Strategic Intervention Framework for Logistics and Supply Chain Management in Small-Scale Borehole Drilling Companies: Enhancing Efficiency and Sustainability in Nigeria

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Abstract- ***Small-scale water borehole drilling companies (SSWBDCs) are critical to achieving Sustainable Development Goal 6.1 in Nigeria, yet they are plagued by operational inefficiencies, variable construction quality, and poor record-keeping (Danert et al., 2009). This article proposes a strategic Logistics and Supply Chain Management (LSCM) intervention framework designed to address the specific contextual gaps prevalent in the Nigerian environment. The framework centers on the integration of Digitalization (SCM 4.0), Lean Management, and Ethical Sourcing to significantly improve project efficacy, operational efficiency, and financial profitability, while establishing a robust foundation for Corporate Social Responsibility (CSR) and sustainability. The recommendations, supported by empirical case studies, serve to professionalize the sector, moving SSWBDCs towards resilient, value-driven operations.***

Keywords: ***Operational Efficacy, Efficiency, Sustainability, Logistics, Supply Chain, Borehole***

I. INTRODUCTION

The provision of safe, potable water remains a significant developmental challenge in Nigeria, with widespread reliance on groundwater due to the failure of public water utilities (Olabode & Bamgboye, 2013). This reliance has spurred the growth of numerous SSWBDCs, whose operations, however, are often characterized by a high failure rate of boreholes—estimated at around 54% in some regions—attributable to poor construction practices, inadequate hydrogeological investigation, and a lack of expertise (Olabode, O. M. & Bamgboye O. A., 2013; Fadare et al., 2015). This paper adopts a logistics and supply chain professional perspective to intervene strategically and professionalize the delivery model. The current operational chaos, coupled with external pressures like volatile material costs and infrastructural decay (Adekile & Olabode, 2009; Danert, 2013), necessitates a shift from reactive procurement to proactive, data-informed logistics and supply chain management.

II. STRATEGIC GAP ANALYSIS IN THE NIGERIAN CONTEXT

The inefficiencies of Nigerian Small-Scale Water Borehole Drilling Companies are deeply rooted in four primary areas, presenting unique logistics and supply chain management challenges:

2.1. Operational and Technical Efficacy Gaps

A major cause of borehole failure is poor siting and construction practices, often undertaken without proper geoscientific evaluation, leading to dry wells or premature contamination (Fatoyinbo et al., 2023; Iqbal, 2023).

LSCM Gap: Lack of Standard Operating Procedures (SOPs) for mobilization, drilling, and casing installation in Nigeria contributes significantly to the high failure rate of water projects and threats to public health. Inconsistent material specification (e.g., using poor quality casing to cut costs) directly undermines long-term project efficacy (Iqbal, 2023). The problem is compounded by weak regulatory enforcement, a proliferation of unlicensed drillers, and a high reliance on groundwater due to the failure of municipal water supplies (Federal Ministry of Information and National Orientation, 2024; Skat Consulting, 2020).

2.2. Efficiency and Financial Control Gaps

SSWBDCs often struggle with high operational costs and inadequate financial planning, directly impacting

profitability (Danert, 2009).

LSCM Gap: Ad-hoc Procurement and Inventory Risk. Purchases are often made per-project, preventing volume discounts. The lack of centralized inventory tracking leads to high carrying costs, material shortages, and project delays. Furthermore, the high cost of imported equipment and associated duties strains working capital (World Bank, 2007).

Nigerian Context: Cumbersome customs processes, poor road conditions, and unreliable power increase logistics costs, hindering competitiveness (World Bank, 2021).

2.3. Compliance and Sustainability Gaps
Indiscriminate drilling without proper regulatory oversight poses a severe threat to groundwater purity and resource depletion (World Bank, 2022).

LSCM Gap: Failure to track or ensure the quality and origin of materials used (pumps, chemicals). A lack of post-installation quality testing exposes customers and the company to health and legal risks (Federal Ministry of Information and National Orientation, 2024).

III. STRATEGIC INTERVENTION FRAMEWORK

The LSCM intervention framework is designed to close the identified gaps by applying global best practices adapted for the Nigerian environment, supported by empirical evidence.

3.1. Digitalization (Supply Chain 4.0) and Integrated Planning
The foundation for efficiency is the digitalization of the Supply Chain Management (SCM) process: Intervention: Implement a Project Management Information System (PMIS) integrated with a real-time Inventory Management solution (SCM 4.0).

Impact on Efficacy & Efficiency: This system will enforce Sales and Operations and Planning (S&OP) alignment. Sales forecasts trigger material procurement and the PMIS ensures crews only mobilize when all critical assets (rigs, casing, bits) are confirmed available. This mitigates delays caused by material shortages, a key constraint for small Nigerian businesses (World Bank, 2007).

Empirical Evidence: A case study from a mid-sized Nigerian construction firm demonstrated that implementing an integrated ERP system reduced project overruns due to material shortages by 35% and improved on-time project delivery by 25% within one year (Adewumi & Omole, 2020). Similarly, empirical research on manufacturing firms in South-East Nigeria confirms that effective inventory management systems have a significant positive effect on operational performance, directly reducing inefficiencies and costs (Nwosu & Eze, 2019).

3.2. Lean Logistics and Transport Network Optimization
Addressing Nigeria's infrastructure deficit requires a focus on fleet and route efficiency: Intervention: Implement GPS Tracking and Route Optimization for all drilling rigs and material delivery trucks. Standardize the rigging-up and rigging-down process into documented lean Standard Operation Procedures (SOPs).

Impact on Efficiency & Profitability: This directly reduces fuel consumption, minimizing the effect of high petroleum costs and reduce non-productive time and improve overall operational time. Furthermore, tracking vehicle maintenance schedules prolongs the life of high-cost assets (drilling rigs), which is vital given the difficulties in financing new equipment (World Bank, 2007).

Empirical Evidence: Research on Nigerian logistics providers by Abiyesuku and Obaye (2025) demonstrates a significant and positive relationship between route optimization and operational efficiency. Implying that optimizing transport networks leads to better cargo handling, reduced operational costs, and improved timeliness, which is crucial for asset-heavy businesses like borehole drilling firms. The findings of Obodoagu (2025) from a doctoral study on food and beverage manufacturing firms in South-East Nigeria provide direct empirical support for the Lean Logistics intervention. The research confirmed that implementing Lean Six Sigma principles, which focus on standardizing processes and eliminating waste, leads to substantial gains in operational efficiency and profitability.

3.3. Strategic Sourcing and Inventory Control
Moving away from reactive purchasing to strategic Global Supply Chain management:

Intervention: Establish formal, long-term contracts with key suppliers of imported materials (submersible pumps, specialized drill bits) to secure volume discounts and mitigate risk from exchange rate volatility. Introduce a Centralized Inventory System with defined reorder points for essential consumables.

Impact on Profitability: Reduces Cost of Goods Sold (COGS) by leveraging economies of scale (Danert, 2013). It prevents costly project standstills that result from the lack of spare parts, a common problem cited by Nigerian drillers (Eduvie & Olabode, 2013).

Empirical Evidence: A case study of a water project in Bauchi State showed that a consortium of drillers who pooled their procurement to achieve economies of scale saved an average of 18% on the cost of casing and screen materials (Skat Consulting, 2020). Furthermore, the application of strategic sourcing and vendor-managed inventory (VMI) in the Nigerian pharmaceutical industry demonstrated a 40% reduction in stock-outs and a 25% improvement in supplier lead time reliability (Okorie & Emeagwali, 2019).

IV. SUSTAINABILITY, CSR, AND ETHICAL COMPLIANCE

To ensure long-term sustainability, the LSCM strategy must integrate ethical and social considerations.

Corporate Social Responsibility (CSR): Formalize the successful stakeholder referral model into a structured affiliate program. This creates a traceable, ethical Retail Logistics network that provides economic empowerment to local community partners, enhancing the company's social license to operate.

Sustainability & Water Quality: Integrate mandatory Quality & Compliance checkpoints into the LSCM process, requiring verifiable post-installation water quality testing before final sign-off. The sourcing strategy should prioritize suppliers offering energy-efficient pump systems to promote long-term cost savings for the customer and minimize environmental impact.

Risk Management: Develop a formal LSCM Risk Register identifying critical risks (e.g., equipment failure, geological setbacks, policy changes) and establish redundant sourcing strategies (e.g., maintaining at least two viable suppliers for pumps) to ensure business continuity.

Empirical Evidence: Research on Nigerian water projects has consistently shown that formal community participation, such as involving locals in management and maintenance, is a critical factor for long-term sustainability, significantly reducing failure rates compared to top-down approaches (Oluwasanya & Thonti, 2020). A study on corporate sustainability in Nigeria found that SMEs with formalized CSR and environmental policies experienced greater community trust and reduced operational conflicts, directly impacting project success and longevity (Adegbite & Nakajima, 2021).

V. CONCLUSION

The strategic LSCM interventions presented—from digital integration and lean operational standards to ethical sourcing and financial controls—are crucial for elevating SSWBDCs in Nigeria. The integration of case studies from Nigeria provides empirical weight to the proposed framework, demonstrating tangible benefits in cost reduction, efficiency gains, and improved project outcomes. By moving from a fragmented, informal operating model to a transparent, data-driven one, small scale water borehole drilling companies can drastically improve project efficacy (reducing borehole failure), enhance efficiency (shortening project cycle times), and secure robust profitability. This integrated, evidence-based approach not only professionalizes the sector but also positions the small-scale water borehole drilling companies as a sustainable provider, contributing directly to the public health and economic well-being of the communities it serves.

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