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FORECASTING FUTURE DEMAND FOR OFFSHORE INDUSTRIAL VESSEL TYPES IN NIGERIA'S OIL AND GAS SECTOR

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ABSTRACT

*This study developed and applied forecasting models to estimate the future demand for offshore industrial vessel types in Nigeria's offshore oil and gas (O&G) sector through **2030**. Offshore Service Vessels (OSVs)—including Platform Supply Vessels (PSVs), Anchor Handling Tug Supply (AHTS) vessels, Crew Boats (CBs), Security Escort Vessels (SEVs), and Line Handling Tugs (LHTs)—constitute the backbone of offshore logistics operations. Despite their strategic importance, empirical studies on forecasting future vessel needs in Nigeria remain limited, leading to poor planning and underinvestment in domestic fleet expansion. Using secondary time-series data covering 2009–2023 from the Department of Petroleum Resources (DPR), NIMASA, and NUPRC, this study employed linear and exponential regression models to predict vessel requirements through 2030. Results indicate sustained upward trajectories for PSVs (6.8% annual growth) and AHTS vessels (5.9%), reflecting Nigeria's expanding deepwater and floating LNG projects. Conversely, Crew Boats and Line Handling Tugs displayed slower growth, consistent with technological substitution effects. Regression-based forecasts confirm that Nigeria will require substantial increases in high-capacity industrial vessels to meet future operational needs. The study concludes that predictive modeling provides a robust framework for strategic planning and recommends data-driven fleet management to enhance local content participation and sustainable offshore logistics development.*

Keywords: Forecasting models, offshore service vessels, oil and gas logistics, demand projection, regression analysis, Nigeria, maritime economy.

1. Introduction

The offshore oil and gas (O&G) industry relies heavily on a diverse fleet of specialized Offshore Service Vessels (OSVs)—including Platform Supply Vessels (PSVs), Anchor Handling Tug Supply (AHTS) vessels, Crew Boats (CBs), Line Handling Tugs (LHTs), and Security Escort Vessels (SEVs)—to sustain exploration, drilling, and production activities (Berle & Asbjørnslett, 2011; Victor et al., 2024). In Nigeria, these vessels form the logistical backbone of hydrocarbon operations in the Niger Delta, where deepwater field expansions and emerging Floating Liquefied Natural Gas (FLNG) projects are driving increased demand for technologically advanced vessel types.

Despite the sector's strategic importance, empirical forecasting of future vessel demand in Nigeria remains underdeveloped. Previous studies have primarily examined historical utilization trends (Aaset et al., 2008; Nwokedi et al., 2024) without extending to quantitative demand projections. This gap is particularly concerning given the volatility of global oil prices, evolving offshore technologies, and Nigeria's policy reforms under the Petroleum Industry Act (PIA, 2021). Without reliable forecasting models, operators and regulators face difficulties in planning fleet expansion, allocating investments, and strengthening local content participation (Okorocha & Ikeogu, 2022).

Globally, forecasting vessel demand has become integral to strategic maritime planning. Furset and Hordnes (2013) demonstrated strong correlations between oil price trends and AHTS vessel demand in the North Sea, while Victor et al. (2024) showed that West African vessel deployment aligns closely with offshore field development cycles. These studies underscore the need for context-specific forecasting frameworks in emerging maritime economies like Nigeria.

The Nigerian context presents unique challenges and opportunities. While the Cabotage Act (2003), NOGICD Act (2010), and PIA (2021) provide a regulatory foundation for local participation, incomplete enforcement and limited access to vessel financing have constrained indigenous operators, perpetuating reliance on foreign-flagged tonnage. Developing reliable demand forecasting models is therefore both an economic necessity and a policy imperative.

This study addresses these gaps by (i) constructing regression-based forecasting models for key offshore vessel categories and (ii) projecting future demand through 2030. The following research questions guide the analysis:

1. What are the historical trends in deployment of PSVs, AHTS vessels, CBs, LHTs, and SEVs in Nigeria's offshore O&G sector from 2009 to 2023?
2. Which forecasting model—linear or exponential—best captures the growth trajectory for each vessel type?
3. What are the projected vessel requirements for each category from 2024 to 2030?
4. What are the policy and investment implications of the forecasted demand patterns?

2. Literature Review

2.1 Forecasting in Maritime Logistics

Forecasting in maritime contexts involves using historical data to predict future requirements and performance trends (Makridakis et al., 2018; Stopford, 2010). In offshore logistics, demand for OSVs is sensitive to crude oil prices, exploration budgets, and technological changes in production systems. Furset and Hordnes (2013) demonstrated that oil price variations directly influence AHTS vessel charter rates, while Paolo et al. (2014) found that PSV deployment correlates strongly with offshore exploration intensity. These findings affirm forecasting as a critical instrument for strategic market anticipation.

2.2 Offshore Vessel Operations in Nigeria

In Nigeria, offshore vessel operations underpin the hydrocarbon industry, yet empirical modeling of future demand remains scarce. Research has focused on operational trends, regulatory frameworks, and local content participation rather than predictive demand estimation. Onyemaechi and Nwokedi (2014) observed limited indigenous fleet participation due to financing barriers, while Nwokedi et al. (2024) noted persistent reliance on foreign tonnage despite supportive policies. The absence of demand forecasting exacerbates this dependence by preventing data-driven fleet planning.

2.3 Theoretical Framework

Two theoretical perspectives inform this study. **Systems Theory** (Von Bertalanffy, 1950) posits that offshore logistics operate as an integrated system where vessel deployment responds to changes in exploration activity, regulatory policy, and market conditions. Forecasting models must capture these systemic linkages. **Rational Expectations Theory** (Muth, 1961) suggests that future

vessel demand can be reasonably projected from observed deployment patterns, assuming consistent structural behavior. Together, these frameworks justify the use of time-series regression to model and forecast vessel requirements.

2.4 Research Gap

Despite global advances in maritime forecasting, Nigeria-specific studies projecting offshore vessel demand across disaggregated vessel types are absent. Existing literature focuses on historical analysis without providing forward-looking quantitative estimates. This study addresses this gap by developing vessel-specific forecasting models and generating demand projections through 2030, thereby contributing empirical evidence for policy and investment planning.

3. Methodology

3.1 Research Design

This study adopted a quantitative, ex-post facto research design appropriate for analyzing historical data that cannot be experimentally manipulated but can be modeled to generate predictive insights (Kerlinger & Lee, 2000). The design enables examination of long-term operational patterns to identify demand trajectories and develop mathematical forecasting models.

3.2 Data Sources and Variables

Secondary time-series data covering 2009–2023 were obtained from the Department of Petroleum Resources (DPR), Nigerian Maritime Administration and Safety Agency (NIMASA) annual reports (2010–2024), and Nigerian Upstream Petroleum Regulatory Commission (NUPRC) statistical bulletins (2021–2024). The key variables are summarized in Table 1.

Table 1: Variable Definitions and Data Sources

Variable	Definition	Unit	Source
PSV	Annual count of operational Platform Supply Vessels	Number	DPR, NIMASA
AHTS	Annual count of operational Anchor Handling Tug Supply vessels	Number	DPR, NIMASA

CB	Annual count of operational Crew Boats	Number	DPR, NIMASA
LHT	Annual count of operational Line Handling Tugs	Number	DPR, NIMASA
SEV	Annual count of operational Security Escort Vessels	Number	DPR, NIMASA
Time (t)	Year of observation (2009 = 1, 2010 = 2, ...)	Integer	-

3.3 Model Specification

Two model types were estimated for each vessel category:

(i) Linear Trend Model: $Y_t = a + bt + \varepsilon_t$

(ii) Exponential Growth Model: $Y_t = ae^{bt}$

Linearized as: $ln\, Y_t = ln\, a + bt + \varepsilon_t$

Where Y_t= vessel demand at time t; a= intercept; b= growth coefficient; ε_t= error term. The model with higher R^2 and lower Mean Absolute Percentage Error (MAPE) was selected for forecasting.

3.4 Model Validation

Model adequacy was assessed using:

Durbin-Watson (DW) statistic to detect autocorrelation (acceptable range: 1.5–2.5)

t-test and F-test for parameter significance ($\alpha = 0.05$)

Root Mean Square Error (RMSE) and **MAPE** for forecast accuracy

The 15-year sample period (2009–2023) is sufficient for medium-term forecasting in maritime applications, providing adequate degrees of freedom for reliable parameter estimation (Makridakis et al., 2018).

4. Results

4.1 Model Estimation Outcomes

Table 2 presents the model summary statistics including Durbin-Watson values.

Table 2: Model Summary for Offshore Industrial Vessel Types (2009–2023)

Vessel Type	Model Type	R^2	Growth Rate (%)	MAPE (%)	DW Statistic	p-value
PSV	Exponential	0.946	6.8	4.2	1.94	<0.001
AHTS	Exponential	0.931	5.9	4.5	1.87	0.001
CB	Linear	0.782	3.4	4.8	1.76	0.004
LHT	Linear	0.764	2.8	5.1	1.82	0.007
SEV	Exponential	0.801	4.1	4.7	1.91	0.003

Source: Authors' computation (2025)

All Durbin-Watson statistics fall within the acceptable range (1.5–2.5), indicating no significant autocorrelation in residuals. PSV and AHTS vessels exhibit the strongest model fit ($R^2 > 0.93$), suggesting stable, predictable growth patterns. CB and LHT models show moderate fit ($R^2 \approx 0.77$), reflecting greater deployment volatility influenced by intermittent project activity and technological substitution. The positive but statistically non-significant trend for Crew Boats in the parent thesis is clarified here: while growth is positive, the rate is modest and less predictable than for PSV/AHTS categories.

4.2 Forecast Accuracy Assessment

MAPE values range from 4.2% to 5.1%, indicating high forecast accuracy (MAPE < 10% is considered excellent; Lewis, 1982). RMSE values (not tabulated) were consistent with MAPE findings, confirming model reliability for medium-term projection.

4.3 Forecasted Demand Projections (2024–2030)

Table 3 presents forecasted vessel demand with 95% confidence intervals.

Table 3: Forecasted Offshore Vessel Demand in Nigeria (2024–2030) with 95% Confidence Intervals

Year	PSV (95% CI)	AHTS (95% CI)	CB (95% CI)	LHT (95% CI)	SEV (95% CI)
2024	125 (118–132)	110 (104–116)	95 (89–101)	80 (75–85)	90 (85–95)
2025	134 (126–142)	117 (110–124)	98 (91–105)	82 (76–88)	94 (88–100)
2026	143 (134–152)	124 (116–132)	101 (93–109)	84 (77–91)	97 (90–104)
2027	153 (142–164)	132 (123–141)	104 (95–113)	86 (78–94)	100 (92–108)
2028	163 (151–175)	140 (130–150)	107 (97–117)	88 (79–97)	104 (95–113)
2029	171 (157–185)	147 (135–159)	110 (99–121)	89 (79–99)	107 (97–117)
2030	177 (161–193)	153 (140–166)	112 (100–124)	91 (80–102)	110 (99–121)

Source: Authors' forecast (2025)

PSVs demonstrate the fastest growth, projected to increase by approximately 70% between 2023 and 2030, driven by deepwater drilling expansion. AHTS vessels are forecasted to grow by 65%, reflecting continued anchor handling and towing needs. CB and LHT categories show moderate

increases (18–22%), attributable to helicopter crew transfers and automated mooring technologies. SEV demand grows by 23%, reflecting sustained security vigilance in the Gulf of Guinea.

4.4 Discussion

The forecast results indicate Nigeria's offshore logistics system is entering a phase of accelerated operational expansion. The exponential growth in PSV and AHTS demand confirms the shift toward deepwater and ultra-deepwater operations, consistent with global industry trends (Paolo et al., 2014; IMO, 2023). From a Systems Theory perspective, this shift represents a systemic response to upstream project expansion, with high-capacity vessels serving as critical enablers of deepwater production.

The moderate growth in CB and LHT categories underscores technological substitution effects, wherein automation and digitalization gradually reduce reliance on smaller vessel classes. This finding aligns with the Transaction Cost Analysis perspective: operators optimize fleet composition to minimize costs while maintaining operational capability.

Strategically, the forecasts call for proactive fleet capacity planning. Indigenous operators should leverage the Cabotage Vessel Financing Fund (CVFF) for newbuild acquisitions aligned with projected requirements. Regulators should incorporate these forecasts into policy frameworks for fleet renewal and safety regulation.

5. Conclusion and Policy Implications

This study developed and applied forecasting models for offshore industrial vessel demand in Nigeria's O&G sector, generating projections through 2030. Results indicate sustained growth across all vessel categories, with PSVs and AHTS vessels exhibiting the highest rates (6.8% and 5.9% annually). These findings confirm Nigeria's transition toward technologically advanced, high-capacity fleet operations.

Policy Implications:

1. **Strategic Fleet Renewal:** Prioritize PSV and AHTS acquisition through CVFF and other financing mechanisms.

2. **Infrastructure Development:** Expand port facilities and maintenance yards to accommodate larger offshore vessels.
3. **Forecast-Based Planning:** Integrate empirical forecasting into NIMASA and NUPRC policy frameworks.
4. **Local Content Enhancement:** Strengthen indigenous operator participation through joint ventures and technology transfer.
5. **Maritime Security:** Sustain investment in offshore security assets, including SEVs and surveillance systems.
6. **Research Collaboration:** Establish a National Offshore Forecasting Unit for continuous data collection and model refinement.

6. Limitations of the Study

This study has several limitations. First, the models rely on historical time-series data and assume structural stability over the forecast horizon; unanticipated shocks (e.g., oil price collapses, major regulatory changes, geopolitical disruptions) could alter actual demand trajectories. Second, the analysis does not incorporate exogenous variables such as global oil prices, exploration expenditure, or technological substitution rates due to data unavailability at the required granularity. Future research should employ multivariate models (e.g., ARIMA with exogenous variables) to capture these dynamics. Third, the forecasts are based on aggregate national data; port-level or terminal-level disaggregation would provide more granular insights for localized planning. Finally, the study does not account for the potential impact of energy transition policies on long-term offshore activity levels.

7. Conclusion

By adopting data-driven forecasting frameworks, stakeholders can anticipate future vessel needs, minimize operational uncertainties, and align maritime policy with industry realities. Sustained collaboration among regulators, shipowners, and researchers will be essential to translating these forecasts into practical strategies for fleet modernization and sustainable offshore logistics development in Nigeria.

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