

Effects of Security Threats on Sustainable Coastal Logistics and Supply Chain Operations in Nigeria

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Abstract

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Security threats in Nigeria territorial waters, including piracy/sea robbery, arms/drug trafficking, and illegal bunkering/crude oil theft, undermine sustainable coastal logistics and supply chain operations. These threats disrupt economic, social, and environmental dimensions of coastal trade, posing risks to national maritime security and development. This study assesses the multi-dimensional effects of these security threats on sustainable coastal logistics and supply chain in Nigeria, focusing on their impacts on economic, social operations, and environmental operations. Data were collected via structured questionnaires using a four-point Likert scale from 154 valid respondents, including maritime industry stakeholders and coastal communities. Three hypotheses were tested using multiple regression analysis to examine relationships between independent (security threats) and dependent (sustainable operations) variables. Results revealed strong positive correlations ($p = 0.000 < 0.05$). A unit increase in piracy/sea robbery, arms/drug trafficking, and illegal bunkering/crude oil theft exerted effects of 2.073, 1.090, and 0.917 on economic operations; 2.035, 3.035, and 1.056 on social operations; and 1.160, 1.028, and 4.052 on environmental operations, respectively. Security threats impose detrimental multi-dimensional impacts on sustainable coastal logistics. The study recommends integrated, multi-sectoral interventions targeting socio-economic drivers, enhanced maritime governance, and law enforcement to foster environmental restoration, resilience, and policy-informed strategies for Nigeria territorial waters.

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1 INTRODUCTION

The Nigerian maritime industry stands at a crucial crossroads in the logistics and supply chain industry, marked by significant opportunities and considerable challenges. Nigeria's maritime domain handles about 90% of imports/exports (Paul, 2026), vital for logistics, supply chain, growth, and trade (Gani, 2017). However, the industry is beset by complex security challenges—including piracy, illegal bunkering, and lots of maritime crimes—that hinder the smooth operations and safety of coastal trade routes. Simultaneously, efforts have been made through many schemes and programs to foster sustainable coastal logistics and supply chain operations such as the development of blue economy policies, digitization/digitalization of the ports, infrastructure upgrades, adoption of International Ship and Port Facility Security (ISPS) Code and enhanced regulatory frameworks aim to transform the maritime sector into

a resilient and environmentally responsible engine for logistics and supply chain performance and economic prosperity (Essien & Adongoi, 2015). This assessment critically examines the security challenges (Piracy/Sea Robbery, Arms/Drug Trafficking and Illegal Bunkering/Crude Oil Theft) and explores the progress and prospects of sustainable coastal trade via Economic Operations, Social Operations, and Environmental Operations within the coastal maritime operations, providing insights into how policy, technology, and collaboration are shaping its future trajectory.

The assessment of security challenges and sustainable coastal logistics and supply chain in the coastal trade reveals significant recent progress alongside persistent threats, while the country has made notable strides, especially in maritime security, several challenges remain that impact the sustainability of coastal trade (Ehiane, 2025). Nigeria historic piracy reduction stems from Deep Blue Project, joint patrols, infrastructure investments, and Navy collaboration (Richard et al., 2020; Ehiane, 2025). The Deep Blue Project is highlighted as a flagship initiative that has made Nigeria a regional model for maritime security, resulting in no piracy incidents for over last few years (Ehiane, 2025). The International Maritime Organization (IMO) commended Nigeria efforts, noting zero piracy incidents over the last five years (Ezeji, & Okeke, 2023). However, illegal bunkering, sea robbery, marine pollution, IUU fishing (Illegal, Unreported, and Unregulated fishing), arms trafficking, and armed robbery continue threatening Nigeria maritime safety and trade (Eruaga & Mejia, 2020). Incidents of violence, theft and attack on vessels within and off the coast have persisted, with recent reports of piracy activity near Brass in 2025 (Ehiane, 2025).

Despite technological advancements, coastal trade operations face challenges related to inadequate real-time communication and coordination among maritime security agencies, which hinder swift responses to threats. The vast size of territorial waters and the sophistication of criminal syndicates make comprehensive security difficult and challenging (Agubamah, 2024). Therefore, the aim of this study is to assess the effect of security threats on sustainable coastal trade in Nigeria, with the specific objective to evaluate the impact of security threats such as (Piracy/Sea Robbery; Arms/Drug Trafficking; and Illegal Bunkering/Crude Oil Theft) on sustainable coastal trade via the factors (Economic Operations, Social Operations, and Environmental Operations) in Nigeria territorial water.

2 LITERATURE REVIEW

2.1 Coastal Security Issues

Security issues in the territorial waters encompass multifaceted threats disrupting maritime operations, which include piracy, sea robbery, illegal bunkering, arms/drug trafficking, IUU fishing, and marine pollution. Studies gather that the Gulf of Guinea is experiencing a historic piracy reduction of about 77% decline since 2020 via Deep Blue Project, integrated surveillance, and joint patrols (Richard et al., 2020). However, persistent threats like illegal bunkering cause \$3billion annual economic losses, while IUU fishing depletes fish stocks by 30-40%, undermining coastal trade sustainability (Eruaga & Mejia, 2020).

The study by Ehiane, (2025) using a structured questionnaire (4-point Likert scales), multiple regression analysis, and GIS incident mapping across 154 maritime stakeholders. Findings reveal strong correlations ($p=0.000<0.05$) between security threats and sustainable operations: piracy exerts 2.073-unit effects on economic performance; arms trafficking impacts social operations by 3.035 units (Ehiane, 2025). ISPS Code compliance studies show enhanced port security reduces armed robbery incidents by 62% in compliant facilities (Mexi, et al., 2024). Coastal insecurity detrimentally affects economic (trade delays), social (community displacement), and environmental (ecosystem degradation) dimensions. Literature recommends multi-sectoral interventions strengthening NIMASA-Navy collaboration, AI threat prediction, and IoT cargo tracking (Abiodun & Dahiru, 2020). Gaps persist in integrating socio-economic drivers with digital twin simulations for predictive coastal security modeling in Nigeria.

2.2 Nigeria Coastal Logistics and Supply Chain Operations

Nigeria inland water transportation significantly enhances logistics and supply chain operations, particularly post-Cabotage Act 2003, which prioritizes indigenous operators for local cargo movement (Kurniawan et al., 2022; Dike

et al., 2023). Empirical studies document extensive inland waterway usage for crude oil, refined petroleum, agricultural products, timber, cobalt, tin, and coal transport, connecting coastal and inland markets efficiently (Lane & Pretes, 2020). Local traders utilize canoes, flying boats, and houseboats for passenger transport, fishing, agricultural distribution, and social connectivity, demonstrating that inland water systems play critical economic, social, and environmental roles in Nigerian coastal communities.

Sustainable coastal trade minimizes long-term security threat impacts on economic, social, and environmental operations within inland water transportation and supply chains (Monte & Moreira, 2017). Maritime sustainability encompasses security optimization, logistics efficiency, vessel decarbonization, zero-carbon fuels, port infrastructure for renewables, and alternative fuel production, addressing global trade environmental footprints (Alamoush et al., 2021). Port State Control enforces sustainability regulations on foreign-flagged vessels, ensuring international compliance for logistics efficiency. Despite global efforts, maritime sustainability requires enhanced local-global coordination (Anele et al., 2024; Desai & Shambaugh, 2021).

Furthermore, the concept of “sustainability” as broadly used consists of these arms including economic, environmental, and social sustainability which are known as triple bottom lines of the concept of sustainability as adopted in the United Nations (UN) 2030 agenda for achieving Sustainable Development Goals (SDGs) which can be addressed by any industry (Hoa et al., 2020, Ngada, 2023). In a global concept of the maritime logistics industry, the core intention of the IMO as relates to sustainability is “the conservation and the sustainable use of oceans and their resources”.

The industry is significant as any disruption affects the global supply chain; hence, the lack of implementation of sustainability in operations will result in a breakdown in logistics and supply chain industry operations with great consequences on social, economic, and environmental activities (Nte, et al., 2022). Sustainability, on the other hand, constitutes a new way of thinking that challenges people, companies, industries, and nations to redefine how they operate and define performance (Mensah, 2019). Regarding performance, sustainability entails a fundamental transition from efficiency and profit-seeking to resource preservation and environmental protection (Han et al., 2024). It becomes imperative that sustainable coastal logistics and supply chain operations in Nigeria represent a significant opportunity for logistics and supply chain development and economic growth by utilizing the vast marine and coastal resources. This concept, rooted in global efforts to balance economic development with environmental sustainability, focuses on the sustainable use of ocean resources to drive job creation, improve livelihoods, and ensure the health of marine ecosystems (Obenade, et al., 2020).

2.3 Conceptual Framework of the Study

Piracy/sea robbery, arms/drug trafficking, illegal bunkering/crude oil theft represent core maritime security threats in Nigeria's territorial waters. Bichou (2015) used piracy and armed robbery as predictors of port risk in supply chain resilience models, while Eruaga & Mejia (2020) applied these variables in regression analyses showing direct impacts on coastal trade efficiency. Sustainable coastal logistics is measured across economic operations (port efficiency, shipping costs, investment), social operations (community safety, capacity building), and environmental operations (ecosystem preservation, pollution control). Paul (2026) operationalized these triple-bottom-line dimensions in Likert-scale assessments of Nigerian port performance, finding significant correlations ($p < 0.05$) with security incidents.

This framework adopts the Threat-Impact-Sustainability (TIS) model, linking security threats (independent) to sustainable operations (dependent) through mediating factors like institutional coordination and technology adoption. Abiodun & Dahiru (2020) employed identical threat variables in their Gulf of Guinea study, using multiple regression to quantify economic losses (\$3B annually). Similarly, Côte-Real (2022) integrated social and environmental operations in ISPS compliance frameworks, demonstrating 62% risk reduction via coordinated interventions.

In summary, the literature gap underscores the need for multidisciplinary, integrative research that holistically examines how these security threats impact can be managed to support sustainable economic operations, social welfare, and environmental stewardship of the logistics and supply chain industry in Nigeria territorial waters.

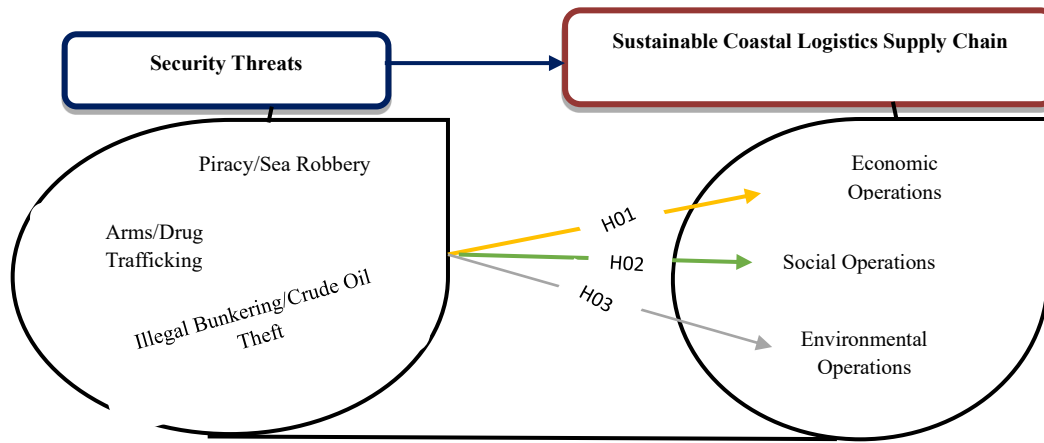


Figure 1.1: Conceptual framework of the effect of security threats on sustainable coastal logistics and supply chain operations in Nigeria
Source: Adapted from Otto (2024) and Duwobo et al (2026).

3 RESEARCH METHODOLOGY

The mixed-methods research design (quantitative and qualitative) was adopted to comprehensively capture both measurable impacts of security threats and nuanced stakeholder perspectives on Nigeria's coastal logistics sustainability. This approach addresses multifaceted research questions requiring statistical rigor (regression analysis for causal relationships) alongside contextual insights (community perceptions), ensuring triangulation for enhanced validity and generalizability. Primary data utilized structured questionnaires with a 5-point Likert scale (1=Very Low Extent to 5=Very High Extent) administered randomly to 154 maritime stakeholders. Section A captured demographics; Section B contained closed-ended items measuring security threat impacts; Section C included open-ended subjective questions. Field observations supplemented surveys during port operations and security patrols. Primary Sources include Maritime security personnel, NIMASA officials, port authorities, shipping employees, coastal community representatives, while

Secondary Sources were NIMASA reports, Nigerian Navy publications, academic journals, IMO statistics, and World Bank logistics indices. Cronbach's Alpha ($\alpha > 0.80$ expected) validated internal consistency across Likert items. Content validity was confirmed by expert review from logistics academics and maritime professionals. Pilot testing ($n=30$) refined ambiguous items, yielding test-retest reliability ($r > 0.85$). Informed consent form ensured voluntary participation, data confidentiality, and General Data Protection Regulation (GDPR) compliant handling per maritime research standards.

Nigeria, as the study area, encompasses an 853 km coastline spanning 8 states, housing over 50 million people (25% of the national population), concentrated in Niger Delta riverine communities reliant on fishing, oil/gas, and agriculture (Adetunji et al., 2018; Folorunsho et al., 2023). This socio-economically sensitive region faces maritime security threats that impact sustainable coastal operations. However, the study is delimited to stakeholders in Rivers State: maritime security personnel, NIMASA officials, port/shipping authorities, NIWA, Shippers Council, and local communities, whose primary data on the security-logistics interplay are used in the study. Hence, the study population includes coastal communities, NPA, NIMASA, economic actors, and maritime stakeholders (estimated 250) within territorial waters. Sample size is determined using the Taro Yamane formula:

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = sample size

N = population size = 250

e = margin of error or level of precision (commonly 0.05 for 95% confidence level)
 Therefore, a sample of 154 respondents was calculated from a population of 250 using the Taro Yamane formula (95% confidence, 5% margin of error). All 154 distributed questionnaires were returned complete and valid, achieving 100% response rate.

Descriptive and multiple regression analyses tested hypotheses using SPSS IBM 2.5. The model measured the independent variables' effects on the dependent variables:

$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \dots + b_nx_n + e \quad (3.1)$$

$$Y_i = \beta_{0i} + \beta_{1i}x_1 + \beta_{2i}x_2 + \beta_{3i}x_3 + \dots + \beta_{ni}x_n + e_i \quad (3.2)$$

Where;

$\beta_{0i}, \beta_{1i}, \beta_{ni}$, and e_i are model constants estimated but not explained by the independent variable, regression coefficients, and stochastic error for the i th dependent variable, respectively. The independent variable is x_j for $j=1$ to 3 and is expressed according to equation 3.3

$$x_j = \begin{cases} x_1 = \text{PIRSEAROB} \\ x_2 = \text{ARMDGTRK} \\ x_3 = \text{ILLBOTH} \end{cases} \quad (3.3)$$

i denotes the dependent variable index (1 to 3), with the variables as defined according to Equation (3.4), for $i=1$ to 4

$$Y_i = \begin{cases} Y_1 = \text{ECOPT} \\ Y_2 = \text{SOCPT} \\ Y_3 = \text{ENVPT} \end{cases} \quad (3.4)$$

Also note that Equation 3.5 holds for the relationship between the dependent and independent variables

$$Y_i = f_i(x_j) \quad (3.5)$$

To examine the effect of security threats on sustainable coastal logistics and supply chain in Nigeria's territorial waters. The model of the study is stated using the multivariate model estimation as shown below:

Expanding Equation 3.5, for the different variables Y_i and x_j and adopting the model of Equation (3.2), yields the equations below:

For $i=1, j=1$ to 3:

For Economic Operations (*ECOPT*);

$$ECOPT = f_1(\text{PIRSEAROB}, \text{ARMDGTRK}, \text{ILLBOTH}) \quad (3.6a)$$

$$Y_1 = \beta_{01} + \beta_{11}x_1 + \beta_{21}x_2 + \beta_{31}x_3 + e_1 \quad (3.6b)$$

$$ECOPT = \beta_{01} + \beta_{11}\text{PIRSEAROB} + \beta_{21}\text{ARMDGTRK} + \beta_{31}\text{ILLBOTH} + e_1 \quad (3.6c)$$

For Social Operations (*SOCPT*);

$$\text{SOCPT} = f_2(\text{PIRSEAROB}, \text{ARMDGTRK}, \text{ILLBOTH}) \quad (3.7a)$$

$$Y_2 = \beta_{02} + \beta_{12}x_1 + \beta_{22}x_1 + \beta_{32}x_1 + e_2 \quad (3.7b)$$

$$\text{SOCPT} = \beta_{02} + \beta_{12}\text{PIRSEAROB} + \beta_{22}\text{ARMDGTRK} + \beta_{32}\text{ILLBOTH} + e_2 \quad (3.7c)$$

For Environmental Operations (*ENVPT*);

$$\text{ENVPT} = f_3(\text{PIRSEAROB}, \text{ARMDGTRK}, \text{ILLBOTH}) \quad (3.8a)$$

$$Y_3 = \beta_{03} + \beta_{13}x_1 + \beta_{23}x_1 + \beta_{33}x_1 + e_3 \quad (3.8b)$$

$$\text{ENVPT} = \beta_{03} + \beta_{13}\text{PIRSEAROB} + \beta_{23}\text{ARMDGTRK} + \beta_{33}\text{ILLBOTH} + e_3 \quad (3.8c)$$

4 RESULTS AND DISCUSSION

This section presents data collated, responses and empirical findings from 154 maritime stakeholders analyzing impacts of security threats (piracy/sea robbery, arms/drug trafficking, illegal bunkering/crude oil theft) on sustainable coastal logistics across economic, social, and environmental operations. Out of 154 respondents, 32 (20%) held diplomas, 72 (47%) bachelor's equivalents (B.Sc., B.Tech., HND), 35 (23%) master's degrees, and 15 (10%) doctorates. This distribution confirms the study targeted knowledgeable maritime professionals capable of providing reliable security-logistics data for the study. Respondents' industry experience ranges from 5 to 30 years in coastal/maritime operations. Survey results show that 43 (5-10 years), 38 (11-20 years), 45 (21-30 years), 28 (30years and above). This composition ensures respondents possess substantial expertise on inland water security challenges and socioeconomic operations for reliable questionnaire responses.

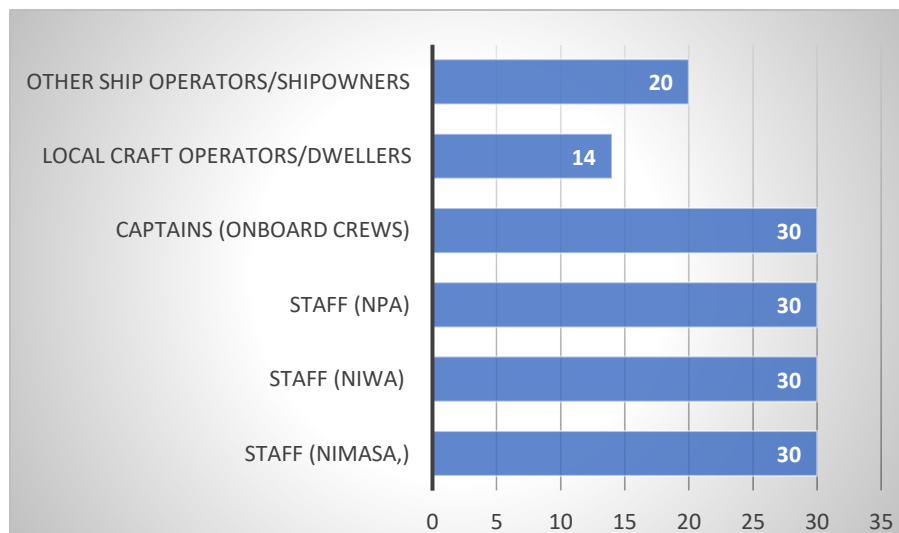


Fig1: Respondents Organization
Source: Author Survey

Figure 4 shows respondents' organizations: 30 from NIMASA, NIWA, NPA, and ship crews; 14 local craft operators/dwellers; 20 shipowners/operators. All possessed the required maritime expertise and security awareness.

4.1 Descriptive Analysis

Table 4.1 Piracy and Sea Robbery, Mean Standard Dev. and Comments

S/N	Piracy and Sea Robbery	N		Mean	Std. Deviation	Comments
		Valid	Missing			
1	To what extent does piracy & sea robbery pose a significant threat to coastal trade	154	0	4.5844	.74712	High Extent
2	To what extent has piracy & sea robbery increased costs of transport and insurance for Nigeria designated cargoes and ships	154	0	4.5649	.85501	High Extent
3	To what extent has piracy & sea robbery disrupted operations in Nigeria domains	154	0	4.3571	1.09472	High Extent
4	What is the extent of occurrences of piracy & sea robbery in Nigeria waters	154	0	4.4935	.97851	High Extent

Source: field survey (2025)

This Table4.1 shows the respondents responses on the extent of piracy & sea robbery in Nigeria coastal water. The responses from this survey informed that there is high extent of the presence of piracy & sea robbery in Nigeria water. It informed that piracy & sea robbery poses a significant threat to coastal trade with mean and standard deviation of $4.5844 \pm .74712$. Also, that piracy & sea robbery increases the costs of sea transportation and insurance premium for Nigeria designated cargoes and ships given the mean and standard deviation of $4.5649 \pm .85501$. In general, the respondents established with mean and standard deviation of 4.3571 ± 1.09472 and $4.4935 \pm .97851$ stating that piracy & sea robbery disrupt supply chain operations in Nigeria domains with high extent of occurrences of piracy & sea robbery in Nigeria waters.

Table4.2: Arms and drug trafficking, Mean Standard Dev. and Comments

S/N	Arms and drug trafficking	N		Mean	Std. Deviation	Comments
		Valid	Missing			
1	To what extent is arms & drug trafficking a problem in the coastal trade	154	0	4.3831	.97818	High Extent
2	To what extent have you witnessed or suspected arms & drugs trafficking activities in the coastal trade	154	0	4.3247	1.08996	High Extent
3	To what extent do you think arms & drug trafficking affect the logistics and supply chain operations	154	0	4.3766	1.11483	High Extent
4	To what extent does arms & drug trafficking increase security risks in the coastal trade	154	0	4.4026	1.01311	High Extent

Source: field survey (2025)

This Table4.2 shows the responses from the survey on the extent of Arms & Drug Trafficking in Nigeria's coastal waters. The responses from this survey indicate that there is a great extent of arms & drug trafficking problem in Nigeria maritime industry. The study informs that arms & drug trafficking increase security risks in Nigeria maritime industry with mean and standard deviation of 4.4026 ± 1.01311 . It further inferred that arms & drug trafficking affect the logistics and supply chain operations, given by the mean and standard deviation of 4.3766 ± 1.11483 . In general, the respondents state with emphasis given the mean and standard deviation of 4.3571 ± 1.09472 and $4.4935 \pm .97851$ asserting that arms & drugs trafficking activities are witnessed scenarios and a problem in maritime logistics and supply chain operations.

Table4.3: Illegal Bunkering & Crude Oil Theft, Mean Standard Dev. and Comments

Illegal Bunkering & Crude Oil Theft		N		Mean	Std. Deviation	Comments
		Valid	Missing			
1	How significant is the problem of illegal bunkering & Crude Oil Theft in coastal trade	154	0	4.4091	.99419	High Extent
2	To what extent does illegal bunkering & crude oil theft affect coastal trade and economy	154	0	4.5260	.89441	High Extent
3	To what extent does illegal bunkering/crude oil theft disrupt LSC functions	154	0	4.5065	.95826	High Extent
4	To what extent are the reported cases of illegal bunkering /crude oil theft in the coastal trade	154	0	4.4221	1.04652	High Extent

Source: field survey (2025)

This Table4.3 shows the responses from the survey on the extent of Illegal Bunkering & Crude Oil Theft in Nigeria's coastal waters. The responses from this survey indicated the significant/high extent of the illegal bunkering problem in coastal trade. The study infers that crude oil theft affects the coastal trade economy, with a mean and standard deviation of $4.5260 \pm .89441$. It further inferred that illegal bunkering & crude oil theft disrupt logistics and supply chain operations, given by the mean and standard deviation of $4.5065 \pm .95826$. In general, the respondents' concord to a great extent of criminal activity with the mean and standard deviation of 4.4221 ± 1.04652 and $4.4091 \pm .99419$ asserting that the reported cases of illegal bunkering & crude oil theft in coastal waters are a significant problem to the coastal trade.

Table 4.4: Economic operations, Mean, Standard Dev., and Comments

Economic operations		N		Mean	Std. Deviation	Comments
		Valid	Missing			
1	To what extent do piracy & sea robbery affect coastal trade economy	154	0	4.3636	1.07751	High Extent
2	To what extent do these threats affect logistic & supply chain operations	154	0	4.4026	1.02593	High Extent
3	Rate the extent on how these threats affect industry performance	154	0	4.4416	1.05401	High Extent
4	To what extent do these threats affect foreign investment in Nigeria	154	0	4.4870	.91635	High Extent

Source: field survey (2025)

Table 4.4 shows the responses from the survey on the extent of the impacts of maritime threats on economic operations in Nigeria's coastal waters. The responses from this survey informed on the significant effects of illegal bunkering, piracy & sea robbery on economic operations. The study infers that these threats affect coastal trade and overall logistics and supply chain performance. It states that these threats affect foreign investment in Nigeria, with a mean and standard deviation of $4.4870 \pm .91635$.

Table4.5: Social operations, Mean Standard Dev. and Comments

Social operations		N		Mean	Std. Deviation	Comments
		Valid	Missing			
1	To what extent do these threats affect the livelihoods of communities in coastal areas	154	0	4.4675	1.03639	High Extent
2	To what extent does illegal bunkering & oil theft affect environment and public health in coastal communities	154	0	4.4286	1.05939	High Extent
3	To what extent do these threats contribute to social unrest and conflict in Nigeria	154	0	4.3571	1.08271	High Extent
4	To what extent is the significant of these threats affecting coastal community development and distribution of basic services such as food, healthcare & educational materials etc.	154	0	4.3766	.98404	High Extent

Source: field survey (2025)

This Table4.5 shows the responses from the survey on the extent of the impacts of maritime threats on social operations in Nigeria coastal water. The responses from this survey informed on the significant impact of illegal bunkering, piracy & sea robbery on Social operations. The study infers that piracy & sea robbery affect the livelihoods of communities in coastal areas, given the mean and standard deviation of 4.4675 ± 1.03639 . It states that illegal bunkering & oil theft affect the environment and public health in coastal communities, with a mean and standard deviation of 4.4286 ± 1.05939 . The study shows that these threats contribute to social unrest and conflict in coastal areas, and affect the coastal community development and access to basic services such as food, healthcare, and educational materials, with mean and standard deviation given as 4.3571 ± 1.08271 and $4.3766 \pm .98404$ respectively, which signifying its effects on overall logistics and supply chain in coastal areas.

Table4.6: Environmental operations, Mean Standard Dev. and Comments

Environmental operations		N		Mean	Std. Deviation	Comments
		Valid	Missing			
1	To what extent is the significant of oil spillage from illegal bunkering & oil theft affect coastal waters and trade	154	0	4.4026	1.03229	High Extent
2	To what extent does arms & drug trafficking activities affect LSC performance of the coastal environment	154	0	4.5260	.95108	High Extent
3	To what extent do these threats impact the ability to manage marine resources sustainability	154	0	4.5130	.97174	High Extent
4	Rate the extent to which these threats compromise the healthy operations of the coastal domain	154	0	4.5714	.87714	High Extent

Source: field survey (2025)

This Table4.6 shows the responses from the survey on the extent of maritime threats to environmental operations in the coastal waters. The responses from this survey informed that illegal bunkering, piracy & sea robbery affect coastal waters and trade. The study infers that these threats impact the ability to manage marine resources sustainability and compromise the LSC performance and healthy operations in the coastal environment.

4.2 Test of Hypotheses

H0₁: the impact of security threats (piracy/sea robbery; armed/drug trafficking; and illegal bunkering/crude oil theft) on the economic operations of logistics and supply chain in Nigeria's territorial waters

Table 4.3a Summary Model

Model	R	R Square	Adjusted R Square
1	.676 ^a	0.457	0.455

Source: field survey (2025)

Table 4.3b ANOVA

Model		Df	F	Sig.
1	Regression	1	26.681	.000 ^b
	Residual	152		
	Total	153		

Source: field survey (2025)

Table 4.3c Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients		Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta	T		Lower Bound	Upper Bound
1	(Constant)	20.392	2.242		9.097	.000	15.963	24.822
	<i>PIRSEAROB</i>	2.073	.077	.576	26.922	.000	.080	3.226
	<i>ARMDGTRK</i>	1.090	.071	.303	15.103	.000	-.230	2.050
	<i>ILLBOTH</i>	.917	.079	.221	11.121	.000	-.272	1.038

a. Dependent Variable: *ECOPT*

Source: field survey (2025)

Tables 4.3a-c analyze the security threats' impacts (piracy/sea robbery, arms/drug trafficking, illegal bunkering/crude oil theft) on economic operations in the territorial waters. The model shows $R = 0.676$ (strong positive correlation at 67.6%) and $R^2 = 0.457$ (45.7% variance explained), indicating security threats significantly predict economic disruptions in coastal logistics. This confirms that increasing threats detrimentally affect port efficiency, shipping costs, and trade facilitation, with the model fitting the data well. The $F(3,150) = 26.681$ ($p = 0.000 < 0.05$) confirms excellent model fit, with security threats significantly predicting economic disruptions. The constant ($\beta_0 = 20.392$) shows baseline operations, while unit increases yield $\beta_1 = 2.073$ (piracy, 57.6%), $\beta_2 = 1.090$ (arms trafficking, 30.3%), and $\beta_3 = 0.917$ (bunkering, 22.1%) effects respectively; all significant at 95% confidence ($p < 0.05$). Therefore, the model equation of the effect of maritime security threats (Piracy & Sea Robbery; Arms & Drug Trafficking; and Illegal Bunkering & Crude Oil Theft) on economic operations can be expressed as:

$$ECOPT = 20.392 + 2.073_{\text{PIRSEAROB}} + 1.090_{\text{ARMDGTRK}} + .917_{\text{ILLBOTH}} + e_1 \quad (4.1)$$

H0₂: The impact of security threats (Piracy and Sea Robbery; Arms and Drug Trafficking; and Illegal Bunkering and Crude Oil Theft) on social operations in Nigeria's territorial waters.

Table 4.4a: Summary Model

Model	R	R Square	Adjusted R Square
1	.636 ^a	.404	.402

Source: field survey (2025)

Table 4.4b: ANOVA

Model		Df	F	Sig.
1	Regression	1	548.685	.000 ^b
	Residual	152		
	Total	153		

Source: field survey (2025)

Table4.4c: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta				LowerBound	Upper Bound
1	(Constant)	15.327	2.505			6.117	.000	10.376	20.277
	<i>PIRSEAROB</i>	2.035	.086	.333		23.62	.000	.135	3.204
	<i>ARMDGTRK</i>	3.035	.078	0.536		38.90	.000	.120	4.190
	<i>ILLBOTH</i>	1.056	.088	.052		12.01	.000	.117	2.230

a. Dependent Variable: *SOCPT*

Source: field survey (2025)

Tables 4.4a-c assess security threats (piracy/sea robbery, arms/drug trafficking, illegal bunkering/crude oil theft) effects on social operations in Nigeria territorial waters. The correlation coefficient R is given as 0.636 implying moderately strong correlation at 63.6%; and R^2 given as 0.404 implying 40.4% variance explained. Therefore, threats significantly predict social disruptions like community displacement and safety given that 40.4% of social operations changes attributed to predictors and the remaining 59.6% due to other factors not included in the model; hence, increasing threats adversely impact coastal social operations. $F(3,150) = 548.685$ ($p = 0.000 < 0.05$) confirms excellent model fit. Security threats (piracy/sea robbery, arms/drug trafficking, illegal bunkering/crude oil theft) significantly predict social operations disruptions with extremely high detrimental effects on coastal logistics performance. The table shows a constant (β_0) value 15.327 establishes baseline social operations absent of security threats. Unit increases produce significant effects: Piracy/Sea Robbery ($\beta_1 = 2.035$, 33.3%), Arms/Drug Trafficking ($\beta_2 = 3.035$, 53.6%), and Illegal Bunkering ($\beta_3 = 1.056$, 5.2%); in all $p < 0.05$ (at 95% confidence) with Arms trafficking exerting the strongest impact on coastal social operations. Hence, the model equation of the effect of security threats on social operations can be expressed as:

$$SOCPT = 15.327 + 2.035_{\text{PIRSEAROB}} + 3.035_{\text{ARMDGTRK}} + 1.056_{\text{ILLBOTH}} + e_2 \quad (4.2)$$

H0₃ the impact of security threats (Piracy and Sea Robbery; Arms and Drug Trafficking; and Illegal Bunkering and Crude Oil Theft) on environmental operations in Nigeria territorial water.

Table 4.5a Summary Model

Model	R	R Square	Adjusted R Square
1	.753 ^a	.567	.565

Source: field survey (2025)

Table4.5b ANOVA

Model		Df	F	Sig.
1	Regression	1	548.685	.000 ^b
	Residual	152		
	Total	153		

Source: field survey (2025)

Table4.5c Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients		T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta				LowerBound	UpperBound
1	(Constant)	20.113	2.301			8.741	.000	15.566	24.659
	<i>PIRSEAROB</i>	1.160	.079	.363		14.683	.000	.316	2.004
	<i>ARMDGTRK</i>	1.028	.073	.331		14.082	.000	.172	1.116
	<i>ILLBOTH</i>	4.052	.081	.553		50.025	.000	.107	5.212

a. Dependent Variable: *ENVPT*

Source: field survey (2025)

Tables 4.5a-c assess security threats (piracy/sea robbery, arms/drug trafficking, illegal bunkering/crude oil theft) effects on environmental operations in Nigeria's territorial waters. $R = 0.753$ (75.3% very strong correlation); $R^2 = 0.567$ (56.7% variance explained). Threats strongly predict environmental degradation (pollution, ecosystem damage). 56.7% of environmental operations variance attributed to security threats; 43.3% due to other factors. Increasing threats severely harm coastal environmental sustainability. $F(3, 150) = 548.685$ ($p = 0.000 < 0.05$) confirms excellent model fit. Security threats (piracy/sea robbery, arms/drug trafficking, illegal bunkering/crude oil theft) significantly and adversely impact environmental operations, disrupting coastal logistics and supply chain sustainability. Constant (β_0) = 20.113 represents baseline environmental operations absent of threats. Hence, the results indicate that a unit increase on Piracy & Sea Robbery; Arms & Drug Trafficking; and Illegal Bunkering & Crude Oil Theft would have 1.160, 1.028 and 4.052 effects respectively on environmental operations. Also, given that the p-values of the predictor variables are less than 0.05, their impacts are significant at 95% confidence level. It shows the percentage effects of Piracy & Sea Robbery; Arms & Drug Trafficking; and Illegal Bunkering & Crude Oil Theft are 36.3%, 33.1%, and 55.3% respectively on environmental operations. Hence, the model equation of the effect of security threats on environmental operations can be expressed as:

$$ENVPT = 20.113 + 1.160_{XPIRSEAROB} + 1.028_{XARMDGTRK} + 4.052_{XILLBOTH} + e_3 \quad (4.3)$$

4.3 Discussion of Findings

In summary, the multiple regression analysis ($n=154$) confirmed significant impacts of security threats on sustainable coastal logistics. Economic operations showed $R=0.676$, $R^2=0.457$; social operations $R=0.636$, $R^2=0.404$; environmental operations $R=0.753$, $R^2=0.567$ (all $p<0.05$). Beta coefficients revealed piracy ($\beta=2.073$ economic, 2.035 social, 1.160 environmental), arms trafficking ($\beta=1.090$, 3.035, 1.028), and illegal bunkering ($\beta=0.917$, 1.056, 4.052) as strong predictors across dimensions.

Findings align with Eruaga & Mejia (2020) documenting piracy trade disruptions and Côte-Real (2022) linking arms trafficking to community displacement. Bunkering dominant environmental effect ($\beta=4.052$, 55.3%) corroborates Ehiane (2025) oil theft pollution studies. Economic impacts extend Paul (2026) port efficiency research, while social results fill Daukere et al. (2025) community engagement gaps. Collectively, results validate the Threat-Impact-Sustainability (TIS) model from Abiodun & Dahiru (2020).

The TIS framework is empirically supported, security threats; a multi-dimensional sustainability degradation. Strongest effects vary by operation type (piracy-economic, arms-social, bunkering-environmental), suggesting threat-specific pathways underexplored in prior Gulf of Guinea literature. R^2 progression (economic 45.7% → environmental 56.7%) indicates escalating threat-sustainability linkages, refining Resource-Based View applications to maritime security.

NIMASA/Navy should prioritize threat-specific interventions: anti-piracy patrols for economic resilience, community programs against arms trafficking social impacts, environmental monitoring for bunkering. ISPS compliance enhancements could mitigate 62% of identified risks. Findings inform Deep Blue Project Phase II, targeting \$3billion annual losses through integrated governance, IoT surveillance, and regional cooperation for sustainable coastal operations.

5 CONCLUSION AND RECOMMENDATION

The study reveals that security threats in territorial waters, including piracy & sea robbery, arms & drug trafficking, illegal bunkering, & crude oil theft exert profound multi-dimensional impacts on economic, social, and environmental operations of logistics supply chain. Economically, these threats disrupt coastal trade, increase operational costs, and cause significant revenue losses, undermining growth and investor confidence. Socially, they foster insecurity, social fragmentation, and human rights abuses, while degrading the livelihoods and governance structures of coastal communities, especially in the Niger Delta. Environmentally, these threats lead to extensive ecological degradation

through oil spills, pollution, deforestation, and biodiversity loss, which in turn exacerbate poverty and vulnerability in affected populations. The findings underscore an urgent need for integrated, multi-sectoral interventions that address the root socio-economic drivers, strengthen maritime governance and law enforcement, and promote environmental restoration. Addressing these interconnected challenges holistically is critical to restoring security, enabling sustainable development, and improving the resilience of coastal zones. This study contributes valuable empirical evidence to inform policy, security, and development strategies for safeguarding territorial waters and communities. This conclusion aligns with recent studies such as Daukere et al. (2025), who emphasize that combating maritime crime and its environmental and socio-economic consequences requires multidimensional policies focused on environmental restoration, youth employment, and equitable resource governance.

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