GPH-International Journal of Educational Research
(Online ISSN 3050-9599)
Volume 9 | Issue 03 | March 2026
Published by: Global Publication House
DOI: https://doi.org/10.5281/zenodo.19950124
Available online at: www.gphjournal.org
Journal homepage: https://gphjournal.org/index.php/er/index

SUPPLY CHAIN VULNERABILITY AND OIL PRODUCTION STABILITY OF UPSTREAM PETROLEUM FIRMS IN RIVERS STATE

Bazia, John N. S. and Jekey, Lekue

Department of Marketing, Faculty of Management Science,
University of Port Harcourt
Correspondence E-Mail: lekkue.jekey@uniport.edu.ng

Abstract

This study investigated the relationship between supply chain vulnerability and oil production stability of upstream petroleum firms in Rivers State, Nigeria. Supply chain vulnerability was operationalized through two dimensions: logistical vulnerability and operational vulnerability. Oil production stability was assessed through output consistency, regulatory compliance, and operational continuity. The study was anchored on Transaction Cost Theory and Dynamic Capabilities Theory. A correlational research design was adopted. The population comprised twenty (20) upstream petroleum firms in Rivers State. A census of 120 respondents was drawn, comprising operations managers, logistics managers, supply chain officers, and senior technical staff. Valid responses totalled 110, representing a response rate of 91.7%. Data were collected using structured questionnaires on a five-point Likert scale. Organizational resilience served as a contextual moderating variable. Analysis was conducted using Pearson Product Moment Correlation (PPMC) at a 0.05 level of significance. The findings revealed that logistical vulnerability has a strong negative and statistically significant relationship with oil production stability ($r = -0.731$, $p < 0.05$). Similarly, operational vulnerability demonstrated a significant negative relationship with oil production stability ($r = -0.684$, $p < 0.05$). The study concludes that supply chain vulnerabilities, particularly logistical and operational in nature, significantly impair oil production stability. It recommends investment in digital supply chain monitoring systems, diversified logistics networks, and adaptive maintenance protocols underpinned by organizational resilience mechanisms.

Keywords:

Supply chain vulnerability, Logistical vulnerability, Operational vulnerability, Oil production stability, Organizational resilience.

Introduction

The upstream petroleum sector occupies a foundational position in Nigeria's national economy, contributing substantially to government revenues, foreign exchange earnings, and industrial employment. However, the sector has consistently been confronted with supply chain disruptions that undermine its capacity to maintain stable oil production. These disruptions, spanning logistical impediments such as pipeline vandalism and transport bottlenecks, as well as operational vulnerabilities including equipment breakdown and labour unrest, constitute a

systemic threat to production continuity that demands rigorous academic investigation (Adeyinka & Olufemi, 2022; Nwokocha & Amadi, 2023).

Supply chain vulnerability, conceptualized as the susceptibility of supply chain actors to disturbances arising from internal or external sources, is increasingly recognized as a central determinant of organizational performance in resource-dependent industries (Christopher & Peck, 2004; Sodhi & Tang, 2012). In the Nigerian upstream petroleum context, vulnerability arises from a confluence of infrastructural deficiencies, security threats, institutional weaknesses, and operational hazards that disrupt the movement of materials, equipment, and energy inputs across the value chain. When these vulnerabilities materialize as actual disruptions, they typically manifest as reduced output volumes, production shut-ins, cost overruns, and non-compliance with regulatory production targets; collectively captured under the construct of oil production stability (Bala & Umar, 2021; Chioma & Okafor, 2023).

Rivers State, as the hub of Nigeria's oil and gas operations, presents an instructive context for examining the supply chain vulnerability-production stability nexus. The state is home to the majority of Nigeria's producing oil wells, petroleum pipelines, and oilfield service infrastructure. It is simultaneously one of the most frequently affected by pipeline vandalism, crude oil theft, community-based disruptions, and logistics failures that interrupt the smooth flow of production inputs (Okoro & Nwachukwu, 2022). The persistence of these challenges, despite sector reforms and increased security expenditure, suggests that upstream firms may lack adequate organizational resilience mechanisms to absorb and recover from supply chain disruptions.

Organizational resilience, encompassing risk management, adaptive capacity, and contingency planning, functions as a contextual moderating variable that mediates the severity of disruption impacts on production outcomes (Lengnick-Hall et al., 2011; Sheffi & Rice, 2005). Resilient firms are better equipped to anticipate supply chain vulnerabilities, deploy contingency responses rapidly, and sustain production stability even under conditions of significant external shock. While a full moderation analysis of organizational resilience falls beyond the scope of the current study, its theoretical influence is acknowledged in framing the conceptual model and interpreting findings. Understanding this moderating dynamic is critical for informing strategy in the upstream petroleum sector (Ponomarov & Holcomb, 2009).

Despite the growing body of research on supply chain disruptions, studies that specifically examine the relationship between logistical and operational vulnerability dimensions and oil production stability in the Rivers State petroleum sector, while considering the contextual role of organizational resilience, remain limited. This study addresses this gap by empirically testing the hypothesised relationships using data from upstream petroleum firms in Rivers State. The specific objectives of the study are to: (i) examine the relationship between logistical vulnerability and oil production stability of upstream petroleum firms in Rivers State; and (ii) assess the relationship between operational vulnerability and oil production stability of upstream petroleum firms in Rivers State.

The following null hypotheses were formulated:

H_{01}. There is no significant relationship between logistical vulnerability and oil production stability of upstream petroleum firms in Rivers State.

H_{02}. There is no significant relationship between operational vulnerability and oil production stability of upstream petroleum firms in Rivers State.

Literature Review

Theoretical Foundation

This study is anchored on two complementary theoretical frameworks: Transaction Cost Theory (TCT) and Dynamic Capabilities Theory (DCT). Together, these theories provide a robust conceptual architecture for understanding how supply chain vulnerabilities arise, how they impair oil production stability, and how organizational capabilities can moderate their effects.

Transaction Cost Theory, originated by Coase (1937) and systematically developed by Williamson (1985), posits that economic exchange is governed not merely by production costs but by the costs of coordinating transactions across organizational boundaries. TCT identifies three categories of transaction costs: search and information costs, incurred in identifying suitable supply chain partners and assessing the quality of available inputs; bargaining and decision costs, associated with negotiating contracts and allocating risks; and policing and enforcement costs, incurred in monitoring contract compliance and resolving disputes. The theory further posits that transaction costs escalate sharply in environments characterized by high asset specificity, behavioural uncertainty, and environmental complexity. It argues that rational firms will choose governance structures, whether markets, hierarchies, or hybrid arrangements, that minimize the total costs of transacting in a given environment (Williamson, 1985).

Contextualizing TCT to the present study, the Nigerian upstream petroleum sector exhibits precisely the conditions under which transaction costs escalate most severely. Logistical vulnerability, manifesting in pipeline vandalism, transport bottlenecks, and import delays, raises information and coordination costs by creating uncertainty about the timing and reliability of input deliveries. When firms cannot rely on stable, predictable logistics networks, they face increased costs of identifying alternative supply routes, renegotiating contracts with logistics providers, and maintaining emergency buffer stocks. Operational vulnerability, encompassing equipment failure, labour strikes, and maintenance lapses, similarly drives transaction costs through increased monitoring, repair, and workforce management expenses. TCT predicts that firms facing high vulnerability without commensurate governance structures will experience direct translation of these vulnerabilities into production disruptions that reduce output stability (Nwokocha & Amadi, 2023; Sodhi & Tang, 2012).

Dynamic Capabilities Theory, developed by Teece et al. (1997) and extended by Eisenhardt & Martin (2000), provides a strategic framework for understanding how firms build, integrate, and reconfigure their resource base to respond effectively to environmental change and disruption. DCT defines dynamic capabilities as higher-order organizational processes that enable firms to sense emerging threats and opportunities, seize advantageous configurations of resources, and transform their operational routines to sustain competitive advantage. The theory holds that sustained competitive performance in dynamic environments depends not on static resource endowments but on the organizational capacity to continuously renew and reconfigure those endowments in response to shifting environmental demands (Teece et al., 1997).

Applied to the current study, DCT explains why some upstream petroleum firms in Rivers State sustain oil production stability in the face of logistical and operational vulnerabilities while others suffer prolonged production shut-ins. Firms with strong sensing capabilities, enabling early detection of pipeline risks and logistics disruptions, and robust integration capabilities, enabling rapid reconfiguration of supply routes and maintenance protocols, are better equipped

to maintain production continuity under conditions of supply chain stress (Chioma & Okafor, 2023). Dynamic capabilities also underpin the effectiveness of organizational resilience as a moderating variable. Resilience mechanisms, including risk management frameworks, contingency planning, and adaptive capacity, are themselves expressions of dynamic capabilities deployed specifically to manage supply chain uncertainty. Firms that invest in developing these capabilities create institutional buffers that absorb the impact of logistical and operational vulnerabilities, translating disruptions into temporary setbacks rather than sustained production losses (Adeyinka & Olufemi, 2022; Sheffi & Rice, 2005; Wieland & Wallenburg, 2013).

Supply Chain Vulnerability

Supply chain vulnerability is broadly defined as the propensity of a supply chain to suffer disruption from internal or external hazards, characterized by the likelihood of exposure to risk events and the severity of their consequences for supply chain performance (Christopher & Peck, 2004; Wagner & Bode, 2006). The concept captures both the structural features of supply chains that create susceptibility to disruption, such as geographic concentration of suppliers, limited inventory buffers, and reliance on single-source logistics providers, and the environmental and institutional factors that increase the probability of adverse events materializing. Tang (2006) distinguishes between operational risks, arising from routine uncertainties in supply and demand, and disruption risks, caused by major catastrophic events, both of which are relevant to the Nigerian upstream petroleum context.

Scholars have operationalized supply chain vulnerability through multiple dimensions. Chopra & Sodhi (2012) identify supply-side, demand-side, and logistics-related disruptions as the primary categories of vulnerability. Hohenstein et al. (2015) emphasize the importance of distinguishing between frequency and severity of disruptions in assessing vulnerability. In the Nigerian upstream petroleum context, vulnerability analysis must account for the distinctive hazard profile of the sector, which includes politically motivated vandalism, infrastructure deterioration, environmental disruptions, and institutional coordination failures (Bala & Umar, 2021; Okoro & Nwachukwu, 2022).

Recent empirical research has confirmed that supply chain vulnerability has significant negative consequences for organizational performance across industries, with effects particularly severe in capital-intensive sectors where production continuity is difficult to recover quickly. Studies in the Nigerian petroleum context specifically document how recurring supply chain disruptions translate into measurable losses in production output, operational efficiency, and revenue generation (Chioma & Okafor, 2023; Nwokocha & Amadi, 2023).

Logistical Vulnerability

Logistical vulnerability refers to the susceptibility of supply chain logistics networks to disruptions that impair the timely and reliable movement of goods, materials, and energy inputs along the supply chain (Manuj & Mentzer, 2008; Norrman & Jansson, 2004). In the upstream petroleum sector, logistical vulnerability encompasses three primary sources of disruption: pipeline vandalism, which physically damages the infrastructure through which crude oil and refined products flow; transport bottlenecks, which arise from inadequate road, rail, and marine transport infrastructure; and import delays, which affect the timely procurement of specialized equipment, chemicals, and technical services critical to production continuity.

Pipeline vandalism constitutes the most acute logistical vulnerability in Rivers State's upstream petroleum sector. Research by Okoro & Nwachukwu (2022) estimates that pipeline vandalism accounts for a substantial proportion of annual production losses in the Niger Delta region, with repairs frequently requiring multi-week shut-ins. The systemic nature of this threat, driven by a combination of community grievances, crude oil theft economics, and inadequate pipeline surveillance, means that it cannot be managed through purely reactive responses. Firms that fail to invest in proactive pipeline monitoring technologies and community stakeholder engagement face heightened logistical vulnerability that directly undermines production stability. Hendricks & Singhal (2005) demonstrated that supply chain disruptions of this nature produce long-term adverse effects on shareholder value, a finding with direct relevance to capital-intensive extraction industries.

Transport bottlenecks represent a structural vulnerability arising from the inadequacy of Nigeria's transportation infrastructure relative to the logistical demands of the petroleum sector. The dependence of many oilfield locations on single access routes, often poorly maintained and susceptible to seasonal flooding, creates single points of failure in the logistics network. Import delays, driven by port congestion, customs clearance inefficiencies, and foreign exchange constraints, similarly create logistical bottlenecks that delay the procurement of critical inputs, extending production downtime and disrupting planned maintenance schedules (Adeyinka & Olufemi, 2022).

Operational Vulnerability

Operational vulnerability encompasses the susceptibility of production operations to disruptions arising from internal organizational and technical failures (Bala & Umar, 2021; Sheffi & Rice, 2005). In the upstream petroleum sector, the primary sources of operational vulnerability are equipment failure, labour strikes, and maintenance lapses. Each of these sources operates through distinct mechanisms to undermine oil production stability.

Equipment failure is an endemic source of operational vulnerability in the Nigerian upstream petroleum sector, reflecting the aging condition of much of the infrastructure deployed in mature producing fields, inadequate preventive maintenance investment, and the demanding physical environments in which oilfield equipment operates. Research by Nwokocha & Amadi (2023) documents that unplanned equipment failures account for a significant share of production downtime in Rivers State's upstream operations, with the cost of reactive maintenance typically far exceeding the investment required for preventive programs. Digital maintenance management systems, encompassing predictive analytics, remote equipment monitoring, and automated maintenance scheduling, are increasingly identified as critical instruments for reducing operational vulnerability by enabling earlier identification and resolution of equipment issues (Zsidisin & Ritchie, 2009).

Labour strikes and industrial actions constitute a recurring source of operational vulnerability in the Nigerian petroleum sector, driven by longstanding disputes over wages, conditions of service, and host community employment obligations. Strikes by petroleum workers' unions and by host community members protesting economic exclusion can rapidly halt production across multiple operating locations. Maintenance lapses, arising from budget constraints, inadequate skill availability, or organizational prioritization failures, progressively degrade operational reliability over time, creating latent vulnerabilities that eventually materialize as acute production disruptions (Adeyinka & Olufemi, 2022; Chioma & Okafor, 2023).

Oil Production Stability

Oil production stability is defined as the capacity of upstream petroleum firms to maintain consistent, reliable, and regulation-compliant oil production over time, minimizing unplanned output reductions caused by supply chain, operational, or environmental disruptions (Bala & Umar, 2021; Okoro & Nwachukwu, 2022). It is a multi-dimensional construct encompassing output consistency, which reflects the degree to which actual production volumes meet planned targets; regulatory compliance, referring to adherence to NNPC-mandated production quotas and environmental standards; and operational continuity, which captures the ability to sustain production operations without prolonged shut-ins.

In the upstream petroleum sector, oil production stability is a primary determinant of financial performance, contract compliance, and organizational reputation. Firms that demonstrate high production stability attract preferential financing terms, retain marquee clients, and sustain their social licence to operate in host communities. Conversely, firms whose production is frequently disrupted by supply chain vulnerabilities face escalating costs, contract penalties, regulatory sanctions, and reputational damage that progressively erode their competitive position (Chioma & Okafor, 2023; Nwokocha & Amadi, 2023). Hendricks & Singhal (2005) provide empirical evidence that firms experiencing supply chain disruptions suffer significant declines in operating income and sales growth in the years following the disruption event, underscoring the enduring consequences of production instability.

The moderating role of organizational resilience in the supply chain vulnerability-production stability relationship has gained increasing empirical support. Ponomarov & Holcomb (2009) define supply chain resilience as the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control. Resilient organizations possess risk management frameworks that identify and assess supply chain vulnerabilities prospectively, adaptive capacity to reconfigure operations rapidly in response to disruptions, and contingency planning protocols that enable swift mobilization of alternative resources. These capabilities collectively buffer the adverse impact of logistical and operational vulnerabilities on production stability, enabling resilient firms to recover more quickly and sustain higher output levels than their less resilient counterparts (Lengnick-Hall et al., 2011; Sheffi & Rice, 2005).

Empirical Review

A number of recent empirical studies have examined the dimensions of supply chain vulnerability and their effects on production outcomes, providing the evidentiary context for the current investigation. Agyabeng-Mensah et al. (2020) examined the role of supply chain resilience in moderating the impact of supply disruptions on operational performance among manufacturing firms in Ghana, finding that firms with stronger resilience capabilities recovered more quickly from disruption events and maintained higher output consistency. Their findings underscore the critical interplay between vulnerability exposure and organizational adaptive capacity, a relationship central to the present study. Kamalahmadi et al. (2022) conducted a systematic analysis of supply chain disruption management strategies in capital-intensive industries, establishing that logistical disruptions generated more severe and prolonged performance losses than internal operational failures, particularly in sectors characterized by long recovery cycles. This finding supports the present study's expectation that logistical

vulnerability will exert a stronger negative effect on oil production stability than operational vulnerability.

Similarly, Ribeiro & Barbosa-Povoa (2021) investigated supply chain vulnerability and resilience in the oil and gas sector across multiple emerging market contexts, confirming that pipeline-related logistical disruptions and unplanned equipment failures were the dominant sources of production instability. Their study specifically identifies the absence of proactive risk monitoring as a key institutional gap that amplifies vulnerability outcomes, directly relevant to the Rivers State upstream context. Ojha et al. (2021) examined the effects of operational disruptions on supply chain performance in resource extraction industries, reporting a significant negative relationship between equipment failure frequency and production output consistency. The study further demonstrated that firms investing in predictive maintenance technologies experienced substantially lower operational vulnerability exposure, providing practical validation for the maintenance-focused recommendations of the current study.

Furthermore, Wieland & Wallenburg (2013) established that supply chain agility and robustness, as components of resilience, significantly moderate the negative impact of supply chain disruptions on firm performance, with agility being particularly important for mitigating the effects of logistical disruptions. Their cross-industry findings lend theoretical and empirical support to the present study's treatment of organizational resilience as a contextual moderating variable. Collectively, these studies support the study's hypotheses regarding the significant negative impact of both logistical and operational vulnerability on oil production stability.

Methodology

This study adopted a correlational research design, which is appropriate for measuring the strength, direction, and significance of associations between variables in natural organizational settings without experimental manipulation (Nworgu, 2015). The design enabled systematic empirical testing of the relationship between supply chain vulnerability dimensions and oil production stability, while acknowledging the contextual moderating influence of organizational resilience. The study population consisted of all twenty (20) upstream petroleum firms registered and operating in Rivers State, as enumerated in the Nigeria Oil and Gas Industry Annual Report (2023). A census approach was adopted given the manageable size of the population and the importance of capturing responses from all operating firms. Six (6) respondents per firm were purposively selected, comprising operations managers, logistics managers, supply chain officers, maintenance supervisors, and senior technical personnel, yielding a total of 120 targeted respondents. This purposive selection strategy was justified by the need to obtain responses from individuals with direct professional exposure to supply chain and production operations, ensuring that the data captured informed and organizationally grounded perspectives on the study constructs. Of the 120 questionnaires administered, 110 valid responses were returned and used for analysis, representing a response rate of 91.7%.

Data were collected using a structured questionnaire with four sections: bio-data; logistical vulnerability items; operational vulnerability items; and oil production stability items. An additional section captured organizational resilience items for contextual descriptive purposes. Each section employed a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). Following the convention adopted in management and social science research, Likert-scale data were treated as interval-level for the purpose of Pearson correlation analysis, consistent with the methodological position of Norman (2010), who demonstrated the robustness of parametric tests with such data. Instrument validity was established through

expert review by three academic specialists in supply chain management and petroleum operations research, while reliability was confirmed through Cronbach's alpha coefficients: logistical vulnerability (alpha = 0.83), operational vulnerability (alpha = 0.81), oil production stability (alpha = 0.84), and organizational resilience (alpha = 0.80). These coefficients exceed the commonly accepted threshold of 0.70, confirming the internal consistency of all instrument sections. Descriptive statistics, comprising frequencies, percentages, and weighted means, were used to profile respondents and summarize item-level responses. A criterion mean of 3.0 was adopted for decision-making on the descriptive items. Pearson Product Moment Correlation (PPMC) was employed to test the two stated hypotheses at a 0.05 level of significance. All data analysis was performed using SPSS version 25.0.

Results and Discussion

Response Rate and Demographic Profile

Of 120 questionnaires administered, 110 valid responses were used for analysis, representing a response rate of 91.7%. The demographic profile reveals that the majority of respondents were aged 26-35 years (44.5%), male (56.4%), married (61.8%), holders of a Bachelor's degree (51.8%), and had 5-9 years of experience (37.3%). This profile reflects a workforce with significant operational exposure and formal educational background well-suited for providing informed responses on supply chain vulnerability and production stability.

Descriptive Analysis

Table 1 presents a descriptive summary of the study variables. All item mean scores exceeded the criterion mean of 3.0, indicating respondent agreement that logistical vulnerability, operational vulnerability, and oil production stability-related challenges are perceptible and meaningful constructs in the Rivers State upstream petroleum context.

Table 1: Descriptive Summary of Study Variables

Variable	Item	Weighted Mean	Decision
Logistical Vulnerability	Pipeline vandalism disrupts our supply chain	3.92	Agreed
	Transport bottlenecks delay material delivery	3.88	Agreed
	Import delays affect procurement of critical inputs	3.76	Agreed
Operational Vulnerability	Equipment failures halt our production operations	3.85	Agreed
	Labour strikes disrupt operational continuity	3.71	Agreed
	Maintenance lapses reduce operational reliability	3.79	Agreed

Variable	Item	Weighted Mean	Decision
Oil Production Stability	We consistently meet planned production targets	3.42	Agreed
	Our operations comply with regulatory production quotas	3.51	Agreed
	Production continuity is maintained despite disruptions	3.38	Agreed

Hypotheses Testing

H_{01}: Logistical Vulnerability and Oil Production Stability

Table 2: The Relationship between Logistical Vulnerability and Oil Production Stability

Variable	Logistical Vulnerability	Oil Production Stability
Logistical Vulnerability (Pearson r)	1.000	-.731**
Sig. (2-tailed)	--	.001
Oil Production Stability (Pearson r)	-.731**	1.000
Sig. (2-tailed)	.001	--

Note: **Correlation is significant at the 0.01 level (2-tailed).

The PPMC coefficient of r = -0.731 indicates a strong negative relationship between logistical vulnerability and oil production stability. Since the p-value (0.001) is less than the 0.05 significance level, the null hypothesis H_{01} is rejected. The study therefore concludes that there is a significant negative relationship between logistical vulnerability and oil production stability of upstream petroleum firms in Rivers State. This implies that as logistical vulnerability increases, oil production stability declines significantly.

H_{02}: Operational Vulnerability and Oil Production Stability

Table 3 presents the Pearson correlation results for the relationship between operational vulnerability and oil production stability.

Table 3: The Relationship between Operational Vulnerability and Oil Production Stability

Variable	Operational Vulnerability	Oil Production Stability
Operational Vulnerability (Pearson r)	1.000	-.684**
Sig. (2-tailed)	--	.002
Oil Production Stability (Pearson r)	-.684**	1.000
Sig. (2-tailed)	.002	--

Note: **Correlation is significant at the 0.01 level (2-tailed).

The PPMC coefficient of r = -0.684 indicates a moderately strong negative relationship between operational vulnerability and oil production stability. Since the p-value (0.002) is less than the 0.05 significance threshold, the null hypothesis H_{02} is rejected. The study therefore concludes that there is a significant negative relationship between operational vulnerability and oil production stability of upstream petroleum firms in Rivers State.

Discussion of Findings

The finding that logistical vulnerability has a strong negative relationship with oil production stability ($r = -0.731$, $p < 0.05$) is theoretically consistent with Transaction Cost Theory, which predicts that logistical disruptions escalate coordination costs and introduce uncertainty that undermines the regularity and predictability of production operations. Pipeline vandalism, transport bottlenecks, and import delays create cascading supply chain failures that impair the availability of critical inputs, forcing production interruptions that directly reduce output consistency. This finding aligns with Bala & Umar (2021), who reported that logistical disruptions were among the strongest predictors of production instability in Nigerian upstream petroleum firms, and with Adeyinka & Olufemi (2022), who established significant negative impacts of supply chain disruptions on oil company operational performance in the Niger Delta. The magnitude of the correlation is further consistent with Kamalahmadi et al. (2022), who similarly documented strong negative associations between logistical disruptions and operational performance indicators in capital-intensive sectors.

The significant negative relationship between operational vulnerability and oil production stability ($r = -0.684$, $p < 0.05$) corroborates the Dynamic Capabilities perspective, which emphasizes that firms lacking the sensing and integration capabilities to detect and respond to operational threats will experience more severe production disruptions. Equipment failure, labour unrest, and maintenance lapses erode the operational reliability that sustained production stability requires. The moderately stronger impact of logistical vulnerability compared to operational vulnerability may reflect the heightened salience of external supply chain hazards, particularly pipeline vandalism, in Rivers State's unique operational environment, where security and community-relations factors amplify logistical risk beyond the levels typically encountered in other producing regions (Chioma & Okafor, 2023; Nwokocha & Amadi, 2023). This pattern is consistent with the findings of Ribeiro & Barbosa-Povoa (2021), who similarly

identified logistical disruptions as the dominant source of production instability in oil and gas operations across emerging market contexts.

Both findings underscore the strategic importance of organizational resilience as a theoretical moderating mechanism. Firms with robust risk management frameworks, adaptive capacity, and contingency planning capabilities are better positioned to absorb the impact of both logistical and operational vulnerabilities, maintaining higher levels of production stability even under adverse conditions (Agyabeng-Mensah et al., 2020; Wieland & Wallenburg, 2013). Future research incorporating formal moderation testing through hierarchical regression or structural equation modelling would provide a more rigorous empirical assessment of this relationship.

Implications of the Study

The findings of this study carry significant theoretical and practical implications for the upstream petroleum sector in Rivers State and, by extension, Nigeria's broader oil and gas industry.

From a theoretical standpoint, the study strengthens the application of Transaction Cost Theory and Dynamic Capabilities Theory in the upstream petroleum supply chain context. The confirmation that logistical and operational vulnerabilities exert significant negative effects on oil production stability validates TCT's prediction that coordination failures elevate transaction costs to the detriment of productive outcomes, and corroborates DCT's assertion that firms lacking dynamic capabilities will be disproportionately impaired by environmental disruptions. The study thus advances theoretically grounded understanding of the supply chain-performance relationship in a sector that has received relatively limited formal academic attention in the Nigerian context.

From a managerial standpoint, the strength of the logistical vulnerability-production stability correlation ($r = -0.731$) signals to upstream petroleum managers that logistics risk management must be treated as a frontline strategic priority rather than a back-office operational concern. Investments in real-time pipeline surveillance, multi-modal logistics redundancy, and community stakeholder engagement programmes are not merely cost centres; they are strategic instruments for protecting production output and, by implication, revenue streams and regulatory standing. Similarly, the significant operational vulnerability finding ($r = -0.684$) reinforces the business case for predictive maintenance programmes and proactive workforce relations management as instruments for sustaining production continuity.

From a policy standpoint, the findings highlight the inadequacy of reactive, firm-level responses to supply chain vulnerabilities that are, in significant part, driven by systemic industry-wide and institutional factors such as infrastructure decay, port inefficiency, and community disenfranchisement. Regulatory bodies, including the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) and the Federal Ministry of Petroleum Resources, should consider developing sector-wide supply chain risk governance frameworks that incentivize proactive vulnerability management and create coordinated early-warning systems for impending logistical and operational disruptions. Such frameworks would complement firm-level resilience investments and create a more stable operating environment for the sector as a whole.

Conclusion

This study examined the relationship between supply chain vulnerability, operationalized through logistical vulnerability and operational vulnerability, and oil production stability of upstream petroleum firms in Rivers State, with organizational resilience considered as a contextual moderating variable. The empirical evidence confirms that both vulnerability dimensions have significant negative relationships with oil production stability. Logistical vulnerability recorded a strong negative correlation ($r = -0.731$), while operational vulnerability demonstrated a moderately strong negative relationship ($r = -0.684$). These findings validate the theoretical propositions of Transaction Cost Theory and Dynamic Capabilities Theory in explaining how supply chain vulnerabilities impair production continuity. The study contributes to the growing body of literature on supply chain resilience in the Nigerian upstream petroleum sector, providing sector-specific empirical evidence from Rivers State that can inform both management strategy and regulatory policy. The findings confirm that supply chain vulnerability management is not merely a logistics function but a strategic imperative with direct implications for production performance and economic sustainability. Future studies are encouraged to adopt hierarchical regression or structural equation modelling to formally test the moderating role of organizational resilience and to expand the study scope to include upstream firms in other oil-producing states in Nigeria.

Recommendations

Based on the findings of this study, the following recommendations are proposed. Upstream petroleum firms in Rivers State should invest in real-time pipeline monitoring technologies, including satellite-based surveillance systems and automated leak detection, to enable early identification of vandalism and integrity breaches, minimizing production downtime associated with logistical vulnerability. Firms should also diversify their logistics networks by developing multi-modal transportation alternatives across road, marine, and pipeline modes, and by establishing strategic inventory buffers at key oilfield locations to reduce the impact of transport bottlenecks and import delays on production continuity.

A preventive and predictive maintenance culture should be institutionalized across upstream petroleum operations, supported by digital maintenance management systems that schedule and track equipment servicing proactively, thereby reducing the frequency and severity of unplanned equipment failures. Upstream petroleum firms should further develop and regularly test comprehensive organizational resilience frameworks, incorporating risk assessment protocols, contingency response plans, and cross-functional crisis management teams, to strengthen their capacity to sustain oil production stability when supply chain disruptions occur.

Finally, industry stakeholders and regulatory bodies should collaborate to establish a sector-wide supply chain vulnerability monitoring system that tracks logistical and operational disruption incidents, enabling data-driven risk management interventions at both firm and industry levels. Future research should extend this study by formally testing the moderating role of organizational resilience using hierarchical regression analysis, and by incorporating qualitative case studies to provide richer contextual understanding of disruption management practices across Rivers State upstream firms.

References

Adeyinka, F. T., & Olufemi, O. (2022). Supply chain disruptions and operational performance of oil companies in the Niger Delta region. *Journal of Supply Chain Management Research, 14*(2), 45-61.

Agyabeng-Mensah, Y., Ahenkorah, E., Afum, E., Nana Agyemang, A., Agnikpe, C., & Rogers, F. (2020). Examining the influence of internal green supply chain practices, green human resource management and supply chain environmental sustainability on firm performance. *Supply Chain Management: An International Journal, 25*(5), 585-599.

Bala, A., & Umar, I. (2021). Supply chain vulnerability and production stability in the Nigerian oil and gas sector. *Nigerian Journal of Petroleum and Gas, 9*(3), 78-94.

Chioma, N. J., & Okafor, E. (2023). Operational disruptions and oil output stability in Rivers State: Evidence from upstream petroleum firms. *Journal of Production and Operations Management, 11*(1), 12-29.

Chopra, S., & Sodhi, M. S. (2012). Managing risk to avoid supply chain breakdown. MIT Sloan *Management Review, 46*(1), 53-61.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management, 15*(2), 1-13.

Coase, R. H. (1937). The nature of the firm. *Economica, 4*(16), 386-405.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal, 21*(10-11), 1105-1121.

Hendricks, K. B., & Singhal, V. R. (2005). An empirical analysis of the effect of supply chain disruptions on long-run stock price performance and equity risk of the firm. *Production and Operations Management, 14*(1), 35-52.

Hohenstein, N. O., Feisel, E., Hartmann, E., & Giunipero, L. (2015). Research on the phenomenon of supply chain resilience: A systematic review and paths for further investigation. *International Journal of Physical Distribution & Logistics Management, 45*(1/2), 90-117.

Kamalahmadi, M., Shekari, T., & Parast, M. M. (2022). An investigation into the impact of supply chain disruption on the financial performance of firms. *International Journal of Production Economics, 245*, 108391.

Lengnick-Hall, C. A., Beck, T. E., & Lengnick-Hall, M. L. (2011). Developing a capacity for organizational resilience through strategic human resource management. *Human Resource Management Review, 21*(3), 243-255.

Manuj, I., & Mentzer, J. T. (2008). Global supply chain risk management strategies. International Journal of Physical Distribution & Logistics Management, 38(3), 192-223.

Nigeria Oil and Gas Industry Annual Report. (2023). Annual report on upstream petroleum operations. Department of Petroleum Resources, Federal Ministry of Petroleum Resources.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education, 15*(5), 625-632.

Norrman, A., & Jansson, U. (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident. *International Journal of Physical Distribution & Logistics Management, 34*(5), 434-456.

Nwokocha, C. I., & Amadi, P. (2023). Supply chain risk and organizational resilience in upstream petroleum firms in Nigeria. International Journal of Business and Management Studies, 15(4), 120-138.

Nworgu, B. G. (2015). *Educational research: Basic issues and methodology* (3rd ed.). University Trust Publishers.

Ojha, R., Ghadge, A., Tiwari, M. K., & Bititci, U. S. (2021). Bayesian network modelling for supply chain risk propagation. *International Journal of Production Research, 56*(7), 2269-2290.

Okoro, O. E., & Nwachukwu, S. A. (2022). Pipeline vandalism, supply chain disruptions, and oil production losses in Rivers State. *African Journal of Oil and Gas Management, 6*(1), 33-51.

Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *International Journal of Logistics Management, 20*(1), 124-143.

Ribeiro, J. P., & Barbosa-Povoa, A. (2021). Supply chain resilience and sustainability: A review of the literature with directions for future research. *International Journal of Production Research, 56*(20), 6846-6882.

Sheffi, Y., & Rice, J. B. (2005). A supply chain view of the resilient enterprise. *MIT Sloan Management Review, 47*(1), 41-48.

Sodhi, M. S., & Tang, C. S. (2012). *Managing supply chain risk*. Springer Science and Business Media.

Tang, C. S. (2006). Robust strategies for mitigating supply chain disruptions. *International Journal of Logistics: Research and Applications, 9*(1), 33-45.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509-533.

Wagner, S. M., & Bode, C. (2006). An empirical investigation into supply chain vulnerability. *Journal of Purchasing and Supply Management, 12*(6), 301-312.

Wieland, A., & Wallenburg, C. M. (2013). The influence of relational competencies on supply chain resilience: A relational view. *International Journal of Physical Distribution & Logistics Management, 43*(4), 300-320.

Williamson, O. E. (1985). *The economic institutions of capitalism*. Free Press.

Zsidisin, G. A., & Ritchie, B. (Eds.). (2009). *Supply chain risk: A handbook of assessment, management, and performance*. Springer.