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WOULD COORDINATION FLEXIBILITY MATTER IF GREEN INNOVATIVE LEADERSHIP INFLUENCED MANUFACTURING FIRMS' SUSTAINABLE PERFORMANCE? EVIDENCE FROM NORTH CENTRAL NIGERIA

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ABSTRACT

Purpose *– Manufacturing firms in North Central Nigeria continue to report weak sustainable performance despite growing leadership commitment to environmental goals: fewer than 12 percent of firms hold certified environmental management systems and the region loses an estimated 12 to 15 percent of productive capacity annually to unreliable energy supply, so leadership commitment alone has not been converting into execution on the factory floor. This study examines whether green innovative leadership (GIL) is positively associated with sustainable performance (SP) among manufacturing firms in North Central Nigeria, and whether this association is statistically mediated by coordination flexibility (CF), the organisational capability that Dynamic Capabilities Theory identifies as the route through which leadership vision is converted into cross-functional execution.*

Theoretical framework *– The study is anchored in Dynamic Capabilities Theory, which underpins the sensing, seizing, and reconfiguring logic linking green innovative leadership to coordination flexibility and sustainable performance, and is supported by Social Learning Theory, which governs the transmission of leadership behaviour to employees through observation and modelling.*

Design/methodology/approach *– A census survey was administered to owners and senior managers of 243 registered medium and large manufacturing firms across the six states and the Federal Capital Territory that make up North Central Nigeria. Of 229 questionnaires retrieved, 221 were valid for analysis (91.0 percent response rate). Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS 4, with bootstrapping of 5,000 subsamples.*

Findings *– Green innovative leadership is positively and significantly associated with sustainable performance and with coordination flexibility, and coordination flexibility is, in turn, positively and significantly associated with sustainable performance. Coordination flexibility partially mediates the association between green innovative leadership and sustainable performance, indicating that leadership is associated with sustainable performance both directly and indirectly through coordination flexibility. All hypothesised relationships are supported.*

Practical & social implications of research *– Findings indicate that manufacturing firms in North Central Nigeria report stronger sustainable performance where green innovative leadership is paired with deliberate investment in coordination flexibility, rather than pursued as a leadership initiative alone.*

Originality/value *– Green leadership in Nigerian manufacturing has stalled at the point of execution, a pattern this study theorises is linked to functional silos and rigid operational structures that limit how far green vision reaches the factory floor. This study addresses that problem directly by providing the first integrated PLS-SEM test of green innovative leadership, coordination flexibility, and sustainable performance within the Nigerian manufacturing sector, closing the construct, integration, contextual, and methodological gaps left open by prior Western, East Asian, and Latin American studies.*

1 Introduction

Manufacturing value added accounted for approximately 15 to 16 percent of world gross domestic product in 2023, and the sector consumed nearly one-third of total final energy while generating roughly one-quarter of global energy-related carbon dioxide emissions (International Energy Agency, 2023; UNIDO, 2023; World Bank, 2023). Energy intensity in manufacturing across industrialised economies fell by more than 20 percent between 2000 and 2022 without a corresponding drop in output, and firms with certified environmental management systems (EMS) report a 13 percent reduction in energy costs and a 9 percent improvement in operational efficiency relative to uncertified firms (Organisation for Economic Co-operation and Development [OECD], 2023; UNIDO, 2023). Sustainable performance has become a defining measure of industrial competitiveness rather than a peripheral concern.

Africa's manufacturing sector faces the same pressure under tighter constraints. Manufacturing contributes less than 13 percent of gross domestic product across most African economies, and firms in sub-Saharan Africa lose an estimated 12 to 15 percent of productive capacity annually to unreliable energy supply, while manufacturing emissions on the continent have grown at approximately 3.4 percent a year over the past decade, the fastest rate among developing regions (Economic Commission for Africa, 2023; African Development Bank, 2023). Firms that do adopt green production practices show measurable gains: a study of West African manufacturers found a 17 percent average improvement in material efficiency and an 11 percent reduction in waste disposal costs within two years of adopting environmental management systems (Adebayo & Olamide, 2023).

Nigeria's manufacturing sector contributes only 8 to 10 percent of gross domestic product, well below its strategic potential (National Bureau of Statistics, 2024). Fewer than 12 percent of Nigerian manufacturing firms hold certified environmental management systems, compared with 48 percent in South Africa and 67 percent in Malaysia, and fewer than one in five has adopted energy efficiency measures or green process innovations (Achem et al., 2025; Ofoegbu & Laguo, 2024; UNIDO, 2023). The Manufacturers Association of Nigeria records 243 registered medium and large manufacturing firms in North Central Nigeria, spanning food and beverage processing, agro-allied production, building materials, metal fabrication, and plastic and rubber products (Manufacturers Association of Nigeria, 2023). Against this backdrop, sustainable performance improvement stands as one of the sector's most consequential unresolved problems.

These macro-level figures on EMS adoption and energy inefficiency are, at root, evidence of a leadership problem rather than only a technology or infrastructure problem: certification, process redesign, and energy-efficiency investment are decisions made, delayed, or ignored inside top-management decision-making frameworks. Low EMS adoption and persistent energy inefficiency in Nigerian manufacturing are therefore theorised to trace back to how firm leadership senses environmental risk, allocates resources toward it, and reconfigures routines in response to it. This positions green innovative leadership as the foundational dynamic capability required to alter the operational routines that the macro-level data above show are not yet changing at scale, and it is the construct to which the discussion now turns.

Green innovative leadership (GIL) has emerged as a leadership orientation of particular relevance to this problem. It is defined as the capacity of leaders to articulate an environmental vision, support environmentally responsible behaviour, and stimulate creativity toward green innovation within organisations (Chen, 2011; Robertson & Barling, 2013). Green innovative leaders mobilise environmental knowledge, employee creativity, and innovation competencies to sense sustainability opportunities, seize them through resource mobilisation, and reconfigure organisational routines around sustainability (Chen et al., 2015; Teece et al., 1997). Empirical evidence links green innovative leadership to sustainable performance across manufacturing contexts (Song et al., 2022; Saleem et al., 2024; Abbas et al., 2022).

Leadership commitment alone, however, does not guarantee execution. Manufacturing sustainability initiatives such as green process innovation, energy efficiency upgrades, and environmental management systems require coordination across functional units; where that coordination is weak, leadership-driven intentions fail at the implementation stage. Coordination flexibility (CF), defined as a firm's ability to align, integrate, and redeploy internal activities and resources across functions in response to changing conditions, has been examined as a mediating capability linking strategic orientation to innovative performance (Vem et al., 2022), which suggests that it may also help firms embed sustainability objectives into operational routines. Studies of the broader construct of strategic flexibility report a parallel pattern (Dwikat et al., 2023; Khan, Yu, et al., 2024) and are cited here for analogous theoretical reasoning rather than as direct empirical evidence on coordination flexibility specifically. Coordination flexibility is conceptually narrower than the broader construct of strategic flexibility examined in much of this antecedent literature, including some of the sources cited above and elsewhere in this study (e.g., Dwikat et al., 2023; Khan, Rahman, et al., 2024; Awais et al., 2023; Agostini et al., 2023): where strategic flexibility denotes a firm's overall capacity to reconfigure resources and strategic posture in response to environmental change, coordination flexibility denotes specifically the operational-level capability to align, integrate, and redeploy activities across functional units, and is treated in this study as one operational expression of the broader strategic flexibility capability rather than as a direct synonym for it. No study has yet tested coordination flexibility as a mediating variable linking green innovative leadership to sustainable performance within the Nigerian manufacturing context, a gap this study is designed to close.

The failure of green leadership in Nigerian manufacturing is, at its core, an execution breakdown: functional silos and rigid operational structures are theorised to inhibit the translation of green vision into sustainable performance, and the four gaps below follow from that single problem rather than standing as unrelated omissions in the literature. This study makes four contributions that together address that execution problem. First, it addresses a construct gap by testing a theoretically grounded, unidimensional sustainable performance construct in a setting where prior Nigerian studies have relied on fragmented or purely descriptive measures (Achem et al., 2025; Ofoegbu & Laguo, 2024). Second, it addresses an integration gap: prior studies test green leadership and sustainable performance without coordination flexibility as a

mediator (Ahmed et al., 2023; Saleem et al., 2024), or test coordination flexibility and sustainability outcomes without situating leadership as the antecedent (Henao & Sarache, 2022; Tiwari, 2024). This study links the two in a single mediation model. Third, it addresses a contextual gap, since the empirical literature on both constructs has been generated predominantly in Western, East Asian, and Latin American manufacturing settings whose institutional conditions differ sharply from North Central Nigeria's unreliable energy supply, weak regulatory enforcement, and fragmented supply chains (Ledi, 2024; Henao & Sarache, 2022; Ahmed et al., 2023). Fourth, it addresses a methodological gap, since most Nigerian sustainability studies rely on descriptive or simple regression techniques that cannot test mediation; this study applies Partial Least Squares Structural Equation Modelling (PLS-SEM), which estimates direct and indirect effects simultaneously and tolerates the non-normal data typical of manufacturing surveys.

1.1 Theoretical background

Dynamic Capabilities Theory, introduced by Teece et al. (1997), holds that ordinary operational routines are necessary but insufficient when environments shift quickly; firms also need dynamic capabilities that let them sense opportunities and threats, seize them through resource mobilisation, and reconfigure the resource base to stay competitive. The theory rests on the premise that competitive advantage depends on the firm's capacity to purposefully reconfigure assets, not merely to possess them (Helfat et al., 2007), and that dynamic capabilities are rooted in people and routines that can be built and institutionalised (Teece, 2007).

Under Dynamic Capabilities Theory, green innovative leaders are theorised to function as a micro-foundation of this capability. They are expected to increase sensing by scanning the environment for sustainability risks and legitimising investment in environmental intelligence; to seize opportunities by mobilising funding, cross-functional teams, and external partnerships for eco-innovation; and to reconfigure firm routines, such as procurement rules or performance indicators, so that green processes become embedded in operations (Teece, 2007; Mubeen et al., 2023). Coordination flexibility is theorised to be the organisational capability through which this reconfiguration is carried out in practice: it reflects the firm's ability to align interdependent units under changing conditions (Vem et al., 2022; see also Dwikat et al., 2023, on the broader construct of strategic flexibility), and its absence is theorised to help explain why leadership commitment to sustainability sometimes fails to reach the shop floor.

Social Learning Theory, developed by Bandura (1977, 1986), complements this framework by explaining how leadership behaviour becomes embedded employee behaviour. Individuals learn not only through direct experience but by observing credible models, particularly leaders and supervisors, and by retaining, reproducing, and being motivated to repeat behaviours that are consistently modelled and rewarded. Leaders who visibly prioritise environmental responsibility and encourage experimentation provide behavioural models that employees observe and imitate, and repeated exposure to such modelling is theorised to teach employees that sustainability-oriented practices and flexible coordination are expected components of performance (Zhang et al., 2024; Saleem et al., 2024). The theory has been criticised for underplaying the structural and infrastructural constraints that can prevent employees from enacting behaviours they have internalised (Junejo et al., 2025), a limitation of particular relevance in a setting such as North Central Nigeria, where energy unreliability and weak regulatory enforcement can blunt the transfer from observed leadership behaviour to enacted employee practice.

1.2 Model and theory integration

Combining the two theories produces an integrated theoretical sequence. Green innovative leadership is theorised to build the micro-foundations of dynamic capability by increasing sensing, seizing, and reconfiguration; social learning theory offers an account of how this leadership behaviour may be transmitted to employees as observed, imitated, and reinforced practice; and coordination flexibility is theorised to be the organisational capability in which this transmission becomes visible, since it is conceptually the means by which reconfigured routines are executed across departments. These are theoretical interpretations; the cross-sectional data test only whether the corresponding statistical associations are present. The model therefore treats coordination flexibility as a mediating capability that is associated with whether green innovative leadership's sustainability intentions convert into performance, rather than as a parallel, independent correlate of performance.

2 Hypotheses development

2.1 Green innovative leadership and sustainable performance

Green innovative leadership refers to leadership behaviours that encourage the generation and application of creative ideas, processes, and technologies that reduce environmental impact while enhancing organisational performance (Chen et al., 2020). Leaders who scan the environment for sustainability opportunities, mobilise resources for eco-innovation, and embed green routines into governance are expected, under Dynamic Capabilities Theory, to be associated with higher firm performance, because these actions are theorised to constitute the sensing-seizing-reconfiguring cycle linked to measurable environmental, social, and economic gains (Teece, 2007; Mubeen et al., 2023). Empirical support is consistent across contexts: green leadership was significantly and positively associated with environmental and organisational performance through green innovation among Pakistani manufacturers (Ahmed et al., 2023), green innovative leadership was positively associated with sustainable performance by way of fostering employee green creativity among Chinese manufacturers (Saleem et al., 2024), and leadership commitment to sustainability predicted sustainable performance among West African manufacturers, although that study did not test green innovative leadership specifically (Adebayo & Olamide, 2023). The study therefore posits that:

H1: Green innovative leadership is positively associated with sustainable performance of manufacturing firms in North Central Nigeria.

2.2 Green innovative leadership and coordination flexibility

Coordination flexibility reflects a firm's ability to align, integrate, and redeploy internal activities and resources across functions as conditions change (Vem et al., 2022). Dwikat et al. (2023), who studied the broader construct of strategic flexibility, are cited here only as analogous theoretical support. Under Social Learning Theory, leaders who model collaboration, adaptability, and environmental commitment are theorised to create the observational conditions through which employees may internalise flexible coordination as an expected norm rather than an occasional response to crisis. Agostini, Nosella, and Corso's (2023) systematic review addresses strategic flexibility rather than coordination flexibility specifically, and is cited here as analogous theoretical support, not as direct empirical evidence, for the expectation that leadership orientation is related to how readily firms reconfigure routines across units. Direct evidence on coordination flexibility comes from the following studies. Kafetzopoulos et al. (2023) reported through structural equation modelling that leadership commitment to innovation predicted

coordination flexibility among manufacturing firms, and Sulmonte et al. (2022) found that leaders who modelled collaboration and adaptability during the COVID-19 disruption were associated with higher coordination flexibility and faster recovery. Feng et al. (2024) reported that Asian manufacturing leaders who emphasised innovation and environmental collaboration were positively associated with coordination flexibility with both internal units and external suppliers, though infrastructural limitations moderated the strength of this effect. The study therefore posits that:

H2: Green innovative leadership is positively associated with coordination flexibility of manufacturing firms in North Central Nigeria.

2.3 Coordination flexibility and sustainable performance

Coordination flexibility is theorised, through both Dynamic Capabilities Theory and scarcity-oriented resource reasoning, to help firms translate sustainability intentions into realised outcomes under changing conditions. Firms that can rapidly reconfigure who does what, how information flows, and how partners are mobilised are better positioned to adopt energy-saving routines quickly, protect social outcomes such as worker safety during disruption, and sustain economic performance through reduced downtime (Henao & Sarache, 2022; see Agostini et al., 2023, for analogous evidence on strategic flexibility). Henao and Sarache (2022) found that coordination flexibility was associated with faster adoption of eco-efficient processes and higher long-term profitability among Latin American manufacturers. Evidence from the broader strategic flexibility literature is analogous rather than direct: Awais et al. (2023) found that strategic flexibility was positively associated with organizational performance, both directly and through innovation, among engineering project-based firms in Pakistan. As direct evidence on coordination flexibility, Nazir, Shafi, and Ahmad (2024) found that coordination flexibility was associated with a stronger link between green supply chain practices and environmental performance. Tiwari (2024) showed, using longitudinal data, that firms with higher coordination flexibility incurred short-term adjustment costs but achieved superior environmental and economic performance over time. The study therefore posits that:

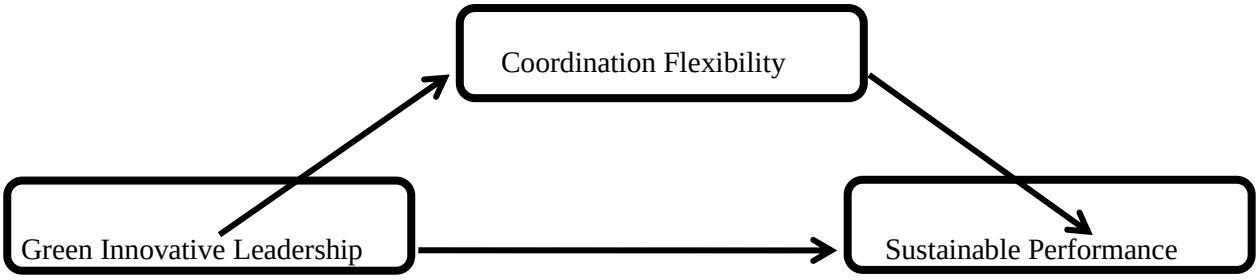
H3: Coordination flexibility is positively associated with sustainable performance of manufacturing firms in North Central Nigeria.

2.4 The mediating role of coordination flexibility

Dynamic Capabilities Theory frames leadership as the antecedent of capability-building, and coordination flexibility as a capability through which that leadership is theorised to be converted into durable, cross-functional outcomes rather than isolated managerial gestures. Mubeen et al. (2023) argued that leadership translates into sustainable outcomes most effectively when firms have developed dynamic and coordination capabilities that enable the sensing, seizing, and reconfiguration DCT specifies, and Khan, Rahman, et al. (2024), studying the broader construct of strategic flexibility, found a parallel pattern in which flexibility was associated with stronger sustainability outcomes of leadership-driven initiatives — evidence drawn on here by analogy rather than as a direct test of coordination flexibility. Where leaders express strong environmental vision but firms lack the coordination capacity to reallocate resources and realign responsibilities across departments, sustainability initiatives are more likely to stall at the point of implementation. The study therefore posits that:

H4: Coordination flexibility significantly mediates the association between green innovative leadership and sustainable performance of manufacturing firms in North Central Nigeria.

Figure 1
Conceptual Framework



Source: Authors (2025). Note: Sustainable Performance is conceptually a second-order construct comprising Economic, Environmental, and Social performance as first-order dimensions (Elkington, 1997); it is estimated here as a single latent construct, and second-order re-estimation is identified as a priority for a future iteration of this model.

3 Method

3.1 Population and sample

The target population comprised 243 registered medium and large manufacturing firms across the six states and the Federal Capital Territory that make up North Central Nigeria: Kwara (58 firms), Kogi (45), Niger (38), Plateau (34), the Federal Capital Territory (28), Benue (24), and Nasarawa (16), as recorded by the Manufacturers Association of Nigeria (2023). Because the population was small, known, and accessible, the study adopted a census approach rather than a sampling procedure, following the methodological guidance that a census is preferable to sampling when the entire population can be reached without impractical cost (Sekaran & Bougie, 2016). A census of all 243 registered medium and large manufacturing firms was therefore attempted rather than a sub-sample of them; the state-level breakdown reported above represents the geographic distribution of the population across the six states and the Federal Capital Territory, not a stratified or purposefully selected subset.

A total of 243 questionnaires were administered to owners and senior managers; 229 were retrieved, and after data cleaning to remove incomplete or inconsistent responses, 221 questionnaires were retained for analysis, a valid response rate of 91.0 percent. This exceeds the generally accepted minimum of 70 percent for management research (Saunders et al., 2019) and satisfies Hair et al.'s (2022) minimum sample threshold for a PLS-SEM model of this complexity. The excluded 8 questionnaires each exceeded the 5 percent missing-data threshold recommended by Hair et al. (2013) for removal.

Male respondents made up 64.7 percent of the sample and female respondents 35.3 percent, consistent with the male-dominated managerial profile of manufacturing firms in the region (Manufacturers Association of Nigeria, 2023). Most respondents fell within the 38–47 age bracket (39.8 percent) or the 28–37 bracket (32.1 percent). A majority were married (67.4 percent), and 52.5 percent held an HND or first degree while 34.4 percent held a postgraduate qualification. Regarding tenure, 42.1 percent had 6 to 9 years of work experience and 40.3 percent had 10 years or more; 66.5 percent were senior staff. Kwara State contributed the largest share of respondents (26.2 percent), followed by Kogi (20.4 percent) and Plateau (15.4 percent), broadly reflecting the geographic distribution of the population across the region.

3.2 Data collection procedure

Primary data were collected through a structured questionnaire administered physically to owners and senior managers of manufacturing firms. The questionnaire captured demographic information alongside Likert-scale items measuring green innovative leadership, coordination flexibility, and sustainable performance. To reduce common method bias, questionnaire sections measuring different constructs were separated with clear headings, positively and negatively worded items were mixed where appropriate, respondent anonymity was guaranteed, and the instrument was pre-tested on 30 respondents drawn from the target population before full administration (Podsakoff et al., 2003; Chang et al., 2010).

Two post-collection diagnostics assessed common method bias directly. Harman's single-factor test, run in IBM SPSS 26, showed that the largest unrotated factor explained 26.8 percent of total variance, well below the 50 percent threshold associated with problematic common method variance (Podsakoff et al., 2003). An unmeasured common latent factor was also introduced within the PLS-SEM model and did not materially alter path coefficients relative to the base model (Liang et al., 2007). Common method bias is therefore not judged to threaten the validity of the study's structural findings.

4 Measures

All constructs were measured on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) and treated as reflective, consistent with established measurement theory (Diamantopoulos & Siguaw, 2006; Anderson & Gerbing, 1988).

4.1 Green innovative leadership

Green innovative leadership was measured with a 6-item scale adapted from Liu and Yu (2023), capturing top management's encouragement of environmentally reducing innovation, support for green technology adoption, integration of sustainability into strategic decisions, motivation of employees toward eco-innovation, resource allocation for green initiatives, and demonstrated commitment to environmental protection through innovation. The scale returned a Cronbach's alpha of 0.964.

4.2 Coordination flexibility

Coordination flexibility was measured with a 6-item scale adapted from Way et al. (2015), capturing the speed with which firms adjust internal coordination arrangements, modify coordination processes, realign responsibilities across units, adjust coordination with suppliers and partners, adapt communication and decision-making routines, and reconfigure reporting lines to match new operational priorities. One item (adjusting coordination with suppliers and partners) was dropped during measurement-model purification for falling below the 0.708 outer-loading threshold (see Section 5.2); the retained 5-item scale returned a Cronbach's alpha of 0.936.

4.3 Sustainable performance

Sustainable performance was measured with a 12-item scale adapted from Elkington's (1997) triple bottom line framework as operationalised by Ahmed et al. (2023) and Nazir et al. (2024), with four items each capturing economic, environmental, and social performance. The triple bottom line is conceptually multidimensional, comprising economic, environmental, and social performance as first-order dimensions of a second-order construct (Elkington, 1997). Sustainable performance was operationalised as a single latent construct in the estimation reported here, following prior manufacturing research that pools economic, environmental, and social items into one composite measure when disaggregated

multidimensional data are difficult to obtain in developing-economy contexts (Chen, Lai, & Wen, 2006; Achem et al., 2025). The measurement instrument represented the three dimensions equally, with four items each capturing economic, environmental, and social performance, so that no single dimension dominates the composite measure. The measurement-model results support this specification, and the two versions of the construct are reported separately. In the original 12-item specification, before purification, the construct achieved a Cronbach's alpha of 0.967 and an average variance extracted (AVE) of 0.691, with one item (SP1) falling below the 0.708 loading threshold. In the final 11-item specification, which is the model used for all results reported in Section 5, the loadings range from 0.812 to 0.886 (Table 1 and Table 1a), Cronbach's alpha is 0.966, composite reliability is 0.970, and AVE is 0.745, indicating that the eleven retained indicators cohere as a single measurement space. The study nonetheless acknowledges, consistent with Elkington's (1997) original triple-bottom-line framework, that the three dimensions are conceptually distinct and can in principle move independently of one another (a firm can, for instance, improve environmental outcomes while economic performance stagnates); the unidimensional specification adopted here therefore rests on the empirical coherence of the eleven retained items rather than on an a priori assumption that the dimensions are interchangeable. A second-order reflective specification, with economic, environmental, and social performance entered as first-order dimensions, together with an explicit test of inter-dimensional covariance, is identified in Section 6.2 as a direction for future model refinement rather than a deficiency in the present specification. One item (an economic-performance item on sustained profitability) was dropped during measurement-model purification for falling below the 0.708 outer-loading threshold (see Section 5.2); the retained 11-item scale returned a Cronbach's alpha of 0.966.

The questionnaire originally fielded 6 (Green Innovative Leadership) + 6 (Coordination Flexibility) + 12 (Sustainable Performance) = 24 indicators. During measurement-model purification, two items were dropped for falling below the 0.708 outer-loading threshold recommended by Hair et al. (2022): CF4 ("Coordination with suppliers and partners can be adjusted rapidly"; loading = 0.698) and SP1 ("Our firm has achieved sustained profitability over time"; loading = 0.705). No other items required removal; all remaining loadings, reported individually in Table 1a, exceed 0.708. The final measurement model therefore comprises 6 (GIL) + 5 (CF) + 11 (SP) = 22 indicators, consistent across the instrument, Table 1, Table 1a, and the results section.

5 Findings

5.1 Descriptive statistics

Prior to the main analysis, the dataset was screened in IBM SPSS 26 for outliers, missing values, normality, and linearity. Box-and-whisker plots identified a small number of extreme values in the Green Innovative Leadership and Coordination Flexibility constructs, consistent with the 8 questionnaires later excluded on Hair et al.’s (2013) missing-data criterion; the cleaned dataset of 221 responses showed no substantial remaining outliers. No individual item exceeded the 5 percent missing-data threshold. A histogram and Normal P-P plot of standardised residuals for Sustainable Performance approximated a normal distribution (mean = -1.87E-16, SD = 0.993), and a scatterplot of residuals against predicted values showed no systematic curvature, confirming that the linearity and homoscedasticity assumptions were satisfied.

5.2 Measurement model assessment

The measurement model was evaluated for indicator reliability, internal consistency, convergent validity, and discriminant validity in SmartPLS 4. All factor loadings exceeded the 0.708 threshold recommended

by Hair et al. (2022). Table 1 presents the reliability and convergent validity statistics for all three constructs.

Table 1

Reliability and Convergent Validity of Study Constructs

Construct	Items	Factor Loading Range	Cronbach's Alpha (≥0.70)	Composite Reliability (0.60–0.95)	AVE (≥0.50)
Green Innovative Leadership	6	0.838–0.935	0.964	0.964	0.815
Coordination Flexibility	5	0.829–0.934	0.936	0.951	0.794
Sustainable Performance	11	0.812–0.886	0.966	0.970	0.745

Note: Criteria follow Hair et al. (2022). All statistics refer to the final measurement model (22 indicators: 6 GIL, 5 CF, 11 SP) after removal of CF4 and SP1; Green Innovative Leadership was unaffected by purification. Statistics for the original 12-item Sustainable Performance specification (alpha = 0.967; AVE = 0.691) are reported in Section 4.3 only.

Table 1 above reports the loading range for each construct; per the Editorial Office's request, Table 1a reports the outer loading of every individual retained item. **Item wording below is reproduced verbatim from the research instrument.**

Table 1a. Individual Item Outer Loadings

Construct	Item	Item content	Outer Loading
Green Innovative Leadership	GIL1	Top management encourages innovative ideas that reduce environmental impact.	0.838
Green Innovative Leadership	GIL2	Leaders actively support the adoption of green technologies and processes.	0.908
Green Innovative Leadership	GIL3	Management integrates environmental sustainability into strategic decision making.	0.928
Green Innovative Leadership	GIL4	Leaders motivate employees to develop environmentally innovative solutions.	0.935
Green Innovative Leadership	GIL5	Top executives allocate resources to support green innovation initiatives.	0.879
Green Innovative Leadership	GIL6	Leaders demonstrate strong commitment to environmental protection through innovation.	0.925
Coordination Flexibility	CF1	Our firm can quickly adjust coordination arrangements with internal departments.	0.908
Coordination Flexibility	CF2	The organization easily modifies coordination processes when conditions change.	0.934
Coordination Flexibility	CF3	Our firm effectively realigns responsibilities across units when necessary.	0.926
Coordination Flexibility	CF5	The organization flexibly adapts communication and decision making routines.	0.853
Coordination Flexibility	CF6	Our firm responds swiftly to unexpected coordination challenges.	0.829
Sustainable Performance	SP2	The firm effectively reduces operational costs through efficient use of resources.	0.812

Construct	Item	Item content	Outer Loading
Sustainable Performance	SP3	Our organization maintains a strong competitive position in the market.	0.834
Sustainable Performance	SP4	The firm achieves long term financial stability through sustainable practices.	0.874
Sustainable Performance	SP5	Our firm actively reduces waste and emissions generated from production activities.	0.878
Sustainable Performance	SP6	The organization efficiently uses energy and raw materials.	0.865
Sustainable Performance	SP7	Our firm complies with environmental regulations and standards.	0.885
Sustainable Performance	SP8	The organization adopts environmentally friendly technologies and processes.	0.864
Sustainable Performance	SP9	Our firm provides a safe and healthy working environment for employees.	0.878
Sustainable Performance	SP10	The organization treats employees fairly and ethically.	0.877
Sustainable Performance	SP11	Our firm contributes positively to the local community.	0.886
Sustainable Performance	SP12	The organization respects the rights and welfare of all stakeholders.	0.839

The results presented in Table 1 confirm the reliability, indicator adequacy, and convergent validity of all three study constructs following removal of two sub-threshold items (see Section 4.3 and the note following Table 1a). For Green Innovative Leadership, all six item loadings range from 0.838 to 0.935, each exceeding the recommended threshold of 0.708. The construct demonstrates excellent internal consistency, with a Cronbach's alpha of 0.964 and CR of 0.964, while the AVE value of 0.815 confirms strong convergent validity. For Coordination Flexibility, the five retained item loadings range from 0.829 to 0.934, all surpassing the recommended minimum. The construct records a Cronbach's alpha of 0.936 and CR of 0.951, with an AVE value of 0.794 confirming strong convergent validity. For Sustainable Performance, the eleven retained item loadings range from 0.812 to 0.886, with a Cronbach's alpha of 0.966, a CR of 0.970, and an AVE of 0.745, all meeting or exceeding the required thresholds. Collectively, these results establish that the measurement model satisfies the criteria for indicator reliability, internal consistency, and convergent validity across all three constructs.

Having established convergent validity, discriminant validity was assessed using both the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio. The square root of the AVE for each construct, Green Innovative Leadership (0.903), Coordination Flexibility (0.891), and Sustainable Performance (0.863), exceeded its highest inter-construct correlation (Fornell & Larcker, 1981). All HTMT values fell below the conservative 0.90 threshold (Henseler et al., 2015), with the highest ratio (0.749) recorded between Green Innovative Leadership and Sustainable Performance and the lowest (0.514) between Coordination Flexibility and Sustainable Performance. The three constructs are therefore empirically distinct, supporting proceeding to structural model evaluation.

5.3 Structural model evaluation

Model fit was assessed through the Standardised Root Mean Square Residual (SRMR), which returned a value of 0.072 for both the saturated and estimated models in the refined 22-item specification (following removal of CF4 and SP1, detailed below), within Hu and Bentler's (1999) 0.08 threshold for acceptable fit. Collinearity was assessed through the Variance Inflation Factor (VIF); all values fell well below the

threshold of 5.0 (GIL→SP and CF→SP: VIF = 1.377; GIL→CF: VIF = 1.000), confirming that multicollinearity does not distort the path estimates.

Coordination flexibility's variance is 27.4 percent accounted for by green innovative leadership ($R^2 = 0.274$, moderate by Cohen's 1988 benchmarks), and sustainable performance's variance is 54.8 percent jointly accounted for by green innovative leadership and coordination flexibility ($R^2 = 0.548$, substantial). Effect sizes indicate that the GIL→SP relationship ($f^2 = 0.634$) and the GIL→CF relationship ($f^2 = 0.377$) are both large, while the CF→SP relationship ($f^2 = 0.053$) is small, indicating that coordination flexibility's statistically significant association with sustainable performance is more modest in practical terms than the dominant association of leadership.

Predictive relevance was assessed through the blindfolding procedure with an omission distance of D = 7, which yields the Q^2 statistic for each endogenous construct. Coordination flexibility returned $Q^2 = 0.209$ and sustainable performance returned $Q^2 = 0.405$. Following Hair et al.'s (2019) benchmarks of 0.02, 0.15, and 0.35 for small, medium, and large predictive relevance respectively, coordination flexibility shows medium predictive relevance and sustainable performance shows large predictive relevance; both values exceed zero, confirming that the structural model has predictive relevance for both endogenous constructs (Hair et al., 2022).

Hypotheses were tested through bootstrapping with 5,000 subsamples at the 95 percent confidence level, with rejection criteria of $t \geq 1.96$ and $p \leq 0.05$. Table 2 summarises the results.

To express the model with the mathematical rigor a PLS-SEM specification requires, the structural relationships are formalised as two equations. Coordination flexibility is specified as a function of green innovative leadership: $CF = \alpha_1 + \beta_1 GIL + \zeta_1$, where β_1 is the path coefficient reported for H2 (GIL → CF) and ζ_1 is the associated error term. Sustainable performance is specified as a joint function of green innovative leadership and coordination flexibility: $SP = \alpha_2 + \beta_2 GIL + \beta_3 CF + \zeta_2$, where β_2 is the direct path coefficient for H1 (GIL → SP), β_3 is the path coefficient for H3 (CF → SP), and ζ_2 is the associated error term. The indirect effect of green innovative leadership on sustainable performance through coordination flexibility is the product of the two constituent paths, $\beta_1\beta_3$, and the total effect of green innovative leadership on sustainable performance is the sum of the direct and indirect paths, $\beta_2 + \beta_1\beta_3$, which is the mediation relationship tested under H4.

Table 2

Structural Model Results

Hyp	Relationship	β	STDEV	t-value	p-value	Decision	95% CI
H1	GIL → SP	0.628	0.054	11.640	0.000	Supported	[0.520, 0.731]
H2	GIL → CF	0.523	0.054	9.697	0.000	Supported	[0.417, 0.627]
H3	CF → SP	0.182	0.057	3.185	0.001	Supported	[0.074, 0.298]

All three direct hypotheses are supported. Green innovative leadership is positively and strongly associated with sustainable performance (β = 0.628): manufacturing firms whose leaders encourage environmentally innovative ideas, support green technology adoption, integrate sustainability into strategic decisions, and allocate resources to green initiatives report significantly better sustainable performance. Green innovative leadership is also positively associated with coordination flexibility (β = 0.523), consistent with leadership functioning as an antecedent of the firm's ability to reconfigure internal and external processes, though the cross-sectional design cannot establish the direction of that relationship. Coordination flexibility, in turn, is

positively associated with sustainable performance (β = 0.182): firms that report faster adjustment of coordination arrangements also report significantly higher sustainable performance.

The mediating role of coordination flexibility was tested through bootstrapped bias-corrected confidence intervals for the indirect path. Table 3 presents the results.

Table 3

Mediation Test Results

Hyp	Indirect Path	β	STDEV	t-value	p-value	Decision	95% CI
H4	GIL → CF → SP	0.095	0.032	3.008	0.003	Supported	[0.039, 0.163]

The confidence interval for the indirect effect excludes zero, confirming significant mediation and leading to the rejection of the null form of H4. Because the direct GIL→SP path (β = 0.628) remains significant alongside the indirect path (β = 0.095), the mediation is partial: the total effect of green innovative leadership on sustainable performance is β = 0.723 ($\beta_2 + \beta_1\beta_3 = 0.628 + 0.095$), of which the coordination-flexibility pathway accounts for a smaller but statistically significant share. Green innovative leadership is therefore associated with sustainable performance both directly and indirectly through its association with coordination flexibility.

Figure 2

Structural Model with Standardised Path Coefficients

Green Innovative Leadership → Sustainable Performance: β = 0.628**

Green Innovative Leadership → Coordination Flexibility: β = 0.523**

Coordination Flexibility → Sustainable Performance: β = 0.182**

*Note: **p < 0.01. Source: SmartPLS 4 output, 2025.*

6 Discussion

This study set out to test whether green innovative leadership is associated with sustainable performance among manufacturing firms in North Central Nigeria, and whether coordination flexibility helps account for part of that association. All four hypotheses are supported. Green innovative leadership has a large, significant positive association with sustainable performance (H1), consistent with Ahmed et al. (2023) in Pakistan and Saleem et al. (2024) in China, and cross-contextually with Adebayo and Olamide's (2023) finding in West Africa that leadership commitment predicts sustainable performance. This result is practically significant given that fewer than one in five Nigerian manufacturing firms has adopted formal sustainable practices (Ofoegbu & Laguo, 2024): it indicates that leadership orientation, not only regulatory pressure or capital investment, is associated with sustainable performance even where formal frameworks remain weak, though the cross-sectional design means this study cannot establish that leadership orientation causes the improvement rather than merely accompanying it.

Green innovative leadership also significantly predicts coordination flexibility (H2), matching Kafetzopoulos et al.'s (2023) structural evidence that leadership commitment to innovation predicts coordination flexibility and, by analogy, the strategic flexibility literature reviewed by Agostini et al. (2023). This is consistent with coordination flexibility not arising as a spontaneous organisational trait, but co-occurring with the leadership orientation associated with it, in line with Social Learning Theory's

premise that employees adopt flexible, adaptive coordination behaviour by observing it modelled by leaders, though that observational mechanism was not directly measured here.

Coordination flexibility significantly predicts sustainable performance (H3), matching Henao and Sarache's (2022) finding in Latin American manufacturing and Tiwari's (2024) longitudinal evidence that coordination flexibility is associated with superior environmental and economic performance despite short-term adjustment costs. Given that unreliable energy supply alone costs sub-Saharan African manufacturers an estimated 12 to 15 percent of productive capacity annually (Economic Commission for Africa, 2023), the ability to reconfigure coordination quickly in response to such shocks is plausibly an important correlate of sustained performance rather than a peripheral operational nicety, although the cross-sectional data cannot show that it contributes to that performance.

The partial mediation result (H4) is the study's central theoretical contribution. It shows that green innovative leadership is associated with sustainable performance through two statistical paths at once: a direct path and an indirect path via coordination flexibility. Under Dynamic Capabilities Theory these paths can be interpreted as leadership vision and resource allocation bearing directly on outcomes, and leadership building coordination flexibility that then sustains performance across functional units; the data establish the associations, not these processes. This matches Mubeen et al.'s (2023) argument that leadership converts most durably into sustainable outcomes when firms have built the coordination capabilities that Dynamic Capabilities Theory identifies as necessary for sensing, seizing, and reconfiguring resources. The comparatively small effect size for CF→SP ($f^2 = 0.053$), alongside the statistical significance of the indirect effect, suggests that coordination flexibility's independent contribution is modest; it can be interpreted theoretically, though not shown here, as a channel through which leadership-driven sustainability intentions become operationally durable.

6.1 Implications

For theory, the findings are consistent with Dynamic Capabilities Theory's premise that firm-level performance depends on the capacity to sense, seize, and reconfigure resources, and are compatible with treating coordination flexibility as a candidate capability through which leadership micro-foundations may convert into firm-level sustainable performance in a developing-economy manufacturing setting, an interpretation that remains to be tested with temporal data. The findings are also consistent with Social Learning Theory's premise that leadership behaviour is linked to organisational practice, but this study measured green innovative leadership, coordination flexibility, and sustainable performance at the firm level through owner and senior-manager reports; it did not measure the observation-imitation-reinforcement mechanism through which Social Learning Theory holds that individual employees internalise modelled behaviour. The results should therefore be read as compatible with, rather than as a direct test or extension of, that mechanism.

For practice, manufacturing firm managers in North Central Nigeria may find it useful, on the basis of these associations, to consider green innovative leadership development and coordination flexibility building together rather than as separate initiatives. Firms that report leadership without coordination capacity, or coordination capacity without leadership vision, may be expected to report weaker sustainable performance than firms that report both, although this study did not test the effect of building either. Leadership development programmes could target environmental opportunity sensing, green resource mobilisation, and cross-functional facilitation skills, as the theoretical framing suggests; the leadership behaviours measured here, such as integrating sustainability into strategic decisions and allocating resources to green

initiatives, were associated with both coordination flexibility and sustainable performance, but the study did not test these specific skills.

For policy, the findings suggest that regulators such as the National Environmental Standards and Regulations Enforcement Agency and the Standards Organisation of Nigeria could consider incorporating coordination flexibility, not only point-in-time compliance, into sustainability auditing frameworks, and designing leadership incentive schemes that reward documented investment in green innovative leadership, options that may be less capital-intensive than infrastructure-based sustainability strategies, although this study did not assess costs or the effects of such schemes.

6.2 Limitations and directions for future research

This study is limited in four respects. First, its cross-sectional design cannot establish the temporal order in which green innovative leadership, coordination flexibility, and sustainable performance develop; a longitudinal design would be needed to examine temporal order and any causal relationship. Second, all data were self-reported by owners and senior managers, introducing potential social desirability bias despite the procedural safeguards applied. Third, the study is geographically bounded to North Central Nigeria, limiting generalisation to other Nigerian zones or Sub-Saharan African manufacturing contexts with different institutional conditions. Fourth, sustainable performance was treated as a unidimensional construct; future research should disaggregate the construct into its economic, environmental, and social components to identify whether green innovative leadership and coordination flexibility contribute differently to each. Future studies should also test moderating variables such as firm size, energy access, and digital infrastructure quality, which this study did not examine but which plausibly shape the strength of the relationships identified.

7 Conclusion

This study set out to determine whether coordination flexibility helps explain the association between green innovative leadership and sustainable performance among manufacturing firms in North Central Nigeria. Green innovative leadership is strongly and positively associated with sustainable performance and with coordination flexibility; coordination flexibility, in turn, is significantly and positively associated with sustainable performance and partially mediates the leadership-performance association. The findings indicate that green innovative leadership and coordination flexibility function as complementary, not substitutable, correlates of sustainable performance: leadership is associated with the environmental vision and innovation motivation reported by firms, and coordination flexibility is associated with the organisational capability through which, on theoretical grounds, that vision may be executed consistently across functions. Manufacturing firms in North Central Nigeria seeking durable sustainability gains may wish to consider both together, on the basis of these associations.

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