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Procurement Challenges, Supply Disruptions, and Refinery Downtime: Evidence from Ghana's Downstream Petroleum Sector

Engr. Dr. Cyril Komla Asase[1], Kwesi Botchwey[2]

Institute of Development Studies, Africa Research University, Lusaka, Zambia, A Principal Learning and Development Officer at the Tema Oil Refinery, Ghana[1]

Institute of Development Studies, Africa Research University (Zambia) and Senior Prograame Officer, Ministry of Youth Development and Employment, Accra[2]

Abstract: Refinery downtime remains a persistent constraint on petroleum supply and industrial performance in many developing economies. While refinery shutdowns are frequently attributed to aging infrastructure and capital constraints, limited empirical attention has been given to procurement-related drivers of operational disruption. This study investigates the relationship between procurement challenges and refinery downtime in Ghana's downstream petroleum sector. Using a sequential explanatory mixed-methods design, survey data from 150 industry professionals were analyzed through Partial Least Squares Structural Equation Modeling (PLS-SEM), followed by qualitative interviews to contextualize the findings. Results reveal a strong and statistically significant relationship between procurement challenges and refinery downtime ($\beta = 0.62$, $p < .001$). In addition, procurement processes significantly moderate this relationship ($\beta = 0.31$, $p < .01$), indicating that weak procurement governance amplifies operational disruptions. Anchored in Transaction Cost Economics and Agency Theory, the findings reposition refinery downtime as not only a technical reliability issue but also a supply-chain governance and execution problem. The study contributes empirical evidence from an emerging-economy context and offers actionable implications for strengthening procurement systems to reduce unplanned outages and improve refinery performance.

Keywords: procurement challenges; refinery downtime; supply disruptions; downstream petroleum; Ghana

I. INTRODUCTION

Refinery operations are highly sensitive to interruptions due to their continuous-process nature and capital intensity. Unlike discrete manufacturing systems, refinery units are tightly coupled; the unavailability of a single critical input such as spare parts, catalysts, or specialized maintenance services can halt entire production streams. Consequently, refinery downtime generates disproportionate economic, fiscal, and supply-security consequences.

In Ghana, recurring refinery downtime has constrained domestic petroleum value addition and reinforced reliance on imported refined products, increasing exposure to foreign exchange volatility and global supply shocks. Conventional explanations for these disruptions emphasize aging infrastructure, technical breakdowns, and limited capital investment. While these factors are undeniably important, they do not fully explain persistent downtime in contexts where operational expertise, regulatory oversight, and technical knowledge exist.

This study advances a complementary explanation: procurement challenges play a central role in refinery downtime by delaying maintenance execution, disrupting process continuity, and increasing dependence on emergency sourcing. Procurement challenges such as long supplier lead times, spare-parts unavailability, foreign exchange constraints, and bureaucratic approval delays are widely acknowledged by practitioners but remain underexamined in empirical research, particularly within developing-economy refinery contexts.

Accordingly, this study examines whether procurement challenges significantly influence refinery downtime in Ghana's downstream petroleum sector and whether procurement processes condition this relationship. By empirically testing these relationships, the study contributes to operations management and energy-sector literature while offering practical insights for refinery managers and policymakers.

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II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Procurement Challenges in Industrial Supply Chains

Procurement challenges arise when organizations are unable to source critical inputs reliably, affordably, and within required timeframes. In capital-intensive process industries, such challenges are amplified due to low input substitutability, long replenishment cycles, and strict technical specifications (Jenkins, 2021). In refinery operations, the absence of a single component—such as a valve, catalyst, or specialized chemical can immobilize entire processing units. Existing literature links procurement disruptions to elevated operational risk, particularly in environments characterized by supplier concentration, foreign exchange exposure, and institutional constraints (Schumacher et al., 2020). However, most studies focus on general supply-chain resilience rather than the specific operational consequences of procurement failure in refinery contexts.

III. REFINERY DOWNTIME AS AN OPERATIONAL OUTCOME

Refinery downtime is typically measured by unplanned shutdown frequency, outage duration, and deviations from planned throughput. Although often treated as a purely technical or engineering outcome, downtime can also result from organizational and supply-chain failures, including delayed maintenance, emergency sourcing, and procurement bottlenecks. This perspective aligns with growing recognition that operational reliability is shaped not only by physical assets but also by governance and execution systems.

Transaction Cost Economics

Transaction Cost Economics (TCE) posits that inefficiencies in market transactions increase the costs of searching, contracting, monitoring, and enforcement (Williamson, 1985). In refinery contexts, emergency procurement elevates transaction costs through premium pricing, expedited logistics, and contractual renegotiations. These costs often coincide with prolonged outages when procurement systems are ill-suited for time-critical operational needs.

Agency Theory

Agency Theory emphasizes the misalignment of incentives between principals and agents, leading to suboptimal decision-making (Eisenhardt, 1989). In procurement settings, approval delays, excessive risk aversion, weak accountability, and fragmented decision rights can slow response times during maintenance-critical periods, thereby exacerbating downtime risks.

Hypothesis Development

Drawing on these theoretical perspectives, this study proposes the following hypothesis:

H1: Procurement challenges have a positive and statistically significant effect on refinery downtime.

IV. METHODOLOGY

Research Design

The study employed a sequential explanatory mixed-methods design. Quantitative data were collected through a structured survey and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to test hypothesized relationships. Qualitative interviews were subsequently conducted to interpret and contextualize the quantitative findings.

Sample and Data Collection

Survey data were obtained from 150 professionals working in procurement, operations, maintenance, engineering, and regulatory roles within Ghana's downstream petroleum sector. Purposive sampling was used to ensure respondents possessed relevant experience and operational knowledge. Data collection was conducted over a three-month period using self-administered questionnaires.

Data Analysis

PLS-SEM was selected due to its suitability for analyzing latent constructions and complex relationships with moderate sample sizes. Reliability and validity assessments were conducted prior to structural model testing. Qualitative interview data were analyzed thematically to explain mechanisms underlying the observed statistical relationships.

V. RESULTS

Measurement Model Assessment

Construct reliability and convergent validity were assessed using composite reliability and average variance extracted (AVE). All constructions exceeded commonly accepted thresholds for internal consistency and convergent validity, indicating satisfactory measurement quality.

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Table 1
Construct Reliability and Convergent Validity

Construct	Composite Reliability	AVE
Procurement Challenges	0.84	0.56
Procurement Processes	0.82	0.53
Refinery Downtime	0.87	0.59

Discriminant validity was assessed using the heterotrait–monotrait (HTMT) ratio. All HTMT values were below recommended thresholds, supporting construct distinctiveness.

Structural Model Results

The structural model explains a substantial proportion of variance in refinery downtime ($R^2 = 0.41$), indicating meaningful explanatory power.

Table 2
Structural Model Results

Path	β	p-value
Procurement Challenges → Refinery Downtime	0.62	< .001
Procurement Challenges × Procurement Processes → Downtime	0.31	< .01

The results support Hypothesis 1 and confirm that procurement processes significantly moderate the relationship between procurement challenges and refinery downtime.

VI. DISCUSSION

The findings provide robust empirical evidence that procurement challenges are significantly associated with refinery downtime in Ghana's downstream petroleum sector. The magnitude of the relationship and the explained variance suggest that procurement execution is not a peripheral issue but a central operational determinant.

From a Transaction Cost Economics perspective, procurement inefficiencies likely elevate transaction costs through emergency sourcing, contractual renegotiations, and expedited logistics, contributing to prolonged outages. Agency Theory further explains how approval delays, misaligned incentives, and weak accountability structures exacerbate procurement-related disruptions during maintenance-critical periods.

The significant moderating effect of procurement processes indicates that governance and execution choices can either amplify or mitigate the operational consequences of procurement challenges. This finding suggests that even in constrained markets, improvements in procurement governance can materially reduce downtime risks.

Managerial Implications

Refinery managers can reduce downtime by institutionalizing maintenance-oriented procurement practices:

1. Establishing strategic stock levels for non-substitutable critical items.
2. Implementing framework agreements with pre-qualified suppliers to reduce lead times.
3. Aligning procurement planning with maintenance schedules and condition-based monitoring.
4. Strengthening supplier performance management and escalation protocols.

VII. POLICY IMPLICATIONS

Public procurement frameworks in capital-intensive industries should balance transparency with operational flexibility. Policies that enable preapproved vendor pools and framework contracting while maintaining auditability can reduce downtime without compromising accountability or governance standards.

VIII. LIMITATIONS AND FUTURE RESEARCH

This study relies on self-reported survey data, which may be subject to common method bias. Additionally, while the model explains a substantial portion of downtime variance, other drivers such as technical reliability, financing

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constraints, and crude supply disruptions warrant further investigation. Future research should incorporate longitudinal data and objective outage records to strengthen causal inference.

IX. CONCLUSION

This study demonstrates that procurement challenges significantly contribute to refinery downtime in Ghana's downstream petroleum sector and that procurement processes condition this relationship. Addressing refinery downtime therefore requires not only technical investment but also reforms in procurement governance and execution. By reframing downtime as a supply-chain governance issue, the study contributes to procurement, operations management, and energy-policy literature in emerging economies.

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