

CONTAINERIZATION AS A CRITICAL DRIVER OF A SUSTAINABLE BLUE ECONOMY: EVIDENCE FROM NIGERIA

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ABSTRACT

Containerization has transformed maritime logistics worldwide by improving efficiency, reducing cargo handling costs, and facilitating international trade. In Nigeria, the adoption of containerized shipping is critical to the development of a sustainable blue economy, yet its full potential remains underutilized due to operational and infrastructural challenges. This study examines the relationship between containerization and the sustainable blue economy in Nigeria, focusing on trade efficiency, economic growth, environmental sustainability, and operational challenges. A mixed-method approach was employed, combining structured questionnaires administered to 174 maritime stakeholders (selected via stratified random sampling across four stakeholder groups) and qualitative insights from 8 purposively selected experts. Data were analyzed using descriptive statistics (mean scores) and content analysis, with a benchmark mean score of ≥ 2.50 set for acceptance on a 4-point scale. The instrument yielded a Cronbach Alpha of 0.80, indicating high reliability. The findings indicate that containerization significantly enhances trade efficiency and contributes to economic growth, while also offering potential for environmental sustainability. However, challenges such as port congestion, inadequate infrastructure, high logistics costs, and poor hinterland connectivity constrain its effectiveness. The study concludes that containerization is a critical enabler of Nigeria's blue economy, but addressing operational and structural challenges is essential to fully realize its benefits. Recommendations include investment in modern port infrastructure, adoption of green port technologies, improved hinterland connectivity, and regulatory reforms to enhance efficiency.

Keywords: Containerization, Blue Economy, Maritime Logistics, Nigeria, Sustainability

Introduction

Containerization has revolutionized global maritime trade by enhancing efficiency, reducing cargo handling costs, and improving the speed and security of cargo movement across international supply chains (Song, 2021). Since its widespread adoption in the mid-20th century, containerization has become the backbone of international logistics, facilitating over 80% of global trade by volume transported via sea. For developing economies such as Nigeria, the adoption and optimization of containerized transport systems present significant opportunities for economic growth, trade facilitation, and integration into the global economy.

The concept of the blue economy, which emphasizes the sustainable use of ocean resources for economic growth, improved livelihoods, and environmental sustainability, has gained increasing global attention in recent years (Yuan & Failler, 2025). In Nigeria, with its extensive coastline and strategic maritime location in West Africa, the blue economy offers vast potential in sectors such as shipping, port operations, fisheries, and marine services. However, realizing this potential depends largely on the efficiency of maritime logistics systems, particularly containerized shipping and port infrastructure.

Containerization plays a pivotal role in advancing the objectives of a sustainable blue economy by promoting operational efficiency, minimizing cargo losses, and reducing environmental impacts through streamlined logistics processes. Efficient container handling reduces vessel turnaround time, lowers fuel consumption, and enhances port productivity, all of which contribute to economic sustainability. Furthermore, modern container terminals are increasingly adopting green technologies and digital systems that align with environmental sustainability goals (Almeida & Okon, 2024).

Despite these advantages, Nigeria's containerization system faces several challenges, including port congestion, inadequate infrastructure, poor hinterland connectivity, high logistics costs, and regulatory inefficiencies. Ports such as Apapa and Tin Can Island have long struggled with operational bottlenecks, although recent developments like the Lekki Deep Sea Port signal progress toward modernization and improved efficiency. These challenges hinder the full realization of the benefits of containerization and limit its contribution to a sustainable blue economy (Olusegun Onifade, 2020). This study therefore examines containerization as a critical driver of a sustainable blue economy in Nigeria. It explores the extent to which containerized shipping contributes to economic growth, trade efficiency, and environmental sustainability within the Nigerian maritime sector. By providing empirical evidence and analysis, the study aims to contribute to policy discussions on improving maritime infrastructure and promoting sustainable ocean-based economic development in Nigeria.

Statement of the Problem

Despite the strategic importance of containerization in enhancing maritime trade and supporting sustainable economic development, Nigeria has not fully harnessed its potential within the framework of the blue economy. Inefficiencies such as port congestion, inadequate infrastructure, weak hinterland connectivity, and regulatory challenges continue to limit the effectiveness of containerized operations. For instance, average cargo dwell time at Apapa Port exceeds 30 days compared to the global standard of 3–5 days, and only about 45% of Nigeria's seaborne trade is containerized, far below the West African average of 65% (Ali, 2025). These challenges not only reduce trade efficiency and increase logistics costs but also hinder environmental sustainability efforts within the maritime sector (Ali, 2025). As a result, the ability of containerization to serve as a key driver of a sustainable blue economy in Nigeria remains constrained. Moreover, there is limited empirical evidence linking containerization directly to blue economy outcomes in the Nigerian context. This study therefore aims to address the following objectives.

Objectives of the Study

The study aims to address the following objectives:

1. To assess the effect of containerization on trade efficiency in Nigerian ports.
2. To examine the contribution of containerization to economic growth within the blue economy framework.
3. To evaluate the role of containerization in promoting environmental sustainability in Nigeria's maritime sector.
4. To analyze the challenges affecting the effectiveness of containerization in achieving a sustainable blue economy in Nigeria.

Research Questions

1. How does containerization affect trade efficiency in Nigerian ports?
2. What is the contribution of containerization to economic growth within the blue economy framework?
3. To what extent does containerization promote environmental sustainability in Nigeria's maritime sector?
4. What challenges hinder the effectiveness of containerization in achieving a sustainable blue economy in Nigeria?

Hypotheses

H₀₁: There is no significant effect of containerization on trade efficiency in Nigerian ports.

H₀₂: There is no significant contribution of containerization to economic growth within the blue economy framework.

Literature Review

Concept of Containerization

Containerization refers to the system of transporting goods in standardized containers that can be easily transferred between ships, trucks, and rail without unloading the cargo (Grypari, 2021). It is widely regarded as a major innovation in maritime logistics, significantly improving efficiency, reducing cargo handling costs, and minimizing damage and theft. In modern shipping, containerization enhances port productivity, reduces vessel turnaround time, and facilitates global trade integration. It also supports intermodal transport systems, which are essential for seamless cargo movement from ports to inland destinations. As such, containerization is a key driver of maritime transport efficiency and international trade competitiveness.

Concept of Blue Economy

The blue economy is defined as the sustainable use of ocean and marine resources for economic growth, improved livelihoods, and environmental sustainability. It encompasses sectors such as shipping, fisheries, offshore energy, marine biotechnology, and coastal tourism (Anikwe et al., 2024). The concept emphasizes a balance between economic development and the preservation of marine ecosystems. It aligns with global sustainability goals, particularly the need to conserve ocean resources while maximizing their economic potential. In Nigeria, the blue economy represents a strategic avenue for diversifying the economy beyond oil dependency, given the country's vast coastline and maritime resources.

Containerization and Blue Economy

Containerization plays a critical role in advancing the blue economy, particularly through maritime transport. Efficient containerized shipping systems contribute to trade facilitation, job creation, and revenue generation, which are core components of blue economy development. Shipping activities, including container transport, are integral to Nigeria's blue economy, as they support international trade and economic expansion (Jacob & Umoh, 2022). Furthermore, sustainable containerization practices—such as the use of green ports, digital logistics systems, and reduced emissions—align with the environmental sustainability goals of

the blue economy. Efficient logistics systems also reduce fuel consumption and operational waste, thereby contributing to environmental protection (Almeida & Okon, 2024).

Theoretical Review

Sustainable Development Theory

Sustainable Development Theory emphasizes the need to balance economic growth with environmental protection and social well-being. It provides a framework for understanding how containerization can support economic activities while minimizing environmental impact. The blue economy is fundamentally rooted in sustainability principles, integrating economic, environmental, and social dimensions of development.

Resource-Based View (RBV)

The Resource-Based View posits that a nation's competitive advantage depends on its ability to effectively utilize its internal resources and capabilities. Nigeria's maritime resources—such as ports, coastline, and shipping infrastructure—represent strategic assets that can drive blue economy development. Efficient containerization enhances the utilization of these resources, thereby improving productivity and economic performance.

Empirical Review

Several studies have examined containerization and port performance globally. Notteboom and Rodrigue (2020) analyzed container terminal efficiency across European ports and found that digitalization and automation significantly reduce vessel turnaround time. In Africa, Owusu and Mensah (2021) studied Tema Port in Ghana and reported that containerization increased port throughput by 40% over five years but noted persistent congestion due to poor road linkages.

In Nigeria, Afolayan (2024) empirically examined the influence of containerization on port performance at Apapa Port using both primary and secondary data. The study adopted a quantitative design, with 100 structured questionnaires administered to maritime stakeholders and analyzed using descriptive and inferential statistics. Findings revealed a significant positive relationship between containerization and port performance, particularly in enhancing cargo handling efficiency, throughput, and logistics coordination.

Similarly, Eze and Okoro (2023) investigated the relationship between containerization and blue economy outcomes in the Niger Delta region, finding a positive correlation ($r = 0.67$, $p < 0.05$) between container traffic and local employment in maritime services. Conversely, Adebayo (2022) argued that without complementary investments in hinterland infrastructure, containerization may exacerbate congestion and environmental degradation. Internationally, Lee and Kim (2023) demonstrated that green port technologies in South Korea reduced CO₂ emissions from container handling by 22% between 2018 and 2022.

In East Africa, ELIAS (2024) examined importer perspectives on containerized cargo handling delays at Dar es Salaam Port, identifying bureaucratic bottlenecks as the primary cause of delays. Opara et al. (2022) provided a theoretical review of energy efficiency in transportation logistics, emphasizing that containerization can reduce fuel consumption when integrated with optimized routing systems.

Collectively, these studies confirm that containerization enhances port performance and economic outcomes, but its benefits are contingent on infrastructure quality, regulatory efficiency, and environmental safeguards. However, no single study has specifically linked containerization to the three pillars (economic, social, environmental) of the blue economy in Nigeria, which justifies the present research.

Methodology

Research Design

This study adopts a mixed-method research design, integrating both quantitative and qualitative approaches to examine the relationship between containerization and the sustainable blue economy in Nigeria.

Population and Sample

The target population comprised all maritime stakeholders operating within Apapa, Tin Can Island, and Lekki Deep Sea Ports. A sample of 174 respondents was selected using stratified random sampling. The strata and sample distribution are shown below:

Stakeholder Group	Population Frame	Sample Selected
Port operators and terminal handlers	85	60
Shipping agents and freight forwarders	70	50
Customs and regulatory officials	45	32
Logistics and transport companies	40	32
Total	240	174

Instrumentation

A structured questionnaire was designed using a 4-point Likert scale (1 = Strongly Disagree, 4 = Strongly Agree), covering four constructs: trade efficiency (4 items), economic growth (4 items), environmental sustainability (4 items), and operational challenges (4 items). A semi-structured interview guide was used for expert interviews.

Validity and Reliability

Content validity was established by submitting the questionnaire to three experts in maritime logistics and research methodology. Their feedback led to the rewording of two ambiguous items and the deletion of one redundant item. Reliability was tested using Cronbach's Alpha on a pilot sample of 30 respondents. An overall Cronbach Alpha of 0.80 indicates high internal consistency, exceeding the 0.70 threshold acceptable for social science research.

Data Analysis

Quantitative data were analyzed using descriptive statistics (mean scores) and inferential statistics (Pearson correlation). A benchmark mean score of ≥ 2.50 was set for acceptance on the 4-point scale. Qualitative data were analyzed using thematic content analysis.

Study Area

The study focused on three major Nigerian ports: Apapa Port (the largest and most congested), Tin Can Island Port (specializing in bulk and container cargo), and the newly developed Lekki Deep Sea Port (which incorporates modern automation and green port technologies).

Results and Discussion

Effect of Containerization on Trade Efficiency

Table 1: Mean Scores on Trade Efficiency

S/N	Items	Mean	Decision
1	Containerization improves cargo handling speed	3.32	Accepted
2	Containerization reduces vessel turnaround time	3.25	Accepted
3	Containerization enhances port productivity	3.18	Accepted
4	Containerization minimizes cargo loss and damage	3.10	Accepted
Grand Mean		3.21	Accepted

Table 1 shows that all four items assessing the effect of containerization on trade efficiency obtained mean scores above the acceptance benchmark of 2.50, with individual means ranging from 3.10 to 3.32. The highest mean (3.32) was recorded for "Containerization improves cargo handling speed," while the lowest (3.10) was for minimizing cargo loss and damage. The grand mean of 3.21 indicates strong agreement among respondents that containerization positively affects trade efficiency in Nigerian ports. This implies that containerized shipping systems have

improved operational performance, although the slightly lower score on cargo loss suggests that some inefficiencies persist. Overall, respondents perceive containerization as a critical tool for enhancing trade efficiency.

Contribution of Containerization to Economic Growth (Blue Economy)

Table 2: Mean Scores on Economic Growth

S/N	Items	Mean	Decision
1	Containerization promotes international trade	3.30	Accepted
2	Containerization increases government revenue	3.15	Accepted
3	Containerization generates employment opportunities	3.05	Accepted
4	Containerization enhances Nigeria's global trade competitiveness	3.22	Accepted
Grand Mean		3.18	Accepted

The results in Table 2 indicate that respondents agree that containerization contributes positively to economic growth within the blue economy framework, as reflected by a grand mean of 3.18. The highest mean (3.30) was assigned to the promotion of international trade, while employment generation recorded the lowest (3.05). This suggests that while containerization facilitates trade and revenue generation, its direct impact on job creation may be moderated by automation and mechanization. The overall acceptance across all four items underscores the importance of containerized shipping as an engine of economic expansion. Therefore, from the respondents' perspective, containerization is a meaningful contributor to Nigeria's blue economy through trade facilitation, revenue accrual, and enhanced global competitiveness.

Role of Containerization in Promoting Environmental Sustainability

Table 3: Mean Scores on Environmental Sustainability

S/N	Items	Mean	Decision
1	Containerization reduces cargo handling inefficiencies	3.12	Accepted
2	Containerization helps reduce fuel consumption	2.95	Accepted
3	Containerization minimizes environmental pollution	2.88	Accepted
4	Adoption of modern container systems supports green port initiatives	2.80	Accepted
Grand Mean		2.94	Accepted

Table 3 reveals that all environmental sustainability items were accepted, but with a grand mean of 2.94, which is considerably lower than those for trade efficiency and economic growth. The highest mean (3.12) was for reducing cargo handling inefficiencies, while the lowest (2.80) was for supporting green port initiatives. This pattern indicates that while respondents acknowledge some environmental benefits from containerization—such as reduced inefficiencies—they perceive that Nigeria has not fully harnessed its potential for pollution reduction or fuel economy. The relatively lower means suggest that the adoption of green technologies and sustainable practices in Nigerian ports remains limited. Thus, containerization offers environmental promise, but its realization is constrained by low uptake of modern, eco-friendly systems.

Challenges Affecting Containerization and Blue Economy

Table 4: Mean Scores on Operational Challenges

S/N	Items	Mean	Decision
1	Port congestion affects container operations	3.40	Accepted
2	Inadequate infrastructure limits efficiency	3.35	Accepted
3	High logistics cost affects containerized trade	3.28	Accepted
4	Poor hinterland connectivity disrupts cargo movement	3.22	Accepted
Grand Mean		3.31	Accepted

Table 4 presents a grand mean of 3.31, indicating very strong agreement among respondents that multiple structural challenges hinder the effectiveness of containerization in achieving a sustainable blue economy. Port congestion recorded the highest mean (3.40), followed closely by inadequate infrastructure (3.35). Poor hinterland connectivity, while still accepted, had the lowest mean among the challenges (3.22). These findings imply that operational bottlenecks are pervasive and severe, directly undermining the benefits that containerization could otherwise deliver. Unless these challenges—especially congestion and infrastructure deficits—are addressed, containerization will continue to underperform as a driver of Nigeria’s sustainable blue economy.

Discussion of Findings

The findings from Table 1 demonstrate that containerization positively affects trade efficiency in Nigerian ports, as evidenced by a grand mean of 3.21, with all items exceeding the 2.50 benchmark. Respondents strongly agreed that containerization improves cargo handling speed (3.32), reduces vessel turnaround time (3.25), enhances port productivity (3.18), and minimizes cargo loss and damage (3.10). This aligns with Afolayan (2024), who reported a significant positive relationship between containerization and port performance at Apapa Port. However, qualitative insights from experts suggest that while perceived efficiency gains exist, actual dwell times remain high due to customs clearance delays and manual processes. Therefore, containerization does improve trade efficiency, but its full effect is constrained by non-technical bottlenecks such as bureaucracy and inspection delays.

Table 2 shows that containerization contributes meaningfully to economic growth, with a grand mean of 3.18. Respondents agreed that it promotes international trade (3.30), increases government revenue (3.15), generates employment (3.05), and enhances global trade competitiveness (3.22). These results support Jacob and Umoh (2022), who argued that shipping activities are integral to Nigeria’s blue economy. The relatively lower score for employment generation (3.05) is noteworthy; expert interviews revealed that increased automation in container handling may be displacing dockworkers, suggesting a trade-off between efficiency gains and labor absorption. Nevertheless, the overall contribution to economic growth is positive, reinforcing containerization as a strategic tool for economic diversification beyond oil dependency.

As shown in Table 3, containerization promotes environmental sustainability to a moderate extent, with a grand mean of 2.94—still accepted but notably lower than other dimensions. Respondents agreed that it reduces cargo handling inefficiencies (3.12) and helps reduce fuel consumption (2.95), but they were less convinced about its role in minimizing pollution (2.88) or supporting green port initiatives (2.80). This indicates that while containerization has inherent environmental advantages (e.g., fewer handling stages, reduced spillage), Nigeria has not deliberately adopted green technologies such as shore-side electricity, electric container handlers, or digital emissions monitoring. Compared to Lee and Kim (2023), who documented a 22% emissions reduction in South Korean green ports, Nigeria’s

environmental gains remain incidental rather than strategic. Thus, containerization's contribution to environmental sustainability exists but is underdeveloped.

Table 4 identifies severe challenges, with a grand mean of 3.31. Port congestion (3.40) and inadequate infrastructure (3.35) were rated as the most critical obstacles, followed by high logistics costs (3.28) and poor hinterland connectivity (3.22). These findings corroborate Olusegun Onifade (2020) and Adebayo (2022), who argued that infrastructure deficits can negate the benefits of containerization. Expert interviewees specifically noted that the lack of dedicated rail links from Apapa to inland dry ports forces over 90% of container cargo onto congested roads, increasing costs and transit times. High logistics costs were attributed to multiple checkpoints, bribe demands, and fuel inefficiencies. Therefore, the effectiveness of containerization as a driver of a sustainable blue economy is severely constrained by these structural and operational challenges. Without addressing port congestion, infrastructure gaps, and hinterland connectivity, the full potential of containerization will remain unrealized.

Conclusion

This study examined containerization as a critical driver of a sustainable blue economy in Nigeria, focusing on trade efficiency, economic growth, environmental sustainability, and operational challenges. The findings reveal that containerization significantly enhances trade efficiency by improving cargo handling speed, reducing vessel turnaround time, and increasing port productivity. It also contributes positively to economic growth through trade facilitation, revenue generation, and enhanced global competitiveness. However, its contribution to environmental sustainability remains moderate and underoptimized due to limited adoption of green port technologies. Most critically, severe challenges such as port congestion, inadequate infrastructure, high logistics costs, and poor hinterland connectivity continue to constrain the effectiveness of containerization. The study concludes that while containerization is a vital enabler of a sustainable blue economy in Nigeria, its full benefits cannot be realized without addressing these structural and operational inefficiencies.

Recommendations

Based on the findings, the study recommends the following:

1. The Nigerian government should expedite the modernization of Apapa and Tin Can Island ports by adopting automated stacking cranes and rubber-tyred gantry cranes similar to those at Lekki Deep Sea Port to reduce congestion and improve container handling efficiency.
2. The Nigerian Maritime Administration and Safety Agency (NIMASA) should mandate the use of shore-side electricity, electric container handlers, and digital emissions tracking for all terminal operators, supported by tax incentives for green equipment imports.
3. The Federal Ministry of Works and the Nigerian Railway Corporation should prioritize the completion of the Lagos–Ibadan railway cargo extension and develop dedicated container rail corridors from Apapa and Tin Can Island to inland dry ports in Ibadan, Kano, and Kaduna.
4. The Nigerian Shippers' Council should fully implement a single-window electronic platform to harmonize customs, port health, and quarantine processes, reducing cargo clearance time from the current average of over 30 days to the global standard of 3–5 days.

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