Original Article
ISSN (Online): 2582-7472

ShodhKosh: Journal of Visual and Performing Arts
Special Issue on Art, Design, and Media Convergence in the Digital Era: An Analytical Study of Creative Practices 7(7s)

ENVIRONMENTAL SUSTAINABILITY AND PERFORMANCE OF SMALL AND MEDIUM ENTERPRISES (SMEs) IN NORTH-CENTRAL NIGERIA

Mariam Shehu-Usman [1], Nasamu Gambo [2], Frank Alaba Ogedengbe [3]

[1] Department of Business Administration and Entrepreneurship, Nile University of Nigeria, Abuja, Nigeria
[2] Department of Business Administration and Entrepreneurship, Nile University of Nigeria, Abuja, Nigeria
[3] Department of Business Administration and Entrepreneurship, Nile University of Nigeria, Abuja, Nigeria

Received 20 February 2026
Accepted 23 April 2026
Published 16 May 2026

Corresponding Author
Frank Alaba Ogedengbe,
frankalabaogedengbe@gmail.com

DOI
10.29121/shodhkosh.v7.i7s.2026.7838

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

This study examined the effect of environmental sustainability practices on the business growth of Small and Medium Enterprises (SMEs) in North-Central Nigeria, focusing on waste management, renewable energy, water conservation, and the moderating role of firm size. A mixed-methods research design was adopted, combining survey data from 2,559 SMEs with qualitative interviews across seven states. Quantitative analysis was conducted using descriptive statistics and Partial Least Squares Structural Equation Modelling (PLS-SEM), while thematic analysis provided contextual insights. Findings revealed that waste management, renewable energy, and water conservation, demonstrated weaker or indirect statistical effects on SME growth. However, qualitative evidence highlighted their operational, reputational, and continuity benefits. Firm size demonstrated a significant moderating effect on SME growth underscoring organizational scale in driving performance. The study concluded that environmental practices are limited by financial and infrastructural barriers, which reduce their immediate impact on SME growth. Firm size further amplifies the adoption and benefits of sustainability, positioning larger SMEs to leverage scale for competitive advantage. The research contributes to knowledge by integrating environmental sustainability into SME growth models, providing insights both theoretical and practical. It recommends tailored support for SMEs through subsidies, training, concessional loans, and policy frameworks that facilitates inclusive and scalable adoption of environmental sustainability practices to strengthen long-term competitiveness and adaptability.

Keywords: Environmental Sustainability, Firm Size, Renewable Energy, Waste Management, Water Conservation

1. INTRODUCTION

1.1. BACKGROUND TO THE STUDY

The escalating environmental challenges facing the global economy ranging from resource depletion to climate change have intensified the call for sustainable business practices. As sustainability becomes a strategic priority, Small and Medium Enterprises (SMEs) are increasingly recognized for their potential to drive environmental transformation at the grassroots level (El-Yaqub, Ismail & Usman, 2025; Toromade & Chikezie, 2024). Despite their size, SMEs represent

the majority of businesses worldwide and are uniquely positioned to implement localized, impactful environmental initiatives (El-Yaqub et. al. 2025; Amiolemen et al., 2024).

Environmental sustainability refers to practices that minimize ecological harm and promote the responsible use of natural resources. These include waste management, energy efficiency, water conservation, and the use of renewable energy sources (Agu et al., 2024; Atadoga et al., 2024). For SMEs in developing economies like Nigeria, adopting such practices is not merely a moral obligation but a strategic necessity for long-term competitiveness and resilience (Toromade & Chiekezie, 2024).

In Nigeria, SMEs dominate the economic landscape, accounting for 96.9% of businesses and contributing significantly to employment and GDP (SMEDAN & NBS, 2021). Their adaptability and proximity to local communities make them ideal candidates for implementing environmentally sustainable practices. However, many SMEs in the region face significant barriers, including limited financial resources, minimal awareness inadequate infrastructure, and restricted access to technical knowledge (Iheanachor & Etim 2022; Ogunyemi 2022; Iheanachor, 2020). Understanding how environmental sustainability influences SME performance is essential for unlocking their potential and guiding policy interventions that support green growth.

Additionally, firm size serves as a moderating variable in the relationship between environmental sustainability practices and business performance. Previous studies indicate that larger SMEs typically possess greater financial capacity, better access to technology, and wider market reach, which enables them to implement sustainability initiatives more efficiently (Zhang & Sharon 2023; Hernandez et. al 2019). Conversely, smaller SMEs encounter resource limitations that hinder their capacity to implement certain sustainability practices comprehensively (Anaman, Ahmed, Suleman & Dzakah 2023; Durrani, Raziq, Mahmood & Khan 2024). Therefore, the moderating role of firm size is essential to determine how businesses of varying sizes can derive benefit from environmental sustainability practices and the challenges they may experience during adoption. The significance of this study lies in its contribution to understanding how environmental responsibility can influence business success, particularly in the context of a developing economy. Furthermore, its findings will provide a practical and academic basis for shaping policies and programs that support sustainability, enabling stakeholders to strengthen sustainable practices within the SME sector.

Against this backdrop, this study examines the relationship between environmental sustainability and the performance of SMEs with firm size as a moderating variable in North-Central Nigeria. It aims to understand how SMEs in the region perceive, adopt, and implement waste management, renewable energy, water conservation and how these practices shape their overall performance. By analysing these dynamics, the study sheds light on the extent to which environmental sustainability can enhance both enterprise performance and community well-being, thereby fostering inclusive and resilient economic development in North-Central Nigeria.

1.2. STATEMENT OF PROBLEM

Despite growing global urgency around environmental sustainability, Most SMEs operate within a linear economic model focused on extraction, production, and disposal (Adesua-Lincoln, 2025). Consequently, environmental degradation, manifested through poor waste management, pollution, and inefficient energy use. Limited awareness of circular economy principles, weak stakeholder collaboration, insufficient policy incentives, and scarce access to green finance further constrain progress (Adesua-Lincoln, 2025; Ogunyemi, 2022).

Nigerian small and medium enterprises (SMEs) face persistent barriers to adopting eco-friendly practices. Although SMEs account for over 90% of Nigerian businesses and significantly contribute to local economic development, their role in environmental sustainability remains limited and underexplored (Adesua-Lincoln, 2025).

This highlights the need for empirical research examining how SMEs, particularly in underrepresented areas such as North-Central Nigeria, perceive and engage with environmental sustainability. In the absence of such understanding, initiatives aimed at advancing sustainability practices and improving resource efficiency are likely to remain fragmented and ineffective.

2. OBJECTIVES OF THE STUDY

The main objective of this study is to evaluate the moderating effect of firm size on environmental sustainability practices and performance of SMEs in North-Central Nigeria. To achieve the main objective, the study has the following specific objectives which are to:

1) assess the effect of waste management on business growth of SMEs in North-Central Nigeria.
2) determine the effect of renewable energy on business growth of SMEs in North-Central Nigeria.
3) examine the effect of water conservation on business growth of SMEs in North-Central Nigeria.
4) evaluate the moderating effect of firm size on sustainability practices and business growth of SMEs in North-Central Nigeria.

3. RESEARCH HYPOTHESIS

In line with the objectives of the study the following null hypotheses are formulated:

Ho1 Waste management has no significant effect on business growth of SMEs in North-Central Nigeria.

Ho2 Use of renewable energy has no significant effect on business growth of SMEs in North-Central Nigeria

Ho3 Water conservation has no significant effect on business growth of SMEs in North-Central Nigeria.

Ho4 Firm size has no significant moderating effect on sustainability practices and business growth of SMEs in North-Central Nigeria.

4. LITERATURE REVIEW

4.1. ENVIRONMENTAL SUSTAINABILITY

Environmental sustainability refers to the responsible management and preservation of natural resources to ensure their availability for future generations, encompassing land use, water and energy consumption, air quality, and hygiene to mitigate the impacts of human and industrial activity (Akor, 2023; Singh, 2024). Beyond ecological systems, it extends to social and institutional frameworks that enable collective responses to environmental challenges, emphasizing renewable resource efficiency, pollution reduction, and substitution of non-renewable materials (Singh, 2024; Akor, 2023).

Scholars have defined environmental sustainability from multiple perspectives. Said et al. (2024) view it as a framework ensuring harmonious coexistence between humans and nature while addressing urgent threats such as climate change and biodiversity loss. Yadav et al. (2024) define it as balancing resource use, conservation, and social equity, employing frameworks like ecological footprint and planetary boundaries. Gaikwad and Sathe (2024) stress enhancing quality of life while minimizing ecological strain through cooperative individual, institutional, and governmental action. Singh (2024) emphasizes quantifying sustainability using metrics such as carbon emissions, energy use, biodiversity indicators, and waste management.

The urgency of sustainability is driven by industrial pollution, deforestation, land degradation, population growth, and rising resource consumption, which threaten long-term development (Sala, 2020; Akor, 2023). While technological advances may mitigate resource depletion, intergenerational equity remains critical. Sustainability also counters negative effects of globalization and industrialization, which, despite economic benefits, exacerbate environmental degradation and inequality in developing countries (Sala, 2020; Akor, 2023). Organizational strategies like green ambidexterity enable businesses to balance resource efficiency with environmental innovation (Vetrivel et al., 2024). Quantitative indicators for sustainability include carbon footprint, energy consumption and renewable energy proportion, water usage and conservation, biodiversity indices, and waste management metrics, including waste reduction, recycling, and composting (Gaikwad & Sathe, 2024; Singh, 2024; Omowole et al., 2024).

SMEs play a significant role in environmental sustainability through informal practices such as waste minimization, energy efficiency, and sustainable supply chains (Al-Shaik & Hanaysha, 2023; Omowole et al., 2024; Ciocnitu, 2024). While SMEs face resource, infrastructure, and policy constraints especially in developing economies (Akor, 2023) their sustainability efforts align with green business practices, fostering competitiveness, innovation, and reduced ecological

impact (Omowole et al., 2024; Ciocnitu, 2024). This study assesses environmental sustainability among SMEs in North-Central Nigeria through waste management, renewable energy, and water conservation.

4.2. WASTE MANAGEMENT

Waste management is central to environmental sustainability, particularly given industrial growth, urbanization, and rising consumption, which have increased waste generation and environmental risks (Kumar, 2019). Mismanagement through indiscriminate dumping, landfilling, and burning has severe ecological and public health consequences, prompting governments and businesses to adopt sustainable strategies (Kumar, 2019). Effective waste management supports green economy objectives, reduces greenhouse gas emissions, and promotes sustainable resource use.

It involves collection, transportation, processing, recycling, and disposal of waste, aiming to mitigate health and environmental risks (Zakhilwal et al., 2024; Mondal et al., 2023; Mehta et al., 2018) and is a key component of sustainable development (Aiguobarueghian et al., 2024). Waste can be categorized by state solid, liquid, gaseous or by origin and decomposition properties, including biodegradable, non-biodegradable, hazardous, and e-waste (Zakhilwal et al., 2024; Mehta et al., 2018). Strategies such as waste reduction, recycling, and composting conserve resources, reduce pollution, and support corporate social responsibility (Chou, 2024; Altassan, 2023). Key indicators of waste management effectiveness include waste generation and recycling rates, landfill diversion, cost efficiency, regulatory compliance, and waste-to-energy performance (Mondal et al., 2023; Zakhilwal et al., 2024).

The benefits of sustainable waste management span environmental, economic, and social dimensions: reduced pollution and greenhouse gas emissions, resource conservation, revenue generation, cost savings, and improved public health (Zakhilwal et al., 2024; Mehta et al., 2018; Mondal et al., 2023).

SMEs are pivotal in waste management due to their cumulative contribution to environmental impacts, despite individual firms often perceiving their waste output as negligible (Anaman et al., 2023). The type and volume of waste generated by SMEs vary by sector: manufacturing produces metal, plastic, and chemical waste, agri-food sectors generate organic waste, and construction contributes substantial demolition debris (Aiguobarueghian et al., 2024; Jahan et al., 2022). While many SMEs implement sustainable practices such as recycling, composting, reusing materials, and adopting lean manufacturing techniques, their effectiveness is frequently constrained by limited financial resources, inadequate infrastructure, and insufficient technical expertise (Mondal et al., 2023; Mehta et al., 2018).

4.3. WATER CONSERVATION

Water conservation is a critical component of sustainable resource management, essential for maintaining ecological integrity, ensuring water security, and supporting economic productivity (Borsacchi & Pinelli, 2019). Increasing pressures from industrial, agricultural, and urban water demand, compounded by climate change and extreme weather events, have intensified the need for efficient water use and sustainable management (Gaikwad & Sathe, 2024; Kurunthachalam, 2014). It involves strategies to reduce consumption, improve efficiency, minimize waste, and implement sustainable practices that safeguard availability for both current and future generations (Kurunthachalam, 2014; Weerasooriya et al., 2021).

Water conservation is interconnected with broader sustainable development goals, linking climate action, responsible production, and economic growth with ecosystem preservation, public health, and community well-being (Omowole et al., 2024; Majeed & Luni, 2019). Industrial sectors such as energy production, steel, and paper manufacturing are high water consumers, requiring process optimization, wastewater recycling, and advanced treatment systems to mitigate environmental impact (Kurunthachalam, 2014; Weerasooriya et al., 2021). Similarly, agriculture and households contribute through efficient irrigation, rainwater harvesting, and water-smart behaviours, while municipalities enhance water reliability via infrastructural improvements, wastewater reuse, and desalination (Kurunthachalam, 2014).

The “3R” paradigm reduce, reuse, recycle offers a practical framework for conservation (Altassan, 2023). Reduction includes technological interventions and behavioural changes to minimize consumption, reuse involves repurposing treated water such as greywater or rainwater for secondary purposes, and recycling ensures safe reintegration into production cycles. For SMEs, water conservation is particularly significant, as it intersects with operational efficiency,

cost savings, and sustainable business practices alongside energy management, waste reduction, and eco-friendly supply chains (Omowole et al., 2024). Effective adoption can improve competitiveness, reduce greenhouse gas emissions, and enhance reputation, as evidenced by Spanish textile SMEs reducing water consumption by 40% and New Zealand small hotels lowering operational costs while appealing to environmentally conscious customers (Omowole et al., 2024).

Despite these benefits, SMEs face barriers including water scarcity, limited capacity for technology adoption, inadequate infrastructure, and low technical skills (Kathambi & Obiero, 2021; Kurunthachalam, 2014; Mapuka et al., 2024). Overcoming these constraints through capacity-building, policy support, and investment in water-efficient systems can enable SMEs to contribute significantly to sustainable water management, with positive spillovers for communities and ecosystems (Kathambi & Obiero, 2021).

4.4. RENEWABLE ENERGY

Renewable energy is sourced from naturally replenished resources that do not deplete over time, offering a sustainable alternative to fossil fuels (Chou, 2024). Unlike coal, oil, and natural gas which contribute significantly to global greenhouse gas emissions renewable sources such as solar, wind, hydropower, biomass, geothermal, and tidal energy reduce environmental degradation while supporting economic growth (Kumar & Majid, 2020; Okpokam, 2021; Majeed & Luni, 2019). By replacing fossil fuels, it reduces greenhouse gas emissions, mitigates environmental degradation, and contributes to a cleaner, more resilient energy system (Kumar & Majid, 2020). Technological and policy advancements have made renewable energy increasingly cost-effective and accessible, enabling businesses and communities to reduce energy dependence while promoting sustainable development (Chou, 2024; Okpokam, 2021).

Beyond environmental benefits, renewable energy adoption supports economic and social objectives. It can lower operational costs, enhance energy security, create employment opportunities, and stimulate industrial growth (Zhang, 2024). Socially, firms that adopt renewable energy demonstrate corporate social responsibility, improve public perception, and appeal to sustainability-conscious consumers and investors (Adebayo et al., 2024). Policy incentives, including tax credits, subsidies, and green financing mechanisms, play a crucial role in overcoming adoption barriers and promoting long-term investment (Ogunyemi & Ishola, 2024; Adebayo et al., 2024).

For SMEs, renewable energy adoption presents both challenges and opportunities. High initial cost, lack of technological readiness, and infrastructural gaps can hinder implementation, yet targeted support such as green loans, capacity-building, and government-backed subsidies enables SMEs to integrate renewable energy into their operations (Ogunyemi & Ishola, 2024). Doing so not only reduces energy costs and operational risks but also enhances competitiveness, market positioning, and alignment with sustainable business practices, contributing to long-term stability and growth (Zhang, 2024; Majeed & Luni, 2019).

4.5. CONCEPT OF PERFORMANCE

Performance is broadly defined as the achievement of an organization in relation to its set goals, including both economic and behavioural outcomes (Enyi et al., 2024; Abdullahi et al. 2022). It reflects the results achieved through the contributions of individuals or teams toward the organization's strategic objectives. Measuring performance is a critical component of organizational management, providing reliable data to assess efficiency and effectiveness. This process involves quantifying past actions through the acquisition, sorting, analysis, interpretation, and dissemination of relevant data, enabling organizations to evaluate their success in achieving strategic objectives (Enyi et al., 2024).

Traditionally, financial metrics have been the dominant means of assessing firm performance. Common financial indicators include profitability, return on investment (ROI), total output turnover, sales volume, and corporate identity (Enyi et al., 2024). These measures offer perspective into a company's ability to generate revenue and sustain financial stability. It reflects an organization's viability, customer acceptance, and ability to seize opportunities while mitigating threats. Sustained growth is considered essential for long-term survival, prosperity, and competitive advantage (Slavik et al., 2023).

However, the reliance on financial metrics alone has been widely criticized for its limitations, particularly in capturing intangible value and long-term sustainability. To address this gap, scholars advocate for a more comprehensive approach that integrates non-financial performance measures (Mahohoma, 2024). Non-financial metrics such as customer satisfaction, innovation, and internal business process efficiency provide deeper assessments of a firm's long-

term success and overall organizational health (Abdullahi et al., 2022). These indicators help firms identify and communicate key success factors, facilitate organizational learning, and enhance evaluation and reward systems.

For small and medium-sized enterprises (SMEs), achieving optimal performance requires a balanced approach that incorporates both financial and non-financial indicators. This integrative method ensures a holistic understanding of value creation, fostering competitive advantage and sustainable growth (Mahohoma, 2024). However, SMEs are typically opaque in terms of their financial health, as they are not required to present financial statements to the public (Kijkasiwat & Phuensane, 2020). Given this lack of financial transparency, relying on financial indicators alone may not provide an accurate representation of an SME's performance.

Therefore, this study opts for non-financial performance measures, which offer more accessible and meaningful insights into SMEs' performance. In this regard, business growth is chosen as the performance measure, providing a practical and widely applicable means of evaluating SME performance across various industries.

4.6. BUSINESS GROWTH

Business growth is a recognized indicator of organizational success, reflecting a firm's ability to expand, compete, and sustain operations over time. For SMEs, business growth serves as a practical and observable performance measure. Given that financial data is often undisclosed or inconsistent, growth provides a clear and comparable indicator across different sectors (Kijkasiwat & Phuensane, 2020). According to Dev (2022), growth is driven by several factors including market expansion, workforce growth, improved operational efficiency, customer base expansion, increased brand awareness and product or service diversification. Strategic initiatives such as starting new ventures or acquiring other businesses also play a vital role in a firm's development. These factors collectively demonstrate a business's capacity to adapt, scale, and thrive in competitive environments (Dev 2022). Positioning business growth as the performance measure in this study enables an assessment of how environmental sustainability practices contribute not only to immediate outcomes but also to a firm's capacity to evolve and succeed over time.

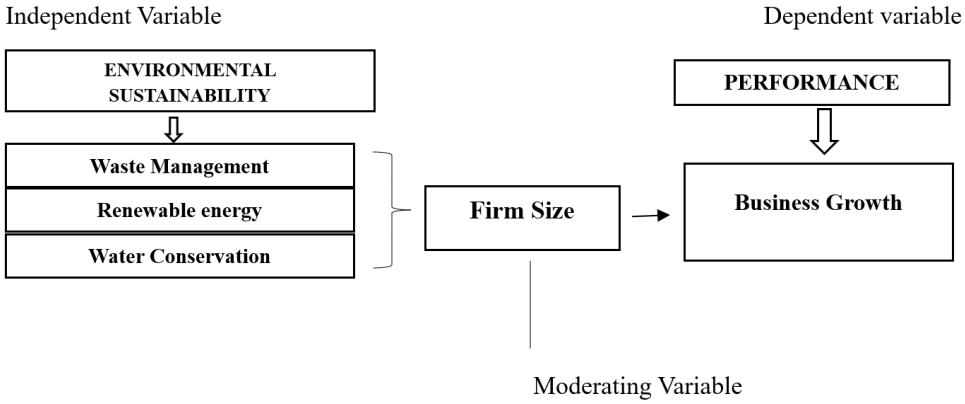
4.7. CONCEPT OF FIRM SIZE

Firm size is a critical moderator in business studies, influencing the relationship between variables and outcomes (Hernández et al., 2020). It classifies firms by assets, sales, or employees, with larger firms generally showing greater financial stability and profitability than smaller ones (Sumaryati & Prawitasari, 2022). Beyond classification, firm size shapes operations, strategic decisions, and sustainability practices, as larger firms benefit from economies of scale and resource availability. In sustainability adoption, larger firms are better positioned due to their resources, capital access, and infrastructure, enabling proactive integration of environmental and social initiatives (Seroka-Stolka & Fijorek, 2020; Baeshen et al., 2021; Abdi et al., 2022; Drempetic et al., 2019). Their size and reputation also heighten sensitivity to stakeholder pressures, reinforcing legitimacy (Zhang & Sharon, 2023). Conversely, smaller firms face resource constraints but may leverage flexibility, entrepreneurial vision, and market proximity to adopt sustainability reactively yet effectively (Baeshen, 2021; Seroka-Stolka & Fijorek, 2020).

Research highlights a complex, possibly curvilinear relationship: while large firms' resources aid sustainability, organizational complexity may hinder it, whereas SMEs' agility fosters innovative strategies (Baeshen et al., 2021; Seroka-Stolka & Fijorek, 2020; Shakil, 2020). The moderating role of firm size in linking environmental sustainability practices to performance remains inconclusive, particularly for SMEs, which can still achieve positive outcomes by capitalizing on unique organizational traits (Seroka-Stolka & Fijorek, 2020). Further empirical work is needed to clarify these dynamics.

4.8. CONCEPTUAL MODEL

Figure 1



5. THEORETICAL FRAMEWORK

The Natural Resource-Based View (NRBV), an extension of the Resource-Based View (RBV), posits that a firm's competitive advantage arises from effectively managing natural resources (Khan, 2024). Introduced by Hart (1995), NRBV suggests that integrating environmental sustainability into core operations through resource efficiency, pollution prevention, and sustainable development can yield long-term competitive benefits (Hart, 1995; Anaman et al., 2023; Mishra & Yadav, 2020). Natural resources such as land, minerals, water, and renewable energy are treated as strategic assets when leveraged responsibly.

NRBV emphasizes stakeholder engagement, including customers, employees, investors, communities, and regulators, to balance economic and environmental goals and maintain legitimacy (Baah et al., 2020; McDougall et al., 2019; Khan, 2024). Firms achieve sustainable advantage by identifying and managing critical resources, optimizing utilization, minimizing waste, and adopting ethical practices such as clean technologies and circular economy principles (Mishra & Yadav, 2020; Anaman et al., 2023; Hart, 1995). Strategic capabilities under NRBV include pollution prevention, product stewardship, and sustainable development. Pollution prevention reduces emissions and waste, improving cost efficiency and compliance (Baah et al., 2020; Mishra & Yadav, 2020). Product stewardship promotes eco-friendly designs and recyclability, enhancing brand differentiation (Khan, 2024; Anaman et al., 2023). Sustainable development integrates economic, environmental, and social objectives to ensure resilience and market stability (McDougall et al., 2019; Hart, 1995; Baah et al., 2020).

NRBV frames sustainability as a competitive strategy, guiding firms toward proactive environmental management, corporate social responsibility, and innovation in clean technologies (Mishra & Yadav, 2020; Baah et al., 2020; Anaman et al., 2023; Khan, 2024). However, challenges include measuring natural resource value, accounting for market fluctuations and regulatory changes, and sustaining long-term advantages amidst complex stakeholder and environmental demands (McDougall et al., 2019; Baah et al., 2020; Anaman et al., 2023; Mishra & Yadav, 2020). Overall, NRBV provides a theoretical foundation for integrating ecological responsibility with economic performance, relevant across industries.

This study adopts NRBV to analyze how environmental sustainability practices influence SME performance. By emphasizing resource efficiency, environmental stewardship, and sustainable development, NRBV guides SMEs in leveraging waste management, water conservation, and renewable energy adoption to reduce environmental impact, lower costs, and strengthen market positioning (Hart, 1995; Anaman et al., 2023; Khan, 2024). Through such strategies, SMEs can enhance productivity, competitive advantage, and long-term viability.

6. EMPIRICAL REVIEW

Waste management has been widely recognized as an essential sustainability practice, offering environmental and economic benefits across sectors. Zakhilwal et al. (2024) emphasize that strategies such as segregation, thermal

treatment, and landfill management, framed within circular economy principles, are crucial for environmental protection and human well-being in Afghanistan. Aiguobarueghian et al. (2024) further highlight that adopting reduce, reuse, recycle, and recover (3R) principles creates economic opportunities, fosters innovation, and strengthens circular business models globally. Derhab and Elkhwesky (2022) demonstrate that recycling, composting, and technology adoption improve environmental performance and competitive advantage, though financial and knowledge constraints remain barriers. Industry-specific studies, such as Jahan et al. (2022) in Australian construction, show that collaboration across stakeholders and adoption of technologies like Building Information Modelling (BIM) enhance waste minimization.

Building on the role of waste management in resource efficiency, water conservation is vital for SMEs to enhance sustainability while maintaining operational efficiency. Omowole et al. (2024) reveal that integrating water-saving technologies alongside energy efficiency and eco-friendly product design can reduce water consumption by up to 40%, lowering costs and protecting community health. Borsacchi and Pinelli (2019) highlight European SMEs implementing wastewater treatment, recycling, and circular economy approaches to optimize resource efficiency, though policy gaps and regulatory barriers remain challenges. Kathambi and Obiero (2021) note that water scarcity, poor quality, and unreliable supply in Kenya disrupt SME operations and financial performance, underscoring the need for proactive water risk management. Industrial-scale reviews, such as Ejairu et al. (2024) and Weerasooriya et al. (2021), further demonstrate that technologies like membrane bioreactors, anaerobic digestion, and water footprint assessment improve efficiency, reduce pollution, and support Sustainable Development Goals (SDGs).

Complementing waste and water management, renewable energy adoption supports environmental conservation while promoting business growth. Majid et al. (2023) show that European SMEs employing eco-efficiency actions such as energy saving, renewable energy use, and offering green productsenhance turnover, particularly when financial incentives are provided. Okere et al. (2023) highlight that private sector credit combined with renewable energy use fosters SME growth and reduces CO_2 emissions across African countries. Ogunyemi and Ishola (2024) demonstrate that data-driven analytics and financial solutions in the USA facilitate renewable energy adoption by overcoming informational and financial barriers. At larger scales, Majeed and Luni (2019) and Khan et al. (2020) confirm that renewable energy mitigates environmental degradation and supports economic growth globally and regionally. Sector-specific research, such as Altassan (2023) in educational institutions and El Khoury et al. (2024) in MENA economies, illustrates that renewable energy integration, when combined with sustainable practices and technological innovation, improves environmental outcomes, reduces costs, and enhances societal benefits. Collectively, these studies demonstrate that SMEs can achieve holistic sustainability by integrating waste management, water conservation, and renewable energy practices.

7. LITERATURE GAP

Despite extensive research on sustainability in Nigeria, significant gaps remain, particularly in the environmental dimension within SMEs. While environmental sustainability has been explored mainly in recycling and renewable energy water conservation is rarely isolated as a key sustainability factor in both global and Nigerian studies, despite its role in resource efficiency.

Little to no research has integrated waste management, water conservation, renewable energy, to measure sustainability while considering firm size as a moderating factor in SME performance. This variable gap limits understanding of how these dimensions interact, leaving gaps in knowledge on their combined impact on business outcomes, specifically in the north-central Nigerian context.

Methodologically, prior research has largely relied on either quantitative or qualitative approaches in isolation, restricting analytical depth and limiting the ability to capture a comprehensive understanding of sustainability practices. While some studies have employed mixed methods, their application remains limited. The predominant reliance on single-method approaches constrains the integration of diverse perspectives, reducing the ability to fully assess the relationship between sustainability practices and SME performance.

This study fills these gaps by examining environmental sustainability practices and performance of SMEs in North-Central Nigeria, incorporating firm size as a moderating variable.

8. METHODOLOGY

The study is grounded in the pragmatic research philosophy, as it provides the necessary flexibility to address complex research problems by integrating multiple perspectives (Saunders et. al 2015). Environmental sustainability practices in SMEs involve both measurable variables and subjective interpretations, making a single philosophical approach insufficient. A purely positivist stance would emphasize numerical data but overlook the contextual and experiential aspects, while an interpretivist stance alone would limit generalizability (Saunders et. al 2015). Pragmatism bridges this gap by allowing the researcher to combine objective data with subjective interpretations, ensuring a more holistic analysis. Survey research design is adopted for the study. This study employs two primary instruments for data collection: a structured questionnaire and a semi-structured interview. These instruments are designed to capture both quantitative and qualitative data to provide a comprehensive understanding of the research problem. The mixed-methods design, supported by pragmatism, ensures that statistical trends from quantitative data are complemented by nuanced perspectives from qualitative interviews. This combination enhances the depth and applicability of the study's conclusions by capturing both the broad patterns of environmental sustainability practices across SMEs and the specific experiences and motivations of SME managers in implementing these practices.

The study focuses on SMEs operating across states in Nigeria's North-central geopolitical zone, specifically Benue, Kogi, Kwara, Nasarawa, Niger, Plateau, and the Federal Capital Territory (FCT). The population consists of SMEs classified by SMEDAN (Small and Medium Enterprise Development Agency of Nigeria) which are nano, micro, small, and medium enterprises based on the number of employees. These classifications align with the study's focus on assessing sustainability practices across different firm sizes.

Table 1

Table 1 Population Distribution of SMEs by Size and by State.

State	Nano	Micro	Small	Medium	Total
Benue	1,580	9,479	13,271	1,580	25,909
Kogi	2,196	7,686	12,087	439	22,400
Kwara	664	10,565	24,952	604	42,561
Nasarawa	2,582	7905	10,163	565	21,450
Niger	3,682	9,205	22,092	1,105	36,084
Plateau	2,912	7,764	19,867	2,265	32,028
FCT	5,047	10,095	18,408	4,453	38,002
Total	18,663	62,699	1,20,840	10,011	2,18,434

(SMEDAN & NBS Report, 2025)

A sample size represents a subset of a population selected for scientific investigation (Taherdoost, 2016). Given the large study population, it is impractical to collect data from every individual. To determine an appropriate sample size, this study applies Yamane's (1967) statistical formula for finite populations:

$$n = \frac{N}{(1 + N(e)2)}$$

Where:

- n = sample size
- N = total population
- e = margin of error (0.05)

Table 2

Table 2 Determination of Sample Size Using Taro Yamane Formula

State	Sample size calculation (Taro Yamane formula)	Sample size (n)
	n = N/ (1 +N (e) 2)	
Benue	n =25,909 /(1 + (25,909 * (0.05)2)	394
Kogi	n= 22,400/ (1 + (22,400 * (0.05)2)	393
Kwara	n = 42,561/ (1 + (42,561 * (0.05)2)	396
Nasarawa	n = 21,450/ (1 + (21,450* (0.05)2)	393
Niger	n = 36,084/ (1 + (36,084 * (0.05)2)	396
Plateau	n = 32,028/ (1 + (32,028 * (0.05)2)	395
FCT	n = 32,028/(1 + (32,028 * (0.05)2)	395
Total		2763

Thus, using Yamane's method, the sample sizes for each state range from 393 to 396. Given that the population consists of SMEs of different categories, Bowley's proportional allocation method was applied to determine the number of respondents per category within each state:

$nh = (Nh/N) * n$

Where:

- nh = sample size allocated to each firm size category
- n = total sample size for the state
- Nh = number of firms in each category
- N= total population in the state

Using Bowley's allocation method, each category (Nano, Micro, Small, and Medium) was assigned a proportionate number of respondents based on its representation within the total SME population in the state.

Table 3

Table 3 Final Allocated Samples

State	Nano	Micro	Small	Medium
Benue	24	144	202	24
Kogi	39	135	212	8
Kwara	7	114	269	7
Nasarawa	48	146	188	10
Niger	40	101	242	12
Plateau	35	93	239	27
FCT	53	105	192	46

Stratified random sampling is adopted to ensure proportional representation across SME subgroups, minimizing bias and enhancing generalizability (Berndt, 2020). Given that firm size is the moderating variable, SMEs are categorized into four strata based on employee count: nano (1–2), micro (3–9), small (10–49), and medium (50–199) (SMEDAN &NBS 2021). Within each stratum, respondents are randomly selected for both the quantitative (questionnaire) and qualitative (interview) phases, ensuring balance and preventing dominance by any single group. This approach aligns with best practices in structured sampling, promoting statistical stability and richer contextual understanding (Turner, 2020).

8.3. MODEL SPECIFICATION

The model used to examine the moderating effect of firm size on the relationship between sustainability practices and SME performance is specified as follows:

SMEP = f (WSM, WCN, REN, FS)

Where: SMEP = SME Performance; WSM = Waste management; WCN = Water conservation; REN = Renewable energy use; FS = Firm size (moderating variable)

The econometric form of the equation is represented as:

$SMEP = \alpha + \beta_1 WSMi + \beta_2 WCNi + \beta_3 RENi + \beta_4 FSi + \varepsilon i$

Where: α = Intercept/Constant; $\beta_1 - \beta_4$ = Coefficients of the independent variables; ε = Error term

9. DATA ANALYSIS

This section presents the validation of the formulated hypotheses through both inferential and thematic analyses. The quantitative data were obtained through a structured questionnaire distributed to SMEs across six states and the Federal Capital Territory in North-Central Nigeria (Benue, Kogi, Kwara, Nasarawa, Niger, Plateau, and FCT) yielding 2,559 valid responses and a response rate of 92.6 percent. Quantitative analysis was performed using Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS, supported by descriptive statistics, reliability, and validity assessments.

The qualitative data, collected through semi-structured interviews with SME owners and managers, were analysed using NVivo software following Braun and Clarke's (2006) six-phase thematic analysis approach. The analysis focused on key environmental sustainability variables namely responsible sourcing, ethical labour practices, and corporate social responsibility (CSR). The integration of both methods enabled the identification of both numerical trends and lived experiences, providing a well-rounded interpretation of findings.

The quantitative model demonstrated good explanatory power, with an R value of 0.688 and an R^2 value of 0.473, indicating that 47.3 percent of the variance in SME performance is explained by environmental sustainability practices and firm size. The model achieved an acceptable fit (SRMR = 0.066, NFI = 0.776), confirming the statistical adequacy for hypothesis testing.

10. MODEL EXAMINATION

The results of the model examination presented in Table 5 provide a detailed picture of how sustainability practices and firm size influence SME performance in North-Central Nigeria. The path coefficients, t-statistics, and p-values collectively determine the significance and strength of each relationship. A key finding is that Firm size (FS → SMEP) shows a positive and statistically significant relationship with SME performance (path coefficient = 0.160, t = 2.303, p = 0.021). This suggests that larger SMEs tend to perform better, likely due to resource advantages, greater capacity to absorb sustainability investments, and stronger market positioning compared to smaller firms.

Table 4

Table 4 Model Examination

Constructs	Path coefficients	T statistics (|O/STDEV|)	P values
FS -> SMEP	0.16	2.303	0.021
REN -> SMEP	0.099	1.21	0.226
WCN -> SMEP	0.117	1.733	0.083
WSM -> SMEP	-0.004	0.052	0.959
FS x WCN -> SMEP	-0.011	0.168	0.867
FS x REN -> SMEP	-0.007	0.08	0.936
FS x WSM -> SMEP	-0.096	1.172	0.241

Source: Research Analysis, 2025

In contrast, other direct relationships show weaker results. renewable energy use (REN → SMEP) had a path coefficient of 0.099 (t = 1.210, p = 0.226), and Similarly, waste management (WSM → SMEP) showed an almost negligible effect (coefficient = -0.004, t = 0.052, p = 0.959). Water conservation (WCN → SMEP)) showed modest positive coefficients of 0.117 but its t-statistics (1.733 and) and p-value (0.083) fall short of the 0.05 threshold, indicating non-

significance at conventional levels. These results suggest that while environmental sustainability practices may conceptually contribute to SME performance, their direct statistical impact in this study context is limited. The moderating role of firm size was also examined by including interaction terms between FS and the sustainability constructs. The results show that none of these interaction effects reached significance. For example, FS × WCN (path coefficient = -0.011, p = 0.867), FS × REN (path coefficient = -0.007, p = 0.936), FS × WSM (path coefficient = -0.096, p = 0.241). These findings imply that while firm size directly influences performance, it does not meaningfully moderate the effect of sustainability practices on SME outcomes.

Taken together, the model examination reveals that the explanatory strength of the model rests mainly on ethical labour practices and firm size, with other sustainability constructs exhibiting limited or non-significant direct effects. This highlights a context-specific reality: environmental sustainability practices, particularly those tied to workforce wellbeing and organisational scale, appear to have greater immediate performance benefits than environmental initiatives. The findings suggest that SMEs in North-Central Nigeria may prioritise social and structural strategies over environmental sustainability due to cost, infrastructure, and awareness challenges. Nonetheless, the positive though insignificant coefficients for CSR, WCN, RSS, and REN indicate potential long-term benefits if these practices are more systematically integrated into SME operations. Overall, the model underscores the dual importance of human-centred sustainability and firm capacity in shaping SME performance.

10.6. SUMMARY OF HYPOTHESES

The results of hypothesis testing, as summarised in Table 5, provide clear insights into the relationships between sustainability practices, firm size, and SME performance in North-Central Nigeria. Each hypothesis was tested using t-statistics and p-values, with the decision rule set at a significance level of 0.05.

Table 5

Table 5 Summary of Hypotheses

Hypothesis	t-statistic	p-value	Decision
Ho1: Waste management has no significant effect on business growth of SMEs	0.052	0.959	Rejected (no effect)
Ho2: Use of renewable energy has no significant effect on business growth of SMEs	1.21	0.226	Rejected (no effect)
Ho3: Water conservation has no significant effect on business growth of SMEs	1.733	0.083	Rejected (no effect)
Ho4: Firm size has no significant moderating effect on sustainability practices and business growth of SMEs	2.303	0.021	Accepted (significant moderating effect)

Source: Research Analysis, 2025

For Ho1, which stated that waste management has no significant effect on business growth of SMEs, the results show a t-statistic of 0.052 and a p-value of 0.959. These values are far from significance, leading to rejection of the null hypothesis on the grounds of statistical insignificance. This suggests that waste management practices, though conceptually valuable, do not currently exert a measurable effect on SME performance in the study context. Ho2, addressing renewable energy use, recorded a t-statistic of 1.210 and a p-value of 0.226. This result is also statistically insignificant, meaning the null hypothesis is rejected, and renewable energy does not demonstrate a meaningful effect on SME growth. The insignificance may be attributed to high initial investment costs and infrastructural barriers that hinder SMEs from realising measurable performance benefits from renewable energy adoption. Ho3 examined the effect of water conservation on SME performance. The test results yielded a t-statistic of 1.733 and a p-value of 0.083, which falls short of the 0.05 threshold. As such, the null hypothesis is rejected on statistical grounds, showing no significant effect. The finding implies that while water conservation may be environmentally beneficial, it has yet to translate into measurable business growth benefits for SMEs in the region. Ho4 addressed the moderating role of firm size. The results show a t-statistic of 2.303 and a p-value of 0.021, both of which are statistically significant. Thus, the null hypothesis is accepted, confirming that firm size significantly moderates the relationship between sustainability practices and SME performance. This finding highlights that larger SMEs are better positioned to translate sustainability initiatives into business growth, due to their stronger resource bases and operational capacities. Peddi and Pandey (2026)

The hypotheses testing indicates that among the four propositions, only firm size moderation (Ho4) show significant effects on SME performance, while all environmental practices (Ho1–Ho3) remain statistically insignificant. These

results suggest that organisational capacity is the most immediate and powerful lever of SME growth in North-Central Nigeria, while environmental practices, although conceptually relevant, face contextual challenges that limit their measurable impact.

10.2. QUALITATIVE FINDINGS FROM INTERVIEWS

The qualitative component explored SME owners' and managers lived experiences and perceptions of environmental sustainability. Semi-structured interviews were conducted across the seven study states, and data were analysed using NVivo software following Braun and Clarke's (2006) six-step thematic analysis framework. The result revealed that sustainability-oriented practices among SMEs in North-Central Nigeria are shaped by practical, economic, and social motivations.

10.3. WASTE MANAGEMENT AND BUSINESS GROWTH

Waste management practices were found to be the most widespread and economically impactful sustainability measure across the seven states studied (Benue, Kogi, Kwara, Nasarawa, Niger, Plateau and FCT). Approximately half of all coded responses referenced activities such as recycling, reuse, composting, and waste-to-energy initiatives. For many SMEs, waste management was not only an environmental concern, but a strategic business decision driven by cost efficiency and reputation building.

In Benue State, agro-based enterprises reported significant cost savings through composting and reuse of organic waste. One agro-processor explained: "Our maize husks and cassava peels are composted and used on our plots. That simple act reduces fertiliser expenses by nearly one-third." This practice transformed agricultural waste from a liability into an input for productivity. However, the same respondent acknowledged labour intensity as a constraint: "It takes time to turn the compost pits, and during peak season that labour could go into production. But we still do it because the savings matter."

In Kogi State, entrepreneurs innovatively turned food-processing waste into feedstock for animals. A juice producer shared: "We sell fruit peelings to local farmers. It brings in about ₦15,000 monthly and saves us from disposal costs." This approach highlights how circular economy thinking though informally applied can enhance income diversification for SMEs.

Niger and Plateau States demonstrated the most advanced recycling practices. Metal, textile, and ceramic SMEs described systematic reuse of by-products. A Plateau-based ceramics manufacturer stated: "We reuse broken or misfired pieces by crushing them into powder and mixing them with new clay. It cuts our raw material costs by 25%, which saves roughly ₦4 million every year."

Nasarawa State SMEs emphasised community relations as a by-product of waste reuse. One cassava processor remarked: "Instead of paying to dump peelings, we let nearby farmers take them for free. It helps them and keeps them loyal to us as suppliers."

Challenges across states included contamination, lack of waste-sorting infrastructure, and insufficient technical knowledge. Yet, SMEs consistently viewed waste as both an economic asset and a social instrument, confirming that sustainability practices contribute to cost reduction, brand enhancement, and relationship-building.

10.4. RENEWABLE ENERGY ADOPTION AND BUSINESS GROWTH

The second major theme, renewable energy adoption, underscored the growing role of energy diversification in SME competitiveness. Across regions, solar photovoltaic (PV) technology was the most adopted renewable option. Respondents frequently linked renewable energy use to lower operating costs, reduced dependence on unreliable public power, and improved brand image.

A Benue State respondent shared a striking example: "We installed a 10 kW solar system, and it has cut diesel use by half. That's about ₦70,000 in monthly savings." Despite these benefits, limitations persisted. Another participant from the same state added: "Our solar system only runs during the day. At night, we still depend on generators, which doubles maintenance costs."

In Kogi State, affordability emerged as the dominant barrier. As one SME owner put it: "A ₦3 million solar setup is out of reach when you're struggling with working capital. If we had access to grants or loans, we'd switch immediately."

Kwara State respondents reported improvements in productivity and reliability. A textile manufacturer noted: "Since switching to solar, we haven't delayed shipments. Our customers stay with us because they can rely on our timelines."

Nasarawa entrepreneurs proposed cooperative and shared energy models to overcome capital constraints: "If five or six of us pool funds for a mini-solar grid, the cost becomes manageable. We could even sell excess energy to nearby shops."

In Niger State, SMEs linked renewable energy adoption directly to profit retention and equipment longevity: "With solar, we save about ₦80,000 every month and avoid generator wear and tear. It's a double gain."

Plateau-based respondents, particularly in hospitality and creative sectors, highlighted the reputational advantage of green branding: "Clients in Abuja prefer to work with us because we use eco-friendly energy. It gives us a modern image."

While the overall sentiment toward renewable energy was positive, widespread adoption remains hindered by high initial costs, limited access to technical expertise, and inconsistent government incentives. Nonetheless, the findings affirm that renewable energy contributes to SME growth through financial efficiency, brand differentiation, and operational continuity.

10.5. WATER CONSERVATION AND BUSINESS GROWTH

Water conservation represented another crucial sustainability practice adopted by SMEs, particularly in agro-processing, textiles, and hospitality. The data revealed a combination of low-cost and innovative techniques rainwater harvesting, wastewater reuse, dual-filtration systems, and the use of low-flow fixtures to reduce consumption and ensure steady water supply during shortages.

In Benue State, water conservation was driven primarily by necessity. One food processor stated: "Public supply is unreliable and expensive. We built rainwater tanks and store enough to last two weeks." This practice not only ensured uninterrupted production but also lowered monthly water bills by an estimated 20–30%.

In Kogi State, entrepreneurs reported installing water-efficient fixtures as a dual strategy for savings and customer appeal: "We fitted low-flow taps to reduce our water bills. It also shows customers that we care about sustainability."

Kwara SMEs emphasised resource recycling. A textile producer shared: "We reuse rinse water for the first stages of dyeing. It saves cost and shows clients that we operate responsibly."

Nasarawa State respondents extended conservation to social collaboration. One bakery owner noted: "We share stored water with neighbours when there's shortage. It builds goodwill and trust in the community."

In Niger and Plateau, the findings revealed relatively advanced systems. A Plateau ceramic SME described the benefits of biofiltration: "Our biofilter system cleans wastewater, and we reuse it for cleaning. It reduces bills and impresses clients who value eco-friendliness."

Despite these innovations, SMEs cited challenges such as maintenance burdens, initial setup costs, and lack of technical skills. However, the broader narrative suggests that water conservation enhances cost control, fosters stability during supply disruptions, and strengthens business-community relations.

10.6. INTERPRETIVE SUMMARY

The findings demonstrate that sustainability practices among SMEs in North-Central Nigeria are not isolated acts of environmental responsibility but integral components of strategic business management. Consistent with Chege and Wang (2020), the results affirm that SMEs contribute significantly to environmental transformation through context-driven innovations that simultaneously advance economic goals.

Waste management practices reveal how environmental consciousness aligns with cost-saving imperatives, supporting the view that ecological efficiency and profitability are mutually reinforcing. Renewable energy adoption underscores the transition from reactive to proactive sustainability, where firms view energy diversification not merely as risk management but as brand differentiation and competitiveness strategy. Meanwhile, water conservation practices

show that even resource-scarce SMEs can embed sustainability in daily operations, enhancing both adaptability and community legitimacy.

Overall, these findings suggest that sustainability-driven growth among SMEs in the region follows a resource-constraint adaptation model entrepreneurs innovate not because of external mandates but because resource efficiency and social reciprocity are essential to survival. However, the transformative potential of these practices remains under-realised due to limited financing, technical expertise, and institutional support. As one respondent aptly concluded,

"We know waste is wealth, solar saves money, and water reuse keeps us running. But without capital and support, our sustainability potential stays half-tapped."

This interpretive finding reinforces the argument that supporting SMEs through targeted financing, capacity-building, and enabling policy frameworks is critical to advancing sustainable economic growth at the grassroots level.

11. CONCLUSION

This study highlights that sustainability practices, though unevenly adopted, play a crucial role in the growth of SMEs in North-Central Nigeria. While environmental practices such as waste management, renewable energy, and water conservation did not exhibit significant direct statistical effects, they generated notable indirect benefits, including improved operational efficiency, community goodwill, and enhanced reputation. Firm size emerged as a key factor, with larger SMEs better positioned to implement sustainable practices due to greater financial and resource capacity, whereas smaller firms faced cost and infrastructure constraints. Overall, despite partial adoption and resource limitations, sustainability remains a critical driver of long-term resilience, competitiveness, and inclusive growth for SMEs in the region

12. RECOMMENDATIONS

To enhance environmental sustainability among SMEs in North-Central Nigeria, the study recommends:

1) Establish cluster-based recycling hubs and provide training on cost-effective waste segregation, composting, and resource recovery. Public–private partnerships can supply collection materials and biodegradable packaging.
2) Introduce concessional loans, tax incentives, and a dedicated "Green SME Fund" to support investments in solar systems. Government certification of reliable suppliers can build trust and ensure quality.
3) Promote rainwater harvesting and wastewater reuse through pilot projects, technical assistance, and rebates or grants for approved equipment. Demonstration sites can showcase practical cost-saving methods.
4) Integrate sustainability modules into entrepreneurship programs, provide online training and mentoring, and expand access to green microfinance, digital credit, and grants for small enterprises.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

REFERENCES

Abdi, Y., Li, X., & Càmara-Turull, X. (2021). Exploring the impact of sustainability (ESG) disclosure on firm value and financial performance (FP) in airline industry: the moderating role of size and age. Environment Development and Sustainability, 24(4), 5052–5079. https://doi.org/10.1007/s10668-021-01649-w

Abdullahi, U., Ardo, Y., Hassan, A., & Ibrahim, G. (2022). Assessment of financial and non-financial performance indicators used by small and medium construction firms in Nigeria. FUTY Journal of the Environment, 15(2). https://www.ajol.info/index.php/fje/article/view/225585

Adebayo, Y. A., Ikevuje, A. H., Kwakye, J. M., & Esiri, A. E. (2024). A model for assessing the economic impact of renewable energy adoption in traditional oil and gas companies. GSC Advanced Research and Reviews, 20(3), 298–315. https://doi.org/10.30574/gscarr.2024.20.3.035

Adesua-Lincoln, A. (2025). Challenges to environmental sustainability and circular economy practices of Nigerian small and medium enterprises. Journal of Sustainable Business, 10(1). https://doi.org/10.1186/s40991-025-00110-9

Agu, N. E. E., Iyelolu, N. T. V., Idemudia, N. C., & Ijomah, N. T. I. (2024). Exploring the relationship between sustainable business practices and increased brand loyalty. International Journal of Management & Entrepreneurship Research, 6(8), 2463–2475. https://doi.org/10.51594/ijmer.v6i8.1365

Aiguobarueghian, N. I., Adanma, N. U. M., Ogunbiyi, N. E. O., & Solomon, N. N. O. (2024). Waste management and circular economy: A review of sustainable practices and economic benefits. World Journal of Advanced Research and Reviews, 22(2), 1708–1719. https://doi.org/10.30574/wjarr.2024.22.2.1517

Akor, M. O. (2023). Business Sustainability: Understanding the influence of managers and stakeholders on adopting sustainability practices in Nigerian SMEs. [PhD]. University of Wolverhampton.

Altassan, A. (2023). Sustainable integration of solar energy, behavior change, and recycling practices in educational institutions: A Holistic Framework for environmental conservation and quality Education. Sustainability, 15(20), 15157. https://doi.org/10.3390/su152015157

Amiolemen, S. O., Adenekan, O., Ologeh, I., Omoyajowo, K., Oludoye, O., & Raimi, M. (2024). Evaluation of the perception and adoption of environmental management system in small and medium enterprises in the manufacturing sector in Lagos and Ogun States, southwestern Nigeria. Journal of Applied Science and Environmental Management, 28(9), 2777–2783. https://doi.org/10.4314/jasem.v28i9.21

Anaman, P. D., Ahmed, I. A., Suleman, A., & Dzakah, G. A. (2023). Environmentally sustainable business practices in micro, small, and medium Enterprises: A Sub-Saharan African Country Perspective. Business Perspectives and Research, 227853372311627. https://doi.org/10.1177/22785337231162740

Atadoga, N. A., Awonuga, N. K. F., Ibeh, N. C. V., Ike, N. C. U., Olu-Lawal, N. K. A., & Usman, N. F. O. (2024). Harnessing Data Analytics for Sustainable Business Growth in the U.S. Renewable Energy Sector. Engineering Science & Technology Journal, 5(2), 460–470. https://doi.org/10.51594/estj.v5i2.806

Berndt, A. E. (2020). Sampling methods. Journal of Human Lactation, 36(2), 224–226. https://doi.org/10.1177/0890334420906850

Borsacchi, L., & Pinelli, P. (2019). Sustainable and innovative practices of small and medium-sized enterprises in the water and waste management sector. In Elsevier eBooks (pp. 255–290). https://doi.org/10.1016/b978-0-12-817382-4.00008-3a

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Chege, S. M., & Wang, D. (2020). The influence of technology innovation on SME performance through environmental sustainability practices in Kenya. Technology in Society, 60, 101210. https://doi.org/10.1016/j.techsoc.2019.101210

Chou, W. (2024). How Sustainable Practices Affect the Financial Performance of Glove Manufacturers [PHd Dissertation]. Dr. Robert K. Jabs School of Business.

Ciocnitu, C. R. (2024). Strategies for Implementing Sustainability in entrepreneurial Businesses. Ovidius University Annals Economic Sciences Series, 23(2), 53–60. https://doi.org/10.61801/ouaess.2023.2.07

Derhab, N., & Elkhwesky, Z. (2022). A systematic and critical review of waste management in micro, small and medium-sized enterprises: future directions for theory and practice. Environmental Science and Pollution Research, 30(6), 13920–13944. https://doi.org/10.1007/s11356-022-24742-7

Dev. (2022). Growth drivers for the SMEs. Research Gate. https://www.researchgate.net/publication/359295002_Growth_drivers_for_the_SMEs

Drempetic, S., Klein, C., & Zwergel, B. (2019). The influence of firm size on the ESG Score: Corporate Sustainability Ratings under review. Journal of Business Ethics, 167(2), 333–360. https://doi.org/10.1007/s10551-019-04164-1

Durrani, N., Raziq, A., Mahmood, T., & Khan, M. R. (2024). Barriers to adaptation of environmental sustainability in SMEs: A qualitative study. PLoS ONE, 19(5), e0298580. https://doi.org/10.1371/journal.pone.0298580

Ejairu, N. U., Aderamo, N. a. T., Olisakwe, N. H. C., Esiri, N. a. E., Adanma, N. U. M., & Solomon, N. N. O. (2024). Eco-friendly wastewater treatment technologies (concept): Conceptualizing advanced, sustainable wastewater treatment

designs for industrial and municipal applications. Comprehensive Research and Reviews in Engineering and Technology, 2(1), 083–104. https://doi.org/10.57219/crret.2024.2.1.0063

El Khoury, R., Du, A. M., Nasrallah, N., Marashdeh, H., & Atayah, O. F. (2024). Towards sustainability: Examining financial, economic, and societal determinants of environmental degradation. Research in International Business and Finance, 73, 102557. https://doi.org/10.1016/j.ribaf.2024.102557

El-Yaqub, A. B., Ismail, Y., & Usman, G. (2025). Impact of Financing Small and Medium Enterprises on Sustainable Development in Nigeria., 2 (6),9-18. MRS Journal of Accounting and Business Management, 2(6), 9–18.

Enyi, L. A., Adebanjo, T. O., & Adudu, C. A. (2024). Green production and performance of small and medium enterprises in north central Nigeria. International Journal of Business & Entrepreneurship Research, 14(11), 86–97.

Gaikwad, R. R., & Sathe, C. (2024). Environment and Sustainability Pillar. Journal of Social Science and Humanities, 6(9), 183–186. https://doi.org/10.53469/jssh.2024.6(09).33

Hart, S. L. (1995). A natural-resource-based view of the firm. Academy of Management Review, 20(4), 986-1014

Hernández, J. P. S., Yañez-Araque, B., & Moreno-García, J. (2019). Moderating effect of firm size on the influence of corporate social responsibility in the economic performance of micro-, small- and medium-sized enterprises. Technological Forecasting and Social Change, 151, 119774. https://doi.org/10.1016/j.techfore.2019.119774

Iheanachor, N. (2020). Sustainable business practices by Nigerian organizations. In IntechOpen eBooks. https://doi.org/10.5772/intechopen.93834

Iheanachor, N., & Etim, E. (2022). SMES and Sustainable Development in Africa: Understanding the impact of governments' supports. In Palgrave Studies in African Leadership (pp. 147–169). https://doi.org/10.1007/978-3-031-04923-1_8

Jahan, I., Zhang, G., Bhuiyan, M., Navaratnam, S., & Shi, L. (2022). Experts' perceptions of the management and minimisation of waste in the Australian construction industry. Sustainability, 14(18), 11319. https://doi.org/10.3390/su141811319

Kathambi, N. B. E., & Obiero, N. L. (2021). Unseen barrier of water risks to sustainable consumption and production in micro, small and medium enterprises (MSMES) in Kenya. East African Journal of Science Technology and Innovation, 2. https://doi.org/10.37425/eajsti.v2i.355

Khan, A. (2024). Business Development and Sustainability: A Systematic Review. International Journal of Multidisciplinary Innovation and Research Methodology (IJMIRM), 3(2), 2960–2068. https://ijmirm.com

Khan, S. a. R., Yu, Z., Sharif, A., & Golpîra, H. (2020). Determinants of economic growth and environmental sustainability in South Asian Association for Regional Cooperation: evidence from panel ARDL. Environmental Science and Pollution Research, 27(36), 45675–45687. https://doi.org/10.1007/s11356-020-10410-1

Kijkasiwat, P., & Phuensane, P. (2020). Innovation and Firm performance: the moderating and mediating roles of firm size and small and medium enterprise finance. Journal of Risk and Financial Management, 13(5), 97. https://doi.org/10.3390/jrfm13050097

Kumar, C. R. J., Arunsi, M. B., Jenova, R., & Majid, M. A. (2019). Sustainable Waste Management Through Waste to Energy Technologies in India-Opportunities and Environmental Impacts. International Journal of Renewable Energy Research, Vol.9(No.1). https://www.researchgate.net/publication/331967959

Kumar, C. R., & Majid, M. A. (2020). Renewable energy for sustainable development in India: current status, future prospects, challenges, employment, and investment opportunities. Energy Sustainability and Society, 10(1). https://doi.org/10.1186/s13705-019-0232-1

Kurunthachalam, S. K. (2014). Water conservation and sustainability: an utmost importance. Hydrology Current Research, 05(02). https://doi.org/10.4172/2157-7587.1000e117

Mahohoma, T. (2024). A comparison of the usage between financial and non-financial performance metrics in Small and Medium Enterprises (SMEs) in South Africa. International Journal of Research in Business and Social Science (2147-4478), 13(5), 547–557. https://doi.org/10.20525/ijrbs.v13i5.3540

Majeed, M. T., & Luni, T. (2019). Renewable Energy, Water, and Environmental Degradation: A Global Panel Data approach. Pakistan Journal of Commerce and Social Sciences, 3(3), 749–778.

Mapuka, F. N., Nel, W., & Kalumba, A. M. (2024). Exploring household water conservation methods in rural South Africa: a case of the Mbhashe and Mnquma local municipalities. Sustainable Water Resources Management, 10(4). https://doi.org/10.1007/s40899-024-01127-x

McDougall, N., Wagner, B., & MacBryde, J. (2019). An empirical explanation of the natural-resource-based view of the firm. Production Planning & Control, 30(16), 1366–1382. https://doi.org/10.1080/09537287.2019.1620361

Mehta, D., Paliwal, D., Tege, S., & Sankhla, V. (2018). Sustainable Waste Management: An Approach Towards Sustainability. Journal of Emerging Technologies and Innovative Research, 5(9), 101–104. https://www.jetir.org/view?paper=JETIRB006022

Mishra, P., & Yadav, M. (2020). "Environmental capabilities, proactive environmental strategy and competitive advantage: A natural-resource-based view of firms operating in India." Journal of Cleaner Production, 291, 125249. https://doi.org/10.1016/j.jclepro.2020.125249

Mondal, S., Singh, S., & Gupta, H. (2023). Green entrepreneurship and digitalization enabling the circular economy through sustainable waste management - An exploratory study of emerging economy. Journal of Cleaner Production, 422, 138433. https://doi.org/10.1016/j.jclepro.2023.138433

Ogunyemi, K. (2022). Leadership for Sustainable Development in Africa: roles and responsibilities. In Palgrave Studies in African Leadership (pp. 1–17). https://doi.org/10.1007/978-3-031-04923-1_1

Ogunyemi, N. F. M., & Ishola, N. A. O. (2024). Encouraging investment in renewable energy through data-driven analytics and financial solutions for SMEs. World Journal of Advanced Science and Technology, 6(2), 058–069. https://doi.org/10.53346/wjast.2024.6.2.0054

Okere, K. I., Ibe, G. I., Muoneke, O. B., & Nwaeze, N. C. (2023). Environmental sustainability, small and medium enterprises, and finance in Africa: a triplicate relationship. Environmental Science and Pollution Research, 30(14), 41359–41378. https://doi.org/10.1007/s11356-022-25012-2

Okpokam, E. A. (2021). Small and medium enterprises' green Energy Strategies for Profitability [PhD Dissertation, Walden University]. https://scholarworks.waldenu.edu/dissertations

Omowole, N. B. M., Olufemi-Phillips, N. a. Q., Ofodile, N. O. C., Eyo-Udo, N. N. L., & Ewim, N. S. E. (2024). Conceptualizing green business practices in SMEs for sustainable development. International Journal of Management & Entrepreneurship Research, 6(11), 3778–3805. https://doi.org/10.51594/ijmer.v6i11.1719

Peddi, S., & Pandey, N. (2026). Meditation And Psychological Capital Among Faculty Members: A Theory-Driven Review Of Well-Being, Engagement, And Performance Outcomes. ShodhPrabandhan: Journal of Management Studies, 3(1), 42-46. https://dx.doi.org/10.29121/ShodhPrabandhan.v3.i1.2026.78

Said, M. A., Hassan, F. U., Islam, M. S., Toriman, M. E. B., Rehim, A., Bashir, M. A., Raza, H. M. A., & Nawaz, R. (2024). Environmental sustainability. In Advances in environmental engineering and green technologies book series (pp. 1–15). https://doi.org/10.4018/979-8-3693-2845-3.ch001

Sala, S. (2020). Triple bottom line, sustainability and sustainability assessment, an overview. In Elsevier eBooks (pp. 47–72). https://doi.org/10.1016/b978-0-12-815581-3.00003-8

Saunders, M. N. K., Bristow, A., Thornhill, A., & Lewis, P. (2015). Understanding research philosophy and approaches to theory development. In Open Research Online (The Open University).

Saunders, M. N., Lewis, P., & Thornhill, A. (2009). Research methods for business students (5th edition). England: Pearson Education Limited.

Seroka-Stolka, O., & Fijorek, K. (2020). Enhancing corporate sustainable development: Proactive environmental strategy, stakeholder pressure and the moderating effect of firm size. Business Strategy and the Environment, 29(6), 2338–2354. https://doi.org/10.1002/bse.2506

Shakil, M. H. (2020). Environmental, social and governance performance and stock price volatility: A moderating role of firm size. Journal of Public Affairs, 22(3). https://doi.org/10.1002/pa.2574

Singh, N. S. (2024). Lifestyle for Environment Mission and Environmental Sustainability. International Journal for Research Publication and Seminars, 15(2), 232–238. https://doi.org/10.36676/jrps.v15.i2.1417

Slávik, S.; Jankelová, N.; Hudáková, I. M.; Mišún, J. (2023). Determinants of the growth of Small and Medium Enterprises, Entrepreneurship and Sustainability Issues 11(2): 480-497. https://doi.org/10.9770/jesi.2023.11.2(32)

SMEDAN & NBS (2021). Small and Medium Enterprises Development Agency of Nigeria & National Bureau of Statistics. National Survey of Micro, Small and Medium Enterprises.

Taherdoost, H. (2016). Sampling methods in research methodology; How to choose a sampling technique for research. International Journal of Academic Research in Management (IJARM), 5(2), 18–27.

Toromade, N. A. S., & Chiekezie, N. N. R. (2024). Driving sustainable business practices in SMEs: Innovative approaches for environmental and economic synergy. International Journal of Management & Entrepreneurship Research, 6(8), 2637–2647. https://doi.org/10.51594/ijmer.v6i8.1411

Turner, D. P. (2020). Sampling methods in research design. Headache: The Journal of Head and Face Pain, 60(1), 8–12.

Vetrivel, S. C., Vidhyapriya, P., & Arun, V. P. (2024). Environmental sustainability and green ambidexterity. In Advances in human resources management and organizational development book series (pp. 121–146). https://doi.org/10.4018/979-8-3693-5981-5.ch006

Weerasooriya, R. R., Liyanage, L. P. K., Rathnappriya, R. H. K., Bandara, W. B. M. a. C., Perera, T. a. N. T., Gunarathna, M. H. J. P., & Jayasinghe, G. Y. (2021). Industrial water conservation by water footprint and sustainable development goals: a review. Environment Development and Sustainability, 23(9), 12661–12709. https://doi.org/10.1007/s10668-020-01184-0

Yadav, P., Saurabh, S., & Bollempalli, V. P. (2024). Environmental sustainability. In Elsevier eBooks. https://doi.org/10.1016/b978-0-443-13701-3.00225-5

Yamane, T. (1967). Statistics: an introductory analysis, 2nd Edition, New York: Harper and Row.

Zakhilwal, S. A., Shirzad, W., & Behsoodi, M. M. (2024). A Comprehensive review of engineering Strategies for environmental sustainability in sustainable waste management. International Journal of Current Science Research and Review, 07(10). https://doi.org/10.47191/ijcsrr/v7-i10-02

Zhang, J. (2024). The Economic Benefits of Renewable Energy: Impact on Traditional energy markets. Highlights in Business Economics and Management, 30, 352–359. https://doi.org/10.54097/0ddb2n81

Zhang, Y., & Sharon, C. P. Y. (2023). The Influence of Firm Size and Institutional Environment on ESG Disclosure - Evidence from Listed Companies in China. International Journal of Academic Research in Economics and Management Sciences, 12(2). https://doi.org/10.6007/ijarems/v12-i2/16284

Zheng, L., Ye, L., Wang, M., Wang, Y., & Zhou, H. (2022). Does water matter? The impact of water vulnerability on corporate financial performance. International Journal of Environmental Research and Public Health, 19(18), 11272. https://doi.org/10.3390/ijerph191811272