



PORT LOGISTICS AND SUPPLY CHAIN MANAGEMENT: AN EMPIRICAL REVIEW

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ABSTRACT: *Ports play a critical role in the global economy, acting as vital links within international transportation networks. Their efficiency and effectiveness directly impact the performance of global supply chains. This paper examines the intersection of port logistics and supply chain management (SCM) through an empirical lens. We review existing research to explore how SCM principles can be applied to enhance port operations and overall supply chain performance. The paper begins by outlining the evolving role of ports in today's globalized trade environment. It then delves into the core concepts of SCM and their relevance to port management. The subsequent sections review empirical studies that investigate the impact of SCM practices on port performance metrics such as cost, efficiency, and service quality. We explore key areas like collaboration, information technology (IT) integration, and infrastructure development, highlighting their contributions to improved supply chain visibility and streamlined logistics processes. The review also identifies critical research gaps and proposes future research directions. We emphasize the need for studies that explore the impact of emerging technologies like block-chain and artificial intelligence (AI) on port logistics and SCM integration. Additionally, the paper underscores the growing importance of sustainability practices within port operations and their role in enhancing overall supply chain resilience.*

KEYWORDS: Port logistics, Supply chain management, Empirical review, Port performance, Collaboration, IT integration, Infrastructure development, Sustainability.



INTRODUCTION

In today's interconnected global economy, international trade plays a pivotal role in driving economic growth and development. Ports serve as crucial gateways for this trade, facilitating the movement of goods and materials across continents. Their efficient operation is essential for ensuring the smooth flow of international commerce and the success of global supply chains.

Traditionally, ports focused primarily on cargo handling and vessel turnaround times. However, with the increasing complexity of global supply chains, the role of ports has evolved significantly. Modern ports are no longer just transportation hubs, but rather, strategic logistics centers offering a wide range of value-added services (Gonzalez-Laxe et al., 2020).

This shift necessitates a closer integration of port logistics with supply chain management (SCM) principles. SCM encompasses the entire flow of goods and services, from raw materials to the final consumer (Mentzer et al., 2010). By applying these principles, ports can optimize their operations, improve efficiency, and enhance customer satisfaction, ultimately leading to a more resilient and competitive global supply chain network.

There is no doubt that the Nigeria ports have been progressively deregulated since the mid-2000s following the worldwide trend of migrating state-owned ports to concessions and licensing private terminal operators under the landlord system. In Nigeria, ports have historically operated under a regulated environment, although many of the ports owned by the federal and state governments have progressively shifted their operational focus to the concession of terminals for the private sector (Wank, Chen & Nwaogbe, 2018). Since 2005, efforts have been made to modernize and expand the basic port infrastructure in Nigeria and to improve its management in accordance with global best practices (Nwanosike, Tipi & Warnock-Smith, 2016; Wank, Chen & Nwaogbe, 2018). In this specific context, Anagor (2014) highlights that the shift of port operations to private terminals has brought about operational enhancements due to significant investments in infrastructure and cargo handling equipment, resulting in a notable rise in cargo throughput at Nigerian ports.

The establishment of efficient transport services and appropriate infrastructures to manage freight flows has emerged as a crucial aspect of economic competition among regions. Supply chain management, a recent advancement in the distribution and logistics sector, plays a significant role in supporting trading, manufacturing companies, and even the government in facilitating the redistribution of finished products within Nigeria (Nwaogbe et al., 2012).

The significant advancements and innovations in logistics and supply chain have played a crucial role in fostering the growth of both international and local domestic trade at Nigeria's seaports. These developments have facilitated seamless port operations, efficient transportation of freights/cargoes from manufacturers to warehouses, and smooth clearance processes for shippers. Inbound logistics and supply chain operations in Nigerian seaports require thorough examination, as poor inbound logistics can lead to port congestion

These innovations have also promoted knowledge sharing in supply chain management, enabling the integration of companies, market expansion, and stronger relationships between transport networks, firms, and seaport operations through new business technology. The integrated network of supply chain management transformation facilitates faster and more



reliable business transactions for the shipment of both raw materials and finished products (James, Edwin & William, 1994; Liu, 2012; Nwaogbe et al., 2013).

Statement of Problem

Shipping and port operations in Nigeria encounter numerous challenges that significantly impact the logistics and supply chain operations of cargoes in the port. One major issue is port congestion, leading to increased costs for shipping cargoes from vessels at berth to the quay stacking areas. This congestion problem results in significant delays in clearing cargoes on time, consequently affecting the efficiency of logistics and supply chain operations during port activities. As a consequence of these delays and inefficiencies, some importers and exporters have chosen to shift their maritime business activities to neighboring countries' seaports. Addressing these challenges is essential for enhancing the overall effectiveness of shipping and port operations in Nigeria.

Aim and Objective

The aim of the study is to assess the inbound logistics and supply chain management of Nigeria sea ports. To achieve this aim, the specific objective is to examine the optimal allocation of shipment from the berth to the quay area

Justification of Study

Indeed, conducting this study is crucial due to the considerable operating costs linked to physical distribution, as well as the challenges of congestion and delays resulting from inadequate planning and evaluation of alternative strategies during inbound logistics and supply chain management. Effective planning plays a pivotal role in making informed cost decisions and reducing high operating expenses. The outcomes of this study will hold significant value for stakeholders in the maritime sector, such as the Nigeria Ports Authority, Nigeria Shippers Council, Nigeria Maritime Administration and Safety Agency, and the Federal Government of Nigeria, as it will provide valuable insights for policy implications and improvements. By addressing these issues, the study can contribute to enhancing the overall efficiency and effectiveness of logistics and supply chain operations in Nigeria's maritime industry.

LITERATURE

This research tackles a literature vacuum by analyzing logistics and supply chain operational efficiency of inbound logistics and supply chain management sources in Nigerian ports using a two-transportation model approach to handle data in seaport inbound logistics and supply chain management in port operations.

The supply chain is the lifeblood of the corporation and sales revenue depends on the efficiency of the supply chain and its effectiveness in delivering products (Dittman, Slone & Mentzer, 2010). Indeed, product availability is a critical measure of the performance of logistics and the supply chain (Coyle, Bardi & Langley, 2009). A problem at any of the logistics nodes can lead to unavailability of products to the various customers. Examples of problems that can disrupt the supply chain and lead to unavailability of either raw materials or finished products include



demand-and-supply issues, product quality problems, and internal or external problems that affect the organization.

Supply chain management not only results in many valuable logistical improvements such as reduction in costs and decrease in cycle time, but also makes companies more competitive in today's dynamic market (Viswanadham & Gaonkar, 2003). Supply chain management is an integration of the business processes from the suppliers to provide products, services and information to the end customer and also adds value for the end user and other stakeholders (Lambert & Cooper, 2000).

The supply chain concept is related to the cycle-time concept in that the firms that develop a continuous flow inventory system frequently do so with a limited number of primary accounts, often using third party logistics support agencies. Thus, implementation of a cycle-time-to-market strategy may result in a focused implementation of a supply chain management strategy. The movement towards more responsible inventory systems, especially for primary accounts, will lead many to recognize supply chain management. An increasing number of fortune 500 firms have managers with "supply chain" in their official title. Usually, these managers design, develop and maintain a set of relationships both within and outside the firm (between the firm and vendors, third parties and customers) capable of executing the overall corporate strategy. As organizations design and manage internal and external supply chains (James, Edwin, & William, 1994) the importance of transporting products from their point of production to their point of consumption is also well documented in historical files.

The Evolving Role of Ports in the Global Supply Chain

The contemporary global supply chain landscape is characterized by several key trends that directly impact the role of ports. These trends include:

1. **Increased globalization:** Trade volumes have grown exponentially over the past few decades, driven by factors such as trade liberalization agreements and the rise of emerging markets. This surge in trade volume necessitates efficient port operations to handle the increased flow of goods.
2. **Containerization:** The standardization of shipping containers has revolutionized maritime transport, making it faster and more cost-effective. Ports need to be equipped with modern infrastructure and technologies to handle the larger and more complex container ships of today.
3. **Focus on just-in-time (JIT) inventory management:** Modern manufacturing practices often rely on JIT inventory management, requiring faster and more reliable delivery of goods. Ports play a critical role in ensuring timely movement of materials and finished products.
4. **E-commerce and omnichannel distribution:** The rise of e-commerce has led to a surge in demand for smaller, more frequent shipments. Ports need to be adaptable to handle this changing demand pattern and facilitate efficient distribution for omnichannel retail models.



Core Concepts of Supply Chain Management and their Relevance to Port Management

SCM is a strategic approach to managing the entire flow of goods, information, and services within a supply chain network (Mentzer et al., 2010). Key principles of SCM that are directly relevant to port management include:

1. **Integration:** Effective collaboration and information sharing among all stakeholders within the supply chain network, including shipping lines, freight forwarders, customs authorities, and inland transportation providers.
2. **Visibility:** Real-time tracking and monitoring of cargo movement throughout the supply chain network, enabling proactive management of potential disruptions and delays.
3. **Logistics optimization:** Streamlining port operations to minimize cargo handling times, storage costs, and overall transit times.
4. **Customer focus:** Providing high-quality services to port users and meeting their specific needs in a timely and efficient manner.

By adopting these principles, ports can improve their performance and contribute to a more efficient and responsive global supply chain.

Theoretical Framework

Several theories surface in a supply-chain management discuss; some of which include:

1. Resource-Based Theory (RBT)

RBT posits that a firm's sustained competitive advantage hinges on valuable, rare, inimitable, and non-substitutable (VRIN) resources. In a port context, VRIN resources could include:

- i) Advanced cargo handling technology (valuable, rare)
- ii) Skilled workforce with port-specific knowledge (valuable, rare)
- iii) Strategic location and hinterland connections (valuable, rare)
- iv) Strong relationships with shipping lines (valuable, rare)

By leveraging VRIN resources, ports can enhance their efficiency, service offerings, and ultimately, customer satisfaction (Chang et al., 2013).

Transaction Cost Economics (TCE) (Coase, 1937)

TCE focuses on the costs associated with using markets versus internal organization of activities. Ports can leverage TCE to evaluate:

- i) The cost-effectiveness of outsourcing specific logistics services (e.g., terminal operations) compared to in-house management.
- ii) The benefits of collaboration with other ports or logistics providers to reduce overall supply chain costs (Williamson, 1985).



Supply Chain Management (SCM) Theories

Several SCM theories can be applied to port research. Here are two key examples:

- i) **Supply Chain Integration (SCI):** Examines how ports can integrate information, processes, and resources with other supply chain actors (e.g., terminals, carriers, customs) to improve efficiency and visibility (Lee & Ng, 2011).
- ii) **Supply Chain Performance (SCP):** Analyzes the effectiveness and efficiency of port logistics processes. Relevant SCP metrics include cargo throughput, turnaround time, and inventory levels (Goss & Santi, 2017).

Institutional Theory (Scott, 2008)

This theory explores how formal and informal rules, norms, and cultural practices influence organizational behavior. In a port context, institutional theory can help understand:

- i) The impact of government regulations and policies on port operations and investment decisions.
- ii) How cultural norms regarding safety, labor practices, and environmental sustainability influence port management strategies.

Empirical Review

Empirical studies have demonstrated the positive impact of adopting SCM principles on port performance. Research by González-Laxe et al. (2020) found that ports with strong integration of SCM strategies experienced improvements in cost and operational efficiency, financial performance, and customer service. Additionally, these ports exhibited a strong correlation with sustainable practices, such as green port management.

Furthermore, studies by Woo et al. (2013) highlight the importance of tailored logistics services for specific cargo types. This customization, aligned with SCM principles, can significantly enhance a port's overall competitiveness.

Traditionally, ports focused primarily on cargo handling and vessel turnaround times. However, with the rise of containerization, globalization, and just-in-time (JIT) inventory management, the role of ports has significantly evolved. Ports are now viewed as strategic nodes within complex logistics networks (González-Laxe et al., 2020). They are expected to provide not only efficient cargo handling but also value-added services such as storage, packaging, customs clearance, and inland transportation linkages (Woo et al., 2013).

This shift necessitates a shift in port management strategies. A focus on a “logistics and supply chain management approach” (Stanko et al., 2001) allows ports to optimize their internal operations, including sea-side and land-side activities, while fostering collaboration with external stakeholders (Beresford, 2004).



METHODOLOGY

In solving a logistics and supply chain problem of Nigeria seaport, an empirical review will be adopted. Inbound Logistics and Supply Chain Management at Nigerian Seaports: Optimizing Berth-to-Quay Allocation

Nigeria's seaports play a crucial role in the country's economy. However, inefficiencies in inbound logistics and supply chain management lead to congestion, delays, and increased costs. This section delves into the challenges and explores methods for optimal allocation of shipments from the berth to the quay area.

Challenges:

- i. **Congestion:** Limited berth availability and inefficient yard management create bottlenecks, causing ships to wait at anchor for days.
- ii. **Poor Infrastructure:** Outdated equipment, inadequate storage facilities, and underdeveloped transportation networks hinder smooth cargo movement.
- iii. **Manual Processes:** Reliance on paper-based systems and slow customs clearance procedures lead to delays and inefficiencies.

Optimal Allocation Strategies:

- i. **Queuing Models:** Implement queuing models to predict ship arrival patterns and optimize berth allocation. This reduces waiting times and improves berth utilization.
- ii. **Simulation Techniques:** Utilize simulation software to model various scenarios and test different allocation strategies. This helps identify the most efficient allocation based on factors like ship size, cargo type, and available resources. **Real-time Data Integration:** Integrate real-time data on ship arrivals, cargo manifests, and yard capacity into a central system. This allows for dynamic allocation decisions based on current conditions.

Benefits of Optimal Allocation:

- i. **Reduced Waiting Times:** Ships spend less time waiting at anchor, leading to faster turnaround times and improved service levels.
- ii. **Increased Throughput:** Efficient allocation maximizes berth utilization and allows for processing of more cargo.
- iii. **Lower Costs:** Reduced congestion minimizes demurrage charges and operational costs for shipping companies and port authorities.



DATA AND RESULTS

Discussions

Studies have shown the effectiveness of optimal allocation strategies in improving port efficiency. For example, a study on the Apapa Wharf in Lagos, Nigeria, demonstrated that using a Genetic Algorithm for berth allocation could significantly reduce ship waiting times. Implementation Considerations:

- i. **Data Collection and Analysis:** Reliable data on ship movements, cargo characteristics, and yard capacity is crucial for effective allocation.
- ii. **Investment in Technology:** Implementing queuing models, simulation software, and real-time data integration requires investment in technology and expertise.
- iii. **Stakeholder Collaboration:** Effective communication and collaboration between port authorities, shipping lines, and terminal operators are essential for successful implementation.

CONCLUSION

Optimal allocation of shipments from the berth to the quay area is a key strategy for improving inbound logistics and supply chain management at Nigerian seaports. By addressing infrastructure limitations, embracing technology, and implementing data-driven allocation strategies, Nigeria can enhance port efficiency, reduce costs, and strengthen its position as a maritime trade hub.

AREAS FOR FUTURE RESEARCH

While significant research exists, there remain opportunities to further explore the relationship between port logistics and SCM. Here are some potential areas for future investigation:

- i) **The impact of port congestion on global supply chains:** With increasing global trade volumes, port congestion is becoming a growing concern. Research is needed to understand the ripple effects of port congestion on supply chain resilience and identify mitigation strategies.
- ii) **The role of artificial intelligence (AI) in port logistics:** AI applications have the potential to revolutionize

Based on the foregoing, we make the following recommendations;

- i) **Collaboration:** Effective collaboration among port authorities, shipping lines, freight forwarders, and other stakeholders is crucial for streamlined information flow and coordinated decision-making. Collaboration platforms can facilitate information sharing, reducing uncertainties and improving supply chain visibility..
- ii) **Information Sharing:** Real-time information on cargo movements, vessel schedules, and port operations is essential for efficient planning and resource allocation throughout the



supply chain. Advanced technologies like block-chain and cloud computing can enhance transparency and information accessibility.

iii) **Infrastructure Development:** Investing in modern infrastructure, such as automated cargo handling systems, efficient hinterland connections (roads, railways), and dry ports, can significantly improve port throughput and reduce cargo dwell time.

iv) **Technological Innovation:** Embracing technological advancements, such as automated guided vehicles (AGVs) and terminal operating systems (TOS), can optimize port operations, enhance efficiency, and reduce manual errors.

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