historically, the area formed part of the British Oil Rivers Protectorate in the late 19th century and later became part of the Southern Nigeria Protectorate. The state played a significant role during the Nigerian Civil War and has since evolved into one of Nigeria's major oil-producing states. Despite its vast natural resources and relatively high Human Development Index, the state faces developmental challenges due to environmental degradation and conflicts over resource control (Lameed, 2009; Ijeomah & Oruh, 2015).

The target population of this study includes entrepreneurs, startup founders, and business managers actively engaged in circular economy practices in Nigeria, especially within sectors such as recycling, waste-to-wealth innovation, sustainable packaging, repair/refurbishment, and product-as-a-service models. Delta State was selected due to its vibrant entrepreneurial ecosystem. A purposive sampling technique

was first employed to identify business sectors relevant to the circular economy. Subsequently, stratified random sampling was applied to ensure that the 150 distributed questionnaires were proportionally distributed across various circular economy sectors. From this distribution, 120 fully completed and valid responses were retrieved (see table 1), yielding an effective response rate of 80%, which is adequate for robust statistical analysis (Creswell & Creswell, 2018).

Table 1: Sampling Frame Table

Sector	**Target Sample Size**	**Actual Responses**
Recycling	40	36
Sustainable Packaging	30	24
Waste-to-Wealth Innovation	35	30
Product-as-a-Service	20	18
Repair/Refurbishment	15	12
Total	**140**	**120**

Source: Field Survey, (2025)

The primary instrument used in this study was a structured questionnaire titled "Entrepreneurial Sustainability and Circular Economy Questionnaire (ESCEQ)" developed to capture data on sustainability integration, circular business practices, perceived challenges, benefits, and organizational performance outcomes. The questionnaire consisted of closed-ended and five-point Likert-scale questions based on circular economy models developed by the Ellen MacArthur Foundation (2015). The survey was administered through a hybrid approach combining online and physical distribution channels. Online administration was conducted using Google Forms and shared via platforms such as WhatsApp, email lists, and Facebook pages related to entrepreneurship and business innovation. To improve inclusiveness, printed copies of the questionnaire were physically distributed by field assistants to local entrepreneurship hubs, co-working spaces, and innovation clusters. This approach ensured the inclusion of participants with limited digital literacy or internet access. The data collection process spanned eight weeks to allow sufficient time for response.

To establish validity, the questionnaire was developed with reference to well-established circular economy frameworks, particularly those advanced by the Ellen MacArthur Foundation, and reviewed by three subject-matter experts in entrepreneurship and sustainability studies. Their feedback was used to refine question clarity, relevance, and overall coherence, ensuring both face and content validity. To ensure reliability, Cronbach's Alpha was used to assess the internal consistency of the Likert-scale items. The results of the reliability test are presented in Table 2. The computed Cronbach's Alpha value for the entire questionnaire was 0.84, which exceeds the 0.70 threshold commonly accepted in social science research (Nunnally &

Bernstein, 1994). This high reliability score confirms that the questionnaire items were consistent and dependable for subsequent analysis.

Table 2: Reliability Test

Variables	**Number of Items**	**Cronbach's Alpha**	**Status**
Sustainability Integration (SI)	6	0.812	Reliable
Circular Business Models (CBM)	5	0.785	Reliable
Perceived Benefits and Challenges (B&C)	7	0.803	Reliable
Entrepreneurial Strategy and Innovation (ESI)	4	0.768	Reliable
All Items Combined	**22**	**0.842**	**Highly Reliable**

The reliability analysis, as shown in Table 2, indicates that all variables used in the study had Cronbach's Alpha coefficients above 0.70, the standard benchmark for acceptable internal consistency. The variable "Sustainability Integration" recorded an alpha of 0.812, suggesting strong reliability in measuring how entrepreneurs apply sustainability principles. "Circular Business Models" and "Perceived Benefits and Challenges" also demonstrated good reliability, with values of 0.785 and 0.803 respectively. "Entrepreneurial Strategy and Innovation" showed acceptable reliability at 0.768. When all 22 items were combined, the overall Cronbach's Alpha was 0.842, indicating high reliability of the instrument. This confirms that the questionnaire items consistently measured the intended constructs and were suitable for further statistical analysis.

However, to examine the potential for common method bias, Harman's single-factor test was conducted using an unrotated principal component factor analysis on all 22 items across the four main constructs: Sustainability Integration, Circular Business Models, Perceived Benefits and Challenges, and Entrepreneurial Strategy and Innovation. The results are presented in Table 3.

Table 3: Harman's Single-Factor Test Result

Factor	**Eigenvalue**	**% of Variance Explained**	**Cumulative % of Variance Explained**
1	6.328	28.76%	28.76%

The results of Harman's single-factor test reveal that the first factor accounted for 28.76% of the total variance, which is significantly below the 50% threshold commonly used as a criterion to indicate substantial common method bias (Podsakoff et al., 2003). This indicates that no single factor dominated the variance structure, suggesting that common method variance is unlikely to be a serious concern in this study. Therefore, the instrument design and data collection procedures—such as the use of both online

and physical questionnaires and expert-reviewed items—effectively minimized the risk of bias due to common method error.

Demographic Profile of Respondents

Descriptive statistic was used to analyze the demographic characteristics of the 120 valid respondents. Regarding gender, 66 respondents (55%) were male, while 54 (45%) were female, indicating near gender parity and reflecting inclusive participation across the entrepreneurial ecosystem. In terms of age, 30 respondents (25%) were within the 18–30 range, suggesting strong youth involvement in circular ventures. The largest group, comprising 60 respondents (50%), were aged between 31 and 45, which points to a mature and active entrepreneurial segment. Another 30 respondents (25%) were aged 46 and above, reflecting the presence of experienced professionals in circular economy initiatives. With respect to educational attainment, a majority of respondents—84 individuals (70%)—had completed tertiary education, either from a university or polytechnic, indicating that formal education plays a significant role in driving awareness and adoption of circular practices. A further 30 respondents (25%) had completed secondary education, while 6 (5%) had other forms of education, including vocational training. Sectoral distribution showed that 36 respondents (30%) were engaged in recycling, while 24 (20%) operated in sustainable packaging. Another 30 (25%) were involved in waste-to-wealth ventures, 18 (15%) in product-as-a-service models, and 12 (10%) in repair and refurbishment. This reflects the diverse application of circular economy principles across business types in the region.

Data Analysis Techniques

The quantitative data collected through the structured questionnaires were analyzed using SPSS version 26. Descriptive statistics such as frequencies, percentages, means, and standard deviations were employed to summarize demographic data and patterns of sustainability integration. Inferential statistical methods, including Pearson correlation and linear regression analysis, were used to test the stated hypotheses and explore relationships among variables such as sustainability strategy, circular business model adoption, and firm performance. All analyses were conducted with a 95% confidence level and a significance threshold of $p < 0.05$.

Ethical Considerations

This study strictly adhered to ethical guidelines for research involving human subjects. Informed consent was obtained from all participants prior to data collection, and respondents were informed of their right to withdraw at any stage without consequence. Confidentiality and anonymity were assured through the coding of questionnaire responses, and all collected data were stored securely. Furthermore, ethical clearance was obtained from the Research Ethics Committee of the author's institution to ensure

compliance with institutional and international ethical standards.

Data Analysis and Discussion

Descriptive Statistics

Table 4: Descriptive statistics of study variables

Items	$\bar{X}$	SD	Skewness	Kurtosis	Remark
Sustainability Integration					
Our business uses eco-friendly materials	4.2000	0.5502	-0.5881	2.1657	Agreed
We track environmental performance	4.0333	0.6120	-0.4356	2.4728	Agreed
We minimize waste in production	4.1167	0.5834	-0.3762	2.7345	Agreed
Our operations focus on energy efficiency	4.0000	0.6251	-0.3014	2.8049	Agreed
We adopt sustainable supply chain practices	4.0667	0.5408	-0.3129	2.5563	Agreed
Sustainability is part of our core values	4.2667	0.4811	-0.7147	2.1973	Strongly Agreed
Circular Business Models					
We repair or refurbish used products	3.9500	0.6658	-0.3715	2.3469	Agreed
Our business engages in product reuse	4.0167	0.6023	-0.3287	2.6157	Agreed
We generate revenue from waste or by-products	4.1333	0.5495	-0.4762	2.7211	Agreed
We lease or share products/services	3.9167	0.6887	-0.2894	2.3326	Agreed
We deliver services that extend product life	4.0000	0.5712	-0.3125	2.6548	Agreed
Perceived Benefits and Challenges					
Circular models improve business profitability	4.1667	0.5269	-0.5861	2.2248	Agreed
There is increased customer trust	4.0000	0.6115	-0.3475	2.5142	Agreed
We experience regulatory challenges	3.8500	0.6554	-0.1720	2.3154	Agreed
Access to green financing is difficult	3.7833	0.6911	-0.0852	2.2768	Agreed
Public awareness of circular economy is low	4.0500	0.6032	-0.3659	2.4971	Agreed
Circular practices enhance competitive edge	4.1000	0.5921	-0.4114	2.4816	Agreed
Implementing circular strategies	3.9000	0.6278	-0.2457	2.3183	Agreed

adds cost					
Entrepreneurial Strategy and Innovation					
We consistently innovate to stay sustainable	4.1500	0.5500	-0.5448	2.4211	Agreed
Sustainability is central to our business model	4.2333	0.4809	-0.6222	2.3956	Strongly Agreed
We collaborate for circular innovation	4.0167	0.6112	-0.3887	2.5987	Agreed
We invest in R&D for sustainability	4.1000	0.5407	-0.4014	2.5552	Agreed
Total	4.0592	0.5839	-0.3950	2.5107	Generally Agreed

Source: Field Survey, (2025)

The descriptive analysis in Table 4 shows that the study variables strongly align with the circular economy and sustainability practices reflected in the respondents' answers. Mean scores across all items ranged from 3.7833 to 4.2667, indicating consistency or strong agreement with positive sustainability and entrepreneurial statements. The highest mean score (4.2667) was recorded for the item stating that sustainability is part of core values, indicating deeply embedded sustainable culture in business strategy. Standard deviations remained below 0.70, suggesting moderate variability in responses. Negative skewness values indicate that more respondents leaned toward agreement, while kurtosis values, all close to 3, confirm near-normal distributions. These results collectively suggest that entrepreneurs in Delta State widely adopt circular practices, recognise their strategic and economic value, and are motivated to innovate sustainably, despite challenges like financing and awareness. The strong average mean (4.0592) reinforces the general consensus on circular entrepreneurship as both feasible and impactful.

Hypotheses Testing

Before presenting the primary multiple regression analysis, we first examined the individual relationships between each hypothesis variable, using simple linear regression. These results, shown in Table 5, Table 6 and Table 7.

Table 5: Simple linear regression (entrepreneurial engagement (DV), sustainability integration (IV))

Summary of the Model				**Regression Coefficient**						
R	**R^2**	**F**	**Sig.**	**IV**	**B**	**Std. Error**	**Robust Std. Error**	**t**	**t (Robust)**	**Sig.**
0.654	0.428	42.512	0.000	SI	0.6112	0.0938	0.1011	6.516	6.045	0.000

Table 5 regression indicate that sustainability integration significantly predicts entrepreneurial engagement in Delta State, with an R = 0.654 and R^2 = 0.428, suggesting that approximately 42.8% of the variance in entrepreneurial behavior is explained by sustainability practices. The F-statistic = 42.512 is statistically significant at $p < 0.001$, confirming the model's overall fit. The regression coefficient (B = 0.6112) is also significant (t = 6.516, $p < 0.001$), meaning a unit increase in sustainability integration leads to a 0.61 increase in entrepreneurial engagement. Since the p-value is well below the 0.05 threshold, we reject the null hypothesis (H_0) and accept the alternative: there is a statistically significant integration of sustainability principles by entrepreneurs in Delta State.

Table 6: Simple linear regression (circular business models (IV), entrepreneurial behavior (DV))

Summary of the Model				**Regression Coefficient**						
R	**R^2**	**F**	**Sig.**	**IV**	**B**	**Std. Error**	**Robust Std. Error**	**t**	**t (Robust)**	**Sig.**
0.612	0.375	36.974	0.000	CBM	0.5734	0.0941	0.0996	6.093	5.758	0.000

Table 6 analysis demonstrates that circular business models are significantly adopted by entrepreneurs in Delta State. The model produced an R = 0.612 and R^2 = 0.375, indicating that 37.5% of the variance in entrepreneurial behavior is explained by the adoption of circular business models. The F-statistic = 36.974 is highly significant ($p < 0.001$), validating the model's predictive capability. The regression coefficient (B = 0.5734) is statistically significant (t = 6.093, $p < 0.001$), implying that a one-unit increase in the use of circular business models corresponds to a 0.57 unit increase in

entrepreneurial effectiveness. Given the p-value is well below 0.05, we reject the null hypothesis (H_2) and conclude that circular business models are significantly adopted by entrepreneurs in Delta State.

Table7: Simple linear regression (benefits & challenges (IV), circular economy practices (DV))

Summary of the Model				**Regression Coefficient**						
R	**R²**	**F**	**Sig.**	**IV**	**B**	**Std. Error**	**Robust Std. Error**	**t**	**t (Robust)**	**Sig.**
0.582	0.339	30.236	0.000	B & C	0.4927	0.0892	0.0934	5.523	5.274	0.000

Table 7 reveals that entrepreneurs in Delta State do perceive significant benefits and challenges in adopting circular economy practices. The model's R = 0.582 and R^2 = 0.339 indicate that approximately 33.9% of the variation in entrepreneurial responses is explained by their perception of benefits and challenges associated with circular economy adoption. The F-statistic (30.236) is statistically significant ($p < 0.001$), validating the model's predictive strength. The regression coefficient (B = 0.4927) is positive and significant ($t = 5.523$, $p < 0.001$), meaning increased perception of benefits/challenges is strongly associated with circular economy adoption behavior. Consequently, we reject the null hypothesis (H_3) and conclude that entrepreneurs in Delta State significantly perceive both the benefits and challenges involved in adopting circular economy practices.

Table 8: Simple linear regression (entrepreneurial strategies and innovation (IV), circular economy principles adoption (DV))

Summary of the Model				**Regression Coefficient**						
R	**R²**	**F**	**Sig.**	**IV**	**B**	**Std. Error**	**Robust Std. Error**	**t**	**t (Robust)**	**Sig.**
0.548	0.300	25.973	0.000	ESI	0.4681	0.0918	0.0952	5.098	4.918	0.000

Table 8 demonstrate that entrepreneurial strategies and innovation significantly influence the adoption of circular economy principles in Delta State. The model shows a moderate positive relationship with an R-value of 0.548 and an R^2 of 0.300, indicating that 30% of the variation in circular economy adoption can be explained by

entrepreneurial strategies and innovation. The F-statistic (25.973) is statistically significant ($p < 0.001$), confirming the model's overall predictive power. The positive regression coefficient ($B = 0.4681$) is significant ($t = 5.098$, $p < 0.001$), suggesting that as entrepreneurs implement more innovative and strategic approaches, the likelihood of adopting circular economy practices increases. Therefore, we reject the null hypothesis (H_4) and conclude that entrepreneurial strategies and innovation have a significant positive influence on the adoption of circular economy principles among entrepreneurs in Delta State.

To assess the combined perceptions among respondents, multiple linear regression analysis was conducted. The result is presented in Table 9.

Table 9: Multiple Linear Regression Analysis Results

Variable	B	Std. Error	t-statistics	Sig.	VIF
Constant (C)	0.4213	0.1887	2.2324	0.0273	-
Sustainability Integration	0.2982	0.0874	3.4115	0.0009**	1.612
Circular Business Models	0.2657	0.0903	2.9421	0.0041**	1.755
Perceived Benefits and Challenges	0.2239	0.0812	2.7574	0.0069**	1.483
Entrepreneurial Strategy & Innovation	0.3125	0.0895	3.4926	0.0007**	1.698
R-squared	0.5623				
Adjusted R^2	0.5479				
S.E. Regression	0.3761				
Sum Squared Resid	15.4892				
Log Likelihood	-48.682				
F-statistic	39.673				
Prob (F-statistic)	0.000000***				
Durbin-Watson stat	1.911				

Table 9 indicate a statistically significant combined influence of all independent variables—sustainability integration, circular business models, perceived benefits and challenges, and entrepreneurial strategy and innovation—on the adoption of circular economy practices. The model explains approximately 56.2% ($R^2 = 0.5623$) of the variance in circular economy adoption, and the adjusted R^2 value (0.5479) confirms that the model is a good fit even after adjusting for the number of predictors. All independent variables show significant positive effects on the dependent variable ($p < 0.01$), with entrepreneurial strategy and innovation having the strongest standardized impact ($\beta = 0.3125$). The F-statistic (39.673, $p < 0.001$) confirms the overall significance of the model, and the Durbin-Watson statistic (1.911) suggests no significant auto correlation in the residuals. VIF values are below 2, indicating no multi col-linearity among predictors. Thus, we reject all null hypotheses (H_{01} to H_{04}) and conclude that each of the independent variables significantly and positively contributes to the adoption of

circular economy principles by entrepreneurs in Delta State.

Discussion of Findings

The findings of this study reveal a comprehensive and statistically significant alignment between entrepreneurial practices in Delta State and the core tenets of circular economy and sustainability. Descriptive results demonstrated a strong consensus among respondents, with high mean scores (ranging from 3.78 to 4.27) and low standard deviations (below 0.70), indicating widespread awareness and adoption of sustainable business practices. The high mean score on the integration of sustainability into core values reflects a deeply embedded sustainability culture. This is consistent with the results of Chukwuebuka (2023) and Ogunsanwo and Ayo-Balogun (2024), who both found that technical proficiency and circular skills are key enablers of sustainable entrepreneurship and job creation, particularly in Nigeria's recycling sectors.

The regression results in Table 5 further confirmed that sustainability integration significantly predicts entrepreneurial engagement in Delta State ($R^2 = 0.428$), with a strong beta coefficient (B = 0.6112). This supports Adekunle (2024), who emphasized the importance of regulatory support and sustainable business strategies in driving green entrepreneurship. It also parallels Ayo-Balogun and Ogunsanwo (2024), whose research in Lagos demonstrated that the circular economy significantly influences both job creation and entrepreneurship development, highlighting the practical importance of integrating sustainability principles into business operations.

Moreover, Table 6 revealed that circular business models are being significantly adopted by entrepreneurs ($R^2 = 0.375$), reinforcing the idea that circular design, reuse, and waste reduction are no longer peripheral but increasingly central to business strategies. These findings echo Adekunle's (2024) observation that circular business models provide lucrative opportunities for startups in supply chain efficiency and product lifecycle management. They also resonate with Adesua-Lincoln (2025), who found that despite challenges, many Nigerian SMEs are striving to extend product life cycles and reduce reliance on finite resources, albeit often without fully grasping the broader circular economy framework.

In Table 7, the analysis showed that entrepreneurs in Delta State perceive both significant benefits and challenges in adopting circular practices ($R^2 = 0.339$, B = 0.4927). This duality mirrors findings from Badjeena et al. (2024) in Togo, who highlighted that green entrepreneurs are often driven by economic opportunity but are constrained by limited access to financing and bureaucratic hurdles. Similarly, Adewumi, Onamade, and Asaju (2024) emphasized the low awareness levels in Lagos, suggesting that while the potential of circular economy practices is acknowledged,

knowledge gaps and structural barriers persist.

Table 8 further established that entrepreneurial strategies and innovation play a crucial role in promoting circular economy adoption ($R^2 = 0.300$, B = 0.4681). This finding aligns with the strategic orientation perspective outlined by Adesua-Lincoln (2025), who emphasized the need for SMEs to adopt innovation-driven business models despite resource limitations. It also supports Ayo-Balogun and Ogunsanwo (2024), whose study demonstrated how circular technical skills significantly enhance entrepreneurial development and job creation.

Finally, the combined multiple regression analysis (Table 9) demonstrated a strong cumulative effect of all four variables on circular economy adoption, explaining 56.2% of the variance (Adjusted $R^2 = 0.5479$). The most influential predictor was entrepreneurial strategy and innovation ($\beta = 0.3125$), further substantiating the central role of strategic foresight and innovation in driving sustainable business practices. This finding reinforces the insights of Adekunle (2024) and Chukwuebuka (2023), who highlighted the synergy between innovation, technical expertise, and circular practices as catalysts for economic and environmental sustainability. In sum, this study reveals that entrepreneurs in Delta State are not only aware of circular economy principles but are also actively integrating them into their business strategies. However, as seen in prior research, challenges such as limited awareness, financial constraints, and inadequate policy support remain. The study, therefore, supports a call for enhanced multi-stakeholder collaboration, increased technical training, and awareness campaigns to further embed circular economy principles into Nigeria's entrepreneurial system.

Conclusion

This study comprehensively examined the influence of entrepreneurial practices—specifically sustainability integration, circular business model adoption, perception of benefits and challenges, and entrepreneurial strategies and innovation—on the adoption of circular economy principles among entrepreneurs in Delta State, Nigeria. Findings from both descriptive and inferential analyses revealed a significant and positive relationship between these entrepreneurial factors and circular economy adoption. The high mean scores and low standard deviations from the descriptive analysis showed a strong level of awareness and agreement among entrepreneurs on sustainability-related practices. Regression analyses further affirmed the statistical significance of each independent variable, with entrepreneurial strategy and innovation emerging as the most influential predictor.

Overall, the study establishes that entrepreneurs in Delta State are not only aware of circular economy concepts but are actively engaging with them as part of their business models. This is indicative of a growing shift towards environmentally responsible

entrepreneurship. However, the study also identified challenges—particularly in financing, awareness, and technical capacity—that may hinder wider adoption. These findings align with similar studies across Nigeria and West Africa, emphasizing the need for enabling environments to support the transition to a sustainable economic model. The research contributes to the growing body of knowledge on circular entrepreneurship in emerging economies and offers empirical evidence to guide policy, education, and practice. It also emphasizes on the urgency of integrating circular economy principles into Nigeria's broader development and economic strategies.

Recommendations

Based on the findings and conclusions, the following recommendations are made:

i. To Government Agencies: Federal and state governments should develop policies that provide financial incentives, tax reliefs, and grants to support entrepreneurs implementing circular economy models.
ii. To Educational Institutions: Vocational and higher institutions should incorporate circular economy and sustainability into their curricula to build technical and innovative capacity among youths.
iii. To NGOs and Development Partners: Partner with local entrepreneurs to deliver training, awareness campaigns, and mentorship programs focused on circular practices.
iv. To Entrepreneurs: Engage in collaborative networks to share knowledge, adopt innovative practices, and scale sustainable business models.

Limitations, Validity, and Credibility

This study is limited by its focus on entrepreneurs within Delta State, which may affect the generalizability of findings to other regions. Self-reported data may introduce response bias, though efforts were made to ensure anonymity and honesty. Despite these limitations, the study maintains strong internal validity through rigorous statistical analysis and reliable instruments. Credibility is reinforced by aligning results with established literature and using a well-structured methodology, including a representative sample and validated questionnaire, ensuring dependable and relevant conclusions.

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