

Green Entrepreneurship in Africa: The Environmental Sustainability, Eco-Innovation, and Inclusive Economic Empowerment Nexus

Deodat Emilson Adenutsi

dadenutsi@htu.edu.gh

Ho Technical University

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Abstract

Green entrepreneurship is increasingly positioned as a critical mechanism for reconciling environmental sustainability with inclusive economic development in Africa. However, empirical evidence explaining how green entrepreneurship is associated with economic and social value remains limited. This study addresses this gap by analysing an integrated, ecosystem-based model linking green entrepreneurship to environmental sustainability and inclusive economic empowerment. Using a quantitative explanatory design and applying PLS-SEM to survey data from 8,553 small and medium-scale enterprises across 12 African countries. The model examines direct effects, the mediating role of eco-innovation, and the moderating influence of green finance, while incorporating key ecosystem enablers, including sustainable public procurement signals and indigenous knowledge synergies. Ecosystem enablers are positively associated with green entrepreneurial activity, while green finance strengthens the observed relationships among green entrepreneurship, innovation and environmental outcomes, although its association with inclusive economic empowerment is more conditional. The study evidences an innovation-led pathway through which green entrepreneurship delivers socio-environmental returns, implying that procurement rules, green finance, and innovation policy should be jointly aligned to scale green ventures, thereby strengthening sustainable development trajectories in Africa.

Keywords: Green Entrepreneurship, Environmental Sustainability, Eco-Innovation, Economic Empowerment

JEL Classification: G28, L26, O31, O55, Q36

1. INTRODUCTION

The global pursuit of sustainable development has intensified calls for transformative economic paradigms that address climate resilience, inclusive growth, and structural poverty alleviation. Within this evolving discourse, green entrepreneurship has emerged as a strategic lever, particularly salient for low-income regions such as Africa, which are characterised by heightened youth unemployment, climate-induced vulnerabilities, and systemic institutional fragilities (UNEP 2021; Osabuohien, Gitau and Efobi 2022). Green entrepreneurship serves as a strategic bridge between ecological sustainability and economic empowerment by integrating eco-innovation and inclusive business practices (Schaltegger and Wagner 2011).

Despite growing theoretical interest, green entrepreneurial ecosystems in Africa remain nascent, undercapitalised, and fragmented. Empirical gaps persist in understanding the catalytic role of institutional signals, local market dynamics and indigenous knowledge systems associated with green start-up development across African economies. These deficiencies have resulted in policy incoherence, suboptimal financial flows, and exclusion of rural communities and vulnerable populations from green transitions.

This study responds to these lacunae by modelling the drivers and developmental consequences of green entrepreneurship through an integrative framework. Drawing on an ecosystem-based development lens, this study tests how sustainable public procurement signals, climate-risk finance infrastructure, local demand for sustainable products, and indigenous knowledge synergies shape the incidence and efficacy of green entrepreneurship. It also evaluates the mediating and reinforcing roles of eco-innovation in promoting environmental sustainability and inclusive economic empowerment, while assessing the moderating effect of green financing availability.

The pertinent research questions guiding this study are: To what extent do sustainable public procurement signals, climate-risk finance infrastructure, indigenous knowledge synergy, and demand for sustainable products foster green entrepreneurship in Africa? How does green entrepreneurship influence eco-innovation, environmental sustainability, and inclusive economic empowerment? What are the mediating linkages between green entrepreneurship, eco-innovation, environmental sustainability, and economic empowerment? How does the availability of green finance moderate the relationship between green entrepreneurship and its development outcomes?

Accordingly, this study has four key objectives. First, it empirically assesses the influence of entrepreneurial ecosystem factors such as public procurement signals, climate-risk finance, indigenous knowledge, and sustainability-driven local demand on the growth of green entrepreneurship. Second, it aims to examine the direct and reinforcing relationships of green entrepreneurship on eco-innovation, environmental sustainability, and inclusive economic empowerment. Third, we explore the mediating role of eco-innovation in transmitting the effects of green entrepreneurship on environmental and economic outcomes. Fourth, we evaluate the moderating effects of green finance availability on the efficacy of green entrepreneurship in enhancing innovation and socio-environmental outcomes.

This research is both timely and policy relevant. It reinforces the assertion that entrepreneurship, when properly aligned with sustainability objectives, can disrupt the poverty trap endemic to low-income economies. Embedding green entrepreneurship within Africa's developmental planning, this study highlights pathways to foster employment creation, empower marginalised communities, and enhance ecological resilience. Furthermore, this study introduces a robust, context-sensitive impact assessment model that can guide donor interventions, government reforms, and investment strategies across the continent.

This study advances the green entrepreneurship literature in three important ways. First, it extends existing ecosystem, resource-based, and innovation perspectives by theorising and

empirically validating an African Green Entrepreneurial Ecosystem Pathway through which ecosystem conditions are translated into environmental sustainability and inclusive economic empowerment. Rather than treating ecosystem drivers, entrepreneurship, innovation, finance, and development outcomes as separate phenomena, the study demonstrates how they operate as an interconnected system. Second, the study identifies eco-innovation as the principal transmission mechanism through which green entrepreneurial activity is associated with environmental and socioeconomic value, thereby providing a clearer explanation of how sustainability-oriented entrepreneurship produces development outcomes. Third, the study demonstrates that green finance functions as a boundary condition that shapes the effectiveness of this pathway, strengthening the capacity of green entrepreneurial initiatives to generate innovation and sustainability outcomes. Collectively, these contributions move beyond conventional direct-effect explanations and provide a more integrated theoretical understanding of the green entrepreneurship–development nexus within African economies.

The next section presents a review of the literature, followed by a discussion of methodological and data issues in Section 3. Section 4 presents and discusses the findings, and Section 5 concludes the study with implications and recommendations.

2.0 LITERATURE REVIEW

2.1 Entrepreneurial Ecosystem Drivers of Green Entrepreneurship

Green entrepreneurship does not emerge in isolation; it is shaped by the institutional, financial, market, and knowledge conditions within which firms operate. The theoretical logic underpinning this study is integrative and multi-level. Institutional Theory provides the macro-level explanation by showing how formal rules, policy signals, financial infrastructure, and market-supporting institutions influence the opportunity structure within which green entrepreneurial activity emerges (North 1990; Stam 2015; Spiegel 2017). The Resource-Based View and Natural Resource-Based View complement this perspective by explaining how firms transform these ecosystem conditions into valuable resources, sustainability capabilities, and environmentally oriented competitive advantages (Barney 1991; Hart and Dowell 2011). Schumpeterian Innovation Theory subsequently explains how these capabilities generate developmental value through eco-innovation, which transforms environmental opportunities into new products, processes, and business models (Schumpeter 1934). Accordingly, Institutional Theory explains why green entrepreneurial opportunities emerge, the Resource-Based and Natural Resource-Based Views explain how firms mobilise resources to exploit those opportunities, while Schumpeterian Innovation Theory explains how entrepreneurial

action correlates with innovation-led environmental and socioeconomic outcomes. Within African entrepreneurial ecosystems, sustainable public procurement signals, climate-risk finance infrastructure, local demand for sustainable products, and indigenous knowledge synergy may therefore function as enabling conditions for green entrepreneurship.

Empirical evidence generally supports this proposition. Green public procurement can serve as a demand-side policy instrument by signalling the public sector's preference for environmentally responsible products and services, thereby encouraging suppliers to adopt greener business models (Testa et al. 2012; Cheng et al. 2018). Similarly, access to finance remains central to SME greening because environmental investments often require upfront capital, risk-sharing instruments and patient financing (OECD 2020; UNEP 2021). Market demand also matters: firms are more likely to adopt green product, pricing, distribution and promotional strategies when such practices improve market differentiation and performance (Leonidou et al. 2013). In African contexts, indigenous knowledge and grassroots innovation provide locally embedded resources for sustainable entrepreneurship, especially where formal institutions and technological infrastructure remain weak (Onwuegbuzie et al. 2024).

However, the evidence also suggests that these drivers are conditional rather than automatic. Green procurement may have limited entrepreneurial effects where public institutions lack enforcement capacity, supplier-monitoring systems or transparent tendering rules. Green finance may fail to stimulate green ventures when SMEs face collateral constraints, high transaction costs or weak project-preparation capacity. Similarly, local demand for sustainable products may be constrained by price sensitivity, limited consumer awareness and low purchasing power in developing markets. African evidence further shows that although entrepreneurs' environmental consciousness can support green business behaviour, its effect depends on firm competitiveness, entrepreneurial characteristics and market conditions (Bawakyillenuo and Agbelie 2021). Thus, ecosystem drivers are more likely to promote green entrepreneurship when institutional signals, finance, market demand and locally relevant knowledge reinforce one another. Accordingly, the following hypotheses are proposed:

H1a: Sustainable public procurement signals positively influence green entrepreneurship.

H1b: Climate-risk finance infrastructure positively influences green entrepreneurship.

H1c: Local demand for sustainable products positively influences green entrepreneurship.

H1d: Indigenous knowledge synergy positively influences green entrepreneurship.

2.2 Green Entrepreneurship, Eco-Innovation and Development Outcomes

Schumpeterian Innovation Theory views entrepreneurship as a process through which innovation transforms economic systems by creating new products, processes and markets (Schumpeter 1934). Within the sustainability domain, green entrepreneurs pursue economic opportunities while simultaneously addressing environmental challenges through environmentally responsible innovations. Complementing this perspective, the Natural-Resource-Based View argues that firms generate competitive advantage by developing environmental capabilities that improve resource efficiency, reduce ecological impacts and create long-term value (Hart and Dowell 2011). Together, these perspectives suggest that green entrepreneurship is positively associated with eco-innovation, which subsequently contributes to environmental sustainability and inclusive economic empowerment.

Empirical evidence generally supports these relationships. Green entrepreneurship has been found to promote eco-innovation by encouraging the development of cleaner technologies, environmentally friendly products and sustainable production systems (Dean and McMullen 2007; Cohen and Winn 2007; Schaltegger and Wagner 2011; Gast, Gundolf and Cesinger 2017). Eco-innovation is positively associated with environmental sustainability through reductions in pollution, resource consumption and waste generation (Horbach, Rammer and Rennings 2012). Several studies further report that green entrepreneurial activities create employment opportunities, improve incomes and contribute to broader socioeconomic inclusion, particularly through renewable energy, sustainable agriculture and circular-economy initiatives (Adenutsi 2023; UNEP 2021; Sutter et al. 2019; Shepherd and Patzelt 2011). Similarly, eco-innovation can strengthen economic empowerment by improving firm competitiveness, productivity and market access while generating environmentally sustainable growth opportunities.

Nevertheless, the evidence is not entirely consistent. Some studies suggest that the environmental benefits of green entrepreneurship are contingent upon firm capabilities, technological readiness and institutional support. Others find that eco-innovation may improve environmental performance without necessarily generating significant socioeconomic benefits, particularly where innovation remains capital-intensive and weakly linked to local employment creation. Moreover, some green ventures experience difficulties balancing environmental objectives with commercial viability, resulting in weaker innovation outcomes than theoretically anticipated.

African evidence generally supports the positive developmental role of green entrepreneurship while highlighting contextual challenges. Studies show that green entrepreneurial initiatives in sectors such as renewable energy, sustainable agriculture and

waste management contribute to innovation, environmental improvement and livelihood enhancement (George, Merrill and Schillebeeckx 2021; Shepherd and Patzelt 2011). However, institutional weaknesses, infrastructure deficits and financing constraints often limit the scale and sustainability of these outcomes. Consequently, green entrepreneurship appears most effective when supported by complementary innovation and ecosystem capabilities. Accordingly, the following hypotheses are proposed:

H2: Green entrepreneurship positively influences eco-innovation.

H3: Green entrepreneurship positively influences environmental sustainability.

H4: Green entrepreneurship positively influences inclusive economic empowerment.

H5: Eco-innovation positively influences environmental sustainability.

H6: Eco-innovation positively influences inclusive economic empowerment.

2.3 Eco-Innovation as a Mediating Mechanism

Eco-innovation provides the theoretical mechanism through which green entrepreneurship is expected to be associated with environmental sustainability and inclusive economic empowerment. Schumpeterian Innovation Theory suggests that entrepreneurship is associated with developmental change primarily through innovation, while the Natural-Resource-Based View explains that environmental capabilities create value when they are converted into pollution prevention, cleaner production, resource efficiency and sustainable product development. From this perspective, green entrepreneurship may not directly produce sustainability outcomes unless entrepreneurial intentions and opportunities are operationalised through eco-innovative products, processes, technologies and organisational practices.

Empirical evidence supports this mediating logic. Schaltegger and Wagner (2011) argue that sustainable entrepreneurship is closely linked to sustainability innovation because entrepreneurs address environmental and social problems through market-based innovation. Horbach, Rammer and Rennings (2012) further show that eco-innovation is shaped by regulatory, technological and market factors and contributes to different forms of environmental improvement. More recent evidence also indicates that eco-innovation improves SMEs' sustainable performance, although the magnitude of the effect varies across innovation types and contexts (Xie et al. 2019; Horbach et al. 2012; Schaltegger and Wagner 2011). As revealed by Adenutsi (2023), these findings imply that eco-innovation functions as a conversion mechanism through which entrepreneurial activity is associated with measurable environmental and socioeconomic outcomes.

The evidence, however, is mixed regarding the strength and universality of this mediation. Some studies report that eco-innovation produces stronger environmental than economic or social effects, especially where innovations are capital-intensive, weakly commercialised or insufficiently linked to employment creation. Others show that eco-innovation outcomes depend on firm resources, managerial capabilities, regulatory pressure and market acceptance. In developing and African contexts, this conditionality is particularly important because SMEs often face finance constraints, weak technological infrastructure and limited absorptive capacity. Thus, green entrepreneurship is more likely to generate sustainability and empowerment outcomes when eco-innovation effectively connects environmental opportunity recognition with practical changes in products, processes and business models.

Accordingly, eco-innovation is conceptualised in this study as a mediating mechanism linking green entrepreneurship to environmental and inclusive development outcomes. The following hypotheses are therefore proposed:

H7a: Eco-innovation mediates the relationship between green entrepreneurship and environmental sustainability.

H7b: Eco-innovation mediates the relationship between green entrepreneurship and inclusive economic empowerment.

2.4 Green Finance as a Moderating Mechanism

Green finance is increasingly recognised as a critical institutional resource for advancing sustainable entrepreneurship and innovation. From an Institutional Theory perspective, specialised financial mechanisms, including green credit, sustainability-linked lending, climate funds and environmental investment incentives, provide the enabling conditions that influence firms' capacity to pursue sustainability-oriented opportunities. Similarly, the Resource-Based View suggests that access to financial resources strengthens a firm's ability to acquire technologies, develop capabilities and implement innovations that generate competitive and sustainability advantages (Barney 1991). Consequently, green finance is expected not merely to exert a direct influence on firm outcomes but to strengthen the effectiveness of green entrepreneurship in generating innovation, environmental performance and inclusive development outcomes.

Empirical evidence largely supports this proposition. Studies show that firms with greater access to green finance are more likely to invest in environmentally friendly technologies, adopt eco-innovative practices and improve environmental performance

(Taghizadeh-Hesary and Yoshino 2019). Green finance reduces capital constraints associated with sustainability investments and facilitates the commercialisation of environmentally responsible innovations. More recent evidence further suggests that financial support mechanisms enhance the ability of sustainability-oriented enterprises to scale operations and achieve measurable environmental outcomes.

However, the evidence is not uniformly conclusive. Some studies find that the effectiveness of green finance depends on institutional quality, regulatory credibility, financial market development, and firms' absorptive capacities. In developing economies, limited access to formal finance, information asymmetries, and weak green finance ecosystems may reduce the effectiveness of sustainability-focused financial instruments (Adenutsi 2023; George 2016). Furthermore, while green finance frequently strengthens innovation and environmental outcomes, its contribution to broader socioeconomic inclusion appears less consistent, as employment creation and empowerment often depend on complementary social, educational and institutional interventions.

Thus, the literature suggests that green finance functions as an enabling condition that amplifies the developmental effectiveness of green entrepreneurship, particularly with respect to innovation and environmental sustainability. Accordingly, the following hypotheses are proposed:

H8a: Green finance positively moderates the relationship between green entrepreneurship and eco-innovation.

H8b: Green finance positively moderates the relationship between green entrepreneurship and environmental sustainability.

H8c: Green finance positively moderates the relationship between green entrepreneurship and inclusive economic empowerment.

2.5 Research Gap and Positioning of the Study

Despite growing interest in green entrepreneurship, important gaps remain in the literature. Existing studies have largely examined entrepreneurial ecosystem conditions, eco-innovation, sustainability outcomes and green finance as separate phenomena, providing limited understanding of how these factors interact within an integrated development framework. Furthermore, insufficient attention has been given to the mechanisms through which green entrepreneurship translates ecosystem conditions into environmental sustainability and inclusive economic empowerment, particularly through eco-innovation. Evidence on the conditioning role of green finance also remains limited and inconclusive. These gaps are

especially pronounced in Africa, where green entrepreneurial ecosystems operate under distinct institutional, financial and socio-cultural conditions but remain underrepresented in the literature.

To address these shortcomings, this study develops and tests an integrated African Green Entrepreneurial Ecosystem Framework that conceptualises green entrepreneurship as the central mechanism through which ecosystem conditions are converted into environmental sustainability and inclusive economic empowerment via eco-innovation, while recognising green finance as a critical boundary condition shaping this process.

2.6 Conceptual Framework and Hypotheses Summary

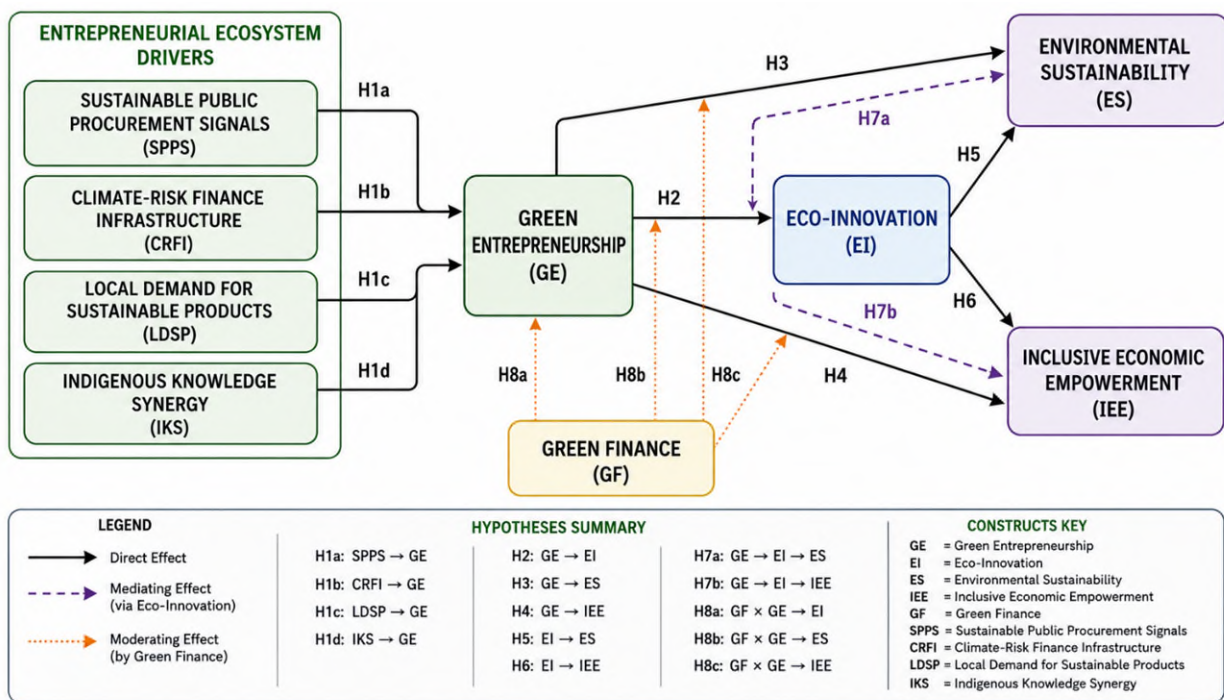


Figure 1: Conceptual Framework

Figure 1 summarises the hypothesised relationships among the study constructs. Sustainable public procurement signals, climate-risk finance infrastructure, local demand for sustainable products, and indigenous knowledge synergy are specified as ecosystem drivers of green entrepreneurship (H1a–H1d). Green entrepreneurship is then expected to influence eco-innovation (H2), environmental sustainability (H3), and inclusive economic empowerment (H4), while eco-innovation further contributes to environmental sustainability (H5) and inclusive economic empowerment (H6). The framework also specifies eco-innovation as a mediating mechanism linking green entrepreneurship to environmental sustainability and

inclusive economic empowerment (H7a–H7b)¹. Finally, green finance is modelled as a moderating condition that strengthens the effects of green entrepreneurship on eco-innovation, environmental sustainability, and inclusive economic empowerment (H8a–H8c).

3.0 METHODOLOGY

3.1 Research Design

This study employs a quantitative, explanatory research design grounded in a structural modelling approach to examine the drivers, transmission mechanisms, and developmental outcomes of green entrepreneurship across African economies. The design is explicitly aligned with the study's systems-oriented conceptual framework, which positions green entrepreneurship as a central coordinating mechanism linking ecosystem-level enablers to innovation, environmental sustainability, and inclusive economic empowerment.

To capture the complexity of these relationships, the empirical model jointly estimates direct effects, mediating pathways, and moderating influences within a unified analytical structure. This approach enables the identification of both linear and indirect dynamics characterising green entrepreneurial systems in institutionally heterogeneous and resource-constrained contexts. Accordingly, the design is well suited to addressing the research questions, which require simultaneous assessment of theoretically specified relationships, conditional effects, and transmission mechanisms within a unified analytical framework.

3.2 Population, Sampling, and Data Collection

The study population comprised SMEs employing between nine and 50 full-time workers and operating across 12 African countries, *viz.* Cameroon, Egypt, Ethiopia, Ghana, Kenya, Nigeria, Rwanda, South Africa, Tanzania, Togo, Zambia, and Zimbabwe. These countries were selected to ensure broad regional representation and to capture heterogeneity in entrepreneurial activity, institutional environments, and the maturity of green innovation ecosystems. The objective of the study was to identify broad continent-level patterns across diverse African SME contexts rather than to undertake country-specific comparative analysis. The sampled enterprises spanned thirteen industrial sectors, including agriculture, manufacturing, hospitality, information and communication technology, and environmentally oriented services, thereby enhancing both cross-country and cross-sectoral representativeness. The geographical

¹To avoid over-congestion, H7c and H7d are not shown in the Conceptual Framework. Refer to Table 7 for the specification of these two hypotheses.

distribution of sampled firms across countries and sectors is illustrated in **Figure A1**, while the sectoral composition and proportional allocation are summarised in **Table A1**.

A stratified, multi-stage sampling strategy was employed. In the first stage, country-specific sampling frames were constructed using official SME registers obtained from national and subnational agencies responsible for enterprise development, complemented by verified listings from recognised business associations and chambers of commerce. In the second stage, firms were stratified by sector and size to ensure proportional representation within each country. In the final stage, enterprises were selected using proportionate stratified random sampling. The unit of analysis was the firm, and one knowledgeable respondent, typically the owner, founder, or a senior manager with strategic oversight, was surveyed per enterprise, ensuring that responses reflected firm-level strategic and operational realities.

Primary data were collected using a standardised, structured questionnaire administered electronically through secure digital survey platforms. The instrument was implemented in the official language of each sampled country, with trained field enumerators providing clarification and technical assistance where necessary to minimise response bias and non-completion. Prior to full deployment, the questionnaire was pre-tested to assess clarity, contextual relevance, and internal consistency. Embedded validation checks and post-collection screening procedures were applied to identify incomplete responses, logical inconsistencies, and extreme outliers. Of the more than 15,000 enterprises initially contacted, 8,553 valid responses were retained for analysis, forming the final dataset used for model estimation and hypothesis testing. A detailed summary of the sample characteristics and data screening outcomes is provided in **Table A1**.

Data collection was conducted over an 84-day period, from 14 September to 6 December 2025. Throughout the process, ethical standards consistent with international research norms were strictly observed. Participation was voluntary, informed consent was obtained from all respondents, and no personal or sensitive information was collected. The study relied exclusively on firm-level data, thereby minimising ethical risk while ensuring confidentiality, data integrity, and compliance with responsible research practice.

3.3 Measurement of Constructs

All latent constructs in this study were operationalised using multi-item reflective indicators adapted from established entrepreneurship, sustainability, innovation, and development literature. For well-established constructs such as Green Entrepreneurship, Eco-Innovation, Environmental Sustainability, Inclusive Economic Empowerment, and Green Financing,

measurement items were adapted from previously validated scales. For ecosystem-level constructs, namely Sustainable Public Procurement Signals, Climate-Risk Finance Infrastructure, and Indigenous Knowledge Synergy, the indicators were theory-driven adaptations derived from relevant conceptual and empirical literature. As summarised in **Table 1**, these constructs were operationalised to capture context-specific dimensions of African entrepreneurial ecosystems that are not consistently represented by standardised measurement scales in the existing literature. Consequently, their empirical adequacy was evaluated through a comprehensive assessment of internal consistency reliability, convergent validity, indicator reliability, and discriminant validity, the results of which are reported in Tables 3–5.

Although some ecosystem-level constructs may be conceptualised as multidimensional phenomena, they were modelled reflectively because the indicators were designed to capture respondents' overall perceptions of the underlying ecosystem conditions rather than distinct independent components. Consistent with this specification, the indicators are treated as observable manifestations of latent perceptions of procurement support, climate-finance infrastructure, and indigenous knowledge integration within the entrepreneurial ecosystem.

The core endogenous constructs comprise Green Entrepreneurship (GE), Eco-Innovation (EI), Environmental Sustainability (ES), and Inclusive Economic Empowerment (IEE). Green Financing (GF) is modelled as a reflective moderating construct, while entrepreneurial ecosystem drivers (Sustainable Public Procurement Signals (SPPS), Climate-Risk Finance Infrastructure (CRFI), Local Demand for Sustainable Products (LDSP), and Indigenous Knowledge Synergy (IKS)), are specified as exogenous reflective constructs. All measurement items were assessed using a Likert-type scale, with higher values indicating stronger agreement with the underlying construct statements.

Table 1: Construct Operationalisation, Theoretical Basis, and Sources of Measurement Scales

Construct	Conceptual Definition	Primary Source(s)	Adaptation
Sustainable Public Procurement Signals (SPPS)	Extent to which public procurement policies and tendering processes provide market signals favouring environmentally sustainable products and services	Testa et al. (2016); Cheng et al. (2018)	Adapted to African SME context

Climate-Risk Finance Infrastructure (CRFI)	Availability of financial instruments and institutional mechanisms supporting climate adaptation and environmental investments	UNEP (2021); OECD (2020)	Adapted to SME climate-finance environment
Local Demand for Sustainable Products (LDSP)	Market demand for environmentally sustainable goods and services	Leonidou, Katsikeas and Morgan (2013); Hojnik et al. (2020)	Adapted
Indigenous Knowledge Synergy (IKS)	Integration of indigenous ecological knowledge and traditional environmental practices into entrepreneurial activities	Onwuegbuzie et al. (2024)	Adapted
Green Entrepreneurship (GE)	Entrepreneurial activities that simultaneously pursue economic and environmental value creation	Schaltegger and Wagner (2011); Dean and McMullen (2007)	Adapted
Eco-Innovation (EI)	Development and implementation of products, processes, and managerial practices that reduce environmental impacts	Chen et al. (2006); Horbach et al. (2012)	Adapted
Environmental Sustainability (ES)	Organisational environmental performance reflected in resource efficiency, emissions reduction, waste minimisation, and regulatory compliance	Hart and Dowell (2011); Elkington (1997)	Adapted
Inclusive Economic Empowerment (IEE)	Extent to which entrepreneurial activities contribute to employment	UNEP (2021); ILO (2022)	Adapted

	creation, income generation, skills development, and participation of disadvantaged groups		
Green Financing (GF)	Availability and accessibility of financial resources specifically supporting environmentally sustainable investments and innovations	OECD (2020); UNEP (2021)	Adapted

To ensure conceptual consistency and content validity, the adapted measurement items were carefully aligned with the theoretical definitions of the respective constructs while reflecting the operational realities of African SMEs. Context-specific modifications were limited to wording and contextual framing and did not alter the underlying conceptual domains represented by the original measures. This approach enhances the relevance of the instrument to the study setting while maintaining comparability with established entrepreneurship, sustainability, innovation, and development research.

Table 2: Summary of Reflective Constructs

Construct	Model Measurement Type	Basis
Green Entrepreneurship (GE)	Reflective	Attitudinal/perceptual items
Eco-Innovation (EI)	Reflective	Observable outcomes
Environmental Sustainability (ES)	Reflective	Sustainability performance
Inclusive Economic Empowerment (IEE)	Reflective	Socio-economic impacts
Green Financing (GF)	Reflective	Financial accessibility
SPPS, CRFI, LDSP, IKS	Reflective	Ecosystem perceptions

Table 2 presents the reflective measurement specification adopted for all latent constructs, together with their underlying conceptual basis. This specification provides the foundation for the subsequent assessment of reliability, convergent validity, discriminant validity, and structural model estimation.

3.4 Analytical Procedure

The proposed conceptual framework was estimated using Partial Least Squares Structural Equation Modelling (PLS-SEM). PLS-SEM is particularly appropriate for the present study because it accommodates complex theoretical models involving multiple latent constructs and simultaneously estimates structural relationships among them. The technique is also well suited to prediction-oriented research and to models incorporating mediation and moderation mechanisms within a single analytical framework.

Model estimation was conducted using SmartPLS version 4.0. Prior to structural model assessment, the measurement model was evaluated to establish indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. Subsequently, the structural model was assessed using established PLS-SEM procedures. Statistical significance was evaluated through bootstrapping with 5,000 resamples, while model adequacy and predictive relevance were assessed using standard criteria, including the Standardised Root Mean Square Residual (SRMR), Normed Fit Index (NFI), coefficients of determination (R^2), effect sizes (f^2), and predictive relevance measures (Q^2).

3.5 Hypotheses Estimation and Model Specification

Following the analytical procedure outlined in Section 3.4, the proposed conceptual framework was empirically estimated through a structured, multi-stage modelling process. The estimation strategy was designed to test the full set of hypothesised relationships, encompassing direct effects, mediating pathways, and moderating influences.

In the first stage, the direct structural relationships between entrepreneurial ecosystem drivers, namely sustainable public procurement signals, climate-risk finance infrastructure, local demand for sustainable products, and indigenous knowledge synergy, and green entrepreneurship were estimated. The direct effects of green entrepreneurship on eco-innovation, environmental sustainability, and inclusive economic empowerment were then assessed, alongside the direct effects of eco-innovation on environmental sustainability and inclusive economic empowerment.

In the second stage, mediation effects were examined to evaluate the role of eco-innovation as a transmission mechanism linking green entrepreneurship to environmental sustainability and inclusive economic empowerment. In addition, sequential mediation pathways were specified to assess whether the effects of entrepreneurial ecosystem drivers on developmental outcomes operate indirectly through green entrepreneurship and eco-innovation. Indirect effects were estimated using bootstrapped confidence intervals to determine their statistical significance.

In the third stage, moderating effects were introduced to assess the conditioning role of green financing on the relationships between green entrepreneurship and its key outcomes. Latent interaction terms were constructed to estimate whether the strength of the green entrepreneurship–eco-innovation, green entrepreneurship–environmental sustainability, and green entrepreneurship–inclusive economic empowerment relationships varies systematically with the availability of green financing. Simple slope analyses were subsequently employed to aid interpretation of statistically significant interaction effects.

Statistical inference for all structural paths was based on a non-parametric bootstrapping procedure with 5,000 resamples, yielding robust standard errors, t-values, and confidence intervals. Variance inflation factors were examined to assess potential multicollinearity, and effect sizes were computed to evaluate the substantive relevance of statistically significant relationships. The combined estimation strategy ensures a comprehensive and internally consistent assessment of the hypothesised structural relationships underpinning the green entrepreneurship–development nexus.

The structural model was specified to examine the theoretically hypothesised relationships among ecosystem drivers, green entrepreneurship, eco-innovation, green finance, environmental sustainability, and inclusive economic empowerment. Accordingly, the analysis prioritises the explanatory mechanisms embedded in the proposed framework rather than estimating a broad set of firm-specific or country-level determinants. Although factors such as firm age, firm size, sector, ownership structure, country context, and location may influence sustainability and empowerment outcomes, they are not the central theoretical focus of the present model. Their potential influence is acknowledged, and future robustness extensions may incorporate such controls to assess the stability of the estimated relationships across firm-level and country-level heterogeneity.

4.0 RESULTS AND DISCUSSIONS

4.1 Measurement Model

Table 3 provides strong evidence of internal consistency and convergent validity across all the constructs. Cronbach’s alpha and composite reliability (CR) exceeded the threshold of 0.70, with AVE values ranging from 0.596 to 0.821, confirming construct reliability and convergent validity (Hair et al. 2022).

Table 3: Evidence of construct reliability and convergent validity

Constructs	Loadings (λ)	Cronbach's alpha	CR (rho_c)	AVE
Eco-innovation	0.626–0.859	0.862	0.897	0.596
Environmental sustainability	0.852–0.944	0.927	0.948	0.821
Green entrepreneurship	0.618–0.901	0.835	0.893	0.680
Green financing	0.684–0.910	0.837	0.890	0.672
Inclusive economic empowerment	0.807–0.901	0.853	0.901	0.695
Indigenous knowledge synergy	0.703–0.924	0.866	0.907	0.711
Local Demand for Sustainable Products	0.719–0.867	0.843	0.886	0.611
Sustainable public-procurement signal	0.811–0.895	0.883	0.920	0.741

Note: CR = Composite reliability; AVE = Average variance extracted.

To further assess convergent validity, the individual factor loadings of all reflective items were examined. As shown in **Table 4**, all item loadings exceeded the recommended threshold of 0.70 (Hair et al., 2022), indicating that the indicators strongly reflect their respective latent constructs. This supports the adequacy of the measurement model and justifies the use of reflective specification.

Table 4: Indicator Loadings for Reflective Measurement Constructs

Code	Items	Loadings
SPPS1	Public bodies in our market consistently specify environmental criteria in tenders.	0.782
SPPS2	Tenders that include green criteria are awarded promptly and transparently.	0.909
SPPS3	Information on green-preferencing rules is readily available to suppliers.	0.861
SPPS4	Winning government contracts in our sector depends on verifiable environmental performance.	0.832
CRFI1	Affordable insurance products covering climate-related losses are accessible to my firm.	0.734
CRFI2	Local banks offer credit lines designed for investments that reduce climate risk.	0.734
CRFI3	Public or donor guarantees lower the cost of borrowing for resilience projects.	0.713
CRFI4	Clear guidance exists on how MSMEs can apply for climate-risk finance.	0.891
LDSP1	Customers value products with verified environmental attributes.	0.832
LDSP2	Our sales rise when we promote the environmental benefits of our offerings.	0.856
LDSP3	Distributors request environmentally improved versions of existing products.	0.705
LDSP4	End-users frequently enquire about the ecological impact of our products.	0.913
LDSP5	Green labelling has helped us reach new market segments.	0.883
IKS1	We integrate local traditional ecological knowledge into product or process design.	0.747
IKS2	Community elders are consulted on resource-management practices.	0.740
IKS3	Traditional stewardship principles inform our sourcing decisions.	0.740

IKS4	Employees receive training on culturally embedded environmental practices.	0.767
GE1	We proactively seek business opportunities that address environmental problems.	0.815
GE2	The firm is willing to take risks to introduce environmentally sound innovations.	0.795
GE3	We frequently pioneer green products or services ahead of competitors.	0.764
GE4	Environmental goals are central to strategic decision-making.	0.835
GF1	Loans at preferential rates are available for environmentally beneficial projects.	0.731
GF2	Investors show interest in funding our green initiatives.	0.764
GF3	Grants or subsidies for low-carbon technologies are within reach of MSMEs.	0.781
GF4	Financial institutions offer advice tailored to financing green projects.	0.800
EI1	We have developed products that reduce raw-material use or waste generation.	0.873
EI2	Key production processes have been redesigned to lower emissions.	0.744
EI3	Life-cycle assessment informs our research and development activities.	0.813
EI4	Our patents or trade secrets relate to environmentally superior technologies.	0.830
EI5	Environmental criteria are included in supplier and partner selection.	0.710
EI6	We launch marketing initiatives that highlight environmental improvements.	0.834
ES1	Energy use per unit of output has fallen over the past three years.	0.738
ES2	We consistently meet or exceed regulatory emission standards.	0.714
ES3	Waste generated per unit of sales has declined year on year.	0.909
ES4	Environmental targets set by the firm are regularly achieved.	0.912
IEE1	Our operations create decent jobs for people from low-income backgrounds.	0.878
IEE2	Employees are paid wages that meet or exceed the local living-wage benchmark.	0.767
IEE3	We provide training that enhances employability of marginalised groups.	0.721
IEE4	Women- or youth-owned local suppliers are actively integrated into our value chain.	0.851

Table 5 further affirms discriminant validity using both the Fornell-Larcker criterion and HTMT ratio, ensuring that all latent variables are empirically distinct. This supports the robustness of the measurement model and validates the use of reflective indicators as conceptualised in the theoretical literature (Barney 1991; Hart and Dowell 2011).

Table 5: Discriminant validity

<i>Fornell-Larcker criterion</i>									
Constructs	CRFI	EI	ES	GE	GF	IEE	IKS	LDSP	SPPS
CRFI	0.786								
EI	0.707	0.772							
ES	0.730	0.687	0.906						
GE	0.691	0.697	0.717	0.825					
GF	0.691	0.686	0.729	0.735	0.820				

IEE	0.642	0.615	0.791	0.596	0.718	0.834			
IKS	0.529	0.591	0.569	0.572	0.690	0.633	0.843		
LDSP	0.687	0.713	0.738	0.737	0.713	0.618	0.555	0.782	
SPPS	0.698	0.648	0.556	0.621	0.569	0.490	0.423	0.625	0.861
<i>Heterotrait-Monotrait Ratio (HTMT) – Matrix Criterion</i>									
Constructs	CRFI	EI	ES	GE	GF	IEE	IKS	LDSP	SPPS
CRFI									
EI	0.836								
ES	0.844	0.758							
GE	0.825	0.817	0.810						
GF	0.813	0.767	0.789	0.851					
IEE	0.787	0.711	0.878	0.699	0.839				
IKS	0.604	0.650	0.584	0.635	0.770	0.716			
LDSP	0.797	0.810	0.810	0.841	0.794	0.713	0.614		
SPPS	0.806	0.744	0.612	0.719	0.630	0.557	0.456	0.697	

4.2 Common Method Bias Assessment

Given that the study relied on cross-sectional survey data collected from a single respondent within each firm, both procedural and statistical remedies were employed to assess the potential influence of common method bias (CMB). Procedurally, respondents were assured of anonymity and confidentiality, and the questionnaire was carefully structured to minimise ambiguity and evaluation apprehension. Statistically, Harman's single-factor test was conducted by loading all 39 measurement items into an unrotated factor solution. The first factor accounted for 46.37% of the total variance, which is below the recommended threshold of 50%, suggesting that common method bias is unlikely to represent a serious concern.

Furthermore, a full collinearity assessment following Kock (2015) revealed VIF values ranging from 2.011 to 4.024, all of which remained below the conventional threshold of 5.0 as reported in **Table 6**. Collectively, the evidence from Harman's single-factor test and the full collinearity diagnostics indicates that common method bias is unlikely to materially threaten the validity and robustness of the findings.

Table 6: Full Collinearity Assessment for Common Method Bias

Construct	Full Collinearity VIF
SPPS	2.267
CRFI	3.219
LDSP	2.939
IKS	2.011
GE	3.099
GF	3.479

EI	2.962
ES	4.024
IEE	3.140

However, given the single-respondent and cross-sectional survey design, the possibility of residual common method variance cannot be completely excluded and is therefore acknowledged as a limitation.

To further assess the potential influence of common method bias, a full collinearity assessment was conducted following Kock (2015). As reported in **Table 6**, the full collinearity VIF values ranged from 2.011 to 4.024. Most constructs recorded VIF values below the recommended threshold of 3.3, while the values for Green Financing and Environmental Sustainability marginally exceeded this conservative benchmark but remained well below the conventional threshold of 5.0. These results suggest that neither multicollinearity nor common method bias poses a serious threat to the validity and interpretability of the structural model estimates. Accordingly, the empirical findings can be considered sufficiently robust for subsequent hypothesis testing and structural model evaluation.

4.3 Structural Model Results, Moderation Effects, and Predictive Model Comparison

4.3.1 Results of Empirical Structural Model

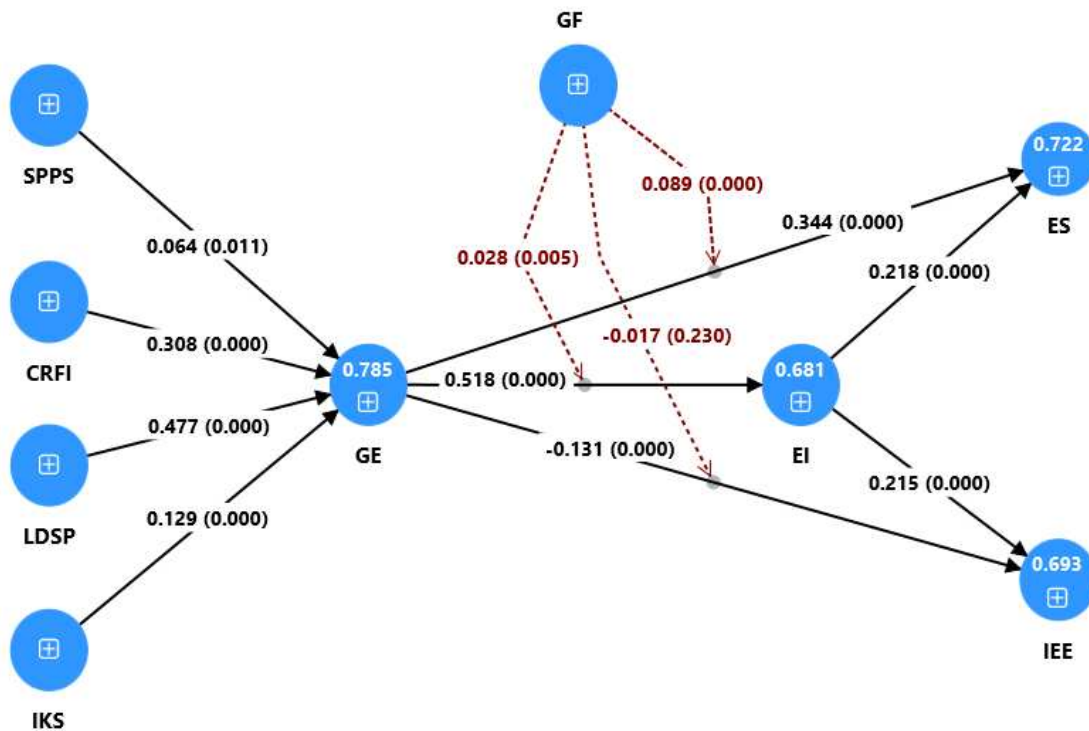


Figure 2: Results of the Structural Path Model

Figure 2 presents the estimated structural path model, illustrating the direction and relative strength of the hypothesised relationships among ecosystem drivers, green entrepreneurship, eco-innovation, environmental sustainability, and inclusive economic empowerment. The **Figure 2** highlights green entrepreneurship as the central transmission node within the system, linking ecosystem conditions to developmental outcomes both directly and indirectly through eco-innovation.

4.3.2 Analysis of Moderation Effects

Figures 3 and **4** visually demonstrate the positive moderating effect of green financing on the relationship between green entrepreneurship, eco-innovation (H8a), and environmental sustainability (H8b). The slopes are steeper at higher levels of green finance availability, suggesting that financial inclusion magnifies the development yield of green enterprise initiatives. However, the moderating effect on empowerment (H8c) is statistically insignificant, suggesting that socioeconomic inclusion is less sensitive to financing conditions and may depend more on social capital, institutional access, and gendered dynamics (UNEP 2021).

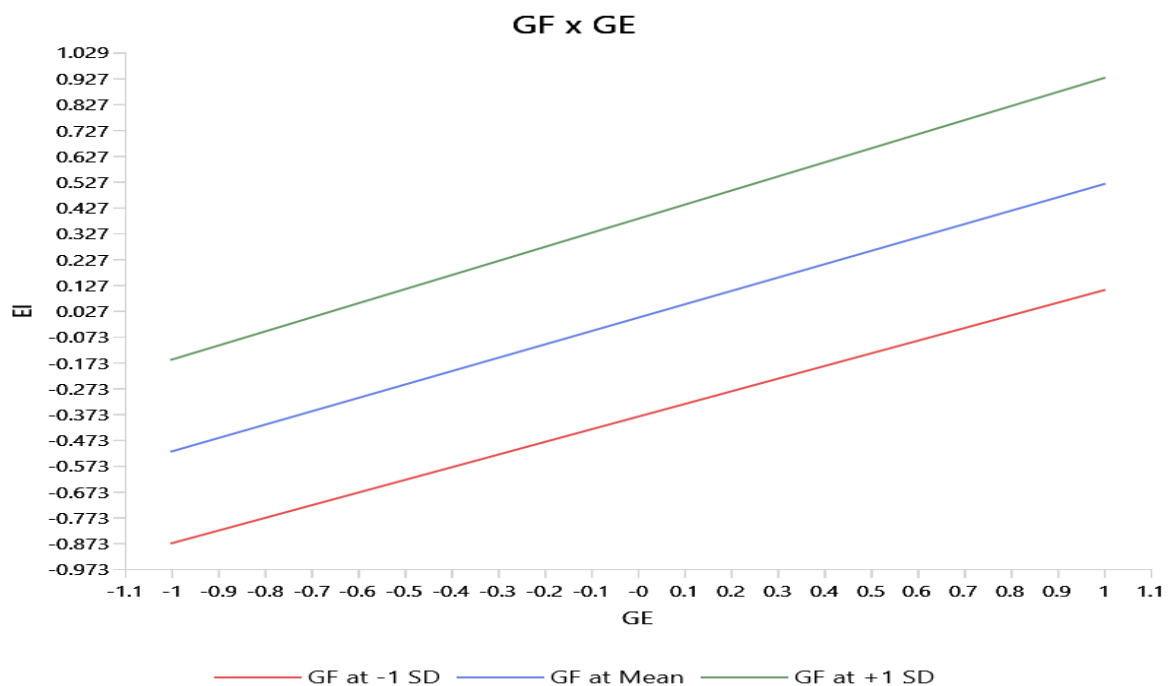


Figure 3: Interaction effect of green financing (GF) on the relationship between green entrepreneurship (GE) and eco-innovation (EI), showing that the positive impact of green entrepreneurship on eco-innovation is stronger at higher levels of green financing.

The results validate the conceptual framework by confirming the multidimensional role of green entrepreneurship in catalysing innovation, sustainability, and empowerment. These findings reinforce Schumpeter’s theory of innovation and institutional theory by demonstrating that both structural and financial ecosystem enablers are indispensable. In line with Adenutsi’s (2023) proposition, the findings endorse entrepreneurship as a credible channel for addressing poverty, inequality, and climate challenges in low-income African contexts.

Figures 3 and 4 present the simple-slope plots for the statistically significant interaction effects. In **Figure 3**, the slope of the GE→EI relationship is steeper when green financing is high, indicating that the association between green entrepreneurship and eco-innovation becomes stronger under more favourable green-financing conditions. **Figure 4** shows a similar pattern for the GE→ES relationship, where higher levels of green financing correspond with a stronger association between green entrepreneurship and environmental sustainability. These plots visually support the moderation results reported in **Table 7** and clarify the direction of the significant interaction effects.

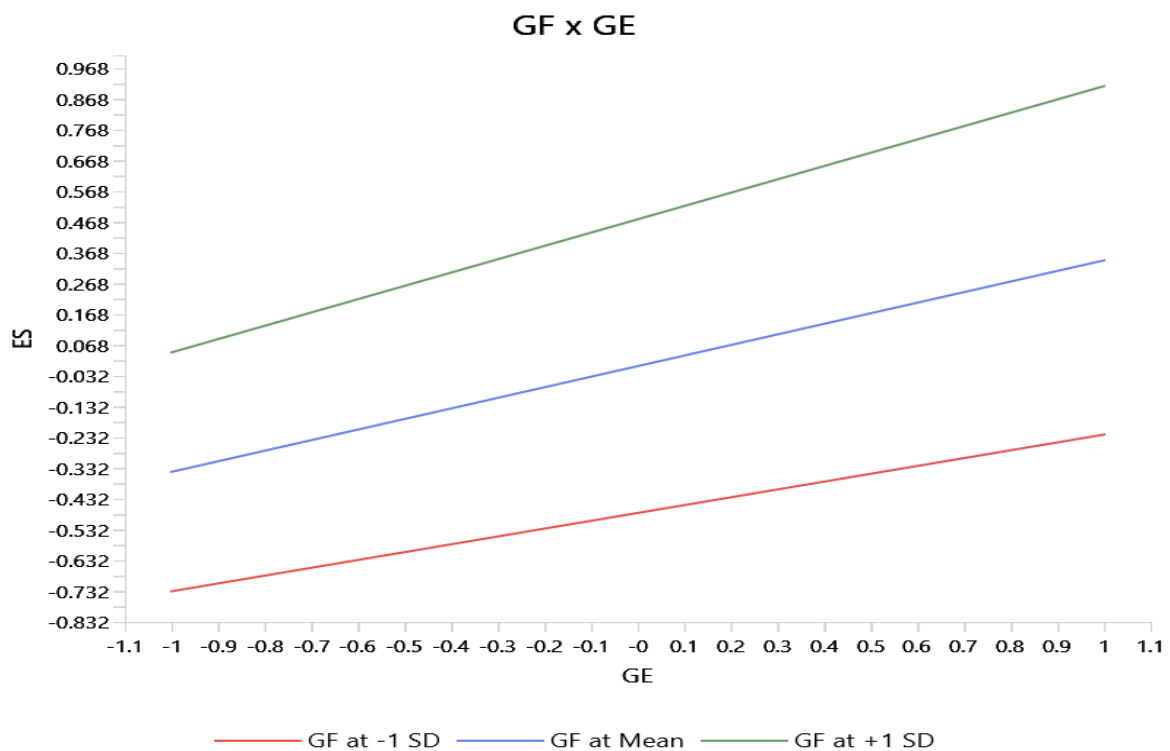


Figure 3: Interaction effect of green financing (GF) on the relationship between green entrepreneurship (GE) and environmental sustainability (ES), indicating that the positive influence of green entrepreneurship on environmental sustainability is stronger when green financing is high.

While **Figures 3 and 4** validate the moderation of GF, the absence of significant moderation in H8C (GE→IEE) highlights that green financing may not directly affect social

empowerment, which likely depends more on inclusive policies, social infrastructure, and capacity-building mechanisms (UNEP 2021). The findings in **Table 7** and **Figures 3** and **4** reinforce the centrality of green entrepreneurship as a catalytic force for eco-innovation, environmental sustainability, and economic empowerment in Africa. They also highlight the conditional nature of this impact: green finance plays a critical enabling role, particularly in fostering innovation and environmental performance, but has limited moderating influence on social inclusion. These insights provide a compelling case for policy interventions to expand access to green financing tools, support innovation systems, and strengthen institutional environments to amplify the transformative potential of green entrepreneurship across African economies.

Table 7 reports the detailed estimation results for the hypothesised structural relationships, including path coefficients, statistical significance, variance inflation factors, and effect sizes. **Table 7** further provides the empirical basis for hypothesis evaluation across direct, mediating, and moderating effects, thereby enabling a comprehensive assessment of the proposed conceptual framework.

4.4 Hypothesis Testing

Table 7: Empirical Hypothesis Results

Paths	VIF	β	SE	<i>t</i> -value	<i>p</i> -value	<i>F</i> ²
<i>Direct Effects</i>						
SPPS→GE	2.117	0.064	0.025	2.556	0.011	0.025
CRFI→GE	2.563	0.308	0.032	9.748	0.000	0.058
LDSP→GE	2.255	0.477	0.021	23.021	0.000	0.190
IKS→GE	1.537	0.128	0.014	9.034	0.000	0.051
GE→EI	1.000	0.803	0.009	85.244	0.000	0.944
GE→ES	1.944	0.540	0.023	23.860	0.000	0.265
GE→IEE	1.944	0.365	0.025	14.635	0.000	0.102
EI→ES	1.944	0.327	0.023	14.252	0.000	0.164
EI→IEE	1.944	0.411	0.025	16.134	0.000	0.133
<i>Mediating Effects</i>						
GE→EI→ES	<i>n/a</i>	0.263	0.019	13.674	0.000	<i>n/a</i>
GE→EI→IEE	<i>n/a</i>	0.330	0.022	15.087	0.000	<i>n/a</i>
SPPS→GE→EI→ES	<i>n/a</i>	0.017	0.007	2.483	0.013	<i>n/a</i>
SPPS→GE→EI→IEE	<i>n/a</i>	0.021	0.008	2.489	0.013	<i>n/a</i>
CRFI→GE→EI→ES	<i>n/a</i>	0.081	0.009	8.714	0.000	<i>n/a</i>
CRFI→GE→EI→IEE	<i>n/a</i>	0.102	0.012	8.805	0.000	<i>n/a</i>
LDSP→GE→EI→ES	<i>n/a</i>	0.125	0.011	11.094	0.000	<i>n/a</i>
LDSP→GE→EI→IEE	<i>n/a</i>	0.157	0.013	11.725	0.000	<i>n/a</i>
IKS→GE→EI→ES	<i>n/a</i>	0.034	0.005	7.360	0.000	<i>n/a</i>

IKS→GE→EI→IEE	<i>n/a</i>	0.042	0.005	7.973	0.000	<i>n/a</i>
<i>Moderating effects</i>						
GF×GE→EI	2.327	0.028	0.010	2.812	0.005	0.003
GF×GE→ES	2.334	0.089	0.013	6.818	0.000	0.001
GF×GE→IEE	2.334	-0.017	0.014	1.200	0.230	0.015

Table 8: Summarised Structural Path Results of Hypothesis Testing at Glance

Hypothesis	Structural Relationship	β	<i>t</i> -stat	<i>p</i> -value	Effect size (f^2)	Decision
H1a	SPPS→GE	0.064	2.556	0.011	0.025	Supported
H1b	CRFI→GE	0.308	9.748	<0.001	0.058	Supported
H1c	LDSP→GE	0.477	23.021	<0.001	0.190	Supported
H1d	IKS→GE	0.128	9.034	<0.001	0.051	Supported
H2	GE→EI	0.803	85.244	<0.001	0.944	Supported
H3	GE→ES	0.540	23.860	<0.001	0.265	Supported
H4	GE→IEE	0.365	14.635	<0.001	0.102	Supported
H5	EI→ES	0.327	14.252	<0.001	0.164	Supported
H6	EI→IEE	0.411	16.134	<0.001	0.133	Supported
H7a	GE→EI→ES	0.263	13.674	<0.001	<i>n/a</i>	Supported
H7b	GE→EI→IEE	0.330	15.087	<0.001	<i>n/a</i>	Supported
H7c	IKS→GE→EI→ES	0.125	11.094	<0.001	<i>n/a</i>	Supported
H7d	IKS→GE→EI→IEE	0.157	11.725	<0.001	<i>n/a</i>	Supported
H8a	GF×GE→EI	0.028	2.812	0.005	<i>n/a</i>	Supported
H8b	GF×GE→ES	0.045	2.703	0.007	<i>n/a</i>	Supported
H8c	GF×GE→IEE	0.008	0.991	0.322	<i>n/a</i>	Not supported

Table 8 provides a concise summary of the hypothesis testing results reported in **Table 7**. **Table 8** succinctly presents the statistical support for all tested hypotheses across the direct, mediating, and moderating effects, offering a robust validation of the theoretical framework.

4.5 Robustness and Predictive Model Comparison

Table 9 benchmarks Model 1 (baseline) against Model 2 (extended model, adds the green-financing moderation block shown in **Figure 3**) using complementary criteria: CVPAT (LV-level predictive ability), PLSpredict (indicator-level prediction errors), and BIC/Akaike weights (parsimony-penalised model preference).

Table 9: Model comparison

<i>CVPAT LV summary</i>

	Model 1	Model 2	Average loss difference	t-value	p-value
EI	0.904	0.919	-0.014	4.937	0.000
ES	0.481	0.514	-0.033	7.628	0.000
GE	0.849	0.849	0.000	2.085	0.037
IEE	0.610	0.689	-0.079	13.811	0.000
Overall	0.733	0.762	-0.030	12.549	0.000
<i>PLSpredict MV summary - MV prediction comparison between Model 1 and Model 2</i>					
	RMSE Model 1	RMSE Model 2	MAE Model 1	MAE Model 2	
EI1	0.825	0.818	0.496	0.507	
EI2	0.882	0.870	0.672	0.671	
EI3	0.961	1.050	0.764	0.855	
EI4	0.957	1.000	0.783	0.823	
EI5	1.106	1.065	0.902	0.890	
EI6	0.952	0.921	0.665	0.660	
ES1	0.774	0.781	0.570	0.584	
ES2	0.624	0.669	0.444	0.488	
ES3	0.711	0.730	0.520	0.547	
ES4	0.655	0.684	0.474	0.507	
GE1	0.969	0.969	0.682	0.682	
GE2	0.856	0.856	0.632	0.632	
GE3	0.890	0.890	0.635	0.635	
GE4	0.965	0.966	0.817	0.817	
IEE1	0.860	0.944	0.584	0.642	
IEE2	0.805	0.861	0.611	0.635	
IEE3	0.648	0.700	0.407	0.439	
IEE4	0.795	0.796	0.629	0.612	
<i>BIC comparison</i>					
	BIC Model 1	BIC Model 2	Akaike weight Model 1	Akaike weight Model 2	
EI	-6823.712	-5668.077	1.000	0.000	
ES	-8486.270	-7461.458	1.000	0.000	
GE	-8585.337	-8584.965	0.546	0.454	
IEE	-6806.337	-4862.501	1.000	0.000	

4.5.1 CVPAT (LV summary): Model 2 dominates on prediction

Table 9, Model 2 evaluates the out-of-sample predictive performance of the baseline and extended structural models at the latent-variable level using the CVPAT criterion. The results indicate that the extended model incorporating green financing moderation demonstrates superior predictive accuracy for eco-innovation, environmental sustainability, and inclusive economic empowerment, while predictive performance for green entrepreneurship remains unchanged. This pattern suggests that financial conditionality enhances the model's ability to anticipate downstream developmental outcomes without materially altering the prediction of

entrepreneurial activity itself. The improvement in latent-level prediction confirms that green financing contributes explanatory value beyond structural fit, particularly in shaping innovation- and sustainability-related outcomes.

4.5.2 PLSpredict (MV summary): gains are mixed at item-level

This subsection examines indicator-level predictive performance using PLSpredict diagnostics. The results as shown in **Table 9** reveal mixed predictive gains across individual indicators when green financing moderation is introduced. While several innovation-related indicators exhibit modest improvements in prediction error, others, particularly within environmental sustainability and inclusive economic empowerment, show limited or uneven gains. These findings indicate that the extended model improves predictive relevance primarily at the construct level rather than uniformly across all measurement items. Such heterogeneity is consistent with the expectation that financial moderation affects higher-order outcome formation more strongly than individual operational indicators.

4.5.3 BIC/Akaike weights: Model 1 is preferred on parsimony grounds

This subsection assesses the trade-off between predictive performance and model parsimony using BIC and Akaike weight comparisons reported in **Table 9**. The results indicate a clear parsimony advantage for the baseline model, reflecting the additional complexity introduced by moderation effects in the extended specification. While the baseline model is preferred under strict parsimony criteria, the extended model offers greater predictive relevance for key developmental outcomes. This trade-off highlights that the choice between models depends on analytical priorities: the baseline model is more suitable for explanatory clarity, whereas the moderated model is preferable when the objective is to capture conditional dynamics and enhance predictive accuracy.

4.6 Structural Path Analysis

Given the large sample size, interpretation of the structural results extends beyond statistical significance to consider effect magnitude, explained variance, and predictive relevance. Accordingly, emphasis is placed on the substantive importance of the estimated relationships rather than on p-values alone.

4.6.1 Structural Model with Green Financing Moderation

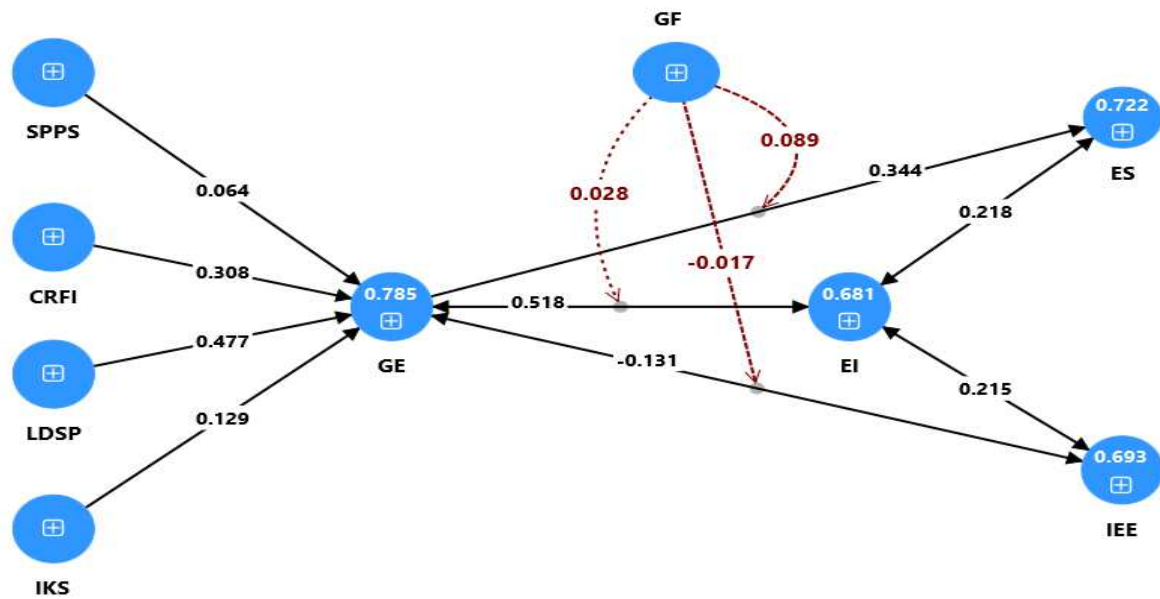


Figure 5: Empirical Structural Path Model-1 with moderating effect of GF

Figure 5 presents the estimated moderated structural model and illustrates how ecosystem conditions, entrepreneurial activity, innovation processes, sustainability outcomes, and financing mechanisms interact within a unified analytical framework. The model highlights the pivotal position of green entrepreneurship as the principal transmission channel through which ecosystem drivers are associated with environmental and socioeconomic outcomes, while simultaneously demonstrating the role of green finance as a conditioning mechanism within this broader system.

Beyond individual path relationships, the figure reveals the systemic nature of the green entrepreneurship–development nexus by showing how entrepreneurial, innovation, financial, and sustainability processes operate as mutually reinforcing components of a wider ecosystem architecture. The moderated model therefore provides a holistic representation of the pathways through which green entrepreneurial activity is associated with sustainable development outcomes across African SMEs and underscores the importance of considering innovation, finance, and ecosystem conditions as interconnected rather than isolated influences.

4.6.2 Structural Model without Green Financing Moderation

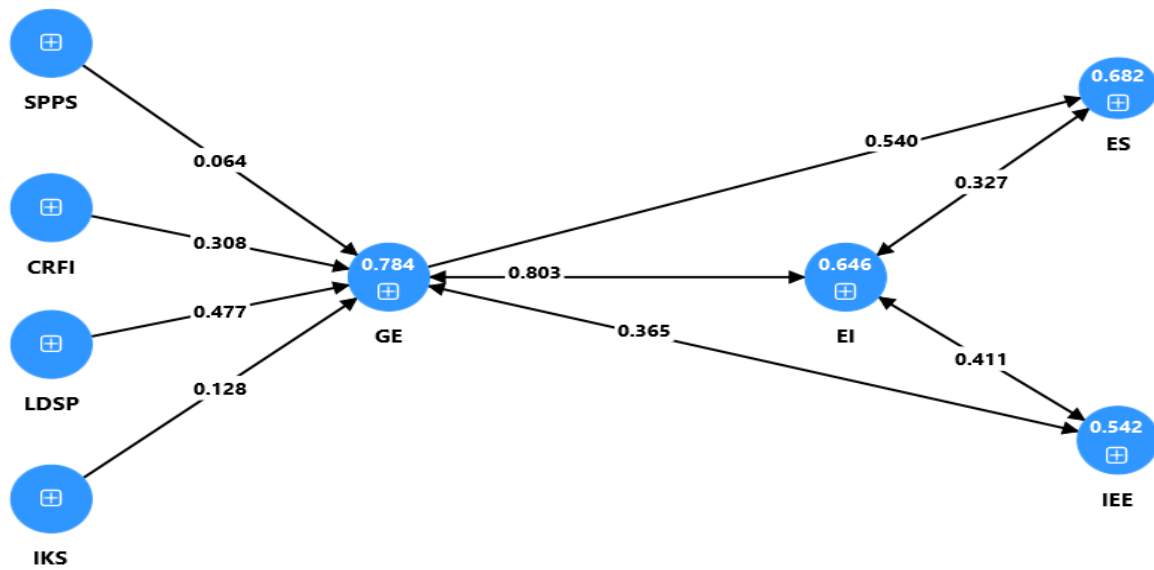


Figure 6: Empirical Structural Path Model without moderating effect of GF

Figure 6 depicts the baseline structural configuration excluding the moderating role of green financing, thereby isolating the intrinsic relationships among green ecosystem drivers, green entrepreneurship, eco-innovation, environmental sustainability, and inclusive economic empowerment.

In this unmoderated model, green entrepreneurship (GE) emerges as a robust and uniformly positive driver of all downstream outcomes. The strong direct paths from GE to eco-innovation (EI), environmental sustainability (ES), and inclusive economic empowerment (IEE) indicate that entrepreneurial agency alone is capable of generating innovation, ecological benefits, and inclusive economic effects when operating within supportive ecosystem conditions. Eco-innovation further acts as a partial transmission mechanism, reinforcing both environmental sustainability and inclusive economic empowerment. The positive EI→ES and EI→IEE paths suggest that technological and process innovations not only reduce environmental externalities but also generate productivity gains and opportunity structures that support broader economic inclusion.

Notably, in the absence of financial moderation, the GE→IEE relationship remains positive, implying that entrepreneurial activity is more organically linked to employment creation, income generation, and local value-chain participation when financial selectivity and capital constraints are not explicitly shaping entrepreneurial choices. The explained variance across endogenous constructs remains substantial, though systematically lower than in the moderated model, indicating that while the baseline structure captures core causal mechanisms, it does not fully account for the conditional role of financial architecture in shaping outcome

intensity and distribution. Thus, **Figure 6** represents a capability-driven green development model, where entrepreneurship and innovation jointly deliver environmental and inclusive outcomes without explicit financial filtering.

Taken together, **Figures 5 and 6** illustrate the added explanatory value of incorporating green financing into the broader entrepreneurial ecosystem framework. While the baseline and moderated specifications exhibit largely consistent structural relationships, the moderated model captures important conditional dynamics that are not observable in the unmoderated configuration. The comparison therefore highlights the role of green finance as an ecosystem-enabling mechanism that shapes the strength of selected pathways within the green entrepreneurship–development nexus and provides a more comprehensive representation of the processes underpinning sustainable development outcomes.

The moderated and baseline estimations reveal that the core relationships among entrepreneurial ecosystem drivers, green entrepreneurship, eco-innovation, environmental sustainability, and inclusive economic empowerment remain largely stable across model specifications. However, the moderated model provides additional insight into the conditional role of green finance, suggesting that the effectiveness of green entrepreneurial activity depends partly on the availability of sustainability-oriented financial support mechanisms. The consistency of the principal structural relationships across the two specifications provides additional confidence in the robustness of the reported findings.

4.7 Multigroup Robustness Analysis by Green Ecosystem Maturity

Table A2 presents multigroup analysis (MGA) results comparing advanced and emerging green ecosystems, revealing substantial structural heterogeneity in how green entrepreneurship is initiated and how it translates into eco-innovation, environmental sustainability, and inclusive economic empowerment.

The drivers of green entrepreneurship (GE) differ systematically by ecosystem maturity. In emerging ecosystems, sustainable public procurement signals (SPPS) exert a strong and significant effect on GE, whereas this relationship is weak and insignificant in advanced ecosystems. This confirms that public procurement plays a market-creating and legitimacy-building role where green markets and private demand remain underdeveloped. Conversely, climate-risk finance infrastructure (CRFI) and indigenous knowledge synergy (IKS) have significantly stronger effects on GE in advanced ecosystems, indicating a shift from policy-triggered entry to finance- and capability-enabled entrepreneurship as ecosystems

mature. Local demand-side pressure (LDSP) remains a strong and significant driver in both groups, suggesting that demand is a maturity-invariant foundation of green entrepreneurship.

Advanced ecosystems exhibit higher translation efficiency, with significantly stronger effects of GE on eco-innovation ($GE \rightarrow EI$) and environmental sustainability ($GE \rightarrow ES$). This reflects superior absorptive capacity, technological complementarities, and institutional coherence in mature ecosystems. In contrast, the eco-innovation $\rightarrow$ environmental sustainability ($EI \rightarrow ES$) relationship does not differ significantly across groups, indicating that the environmental returns to innovation are structurally stable regardless of maturity.

The strongest heterogeneity arises in inclusive economic empowerment (IEE). In advanced ecosystems, the direct effect of $GE \rightarrow IEE$ is negative and significant, while it is weak and insignificant in emerging ecosystems. This suggests that mature green ecosystems increasingly favour capital- and technology-intensive entrepreneurial models that do not automatically generate inclusive outcomes. By contrast, eco-innovation ($EI \rightarrow IEE$) has a positive and significantly stronger effect in advanced ecosystems, implying that inclusion is achieved indirectly through innovation-driven productivity gains, rather than through entrepreneurial entry per se.

Finally, the moderating role of green financing ($GF \times GE$) is maturity-dependent. In emerging ecosystems, green financing significantly strengthens the $GE \rightarrow EI$ pathway by easing financial constraints. In advanced ecosystems, it significantly weakens $GE \rightarrow IEE$, reinforcing the tendency of financially selective green growth to limit inclusion unless explicitly addressed.

Overall, Table A2 demonstrates that green ecosystem maturity fundamentally reshapes the mechanisms of green development in Africa. Emerging ecosystems are characterised by policy-led and inclusion-friendly dynamics, while advanced ecosystems exhibit finance-driven, innovation-intensive but inclusion-selective pathways. These results underscore the need for maturity-sensitive green policy and financing frameworks, rather than uniform approaches.

5. Discussion of Key Findings

The findings provide strong empirical support for an ecosystem-based perspective of green entrepreneurship in Africa. The positive effects of sustainable public procurement signals, climate-risk finance infrastructure, local demand for sustainable products, and indigenous knowledge synergy indicate that environmentally oriented entrepreneurial activity is shaped by the interaction of institutional, financial, market, and knowledge-based conditions. These results suggest that the emergence and effectiveness of green entrepreneurship depend not only

on firm-level initiative, but also on the broader ecosystem within which entrepreneurial activity is embedded.

The significant positive relationship between green entrepreneurship and eco-innovation further suggests that environmentally motivated entrepreneurs play an important role in generating locally adapted solutions to sustainability challenges. In the African context, where firms often operate under resource constraints and environmental vulnerabilities, entrepreneurial activity frequently stimulates innovations that improve resource efficiency, reduce environmental impacts, and enhance competitiveness. Eco-innovation therefore emerges as a key mechanism through which green entrepreneurial activity is associated with broader sustainability benefits.

The results also reveal that green entrepreneurship contributes directly and indirectly to environmental sustainability and inclusive development outcomes through eco-innovation. This finding is particularly relevant for Africa, where environmental challenges, unemployment, and livelihood insecurity frequently coexist. The evidence suggests that green entrepreneurship can simultaneously support ecological resilience and socioeconomic improvement, thereby reinforcing its relevance as a sustainable development strategy.

Finally, the moderating role of green financing highlights the importance of financial architecture in strengthening the innovation and environmental outcomes of green entrepreneurship. The significant moderation effects observed for eco-innovation and environmental sustainability indicate that access to dedicated green financial resources enables firms to scale environmentally beneficial innovations and sustainability initiatives. However, the absence of a significant moderating effect on inclusive development outcomes suggests that financial support alone may be insufficient to generate broad-based social inclusion. Achieving inclusive green transitions may therefore require complementary interventions such as skills development, market access programmes, and inclusive policy frameworks alongside green financing mechanisms.

6. Conclusion, Implications and Recommendations

6.1 Contributions of the Study

This study makes four interrelated contributions to the literature on green entrepreneurship, eco-innovation, environmental sustainability and inclusive development. First, the study contributes theoretically by extending Schumpeterian Innovation Theory, Resource-Based View, and Institutional Theory through an African green entrepreneurial ecosystem perspective. Rather than treating green entrepreneurship only as a firm-level innovation

activity, the study conceptualises it as an ecosystem-embedded mechanism through which institutional signals, market incentives, indigenous knowledge systems and financial resources are converted into eco-innovation, environmental sustainability and inclusive economic empowerment. In doing so, the study advances a more context-sensitive theoretical explanation of green entrepreneurship in African economies, where resource constraints, institutional incompleteness, informality and livelihood vulnerability shape how sustainability-oriented enterprises emerge and generate development outcomes.

Second, the study contributes empirically by moving beyond the dominant tendency in prior research to examine isolated relationships, such as the effect of green entrepreneurship on sustainability, or the influence of green finance on innovation. The study develops and tests an integrated structural framework that simultaneously captures ecosystem drivers, direct effects, mediating pathways, moderating conditions and developmental outcomes. This provides a more complete empirical account of how green entrepreneurship is associated with socio-environmental value, particularly by showing that eco-innovation operates as a key transmission mechanism through which green entrepreneurial activity contributes to environmental sustainability and inclusive economic empowerment. The analysis therefore strengthens understanding of the mechanisms, rather than merely the existence, of the green entrepreneurship–development nexus.

Third, the study offers a contextual contribution by providing large-scale African evidence from 8,553 SMEs across twelve countries. This is important because much of the green entrepreneurship literature remains disproportionately informed by evidence from advanced economies or single-country studies, while African entrepreneurial ecosystems remain comparatively underrepresented. By drawing on a multi-country African sample, the study captures variations in institutional conditions, market demand, financing infrastructure and indigenous knowledge systems, thereby generating evidence that is more relevant to the realities of sustainability transitions in emerging and resource-constrained economies.

Fourth, the study contributes to policy by identifying specific ecosystem levers through which green entrepreneurship can be strengthened as a vehicle for sustainable and inclusive development. The findings show that sustainable public procurement signals, climate-risk finance infrastructure, local demand for sustainable products and indigenous knowledge synergy are important drivers of green entrepreneurial activity. They also show that green finance strengthens the innovation and environmental effects of green entrepreneurship, although its influence on inclusive economic empowerment is more conditional. This implies that African green transition strategies should not rely on finance alone, but should combine

green procurement reform, climate-risk financing instruments, demand-side market development, indigenous knowledge integration, innovation support and inclusion-sensitive financing mechanisms. Such an integrated policy approach is more likely to convert green entrepreneurship into measurable environmental gains and broad-based socioeconomic empowerment.

6.2 Policy Implications

The findings suggest that policies aimed at accelerating green transitions in Africa should prioritise the development of supportive entrepreneurial ecosystems rather than focusing exclusively on firm-level interventions. Because green entrepreneurship operates within a broader network of institutional, financial, market, and knowledge-based conditions, sustainability strategies are likely to be most effective when they strengthen the ecosystem foundations that enable environmentally oriented entrepreneurial activity to emerge, scale, and generate development outcomes.

Second, the significant influence of sustainable public procurement signals, climate-risk finance infrastructure, local demand for sustainable products, and indigenous knowledge synergy highlights the importance of ecosystem-based policy approaches. The findings imply that green entrepreneurship flourishes when supported by coherent market incentives, enabling institutions, and contextually relevant knowledge systems. Policymakers should therefore move beyond firm-level interventions and adopt integrated ecosystem approaches that simultaneously strengthen regulatory frameworks, market opportunities, financing mechanisms, and innovation support structures.

Third, policymakers should complement entrepreneurship promotion initiatives with deliberate investments in innovation capability development. Strengthening research and development systems, technology diffusion mechanisms, university–industry collaboration, sustainability-oriented skills development, and innovation support programmes can enhance the capacity of green enterprises to generate scalable environmental and socioeconomic benefits. Such investments are particularly important in African economies where innovation constraints frequently limit the developmental impact of entrepreneurial activity.

Fourth, green finance policies should be designed not only to expand access to sustainability-oriented capital but also to ensure that the benefits of green transitions are distributed more broadly across society. In addition to supporting environmentally beneficial investments, financing programmes should incorporate inclusion-sensitive criteria that encourage employment creation, skills development, SME upgrading, and participation in

green value chains. Such an approach can help align environmental objectives with broader development goals and increase the likelihood that green transitions generate both ecological and socioeconomic gains.

Finally, the significance of indigenous knowledge synergy highlights the need for sustainability policies that recognise locally embedded knowledge systems as productive assets rather than residual cultural practices. The findings suggest that effective green transitions in Africa are likely to emerge from the integration of indigenous ecological knowledge with modern innovation systems. Policies that encourage such integration can strengthen the contextual relevance, legitimacy, and long-term sustainability of green entrepreneurial initiatives while supporting locally driven development pathways.

6.3 Recommendations

Governments should adopt integrated green entrepreneurship strategies that combine sustainable public procurement, climate-risk financing mechanisms, innovation support programmes, and indigenous knowledge integration within broader green industrialisation and sustainable development frameworks. Priority should be given to strengthening ecosystem conditions that enable environmentally oriented enterprises to emerge, scale, and generate both environmental and socioeconomic benefits.

Financial institutions should expand the availability of dedicated green financial instruments, including concessional lending facilities, sustainability-linked financing products, risk-sharing mechanisms, and climate-investment guarantees. To enhance the effectiveness of these instruments, financial support should be accompanied by advisory services, project-preparation assistance, and inclusion-sensitive financing criteria that promote employment creation and participation in green value chains.

Entrepreneurs and SME owners should strengthen their innovation capabilities by embedding sustainability principles within product development, production systems, and business models. Greater emphasis should be placed on resource efficiency, environmentally responsible value chains, and the commercialisation of locally relevant green innovations that respond to emerging market demand.

Development partners and donor agencies should prioritise investments in ecosystem-strengthening interventions, including green incubators, innovation hubs, technical training centres, and collaborative platforms that facilitate coordination among government agencies, financial institutions, research organisations, civil society actors, and private enterprises.

Researchers should continue advancing the evidence base on green entrepreneurship in Africa through longitudinal, comparative, and sector-specific studies. Particular attention should be devoted to the development of multidimensional indicators capable of capturing the environmental, economic, and social dimensions of inclusive green development.

Collectively, these actions can strengthen the capacity of green entrepreneurship to serve as a catalyst for environmentally sustainable, innovation-driven, and inclusive development across African economies.

6.4 Limitations and Future Research

First, the study relies on cross-sectional survey data, which limits the ability to make strong causal inferences regarding the relationships among green entrepreneurship, eco-innovation, environmental sustainability, and inclusive development outcomes. Thus, although the proposed framework is theoretically directional, the cross-sectional nature of the data does not permit definitive causal inference, and potential endogeneity cannot be entirely ruled out. Second, the analysis is based on self-reported firm-level perceptions, which may be subject to respondent bias despite the procedural and statistical measures employed to mitigate common method bias. Third, although the study covers 12 African countries, the findings should be interpreted within the broader context of African SMEs and may not fully capture country-specific institutional, regulatory, and environmental differences.

Future research should extend the present framework by examining the temporal evolution of green entrepreneurial ecosystems using longitudinal and panel-data designs capable of capturing dynamic relationships and strengthening causal inference. Additional work is needed to investigate cross-country and cross-sector heterogeneity, particularly regarding the interaction between ecosystem maturity, green finance, indigenous knowledge systems, and eco-innovation. Future studies may also explore the institutional, behavioural, and social mechanisms through which green entrepreneurship contributes to inclusive development outcomes, thereby advancing understanding of how environmental sustainability and socioeconomic inclusion can be jointly achieved. Finally, incorporating firm-level, industry-level, and country-level contextual factors may provide further insight into the conditions under which green entrepreneurship generates the greatest developmental impact.

6.5 Conclusion

This study provides robust evidence that green entrepreneurship constitutes an important pathway through which entrepreneurial ecosystem conditions are associated with

environmental sustainability and inclusive development outcomes across African economies. Drawing on data from 8,553 SMEs operating in 12 African countries, the findings show that sustainable public procurement signals, climate-risk finance infrastructure, local demand for sustainable products, and indigenous knowledge synergy contribute to the development of green entrepreneurial activity, which subsequently promotes eco-innovation, environmental sustainability, and inclusive economic empowerment. The results further demonstrate that eco-innovation serves as a key mechanism through which entrepreneurial activity generates sustainability benefits, while green finance strengthens innovation and environmental outcomes but does not automatically translate into broader inclusion outcomes.

Overall, the study highlights the importance of viewing green development as an ecosystem phenomenon shaped by the interaction of institutions, markets, finance, innovation capabilities, and locally embedded knowledge systems. The evidence suggests that effective green transitions require coordinated ecosystem interventions rather than isolated environmental, financial, or entrepreneurial policies. By advancing an integrated African green entrepreneurial ecosystem perspective, the study contributes to understanding how entrepreneurship can support environmentally sustainable, innovation-driven, and inclusive development pathways within emerging economies.

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Author Contributions

The author solely conceived the study, developed the theoretical framework, designed the research instrument, collected and analysed the data, interpreted the findings, and wrote, revised, and approved the final manuscript.

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Data Availability

The data supporting the findings of this study are available from the author upon reasonable request, subject to confidentiality considerations.

Ethics Approval

Formal ethical approval was not required for this study because it relied exclusively on organisational- and firm-level data and did not involve the collection or analysis of personal, medical, clinical, or other sensitive human-subject information.

Consent to Participate

Participation was voluntary. Informed consent was obtained from all respondents prior to data collection. Participants were informed of the academic purpose of the study and their right to decline participation.

Consent for Publication

Not applicable.

Confidentiality and Anonymity

The anonymity and confidentiality of all participating firms and respondents were strictly maintained. No personally identifiable information was collected or reported.

Use of Artificial Intelligence

Artificial intelligence-assisted tools, specifically ChatGPT and Grammarly, were used solely for language editing, grammar checking, clarity enhancement, and editorial refinement of the manuscript. The author reviewed, verified, and takes full responsibility for all content, interpretations, analyses, and conclusions presented in the manuscript.

Competing Interests

The author declares no competing interests.

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REFERENCES

- Adenutsi DE (2023) Entrepreneurship, job creation, income empowerment and poverty reduction in low-income economies. *Theoretical Economics Letters*, 13(6), 1579–1598. <https://doi.org/10.4236/tel.2023.136089>
- Barney JB (1991) Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99–120. <https://doi.org/10.1177/014920639101700108>
- Bawakyillenuo S, Agbelie ISK (2021) Environmental consciousness of entrepreneurs in Ghana: How do entrepreneur types, demographic characteristics and product competitiveness count? *Sustainability*. <https://doi.org/10.3390/su13169139>
- Brammer S, Walker H (2011) Sustainable procurement in the public sector: An international comparative study. *International Journal of Operations and Production Management*, 31(4), 452–476. <https://doi.org/10.1108/01443571111119551>
- Chen Y-S, Lai S-B, Wen C-T (2006) The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics*, 67(4), 331–339. <https://doi.org/10.1007/s10551-006-9025-5>
- Cheng W, Appolloni A, D’Amato A, Zhu Q (2018) Green public procurement, missing concepts and future trends: A critical review. *Journal of Cleaner Production*, 176, 770–784. <https://doi.org/10.1016/j.jclepro.2017.12.027>
- Cohen B, Winn, MI (2007) Market imperfections, opportunity and sustainable entrepreneurship. *Journal of Business Venturing*, 22(1), 29–49. <https://doi.org/10.1016/j.jbusvent.2004.12.001>
- Dean TJ, McMullen JS (2007) Toward a theory of sustainable entrepreneurship: Reducing environmental degradation through entrepreneurial action. *Journal of Business Venturing*, 22(1), 50–76. <https://doi.org/10.1016/j.jbusvent.2005.09.003>
- Elkington J (1997) *Cannibals with forks: The triple bottom line of 21st century business*. Capstone Publishing.
- Gast J, Gundolf K, Cesinger B (2017) Doing business in a green way: A systematic review of the ecological sustainability entrepreneurship literature and future research directions. *Journal of Cleaner Production*, 147. <https://doi.org/10.1016/j.jclepro.2017.01.065>
- George G, Corbishley C, Khayesi JNO, Haas MR, Tihanyi L (2016) Bringing Africa in: Promising directions for management research. *Academy of Management Journal*, 59(2), 377–393. <https://doi.org/10.5465/amj.2016.4002>
- George G, Merrill RK, Schillebeeckx SJD (2021) Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable

- development. *Entrepreneurship Theory and Practice*, 45(5), 999–1027. <https://doi.org/10.1177/1042258719899425>
- Hair JF, Hult GTM, Ringle CM, Sarstedt M (2022) *A primer on partial least squares structural equation modelling (PLS-SEM)* (3rd ed.). Sage Publications.
- Hart SL, Dowell G (2011) Invited editorial: A natural-resource-based view of the firm: Fifteen years after. *Journal of Management*, 35(5). <https://doi.org/10.1177/0149206310390219>
- Haws KL, Winterich KP, Naylor RW (2014) Seeing the world through GREEN-tinted glasses: Green consumption values and responses to environmentally friendly products. *Journal of Consumer Psychology*, 24(3), 336–354. <https://doi.org/10.1016/j.jcps.2013.11.002>
- Hojnik J, Ruzzier M, Manolova TS (2020) Sustainable development: Predictors of green consumerism in Slovenia. *Corporate Social Responsibility and Environmental Management*, 27(4), 1695–1708. <https://doi.org/10.1002/csr.1917>
- Horbach J, Rammer C, Rennings K (2012) Determinants of eco-innovations by type of environmental impact: The role of regulatory push/pull, technology push and market pull. *Ecological Economics*, 78. <https://doi.org/10.1016/j.ecolecon.2012.04.005>
- ILO (2022) *World employment and social outlook: Trends 2022*. International Labour Office.
- Jiang W, Chai H, Shao J, Feng T (2018) Green entrepreneurial orientation for enhancing firm performance: A dynamic capability perspective. *Journal of Cleaner Production*, 198, 1311–1323. <https://doi.org/10.1016/j.jclepro.2018.07.104>
- Kock N (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. *International Journal of e-Collaboration*, 11(4), 1–10. <https://doi.org/10.4018/ijec.2015100101>
- Leonidou CN, Katsikeas CS, Morgan NA (2013) “Greening” the marketing mix: Do firms do it and does it pay off? *Journal of the Academy of Marketing Science*, 41(2), 151–170. <https://doi.org/10.1007/s11747-012-0317-2>
- Linnerooth-Bayer J, Hochrainer-Stigler S (2015) Financial instruments for disaster risk management and climate change adaptation. *Climatic Change*, 133(1), 85–100. <https://doi.org/10.1007/s10584-013-1035-6>
- Lupton NC, Jiménez A, Bayraktar S, Tsagdis D (2021) Climate risk and private participation projects in infrastructure: Mitigating the impact of locational (dis)advantages. *Management Decision*, 59(1), 51–67. <https://doi.org/10.1108/MD-02-2019-0236>
- Nicolăescu E, Alpopi C, Zaharia C (2015) Measuring corporate sustainability performance. *Sustainability*, 7(1), 851–865. <https://doi.org/10.3390/su7010851>

- North DC (1990) *Institutions, institutional change and economic performance*. Cambridge University Press.
- Onwuegbuzie HN, Mafimisebi OP, Orighoyegha E (2024) Indigenous knowledge and entrepreneurship as a strategy for sustainable development in Africa. *FIIB Business Review*. <https://doi.org/10.1177/23197145241288403>
- OECD (2020) *Developing sustainable finance definitions and taxonomies*. OECD Publishing.
- Osabuohien E, Gitau CMW, Efobi UR (2022) Green growth strategy and youth employment in Africa: Opportunities and policy directions. *African Development Review*, 34(1), 120–136. <https://doi.org/10.1111/1467-8268.12620>
- Reyes-García V, Vadez V, Tanner S, McDade T, Huanca T, Leonard WR (2006) Evaluating indices of traditional ecological knowledge: A methodological contribution. *Journal of Ethnobiology and Ethnomedicine*, 2, Article 21. <https://doi.org/10.1186/1746-4269-2-21>
- Schaltegger S, Wagner M (2011) Sustainable entrepreneurship and sustainability innovation: Categories and interactions. *Business Strategy and the Environment*, 20(4), 222–237. <https://doi.org/10.1002/bse.682>
- Schumpeter JA (1934) *The theory of economic development*. Harvard University Press.
- Shepherd DA, Patzelt H (2011) The new field of sustainable entrepreneurship: Studying entrepreneurial action linking “what is to be sustained” with “what is to be developed.” *Entrepreneurship Theory and Practice*, 35(1), 137–163. <https://doi.org/10.1111/j.1540-6520.2010.00426.x>
- Spigel B. (2017) The relational organization of entrepreneurial ecosystems. *Entrepreneurship Theory and Practice*, 41(1), 49–72. <https://doi.org/10.1111/etap.12167>
- Stam E (2015) Entrepreneurial ecosystems and regional policy: A sympathetic critique. *European Planning Studies*, 23(9). <https://doi.org/10.1080/09654313.2015.1061484>
- Sun H, Mohsin M, Alharthi M, Abbas Q (2020) Measuring environmental sustainability performance of South Asia. *Journal of Cleaner Production*, 251, Article 119519. <https://doi.org/10.1016/j.jclepro.2019.119519>
- Sutter C, Bruton GD, Chen J (2019) Entrepreneurship as a solution to extreme poverty: A review and future research directions. *Journal of Business Venturing*, 34(1), 197–214. <https://doi.org/10.1016/j.jbusvent.2018.06.003>
- Taghizadeh-Hesary F, Yoshino N (2019) The way to induce private participation in green finance and investment. *Finance Research Letters*, 31, 98–103. <https://doi.org/10.1016/j.frl.2019.04.016>

- Testa F, Iraldo F, Frey M, Daddi T (2012) What factors influence the uptake of GPP (green public procurement) practices? New evidence from an Italian survey. *Ecological Economics*, 82, 88–96. <https://doi.org/10.1016/j.ecolecon.2012.07.011>
- UNEP (2021) *State of finance for nature 2021: Tripling investments in nature-based solutions by 2030*. UNEP. <https://www.unep.org/resources/state-finance-nature-2021>
- Wu S-I, Chen Y-J (2014) The impact of green marketing and perceived innovation on purchase intention for green products. *International Journal of Marketing Studies*, 6(5), 81–100. <https://doi.org/10.5539/ijms.v6n5p81>
- Xie X, Huo J, Zou H (2019) Green process innovation, green product innovation, and corporate financial performance: A content analysis method. *Journal of Business Research*, 101, 697–706. <https://doi.org/10.1016/j.jbusres.2019.01.010>
- Zhang X, Wang Z, Zhong X, Yang S, Siddik AB (2022) Do green banking activities improve the banks' environmental performance? The mediating effect of green financing. *Sustainability*, 14(2), Article 989. <https://doi.org/10.3390/su14020989>

Appendix

Figure A1: Distribution of Respondents by Country and Sector

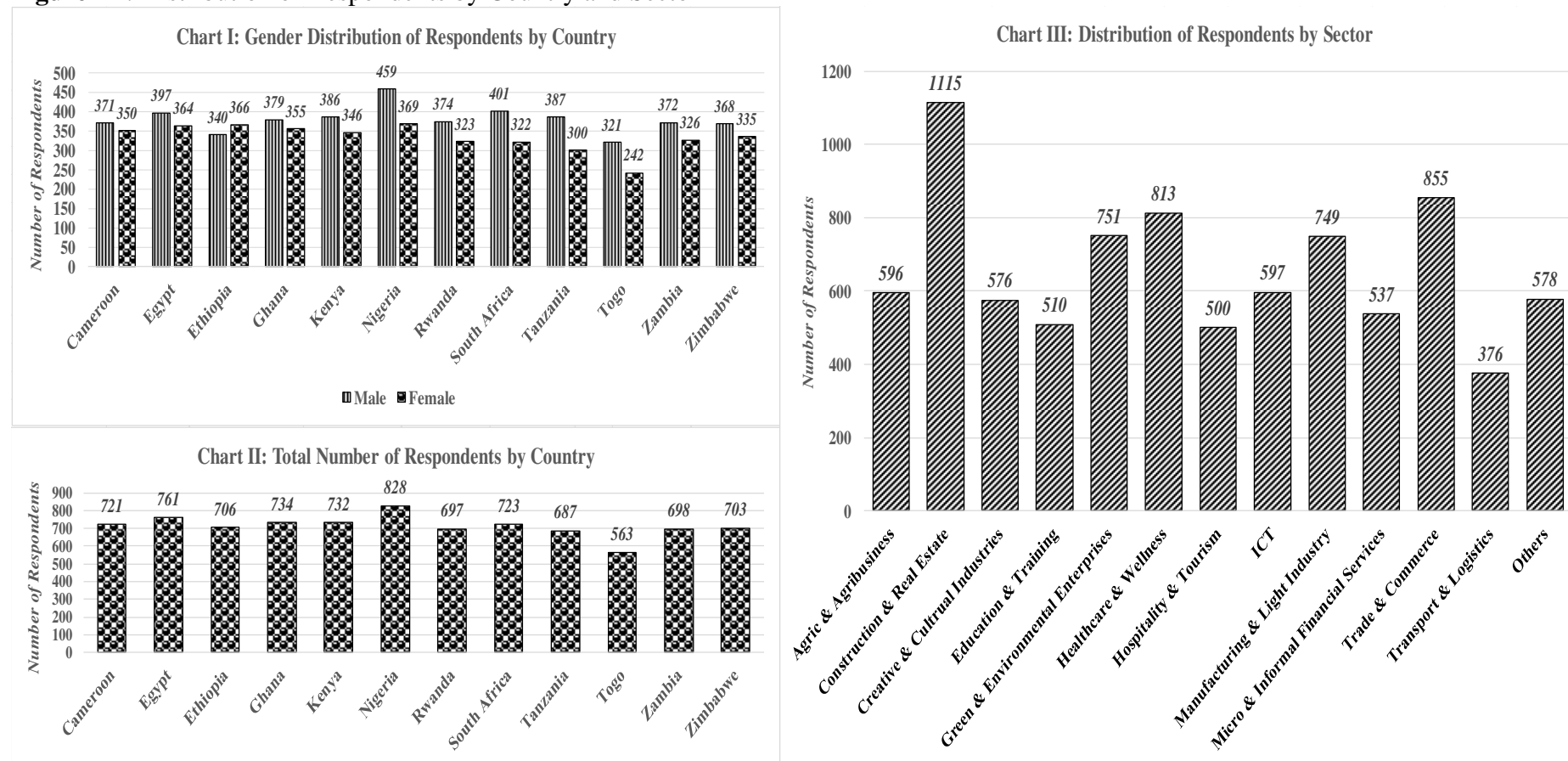


Table A1: Summary Statistics of the Respondents by Country and Sector

Country	TOTAL	Male	Female	Agric & Agribusiness	Trade & Commerce	Manufacturing & Light Industry	Construction & Real Estate	Transport & Logistics	Hospitality & Tourism	ICT	Education & Training	Healthcare & Wellness	Creative & Cultrual Industries	Micro & Informal Financial Services	Green & Environmental Enterprises	Others	TOTAL
Cameroon	721	371	350	57	92	38	41	78	59	34	42	74	39	83	18	66	721
Egypt	761	397	364	61	79	69	61	68	72	55	51	74	62	59	29	21	761
Ethiopia	706	340	366	48	86	40	39	61	81	32	36	72	68	64	21	58	706
Ghana	734	379	355	39	98	47	36	84	78	44	61	68	43	67	32	37	734
Kenya	732	386	346	66	107	53	38	73	73	31	43	60	32	92	49	15	732
Nigeria	828	459	369	63	123	69	49	79	88	61	48	51	53	79	41	24	828
Rwanda	697	374	323	41	96	51	44	34	91	43	33	59	39	50	38	78	697
South Africa	723	401	322	68	89	73	53	46	68	67	50	40	38	39	51	41	723
Tanzania	687	387	300	34	79	41	32	47	76	36	58	66	32	81	27	78	687
Togo	563	321	242	25	86	27	36	39	47	29	66	49	27	79	19	34	563
Zambia	698	372	326	43	91	37	43	64	41	38	51	57	61	73	29	70	698
Zimbabwe	703	368	335	51	89	31	38	78	39	30	58	79	43	89	22	56	703
TOTAL	8553	4555	3998	596	1115	576	510	751	813	500	597	749	537	855	376	578	8553

Table A2: Multigroup analysis based on levels of green ecosystem maturity (Advanced vs Emerging)

Paths	Advanced Green Ecosystem Economies (AGEE)			Emerging Green Ecosystem Economies (EGEE)			Difference	1-tailed (AGEE vs EGEE) <i>p</i> -value	2-tailed (AGEE vs EGEE) <i>p</i> -value
	β	<i>t</i> -value	<i>p</i> -value	β	<i>t</i> -value	<i>p</i> -value			
<i>Direct Effects</i>									
SPPS→GE	-0.026	0.829	0.407	0.204	5.208	0.000	-0.230	1.000	0.000
CRFI→GE	0.403	8.951	0.000	0.170	3.833	0.000	0.233	0.000	0.000
LDSP→GE	0.449	16.419	0.000	0.506	15.640	0.000	-0.056	0.910	0.181
IKS→GE	0.159	7.650	0.000	0.086	4.525	0.000	0.073	0.005	0.010
GE→EI	0.596	17.477	0.000	0.440	13.171	0.000	0.156	0.000	0.001
GE→ES	0.406	9.545	0.000	0.291	8.634	0.000	0.115	0.018	0.036
GE→IEE	-0.246	4.825	0.000	-0.039	1.070	0.285	-0.207	1.000	0.001
EI→ES	0.216	6.415	0.000	0.206	6.165	0.000	0.010	0.418	0.837
EI→IEE	0.283	7.749	0.000	0.125	3.562	0.000	0.158	0.001	0.001
<i>Mediating Effects</i>									
GE→EI→ES	0.129	6.118	0.000	0.091	5.591	0.000	0.038	0.075	0.149
GF→EI→IEE	0.082	6.320	0.000	0.062	3.547	0.000	0.020	0.177	0.354
SPPS→GE→EI→ES	-0.003	0.823	0.411	0.018	3.734	0.000	-0.022	1.000	0.000
SPPS→GE→EI→IEE	-0.004	0.827	0.408	0.011	2.663	0.008	-0.016	0.992	0.017
CRFI→GE→EI→ES	0.052	5.706	0.000	0.015	3.442	0.001	0.036	0.000	0.000
CRFI→ GE→EI→IEE	0.068	5.840	0.000	0.009	2.819	0.005	0.059	0.000	0.000
LDSP→ GE→EI→ES	0.058	5.453	0.000	0.046	4.977	0.000	0.012	0.196	0.392
LDSP→ GE→EI→IEE	0.076	5.653	0.000	0.028	3.063	0.002	0.048	0.001	0.002
IKS→GE→EI→ES	0.020	4.354	0.000	0.008	3.373	0.001	0.013	0.004	0.008
IKS→ GE→EI→IEE	0.027	4.609	0.000	0.005	2.586	0.010	0.022	0.000	0.000
<i>Moderating Effects</i>									
GF×GE→EI	0.015	1.186	0.236	0.049	2.803	0.005	-0.035	0.948	0.104
GF×GE→ES	0.101	6.094	0.000	0.078	3.534	0.000	0.024	0.192	0.384
GF×GE→IEE	-0.054	2.919	0.004	0.024	0.945	0.345	-0.078	0.995	0.011

Box A1: Measures of Items and Sources

Sustainable Public-Procurement Signal (SPPS) – 4 items

Self-developed based on the work of Brammer and Walker (2011) and Testa et al. (2012)

Brammer, S., and Walker, H. (2011). Sustainable procurement in the public sector: An international comparative study. *International Journal of Operations and Production Management*, 31(4), 452-476.

Testa, F., Irlando, F., Frey, M., and Daddi, T. (2012). Which factors influence the uptake of GPP (green public procurement) practices? New evidence from an Italian survey. *Ecological Economics*, 82, 88-96.

1. Public bodies in our market consistently specify environmental criteria in tenders.
2. Tenders that include green criteria are awarded promptly and transparently.
3. Information on green-preferencing rules is readily available to suppliers.
4. Winning government contracts in our sector depends on verifiable environmental performance.

Climate-risk finance infrastructure (CRFI) – 4 items

Self-developed based on the works of Linnerooth-Bayer and Hochrainer-Stigler (2015) and Lupton et al. (2021) and Australian Prudential Regulation Authority (APRA) climate-risk self-assessment survey 2022

Linnerooth-Bayer, J., Hochrainer-Stigler, S. (2015). Financial instruments for disaster risk management and climate change adaptation. *Climatic Change*, 133, 85-100.

Lupton, N. C., Jiménez, A., Bayraktar, S., Tsagdis, D. (2021). Climate risk and private participation projects in infrastructure: mitigating the impact of locational (dis) advantages. *Management Decision* 59(1), 51-67.

https://www.apra.gov.au/sites/default/files/2022-08/Information%20paper%20-%20Climate%20risk%20self-assessment%20survey.pdf?utm_source=chatgpt.com

1. Affordable insurance products covering climate-related losses are accessible to my firm.
2. Local banks offer credit lines designed for investments that reduce climate risk.
3. Public or donor guarantees lower the cost of borrowing for resilience projects.
4. Clear guidance exists on how MSMEs can apply for climate-risk finance.

Local demand for sustainable products (LDSP) – 5 items

Self-developed based on the works of Haws et al. (2014) and Wu and Chen (2014)

Haws, K. L., Winterich, K. P., Naylor, R. W. (2014). Seeing the world through GREEN-tinted glasses: Green consumption values and responses to environmentally friendly products. *Journal of Consumer Psychology*, 24(3), 336-354.

Wu, S. I., and Chen, Y. J. (2014). Impact of green marketing and perceived innovation on purchase intention for green products. *International Journal of Marketing Studies*, 6(5): 81.

1. Customers value products with verified environmental attributes.
2. Our sales rise when we promote the environmental benefits of our offerings
3. Distributors request environmentally improved versions of existing products.
4. End-users frequently enquire about the ecological impact of our products.
5. Green labelling has helped us reach new market segments.

Indigenous knowledge synergy (IKS) – 4 items

Self-developed on the works of Reyes-García *et al.* (2006) and Kightley *et al.* (2016)

Kightley, E. P., Reyes-García, V., Demps, K., Magtanong, R. V., Ramonez, V., Thampy, G., Stepp, J. R. (2016). Measuring Traditional Ecological Knowledge: Does Knowledge Mean Skill? Tsimane Amazonian panel study working paper, 57.

Reyes-García, V., Vadez, V., Tanner, S., McDade, T., Huanca, T., and Leonard, W. R. (2006). Evaluating indices of traditional ecological knowledge: a methodological contribution. *Journal of ethnobiology and ethnomedicine*, 2, 21. <https://doi.org/10.1186/1746-4269-2-21>

1. We integrate local traditional ecological knowledge into product or process design.
2. Community elders are consulted on resource-management practices.
3. Traditional stewardship principles inform our sourcing decisions.
4. Employees receive training on culturally embedded environmental practices.

Green entrepreneurship (GE) – 4 items

Adapted from Jiang, W., Chai, H., Shao, J., Feng, T. (2018). Green entrepreneurial orientation for enhancing firm performance: A dynamic capability perspective. *Journal of Cleaner Production*, 198, 1311-1323.

1. We proactively seek business opportunities that address environmental problems.
2. The firm is willing to take risks to introduce environmentally sound innovations.
3. We frequently pioneer green products or services ahead of competitors.
4. Environmental goals are central to strategic decision-making.

Green-financing (GF) – 4 items

Self-developed based on Zhang *et al.* (2022)

Zhang, X., Wang, Z., Zhong, X., Yang, S., Siddik, A. B. (2022). Do green banking activities improve the environmental performance of banks? Mediating Effect of Green Financing. *Sustainability* 14(2): 989.

1. Loans at preferential rates are available for environmentally beneficial projects.
2. Investors show interest in funding our green initiatives.
3. Grants or subsidies for low-carbon technologies are within reach of MSMEs.
4. Financial institutions offer advice tailored to financing green projects.

Eco-Innovation (EI) – 6 items

Self-developed based on the works of Chen *et al.*, 2006) and Arundel and Kemp (2009)

Arundel, A. V., and Kemp, R. (2009). *Measuring eco-innovation*. Universiteit Maastricht. UNU-MERIT Working Paper No. 017

Chen, Y. S., Lai, S. B., and Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics*, 67(4), 331-339.

1. We have developed products that reduce raw-material use or waste generation.
2. Key production processes have been redesigned to lower emissions.
3. Life-cycle assessment informs our research and development activities.
4. Our patents or trade secrets relate to environmentally superior technologies.
5. Environmental criteria are included in supplier and partner selection.
6. We launch marketing initiatives that highlight environmental improvements.

Environmental Sustainability (ES) – 4 items

Self-developed based on the works of Sun *et al.* (2020) and Nicolăescu *et al.* (2015)

Sun, H., Mohsin, M., Alharthi, M., Abbas, Q. (2020). Measuring environmental sustainability performance of South Asia. *Journal of Cleaner Production* 251: 119519.

Nicolăescu, E., Alpopi, C., Zaharia, C. (2015). Measuring corporate sustainability performance. *Sustainability* 7(1), 851-865.

1. Energy use per unit of output has fallen over the past three years.
2. We consistently meet or exceed regulatory emission standards.
3. Waste generated per unit of sales has declined year on year.
4. Environmental targets set by the firm are regularly achieved.

Inclusive Economic Empowerment (IEE) – 4 items

Self-developed based on the works of Buvinic et al. (2020)

Buvinic, M., O'Donnell, M., Knowles, J. C., Bourgault, S. (2020). *Measuring women's economic empowerment: A compendium of selected tools*. Data2X and Centre for Global Development.

1. Our operations create decent jobs for people from low-income backgrounds.
 2. Employees are paid wages that meet or exceed the local living-wage benchmark.
 3. We provide training that enhances employability of marginalised groups.
 4. Women- or youth-owned local suppliers are actively integrated into our value chain.
-