

Institutional Norms and Leadership Dynamics: Assessing Internal Human Resource Capabilities and Organizational Culture in Driving Sustainable SCM Practices in Petroleum Infrastructure

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Abstract

The petroleum infrastructure sector faces mounting pressure to integrate sustainable supply chain management (SSCM) practices amid intensifying institutional demands and environmental imperatives. Despite growing recognition of external institutional pressures, the internal organizational mechanisms that translate these pressures into sustainable outcomes remain inadequately understood. This study investigates the interplay between institutional norms, leadership dynamics, internal human resource capabilities, and organizational culture in driving SSCM practices within petroleum infrastructure organizations. Employing a quantitative research design with survey data from 159 petroleum infrastructure firms operating in developing economy contexts, the study utilizes structural equation modeling and regression analysis to test hypothesized relationships. The findings reveal that coercive and normative institutional pressures significantly enhance SSCM adoption ($\beta = 0.417$, $p < 0.001$), with leadership commitment emerging as the strongest internal predictor ($\beta = 0.462$). Organizational culture demonstrates a significant mediating effect, explaining 34.7% of the relationship between HR capabilities and SSCM implementation. The integrated model achieves predictive accuracy of 89.4% in distinguishing high-performing SSCM adopters. This research contributes a validated framework explaining how institutional norms interact with internal organizational resources to drive sustainable supply chain practices. Practical implications include actionable recommendations for enhancing leadership development programs and culture-building initiatives to improve SSCM outcomes in petroleum infrastructure operations.

Keywords: Institutional Theory, Sustainable Supply Chain Management, Leadership Dynamics, Organizational Culture, Human Resource Capabilities, Petroleum Infrastructure

1. Introduction

1.1 Background

The petroleum industry occupies a paradoxical position in contemporary sustainability discourse. As the primary engine of global economic development and energy provision, it simultaneously represents one of the most significant contributors to environmental degradation and carbon emissions (Okeke, 2025). This dual reality has generated intensifying pressure from multiple stakeholders—governments, environmental organizations, local communities, and international bodies—for the industry to fundamentally transform its operational practices and supply chain management approaches toward greater sustainability.

The concept of sustainable supply chain management (SSCM) has emerged as a critical framework for addressing these pressures, integrating economic, environmental, and social considerations into the management of material, information, and capital flows across the supply chain (Okeke & Rahim, 2026). For petroleum infrastructure organizations—encompassing exploration, extraction, refining, transportation, and distribution networks—the implementation of SSCM practices presents unique challenges due to the capital-intensive nature of operations, complex regulatory environments, and significant environmental risks associated with core activities (Ahi & Searcy, 2015).

Research has increasingly recognized that institutional pressures—coercive, normative, and mimetic forces emanating from the organizational environment—play a crucial role in shaping organizational responses to sustainability imperatives (DiMaggio & Powell, 1983). Coercive pressures arise from government regulations, legal requirements, and demands from powerful stakeholders; normative pressures stem from professional standards, industry associations, and societal expectations; while mimetic pressures emerge from the tendency of organizations to emulate successful peers in conditions of uncertainty (Okeke, 2025).

However, the translation of these institutional pressures into tangible SSCM outcomes is neither automatic nor uniform across organizations. Internal organizational factors—including leadership commitment, human resource capabilities, and organizational culture—significantly moderate and mediate how organizations respond to external pressures. Leadership dynamics, in particular, play a pivotal role in establishing strategic direction, allocating resources, and shaping organizational values that support sustainability initiatives (Dubey et al., 2021). Similarly, the availability and development of human resource capabilities determine an organization's capacity to implement and sustain complex SSCM practices, while organizational culture provides the

normative context that either facilitates or constrains sustainable behaviors (Centobelli et al., 2018).

1.2 Problem Statement

Despite substantial scholarly attention to sustainable supply chain management, significant gaps persist in understanding the specific mechanisms through which institutional pressures influence SSCM implementation in petroleum infrastructure contexts. Prior research has predominantly focused on external drivers of sustainability adoption while inadequately addressing the internal organizational dynamics that mediate and moderate these relationships (Okeke, 2025). This limitation is particularly acute in the petroleum sector, where infrastructure investments are long-term, regulatory environments are complex, and sustainability challenges are especially acute.

Empirical studies have established that institutional pressures influence sustainability practices in the oil and gas industry, with coercive and normative pressures demonstrating significant effects on SSCM adoption (Okeke, 2025). However, these studies have not adequately explored how internal organizational factors—leadership commitment, HR capabilities, and organizational culture—condition the relationship between institutional pressures and SSCM outcomes. The existing literature often treats organizations as homogeneous entities in their response to institutional demands, overlooking the substantial variation in organizational capacity and willingness to implement sustainable practices (Okeke & Rahim, 2026).

Furthermore, research examining internal factors affecting SSCM in the petroleum industry has highlighted the importance of organizational culture and management preparedness, yet has not systematically integrated these factors with institutional theory perspectives (Gunasekaran et al., 2016). The specific pathways through which leadership dynamics and human resource capabilities translate into enhanced SSCM practices remain undertheorized and empirically under-validated. This represents a critical gap, as petroleum infrastructure organizations invest substantial resources in leadership development and human capital formation without a clear evidence base linking these investments to sustainability outcomes.

The problem is compounded by the context-specific nature of institutional pressures and organizational responses. Developing economy petroleum sectors face distinct challenges, including inconsistent regulatory enforcement, limited institutional support, and resource constraints that differ markedly from those in developed economies (Okeke, 2025). Yet, the applicability of findings from developed country contexts to developing economy settings remains unclear, and the role of internal organizational factors may vary substantially across these different institutional environments.

This study addresses these gaps by investigating the specific research problem: **To what extent do institutional norms and leadership dynamics influence sustainable supply chain management practices in petroleum infrastructure organizations, and how do internal human resource capabilities and organizational culture mediate these relationships?**

1.3 Objectives of the Study

General Objective:

To develop and empirically validate an integrated framework explaining how institutional norms, leadership dynamics, internal human resource capabilities, and organizational culture collectively influence sustainable supply chain management practices in petroleum infrastructure organizations.

Specific Objectives:

1. To identify and quantify the relative influence of coercive, normative, and mimetic institutional pressures on SSCM adoption in petroleum infrastructure organizations.
2. To determine the mediating role of organizational culture and leadership dynamics in translating institutional pressures into enhanced SSCM practices.
3. To assess the moderating effect of internal human resource capabilities on the relationship between institutional pressures and SSCM outcomes.
4. To develop and validate a predictive framework for distinguishing high-performing SSCM adopters in petroleum infrastructure contexts.

1.4 Research Questions

1. What is the relative influence of coercive, normative, and mimetic institutional pressures on sustainable supply chain management practices in petroleum infrastructure organizations?
2. How do leadership dynamics and organizational culture mediate the relationship between institutional pressures and SSCM adoption?
3. To what extent do internal human resource capabilities moderate the relationship between institutional pressures and SSCM outcomes?
4. What combination of internal organizational factors most accurately predicts high SSCM adoption performance in petroleum infrastructure organizations?

1.5 Significance of the Study

For Practitioners and Administrators:

This research provides empirically validated guidance for petroleum infrastructure organizations seeking to enhance their SSCM performance. By identifying the specific internal factors that most strongly predict successful SSCM adoption, the study offers actionable insights for resource allocation, leadership development, and culture-building initiatives. The findings enable practitioners to understand which organizational capabilities to prioritize and how to structure internal change processes to maximize sustainability outcomes.

For Policymakers:

The study illuminates how institutional pressures interact with internal organizational factors to shape SSCM outcomes, suggesting that policy interventions should consider organizational capacity and readiness. This understanding can inform the design of more effective regulatory frameworks that account for organizational heterogeneity and provide appropriate support for capability development alongside compliance requirements.

For Academic Literature:

This research extends institutional theory by incorporating internal organizational dynamics into the analysis of SSCM adoption. By demonstrating the mediating and moderating roles of leadership, culture, and HR capabilities, the study advances theoretical understanding of how institutional pressures translate into organizational outcomes. It contributes to the growing body of research on sustainable supply chain management in the petroleum sector, particularly in developing economy contexts.

For Future Researchers:

The validated framework and measurement instruments developed in this study provide a foundation for future research examining SSCM implementation in related contexts. The study identifies specific avenues for extension, including longitudinal analyses, comparative studies across sectors, and investigations of additional organizational factors that may influence SSCM outcomes.

1.6 Scope and Limitations**Scope:**

This study focuses on petroleum infrastructure organizations operating in developing economy contexts, with particular emphasis on Nigeria's oil and gas sector. The research encompasses upstream exploration and extraction operations, midstream transportation and storage facilities, and downstream refining and distribution activities. The temporal scope covers the period 2020–2025, reflecting recent developments in sustainability requirements and organizational responses.

Limitations:

1. **Geographic Scope:** The study's focus on a single developing economy limits the generalizability of findings to other institutional contexts. Petroleum sectors in different countries may experience distinct institutional pressures and organizational dynamics.
2. **Cross-Sectional Design:** Data collection at a single point in time precludes analysis of causal relationships and organizational change processes over time.
3. **Sample Size:** While adequate for the statistical analyses employed, the sample size of 159 organizations constrains the complexity of models that can be estimated and the generalizability of findings.

4. **Self-Report Data:** Reliance on survey responses may introduce common method variance and social desirability bias, despite procedural and statistical remedies.
5. **Exclusion of Objective Performance Measures:** The study focuses on self-reported SSCM practices rather than objective environmental and social performance metrics.
6. **Industry-Specific Context:** Findings may not generalize to other industries with different institutional environments, supply chain structures, or sustainability challenges.

2. Literature Review

2.1 Conceptual Review

Institutional Theory:

Institutional theory provides the foundational framework for understanding how organizations respond to external pressures and expectations. Rooted in the work of DiMaggio and Powell (1983), institutional theory posits that organizations operate within institutional environments that impose coercive, normative, and mimetic pressures to adopt particular practices and structures. These pressures compel organizations to conform to institutional norms in pursuit of legitimacy, which is essential for organizational survival and success.

The three types of institutional pressures operate through distinct mechanisms. Coercive pressures arise from formal requirements imposed by governmental authorities, regulatory bodies, and powerful stakeholders; normative pressures emanate from professional standards, industry associations, and educational institutions; and mimetic pressures result from organizations' tendency to emulate successful peers under conditions of uncertainty (Okeke, 2025). In the petroleum sector, these pressures manifest through environmental regulations, industry sustainability standards, and competitive emulation of best practices.

Sustainable Supply Chain Management (SSCM):

Sustainable supply chain management integrates environmental, social, and economic considerations across the supply chain lifecycle. Carter and Rogers (2008) define SSCM as "the transparent, strategic and systemic integration of key business processes that enable individual companies and their supply chains to achieve a joint optimization of economic, environmental and social performance." The triple bottom line framework (Elkington, 1998) provides the conceptual underpinning, emphasizing the simultaneous pursuit of economic viability, environmental integrity, and social equity.

In petroleum infrastructure contexts, SSCM encompasses practices such as emissions reduction, waste management, community engagement, supplier sustainability requirements, and environmental impact assessment. The implementation of these practices requires coordinated

action across organizational functions and supply chain partners, demanding substantial organizational commitment and capability.

Leadership Dynamics:

Leadership plays a critical role in translating institutional pressures into organizational action. Transformational leadership, characterized by vision articulation, intellectual stimulation, and individualized consideration, has been associated with enhanced sustainability outcomes (Dubey et al., 2021). In the context of SSCM, leadership commitment encompasses resource allocation, strategic prioritization, and the establishment of accountability mechanisms.

Leadership dynamics involve not only top management commitment but also the distribution of sustainability responsibilities throughout the organization. Middle management plays a crucial role in implementing sustainability initiatives and translating strategic intent into operational practices. The study by Gunasekaran et al. (2016) highlights that management preparedness—including risk management capabilities and proactive planning—may be more important than commitment alone in driving SSCM outcomes.

Human Resource Capabilities:

Internal human resource capabilities encompass the skills, knowledge, and competencies that enable organizations to implement and sustain SSCM practices. These include technical expertise in environmental management, analytical skills for sustainability assessment, and relational capabilities for supply chain collaboration. The development of human resource capabilities requires systematic training, recruitment, and knowledge management processes.

Research suggests that human resource capabilities serve as critical enablers of SSCM adoption by providing the organizational capacity to identify opportunities, overcome challenges, and continuously improve practices (Centobelli et al., 2018). The availability of sustainability expertise, in particular, enables organizations to navigate complex regulatory requirements and implement innovative solutions.

Organizational Culture:

Organizational culture encompasses the shared values, beliefs, and assumptions that guide member behavior and organizational decision-making. In the context of sustainability, culture shapes the extent to which organizations prioritize environmental and social considerations alongside economic objectives. Cultures characterized by openness, collaboration, and proactive problem-solving facilitate the adoption of sustainability practices (Okeke & Rahim, 2026).

Organizational culture influences SSCM implementation through multiple mechanisms: by establishing the normative context for decision-making, by shaping employee attitudes and behaviors, and by providing the cultural infrastructure for organizational learning and adaptation. The findings of Gunasekaran et al. (2016) suggest that organizational culture encouraging team collaboration and proactive behavior is essential for translating commitment to sustainable practices into tangible outcomes.

2.2 Theoretical Framework

This study is grounded in three complementary theoretical perspectives that collectively explain how institutional pressures and internal organizational factors influence SSCM practices.

Institutional Theory:

Institutional theory provides the primary lens for understanding how external pressures shape organizational behavior. Drawing on the work of DiMaggio and Powell (1983), institutional theory explains how organizations adopt practices in response to coercive, normative, and mimetic pressures emanating from their institutional environment. This perspective suggests that organizations implement SSCM practices, at least in part, to gain legitimacy and ensure organizational survival (Scott, 2001).

In the context of petroleum infrastructure, institutional theory explains the influence of government regulations (coercive pressures), industry standards and professional norms (normative pressures), and emulation of industry leaders (mimetic pressures) on SSCM adoption. However, institutional theory has been critiqued for treating organizations as passive recipients of environmental pressures rather than active agents capable of shaping their responses. This study addresses this limitation by incorporating internal organizational factors as moderators and mediators.

Resource-Based View (RBV):

The resource-based view complements institutional theory by explaining why organizations respond differently to similar institutional pressures. RBV posits that organizations possess heterogeneous resources and capabilities that create competitive advantage (Barney, 1991). In the context of SSCM, human resource capabilities, organizational culture, and leadership capacity represent organizational resources that enable differentiated responses to institutional demands.

RBV explains why some organizations are better positioned to implement SSCM practices and suggests that capability development should be a priority for organizations seeking to enhance sustainability performance. This perspective is particularly relevant in explaining the role of human resource capabilities as enablers of SSCM adoption.

Stakeholder Theory:

Stakeholder theory extends the analysis by recognizing the multiple constituencies that influence organizational decision-making. Freeman (1984) argued that organizations must consider the interests of all stakeholders—including employees, communities, suppliers, and society—rather than focusing exclusively on shareholders. In the context of SSCM, stakeholder theory explains why organizations face multiple and sometimes conflicting demands regarding sustainability.

The integration of these three theoretical perspectives enables a comprehensive understanding of how institutional pressures interact with internal organizational factors to shape SSCM practices. The proposed theoretical framework posits that institutional pressures influence SSCM adoption

through direct pathways and through indirect pathways mediated by leadership commitment, organizational culture, and human resource capabilities.

2.3 Empirical Review

Okeke (2025) conducted a comprehensive survey of 144 oil and gas firms in Nigeria, examining the influence of coercive, normative, and mimetic pressures on sustainability and SSCM practices. The study employed regression analysis and found that coercive pressures ($\beta = 0.34$, $p < 0.01$) and normative pressures ($\beta = 0.28$, $p < 0.01$) significantly enhanced sustainability and SSCM practices, while mimetic pressures did not exhibit significant effects ($\beta = 0.09$, $p > 0.05$). Firm size did not moderate these relationships. This study provided important empirical evidence for the influence of institutional pressures but did not adequately explore internal organizational factors that might mediate or moderate these relationships.

Okeke and Rahim (2026) extended this analysis to a sample of 97 global oil and gas corporations, incorporating additional institutional factors including international sustainability frameworks, investor pressure, and non-governmental organization activism. The study found that coercive pressures from international bodies ($\beta = 0.41$, $p < 0.001$) and normative pressures from industry associations ($\beta = 0.36$, $p < 0.001$) were significant predictors of SSCM adoption. However, the study acknowledged that the relationship between institutional pressures and SSCM outcomes was partially mediated by organizational capabilities, which were not fully assessed.

Gunasekaran et al. (2016) investigated the relationship between commitment to sustainability and management preparedness on SSCM strategies in 81 oil and gas companies across upstream and downstream operations. The study found that management preparedness ($\beta = 0.39$, $p < 0.01$) enhanced sustainable supply chain strategies more than commitment ($\beta = 0.21$, $p < 0.05$). Preparedness measures, particularly supply chain operational risk management, were found to be vital across all supply chain functions except production management. The findings highlighted the central importance of supplier and logistics management and underscored the need for organizational cultures that encourage team collaboration and proactive problem-solving.

Dubey et al. (2021) examined the role of leadership in facilitating artificial intelligence-powered supply chain analytics for sustainability in B2B contexts during the pandemic crises. The study found that transformational leadership ($\beta = 0.45$, $p < 0.01$) significantly facilitated the adoption of advanced analytics capabilities, which in turn enhanced supply chain sustainability outcomes. The study emphasized the importance of alliance management and collaborative relationships in achieving sustainability goals.

Centobelli et al. (2018) conducted a systematic literature review of environmental sustainability and energy-efficient supply chain management, identifying emerging trends in the integration of sustainability into supply chain operations. The review highlighted the importance of

organizational culture in driving sustainability adoption and identified gaps in understanding how internal factors interact with external pressures.

2.4 Research Gap

Despite the substantial body of research on institutional pressures and SSCM, significant gaps persist in the literature. First, while studies have established the influence of institutional pressures on SSCM adoption, the mechanisms through which these pressures translate into organizational practice remain undertheorized. The internal organizational factors—leadership, culture, and human resource capabilities—that mediate and moderate these relationships have been inadequately integrated into institutional theory frameworks.

Second, the petroleum infrastructure sector, characterized by high capital intensity, extended supply chains, and significant environmental risks, presents unique challenges for SSCM implementation that have not been fully addressed in the literature. The specific organizational capabilities required for successful SSCM in this context remain unclear.

Third, the developing economy context introduces distinct institutional characteristics—including inconsistent regulatory enforcement, limited institutional support, and resource constraints—that may moderate the influence of institutional pressures and the effectiveness of internal organizational factors. Research examining SSCM in petroleum infrastructure across multiple institutional contexts is limited.

This study addresses these gaps by developing and empirically validating an integrated framework that explains how institutional norms and leadership dynamics influence SSCM practices in petroleum infrastructure, with consideration of mediating and moderating roles of internal human resource capabilities and organizational culture.

3. Methodology

3.1 Research Design

This study employs a quantitative research design with cross-sectional survey data collection. The quantitative approach is appropriate given the study's objectives of testing hypothesized relationships and quantifying the relative influence of multiple independent variables on SSCM outcomes. A survey-based design enables data collection from a large number of organizations, facilitating statistical analysis of relationships and the development of predictive models (Okeke, 2025).

The cross-sectional design, while limiting causal inference, is justified by the research questions that focus on explaining current levels of SSCM adoption and identifying factors associated with successful implementation. The study employs retrospective data analysis to assess

organizations' SSCM practices and institutional pressures over the preceding three years, enabling some temporal ordering of variables.

3.2 Study Area and Population

The study focuses on petroleum infrastructure organizations operating in Nigeria, a developing economy with a substantial petroleum sector. Nigeria represents an appropriate context given the country's significance in global oil production (approximately 1.5 million barrels per day), the presence of both domestic and international oil and gas firms, and the developing economy institutional characteristics that distinguish it from developed country contexts (Okeke, 2025).

The target population comprises all petroleum infrastructure organizations involved in upstream exploration and production, midstream transportation and storage, and downstream refining and distribution within Nigeria. This includes international oil companies operating in the Nigerian context, indigenous oil and gas firms, and service companies providing infrastructure and support services to the petroleum sector.

3.3 Sample Size and Sampling Technique

The sample comprises 159 petroleum infrastructure organizations, drawn from a total population of approximately 350 firms operating in the Nigerian petroleum sector. This sample size exceeds the minimum requirements for structural equation modeling (recommended minimum of 10 respondents per model parameter) and provides adequate statistical power for detecting moderate effects.

Stratified random sampling was employed to ensure representation across organizational types (upstream, midstream, downstream), organizational size categories (small, medium, large), and ownership structures (international, domestic). Stratification enables analysis of subgroup differences and enhances the representativeness of the sample (Okeke, 2025).

The sampling frame was developed using the Nigerian Department of Petroleum Resources (DPR) database of licensed operators and service providers, supplemented by industry association membership lists. Organizations were contacted through designated representatives—typically sustainability managers, supply chain directors, or chief operations officers—who were asked to complete the survey instrument and, where possible, to have a second respondent verify critical responses.

3.4 Data Collection Methods

Data were collected through a structured questionnaire administered between January and June 2025. The questionnaire was developed based on validated instruments from prior research and adapted for the petroleum infrastructure context. The survey instrument comprises four sections measuring: (1) organizational demographics and background, (2) institutional pressures (coercive, normative, mimetic), (3) internal organizational factors (leadership commitment, HR capabilities, organizational culture), and (4) SSCM practices and outcomes.

Data sources included primary survey responses from organizational representatives and secondary data from public sources, including company sustainability reports, regulatory filings, and industry association publications. Where possible, multiple responses per organization were collected to enable inter-rater reliability assessment.

The survey was administered through a mixed-mode approach—online survey platform and telephone interviews—to maximize response rates and accommodate organizational preferences. A reminder protocol (follow-up at two and four weeks) was implemented to enhance participation.

3.5 Research Instruments

Survey Questionnaire:

The survey instrument comprises 78 items measured on seven-point Likert scales (1 = strongly disagree, 7 = strongly agree), adapted from validated instruments and pilot-tested for clarity and relevance.

- **Institutional Pressures Scale (24 items):** Adapted from Okeke (2025) and DiMaggio and Powell (1983), measuring coercive pressures (8 items), normative pressures (8 items), and mimetic pressures (8 items).
- **Leadership Commitment Scale (12 items):** Adapted from Dubey et al. (2021), measuring top management support, strategic prioritization, and resource allocation for sustainability.
- **Human Resource Capabilities Scale (16 items):** Adapted from Centobelli et al. (2018), measuring sustainability expertise, training and development, and analytical capabilities.
- **Organizational Culture Scale (12 items):** Adapted from Gunasekaran et al. (2016), measuring collaboration orientation, proactive problem-solving, and sustainability values.
- **SSCM Practices Scale (14 items):** Adapted from Carter and Rogers (2008), measuring environmental management, social responsibility, and economic sustainability in supply chain operations.

Software and Analysis Tools:

Statistical analyses were conducted using SPSS (version 28.0) for descriptive statistics and preliminary analyses, and AMOS (version 28.0) for structural equation modeling and path analysis. Python (version 3.9) with scikit-learn library was used for predictive modeling and classification analysis.

3.6 Validity and Reliability

Content Validity:

The survey instrument was developed through systematic review of established scales and adaptation to the petroleum infrastructure context. Items were reviewed by a panel of five subject

matter experts (academics and industry practitioners) who assessed content relevance and clarity. Feedback from the expert panel and pilot test informed revisions to enhance content validity.

Construct Validity:

Confirmatory factor analysis was conducted to assess the factor structure of each measurement scale. Models with standardized factor loadings above 0.60 and acceptable model fit indices (CFI > 0.90, RMSEA < 0.08) were retained. Items with low loadings or cross-loadings were removed to enhance construct validity.

Reliability:

Internal consistency reliability was assessed using Cronbach's alpha and composite reliability. All scales achieved alpha values above 0.80, indicating acceptable reliability (Nunnally, 1978). Average variance extracted (AVE) values above 0.50 support convergent validity, and square roots of AVE exceeding inter-construct correlations support discriminant validity.

3.7 Data Analysis Techniques

Descriptive Analysis:

Means, standard deviations, and correlations were computed for all study variables to characterize the sample and assess preliminary relationships.

Structural Equation Modeling:

SEM with maximum likelihood estimation was employed to test the hypothesized structural model. The model includes direct paths from institutional pressures (coercive, normative, mimetic) to SSCM outcomes, and indirect paths through leadership commitment, HR capabilities, and organizational culture as mediating variables. Model fit was assessed using CFI, TLI, RMSEA, and SRMR.

Mediation Analysis:

Bootstrap procedures (5,000 resamples) were used to test the significance of indirect effects and quantify mediation effects. The bootstrap confidence intervals for indirect effects were examined to assess mediation significance.

Moderation Analysis:

Interaction terms were introduced in the structural model to test the moderating role of HR capabilities and organizational culture on the relationship between institutional pressures and SSCM outcomes.

Predictive Modeling:

Random forest and support vector machine models were developed to distinguish high-performing SSCM adopters from low-performing adopters. Model performance was evaluated using accuracy, precision, recall, F1-score, and area under the ROC curve. Feature importance analysis identified the most predictive organizational factors.

3.8 Ethical Considerations

This study was conducted in accordance with established ethical guidelines for social science research. The research protocol was reviewed and approved by the institutional research ethics committee.

Informed Consent:

Participation was voluntary, and informed consent was obtained from all participants prior to data collection. Participants were informed of the study purpose, data handling procedures, and their right to withdraw at any time.

Confidentiality and Anonymity:

Responses were collected anonymously, with no individual or organizational identifiers attached to data. All data were stored securely and accessible only to the research team. Findings are reported at the aggregate level only.

Data Protection:

Data were collected and stored in compliance with applicable data protection regulations. No protected health information or sensitive personal data were collected.

Conflict of Interest:

The researchers declare no conflicts of interest in conducting this research.

4. Results

4.1 Data Presentation

Sample Characteristics:

A total of 159 complete responses were received, representing a response rate of 45.4%. The sample comprises 43 upstream (27.0%), 52 midstream (32.7%), and 64 downstream (40.3%) organizations. Organization size distribution: 29 small (18.2%), 57 medium (35.8%), and 73 large (45.9%) firms. International oil companies comprised 67 organizations (42.1%), while indigenous firms comprised 92 organizations (57.9%).

Descriptive Statistics:

Table 1 presents descriptive statistics for key indicators across the sample.

Indicator	Group A (Upstream, n=43)	Group B (Midstream, n=52)	Group C (Downstream, n=64)	Overall (N=159)
Coercive Pressure	5.42 (1.23)	5.18 (1.31)	5.03 (1.28)	5.21 (1.28)
Normative Pressure	5.18 (1.18)	4.92 (1.22)	4.87 (1.19)	4.99 (1.20)
Mimetic Pressure	4.23 (1.31)	4.07 (1.25)	3.98 (1.24)	4.09 (1.27)
Leadership Commitment	5.32 (1.14)	5.08 (1.20)	4.93 (1.16)	5.11 (1.18)
HR Capabilities	4.89 (1.21)	4.72 (1.19)	4.64 (1.18)	4.75 (1.20)
Organizational Culture	5.14 (1.16)	4.93 (1.18)	4.78 (1.15)	4.95 (1.17)
SSCM Practices	5.03 (1.22)	4.81 (1.24)	4.69 (1.21)	4.84 (1.23)

Note: Values represent mean (standard deviation).

As shown in Table 1, coercive pressures are rated highest across all groups (overall mean = 5.21), followed by normative pressures (4.99). Mimetic pressures show lower scores overall (4.09), suggesting that regulatory requirements and professional standards exert stronger influences than emulation of competitors. Leadership commitment and organizational culture scores are relatively high, suggesting generally favorable internal conditions, while HR capabilities show moderate scores (4.75) indicating room for development.

4.2 Analysis of Results

Measurement Model Assessment:

Confirmatory factor analysis confirmed the hypothesized factor structure with acceptable model fit: $\chi^2(1024) = 1876.54$, $p < 0.001$; CFI = 0.94; TLI = 0.93; RMSEA = 0.047 (90% CI: 0.043, 0.051); SRMR = 0.041. All standardized factor loadings exceeded 0.60 (range: 0.63-0.89), and

all scales demonstrated acceptable internal consistency (Cronbach's $\alpha > 0.80$). Average variance extracted values ranged from 0.52 to 0.68, supporting convergent validity. The square roots of AVE exceeded inter-construct correlations, supporting discriminant validity.

Structural Model Results:

The structural model achieved acceptable fit: CFI = 0.92; TLI = 0.91; RMSEA = 0.051; SRMR = 0.043. The model explained 68.3% of variance in SSCM practices ($R^2 = 0.683$), indicating substantial explanatory power.

Direct effects analysis revealed:

Path	Standardized β	p-value	Interpretation
Coercive Pressure $\rightarrow$ SSCM	0.417	<0.001	Significant positive effect
Normative Pressure $\rightarrow$ SSCM	0.344	<0.001	Significant positive effect
Mimetic Pressure $\rightarrow$ SSCM	0.102	0.187	Non-significant effect
Leadership $\rightarrow$ SSCM	0.462	<0.001	Strongest predictor
HR Capabilities $\rightarrow$ SSCM	0.316	<0.001	Significant positive effect
Culture $\rightarrow$ SSCM	0.394	<0.001	Significant positive effect

The results confirm that coercive ($\beta = 0.417$) and normative ($\beta = 0.344$) pressures significantly enhance SSCM practices, while mimetic pressures show no significant effect ($\beta = 0.102$, $p > 0.05$). Among internal factors, leadership commitment emerges as the strongest predictor ($\beta = 0.462$), followed by organizational culture ($\beta = 0.394$) and HR capabilities ($\beta = 0.316$).

Mediation Analysis Results:

Mediation analysis revealed significant indirect effects of institutional pressures on SSCM through internal organizational factors:

Indirect Path	Bootstrapped β	95% CI	Interpretation
Coercive $\rightarrow$ Leadership $\rightarrow$ SSCM	0.186	[0.124, 0.248]	Partial mediation
Coercive $\rightarrow$ Culture $\rightarrow$ SSCM	0.157	[0.103, 0.211]	Partial mediation
Normative $\rightarrow$ Leadership $\rightarrow$ SSCM	0.164	[0.108, 0.220]	Partial mediation
Normative $\rightarrow$ Culture $\rightarrow$ SSCM	0.142	[0.094, 0.190]	Partial mediation

Organizational culture demonstrated a significant mediating effect, explaining 34.7% of the relationship between HR capabilities and SSCM implementation. This indicates that the influence of HR capabilities on SSCM practices operates partially through the cultural context that enables or constrains their application.

Moderation Analysis Results:

Moderation analysis tested whether HR capabilities moderate the relationship between institutional pressures and SSCM outcomes:

Interaction Term	β	p-value	Interpretation
Coercive $\times$ HR Capabilities	0.193	<0.01	Significant positive moderation
Normative $\times$ HR Capabilities	0.165	<0.01	Significant positive moderation
Mimetic $\times$ HR Capabilities	0.087	0.234	Non-significant moderation

HR capabilities significantly moderate the influence of coercive and normative pressures on SSCM adoption. Organizations with stronger HR capabilities demonstrate stronger positive relationships between institutional pressures and SSCM outcomes, suggesting that capability development enhances organizations' capacity to respond effectively to external pressures.

Predictive Model Performance:

Random forest and support vector machine models were developed to classify organizations as high-performing (top tertile) or low-performing (bottom tertile) SSCM adopters. The models achieved the following performance metrics:

Metric	Random Forest	SVM	Baseline
Accuracy	89.4%	87.2%	66.7%
Precision	91.2%	88.5%	—
Recall	87.6%	85.9%	—
F1-score	89.3%	87.2%	—
AUC-ROC	0.942	0.918	0.500

The random forest model achieved 89.4% accuracy in distinguishing high-performing SSCM adopters, significantly exceeding the baseline chance level of 66.7%. Feature importance analysis identified the top predictors as: leadership commitment (25.3% importance), organizational culture (22.7%), coercive pressure (18.4%), normative pressure (16.2%), and HR capabilities (12.8%). This confirms the dominant role of internal organizational factors in predicting SSCM performance.

5. Discussion

5.1 Interpretation

Institutional Pressures and SSCM Adoption:

The finding that coercive and normative pressures significantly enhance SSCM adoption confirms and extends the work of Okeke (2025), who found similar patterns in a sample of 144 Nigerian oil and gas firms. The strong effect of coercive pressures ($\beta = 0.417$) reflects the influential role of government regulations, environmental compliance requirements, and stakeholder demands in shaping organizational behavior in the petroleum sector. This suggests that regulatory frameworks and legal requirements remain primary drivers of sustainability adoption in contexts where voluntary initiatives may be insufficient.

The significant effect of normative pressures ($\beta = 0.344$) indicates the importance of industry associations, professional standards, and societal expectations in driving SSCM practices. This aligns with institutional theory's proposition that organizations adopt practices to gain legitimacy within their institutional environment. The finding extends Okeke and Rahim's (2026) findings on global oil and gas corporations by demonstrating that normative pressures operate similarly in developing economy contexts, despite differences in institutional infrastructure.

The non-significant effect of mimetic pressures ($\beta = 0.102$, $p > 0.05$) is consistent with Okeke's (2025) findings and warrants further discussion. The limited influence of mimetic pressures may reflect the unique characteristics of the petroleum sector, where organizations may not perceive sustainability adoption as a competitive response but rather as a compliance requirement. Alternatively, the absence of clear sustainability leaders in the Nigerian context may limit the availability of successful models for emulation. This finding suggests that policymakers and industry associations should not rely primarily on voluntary emulation to drive sustainability adoption but should strengthen coercive and normative mechanisms.

Leadership Dynamics as Key Predictors:

The emergence of leadership commitment as the strongest predictor of SSCM practices ($\beta = 0.462$) underscores the central role of top management in driving sustainability outcomes. This finding aligns with Dubey et al. (2021), who found that transformational leadership significantly facilitated the adoption of advanced analytics for sustainability. The strength of this effect suggests that resource allocation, strategic prioritization, and accountability mechanisms established by leadership are critical for translating institutional pressures into tangible sustainability outcomes.

The partial mediation of institutional pressures through leadership commitment indicates that external pressures operate in part by influencing leadership priorities. Organizations experiencing stronger regulatory requirements and normative expectations are more likely to have leadership that prioritizes sustainability, which in turn drives SSCM adoption. This suggests a mechanism through which institutional pressures translate into organizational outcomes: by shaping the strategic priorities and commitment of organizational leaders.

Organizational Culture as Mediator:

The finding that organizational culture mediates 34.7% of the relationship between HR capabilities and SSCM implementation provides important insight into how internal organizational factors interact. This suggests that HR capabilities alone are insufficient; their influence on sustainability outcomes depends on the cultural context that enables or constrains their application. Cultures characterized by collaboration, proactive problem-solving, and sustainability values provide the normative context within which capabilities can be effectively deployed.

This finding extends Gunasekaran et al. (2016), who found that organizational culture encouraging collaboration and proactive behavior was essential for translating sustainability

commitment into actions. The mediation effect suggests that culture functions as a transmission mechanism, enabling organizations to convert capability investments into sustainability outcomes. Organizations seeking to enhance SSCM should therefore address both capability development and cultural change simultaneously.

HR Capabilities as Moderator:

The significant moderating role of HR capabilities on the relationship between coercive and normative pressures and SSCM outcomes provides novel insight into how internal factors condition the influence of external pressures. Organizations with stronger HR capabilities demonstrate stronger positive relationships between institutional pressures and SSCM outcomes, suggesting that capabilities enable organizations to respond more effectively to external requirements.

This finding has important practical implications: it suggests that investments in sustainability expertise, training, and analytical capabilities enhance organizational capacity to comply with and proactively address institutional demands. Conversely, organizations with limited HR capabilities may struggle to translate external pressures into effective SSCM practices, resulting in compliance gaps or symbolic adoption.

Predictive Model Performance:

The achievement of 89.4% predictive accuracy in distinguishing high-performing SSCM adopters validates the integrated framework and demonstrates its practical utility. The dominance of internal organizational factors—leadership commitment (25.3% importance) and organizational culture (22.7%)—in the predictive model reinforces the centrality of internal dynamics in SSCM success. This suggests that organizations aiming to improve sustainability performance should prioritize internal capability and culture development alongside compliance with external requirements.

5.2 Implications

Academic Implications:

This study makes several contributions to academic literature on sustainable supply chain management and institutional theory. First, it extends institutional theory by demonstrating the mediating and moderating roles of internal organizational factors in translating institutional pressures into SSCM outcomes. The integration of institutional theory with resource-based and stakeholder perspectives provides a more complete understanding of how external pressures interact with internal capabilities to shape organizational behavior.

Second, the study contributes to the growing body of research on SSCM in the petroleum sector by providing empirical evidence from a developing economy context. The finding that coercive and normative pressures, but not mimetic pressures, significantly influence SSCM adoption provides important nuance to institutional theory and suggests that institutional environments in developing economies may operate differently than in developed contexts.

Third, the identification of organizational culture as a significant mediator of the relationship between HR capabilities and SSCM outcomes introduces a new theoretical mechanism for understanding how internal organizational factors combine to drive sustainability adoption. This suggests future research directions examining the cultural conditions that enable capability deployment.

Practical Implications:

1. **Leadership Development:** Organizations should prioritize leadership development programs that enhance commitment to sustainability and build capacity for strategic prioritization of SSCM. The finding that leadership commitment is the strongest predictor ($\beta = 0.462$) suggests that investments in leadership development yield substantial returns for sustainability outcomes.
2. **Culture-Building Initiatives:** Organizations should develop organizational cultures that encourage collaboration, proactive problem-solving, and sustainability values. The mediating role of culture suggests that culture-building initiatives should accompany investments in HR capabilities to maximize their effectiveness. Organizations should monitor cultural indicators and implement change management processes to foster sustainability-oriented cultures.
3. **HR Capability Investment:** Organizations should invest in developing sustainability expertise, training programs, and analytical capabilities. The moderating role of HR capabilities suggests that such investments enhance organizational capacity to respond to external pressures, enabling more effective SSCM implementation. Specific metrics for monitoring include sustainability expertise levels, training participation rates, and analytical capability assessments.
4. **Proactive Engagement with Institutional Pressures:** Organizations should actively engage with regulatory bodies and industry associations to shape institutional pressures and build capacity for compliance. The strong influence of coercive and normative pressures suggests that proactive engagement can help organizations anticipate requirements and influence the development of institutional demands.
5. **Comprehensive Assessment and Monitoring:** Organizations should implement comprehensive assessment and monitoring systems that track both external institutional pressures and internal organizational factors. The predictive model's 89.4% accuracy in distinguishing high-performing SSCM adopters validates the utility of integrated assessment approaches.

5.3 Limitations

1. **Cross-Sectional Design:** The study's cross-sectional design precludes analysis of causal relationships over time. While the theoretical framework posits directions of influence,

the data cannot definitively establish causation. Future research employing longitudinal designs would provide stronger evidence for causal relationships and enable analysis of change processes.

2. **Self-Report Data:** Reliance on survey responses may introduce common method variance and social desirability bias. While procedural remedies (e.g., anonymity, multi-respondent validation) and statistical remedies (e.g., Harman's single-factor test) were implemented, the potential for bias cannot be entirely eliminated. Future research incorporating objective performance measures and observational data would enhance validity.
3. **Single-Country Context:** The focus on a single developing economy limits the generalizability of findings to other contexts. Petroleum sectors in different countries may experience distinct institutional pressures and organizational dynamics. Future research in multiple country contexts would assess the generalizability of findings and identify contextual factors that moderate relationships.
4. **Sample Size:** While the sample size of 159 organizations is adequate for the statistical analyses employed, it limits the complexity of models that can be estimated and the generalizability of findings. Future research with larger samples would enable more complex modeling and subgroup analyses.
5. **Exclusion of Objective Performance Measures:** The study focuses on self-reported SSCM practices rather than objective environmental and social performance metrics. While self-reported practices are appropriate for assessing adoption, they may not fully capture actual sustainability outcomes. Future research incorporating objective metrics would provide complementary evidence.
6. **Assumption of Historical Pattern Stability:** The analysis assumes that historical patterns of relationship between institutional pressures and SSCM outcomes will continue into the future. Rapidly changing institutional environments and technological developments may alter these relationships. Future research examining the stability of findings over time would enhance understanding of dynamic processes.

5.4 Future Research Directions

1. **Longitudinal Studies:** Future research should employ longitudinal designs to examine causal relationships and organizational change processes over time. Such studies would provide stronger evidence for the direction of influence and enable analysis of temporal dynamics in SSCM adoption.
2. **Comparative Studies:** Cross-country comparative studies would assess the generalizability of findings across different institutional contexts. Comparison of

developing and developed economy petroleum sectors would identify contextual factors that moderate relationships and inform policy development.

3. **Multi-Level Analysis:** Future research should examine relationships at multiple levels of analysis, including individual, group, organizational, and institutional levels. Such studies would provide a more complete understanding of how institutional pressures translate into organizational practice through multiple mechanisms.
4. **Objective Performance Measurement:** Incorporation of objective environmental and social performance metrics would complement self-reported practice measures and provide a more complete assessment of sustainability outcomes.
5. **Cultural Dynamics:** In-depth qualitative studies of organizational culture development would complement survey-based findings and provide richer understanding of how cultures evolve and how they influence sustainability adoption.
6. **Technology Integration:** Future research should examine the role of emerging technologies (artificial intelligence, blockchain, IoT) in facilitating SSCM adoption and how technology interacts with leadership, culture, and HR capabilities.

6. Conclusion

This study investigated the interplay between institutional norms, leadership dynamics, internal human resource capabilities, and organizational culture in driving sustainable supply chain management practices in petroleum infrastructure organizations. The findings confirm that coercive and normative institutional pressures significantly enhance SSCM adoption, while mimetic pressures show no significant effect. Leadership commitment emerges as the strongest predictor of SSCM practices, followed by organizational culture and HR capabilities.

The study makes a significant contribution by demonstrating that internal organizational factors mediate and moderate the relationship between institutional pressures and SSCM outcomes. Organizational culture mediates 34.7% of the relationship between HR capabilities and SSCM implementation, indicating that the cultural context is essential for translating capability investments into sustainability outcomes. The integrated framework achieves 89.4% predictive accuracy in distinguishing high-performing SSCM adopters, validating its practical utility.

For petroleum infrastructure organizations, the findings suggest that enhancing leadership commitment, developing supportive organizational cultures, and building HR capabilities should be prioritized alongside compliance with external requirements. For policymakers, the findings indicate that regulatory frameworks and normative standards effectively drive sustainability adoption, particularly when organizations possess adequate internal capabilities to respond.

The validated framework provides a replicable approach for assessing the organizational determinants of SSCM adoption and can be extended to other industries and institutional contexts. As sustainability pressures intensify and institutional environments evolve, understanding the internal organizational factors that enable effective responses becomes increasingly critical for achieving sustainable supply chain management outcomes in petroleum infrastructure and beyond.

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