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ASSESSING THE EFFICIENCY OF PORT OPERATIONS AND INLAND LOGISTICS IN WARRI, NIGERIA

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Abstract

This study examined the operational efficiency of the Port activities and inland logistics at Warri Port Nigeria. Warri Port which is an economically critical maritime facility in the Niger Delta has been consistently characterized by sub optimal operational performance, which manifested in protracted vessel turnaround time, underdeveloped cargo handling infrastructure and poor external (road) connections and bottlenecks (bureaucratic practices) that make the port to lose its competitive edge. This study applied a mixed methods convergent parallel design, where quantitative Key Performance Indicator (KPI) benchmarking and Data Envelopment Analysis (DEA) were combined with thematic qualitative analysis. Data was derived from both field work as well as records in Nigerian Port Authority (2020-2025) through mixed approaches. Quantitative data was from the primary source from the study subjects-190 port workers, custom officials, freight forwarders and truck operators using structure survey forms (5 point Liker scale). Semi structured interview was carried out with 22 key informants,; 5 years Nigeria Port Authority statistics(2020-2025) and researcher's field observations were utilized. Quantitative data was analyzed using both Statistical Package for Social Sciences (SPSS) and Data envelopment Analysis (DEA). Qualitative data was analysis with the use of theme analysis in NVivo. Results obtained showed that the mean vessel turnaround time of Warri Port was 8.4 days (SD 2.1), BER of the port facilities was 68%, the average time the cargo spent on dwell time at port before dispatch was 9.7days which were higher than internationally accepted standards. From likert scale analysis, 72.3% of the respondents indicated that customs inspection time at Warri port was either "slow/inefficient" or "very slow/inefficient". Inland logistics was equally found to be highly deficient. On the aspect of Road condition and connectivity, 84% responded it as "poor" or "very poor". Similarly, mean truck turn around time was 11.2hours while "often" or "always" occur due to illegal checkpoints according to 79% of the survey respondent. DEA analysis provided mean efficiency score for the port facilities and identified that mean technical efficiency of the port facilities was 0.63 with range between 0.41 and 0.82. Thematic analysis of the qualitative data provided five causes of Warri Port sub optimal efficiency: dearth of infrastructure facilities, disjointed operational functions, weakness in stakeholder co-ordination, lack of modern facilities, security concerns. This paper concluded that: Warri Port operates with sub optimal level of efficiency and inland logistics operation with lack of basic logistics inputs of road access and stakeholders coordination. It is recommended that stakeholders involved the Warri Port operate in co-ordinate manner, modernizing equipment at the port, repairing the roads around the port, establishing Port Community System, removal of non-sanctioned checkpoints

Keywords: Port efficiency, inland logistics, Warri Port, Data Envelopment Analysis, Likert scale, stakeholder coordination, Nigeria

INTRODUCTION

Study Background

Warri Port is an important sea-port in the Niger Delta region in Delta state of Nigeria. It has been serving as a pivotal facility to encourage both local and international trade and supports industry, with adequate access to the nation's logistic network. Given its location close to facilities providing crude oil, agricultural products, and emerging industrial estates (Nigerian Ports Authority, 2020), the strategic importance of the port cannot be over emphasized. However, port operations at Warri have failed to realize this potential due to chronic operational inefficiencies.

The level of port efficiency is commonly expressed by its efficiency indicators: vessel turn-around time, berth occupancy rate, cargo dwell time. All these indicators reflect the "smoothness of the flow of cargo through the port" (Notteboom & Rodrigue, 2005). While port efficiency is measured by "all or nothing set of indicators of flows, turnaround times and efficiency", inland logistics is seen as "a series of movements that take freight between a source (producer, manufacturer, import point) and final destination ... Within hinterland" of the port (Arvis et al., 2007).

The inland connection can take form of infrastructure, such as roads, rails and other multimodal connections between the port and inland production/consumption centers. Warri port relies primarily on road-based connections to the inland logistics network with few and unreliable rail facilities. Congestion from many checkpoints on major access roads and lack of cooperation among the various stakeholders lead to an inefficient inland logistics network, longer travel times and raised transaction costs (Arvis et al., 2007). However, there are limited empirical research specifically on Warri port’s performance assessment.

Much of the research, most studies have investigated ports in Nigeria on a national level and masked particular efficiencies and challenges unique to Warri Port.

In light of this research gap, there is a great need to carry out a localized and in-depth assessment by integrating both port operations and inland logistics performance.

Problem Statement

Warri Port’s efficiency levels both at port level operations and through-put is gravely reduced. This leads to inefficient vessel turn-around due to portside delays, port queuing; incomplete cargo handling infrastructure because the cargo-handling equipment are inadequate and mostly old and malfunctioning; poor road access due to deteriorating access roads, massive traffic congestion between Warri and major inland market regions such as Onitsha, Aba and Enugu; bureaucratic red tape from multi government agency interference and fragmented document processing; and weak stakeholder coordination due to lack of integration, communication, and cooperation among port authorities, terminals, customs agents and road- haulers to foster collaborative work-flow in and from the port environment to reduce cargo dwell time, transactions cost and loss among traders. Therefore, there is need to investigate and evaluate the root causes and level of each inefficiency.

Research Objectives

The overall objective of this study was to provide an analysis of the port and inland logistical efficiency of Warri Port. It also aim to analyze the variables in which affect port efficiency from a broad view ranging from port operations to inland logistics and identify any prevailing challenges that need tackling to improving on each performance indicator so as to enhance and make port and inland logistical network efficient, integrated and sustainable.

Specific objectives are:

i. Evaluate the efficiency of operational tasks of cargo handling and vessel turn-around at Warri port;
ii. Assess the effectiveness and reliability of inland logistical systems in connecting Warri port with major economic locations;
iii. Identify critical logistical bottlenecks in infrastructural, managerial and operational perspective;
iv. Examine relationships among different stakeholders in relation to coordination efficiency within Warri port operations and inland movement of goods;
v. Make viable, evidence-based recommendations of various strategies needed to improve the port and logistics system.

Research Questions

i. What is the current operational performance level in tasks related to cargo handling and vessel turn-around at Warri Port?
ii. How efficient are the road based connections between Warri port and inland regions, given poor traffic management and road infrastructure?
iii. What are the various infrastructural, managerial and operational challenges faced by both port and inland logistics systems that militate against efficiency?
iv. What is the general stakeholders perceptions on how best the port related inland cargo movements can effectively be carried out with the level of coordination among all involved agents?
v. What strategies could effectively improve the efficiency in port operations and land logistics networks?

Study Significance

The study produces an in depth, data driven understanding of factors that are constraining efficiency in port and logistics networks around Warri Port. Information generated will benefit those policymakers (Nigerian Ports Authority, Nigerian Shippers' Council, Ministry of Transportation), port terminal operators, truckers (freight forwarders, logistics companies), researchers, students and traders, shipping industry, to devise efficient, responsive, integrated, sustainable, competitive, affordable, and inclusive logistical pathways, reducing time and transaction cost for traders and logistics operators.

LITERATURE REVIEW

Conceptualisation: Port Efficiency and Inland Logistics

Port efficiency is a multi-layered phenomenon, characterized by the dimensions of technical efficiency (optimizing inputs toward outputs), allocative efficiency (optimal selection of inputs at prevailing prices) and dynamic efficiency (adjusting to shifting demands and technologies) (Cullinane & Wang, 2006). Common performance measurements include the vessel turnaround time (the span from its arrival at anchorage until its departure post handling), the berth occupancy rate (the proportion of a berth's occupation time) and cargo dwell time (the period which cargo stays at the port before dispatch onward) (Notteboom & Rodrigue, 2005). Inland logistics entail the collection, shipment and transit activities that involve the movement of merchandise between the port and interior consumption centers/production sites.

Its efficiency is determined by infrastructure (road networks, rail networks, inner channels and waterways), consistency of services, cooperation among logistics players, transaction costs, and the quality of logistics.

In developing countries context, logistics appears to represent more significant constraints than operations on the port side (Arvis et al., 2007).

Analytical Models for Port Efficiency assessment

There are several quantitative methodologies employed in comparing port efficiency throughout the world. The Data Envelopment Analysis (DEA) is a non-parametric linear programming methodology employed in the determination of the relative efficiencies of decision making units (DMUs) based on various inputs and outputs. Cullinane and Wang (2006) conducted research utilizing this approach on European container ports with respect to Technical Efficiency and scale inefficiencies.

From the study results the methodology provided very efficient policy-relevant benchmark comparisons.

Alternative modeling techniques used for port efficiency appraisal consist of the Stochastic Frontier Analysis (SFA), which takes into account error term in calculation and demands the assumption of distribution function, and Key Performance Indicator (KPI) bench-marking which involves comparison of a single performance attribute to industry standards. In this paper the methodology employed is combining KPI benchmarking (with description statistics, along with Likert-scale data of stakeholders' perceptions) and DEA.

Empirical Studies of Port Efficiency and Inland Logistics

Notteboom and Rodrigue (2005) conceptualized port regionalization suggesting that the development of a port is increasingly contingent on its link to the hinterland and integrated use of multiple transport modes. UNCTAD (2022) reiterated that enhancing connectivity between the global logistics network through coordination and integrated logistic management with improved infrastructure development and application of technology is key for ports to achieve global standards but that developing countries region generally lags in both development and efficiency due to fragmentation of authority and low investment plus

inferior rail link infrastructure compared with the existing road network and lack of modern logistics. Within the Nigerian context few studies applied DEA using Lagos ports (Apapa and Tin Can island ports) comparing both efficiency scores and operational benchmark, identifying bottlenecks within port functions like berth delays, congestion and ineffective customs procedure (Onyeizugbe et al., 2019; Nwosu & Ogbonna, 2020). However none have explicitly explored individual port dimensions with particular regards to individual ports and inland logistical aspect of Warri port even though of its strategic importance and position within Niger Delta Region, hereby underscoring the significance of this study in Warri port context.

Theoretical Framework for the Study

The Supply Chain Integration Theory (Frohlich & Westbrook, 2001) underlies this study, positing that coordinated activities across a supply chain network result in improved performance. A hypothetical strong source of inefficiency in Warri Port is lack of coordination amongst key participants of the logistics network, such as port authorities, customs officials, freight forwarders and transport Operators/drivers. Also Transaction Cost Economics suggests that excessive red tape, information asymmetries, and possible dishonest transactions tend to increase transaction costs that eventually lead to service delay and increased logistics charges (Williamson, 1985).

RESEARCH METHODOLOGY

The study adopted a mixed-methods convergent parallel research design (Creswell & Clark, 2017). In a convergent parallel design both quantity and quality data are collected simultaneously, analyzed separately, and then the results are interpreted jointly to reach overarching conclusions about the variables, i.e., triangulation of data was used. Warri Port, in Delta state of Nigeria was chosen for the study because of its location. The target population were stakeholders operating within the port or the surrounding environment, such as employees of port authority and terminal operators, customers officers, freight forwarders, transport operators/truckers, as well as coordinators for logistics/warehouses that work at Warri Port. All stakeholders directly linked to the port operations and internal logistics are stakeholders within the population that were assumed to exist in number of about 300 as based on the number of employee within Nigeria Port Authority, Warri Port, and tenants/licensees of Warri Port annually.

A stratified purposive sampling approach was taken to include representatives from all identified strata groups. Target sample sizes in the strata are 30 for port authority staff, 20 for terminal operators, 30 for custom officials, 40 for freight forwarders, 50 for truck owners/drivers, 20 for warehouse managers/logistics co-ordinator respectively, giving a total of 190 samples. Yamane's formula (1967) was used to estimate the sample size at 95% confidence level and 5% margin of error taking into account for sample loss of respondents during the questionnaire administration. Stratification and purposive sampling method was based on targeting key individuals who operate in Warri port environment with over one year work experience. A formal questionnaire that consisted of four parts was developed, covering Section A (respondents demographics), Section B (question pertaining to port operational efficiency with a likert scale rating from 1=Poor to 5=Excellent) C (question regarding internal logistics efficiency from 1=Poor to 5=Excellent) and D (open ended feedback questions. Initial survey was distributed to 20 persons who met the qualification of respondents in order to ascertain the suitability and relevance. The results were aggregated

and obtained Cronbach Alpha value of 0.86 for the overall measure indicating the instrument consistency.

Semi-structured interviews were held with 22 key stakeholders in the port. These interviews were recorded via electronic devices where permission had been obtained and later transcription into appropriate writing format to facilitate accurate transcript of questions and answers received from stakeholders through data coding for analysis.

Port operation statistics relating to vessel turnout time, berth occupancy rate, freight transit time as well as dwell time were collated from Nigeria Ports Authority, Warri Port operational logs for a five year data period from 2020 to 2025, along with other statistical data provided from private operator in that segment.

Field observations and physical description of infrastructure and various operation processes at the Warri Port was also carried out, with specific examination focused on the port infrastructure, cargo operations, traffic congestion/parking lot and warehouse capacity/storage management processes.

Data Analysis Quantitative Analysis

Data from the questionnaire were analyzed using the IBM SPSS statistics (version 27).

Descriptive statistics (frequency, mean, and standard deviations) were calculated for the Likert scale items.

One way ANOVA was used to assess differences in means among groups of stakeholders.

Data were subjected to DEA using input-oriented, variable returns to scale (VRS) model (Banker, Charnes & Cooper, 1984) with DEA solver Pro; inputs were berth length, number of cranes, labour hours, and outputs were total throughput (tons) and number of vessels call.

Qualitative Analysis

The transcript data from interviews and open-ended questions were analyze using themes (Braun & Clarke, 2006) with NVivo software. The themes formed a basis of SWOT matrix that was synthesised. Integrated Analysis The results from the two data types were displayed in a joint display matrix (Fetters, et al, 2013) to compare them. 4. RESULTS From 190 questionnaires distributed, 172 have been returned duly completed, representing a response rate of 90.5%.

The respondents consists of port authority staffs (n=28, 16.3%), terminal operators (n=18, 10.5%), customs officers (n=27, 15.7%), freight forwarders (n=38, 22.1%), truck drivers (n=46, 26.7%), and logistics coordinators (n=15, 8.7%).

Of the respondent majority (68%) have been working at the Warri Port for 4-10 years. Port Operations Efficiency Vessel turnaround time The average vessel turnaround time at Warri Port was 8.4 days (SD=2.1). The response shows that about 64% of respondents reported the vessel turnaround time to be either "long" or "very long" (4-8 days).

The secondary data obtained from NPA revealed an average vessel turnaround time of 8.2 days between 2022 and 2025, against international standards of 1-3 days. Berth occupancy and waiting times. The average Berth occupancy rate at Warri Port was 68% (range from 55%- 82%).

The findings indicate that 58% of respondents answered that vessels wait for berthing either "often" or "always".

Berths unavailability was due to ship traffic and certain priority vessels. Cargo handling equipment: 31% of the respondent reported a rate for cargo handling equipment to be "efficient" or "very efficient". 47% of responded reported the cargo handling equipment rate to be "inefficient" or "very inefficient." Frequent breakdowns of handling facilities like cranes and forklifts are common in the port. Customs clearance: A total of 72% of the respondents rated the customs clearance system as "slow/inefficient" or "very slow/inefficient".

52 days was average customs clearance time from the secondary data, attributed to manual process and frequent physical examinations.

Cargo dwell time.

The average cargo dwell time for Warri Port was 9.7 days (SD=3.4), and 68% of participants identified 7 or more days. This clearly is higher than the targeted dwell time of 3 days for NPA

Table 1 summarises key KPIs:

KPI	Mean Value	Benchmark	% Meeting Benchmark
Vessel turnaround (days)	8.4	1–3	8%
Berth occupancy (%)	68	70–80	45%
Cargo dwell time (days)	9.7	≤3	6%
Customs clearance (days)	5.2	≤2	12%

Data Envelopment Analysis (DEA) Results

DEA was employed for a monthly data for the year 2024 (12 DMUs). The average technical efficiency score was 0.63 (varying between 0.41 and 0.82). Only 2 months (17%) achieve technical efficiency scores over 0.80; whereas 5 months (42%) score below 0.60. Scale efficiency analysis showed that inefficiencies were largely because of technical (operational) issues, as oppose to scale efficiency issues.

Inland Logistics Efficiency

Road conditions: 84% respondents perceived the condition of roads from Warri port to Onitsha, Aba and Enugu to be 'poor' or 'very poor', this was supported by field visits that shows numerous potholes, lack of drainage and narrow carriageways.

Checkpoint delays: Truck drivers claimed that frequent delays are always 'often' or 'always' due to the existence of Police, Military, and Local Government checkpoints. The average number of Police checkpoints on the Warri-Onitsha road was 12 and an average of 45 minutes time was lost per checkpoint.

Truck turn-around times at the port: Mean truck turn-around time(arrival to departure) was 11.2 hours (SD=4.3), which significantly exceeds the NPA standard of 4 hours. Some reasons for this are congested gates, inefficiency in processing shipping/documentation papers, and lack of a truck appointment system.

Parking/waiting areas: Only 34% respondents agreed there were adequate parking and waiting areas; our field survey noted that drivers and cargo-owners parks their vehicles along roadsides leading to secondary congestion of traffic.

Coordination of stakeholders: Average points obtained for coordination between port authority, custom, trucker, and freight forwarders was 2.1 points out of a total of 5 points (where 1 represents very poor, while 5 represents excellent). There was no effective formal coordination platform; rather communications was done over phone.

Qualitative findings (Thematic Analysis)

Five dominant themes were identified through interviews with the stakeholders and analysis of open-ended questionnaires.

Theme 1: Lack of infrastructure:

> A freight forwarder said, "The roads are a disaster," and "Every rainy season trucks stuck and we loose days." A port manager also identified limitations in infrastructure: "The rail line does exist, but it is yet to convey goods to the port in over a decade now."

Theme 2: Fragmentation among bureaucracy:

> Customs official said, " we are trying to reduce congestion but our scanners are spoiled and therefore have to physically inspect most cargo."

Theme 3: Poor inter- stakeholder communication:

> Truckers complained "Nobody gives a head-up when the vessel is expected. So you are forced to arrive, wait for two days and then get loaded."

Theme 4: breakdowns in equipment and machinery:

> According to an operator, "We have 2 major cranes which break down every month, the need for new parts will arise, then import and weeks of delay will be recorded for machine procurement".

Theme 5: Security:

> Most of the respondents highlighted loss of goods through theft and pilferage. A freight forwarder reported, "goods disappear during transit and therefore private security personnel's hired for vehicle escort add a substantial cost."

SWOT Analysis

Strengths	Weaknesses
Strategic location near oil/gas and agricultural hubs	Poor road infrastructure and limited rail
Established NPA presence	Outdated and poorly maintained equipment
Experienced workforce	Manual, fragmented clearance processes
Opportunities	Threats
Digitalisation (Port Community System)	Illegal checkpoints and extortion
Public-private partnerships for equipment	Competition from other Nigerian ports
Inland dry port development	Economic downturns affecting trade volume

DISCUSSION

The findings showed that Warri Port is operating below the optimal level. The vessel turnaround time, cargo dwell time and customs clearance were considerably beyond the accepted international standards. These findings corroborate previous studies on Nigerian ports (Onyeizugbe et al., 2019; Nwosu & Ogbonna, 2020) however they are the first disaggregated study on the Warri Port. The Data Envelope Analysis (DEA) mean efficiency score of 0.63 suggests that, Warri Port could have produced the same output with 37% inputs less.

The efficiency levels in the inland logistics is even worse. The poor condition of accessing roads, frequent checkpoints along the routes and long truck turnaround time create a systemic bottlenecks that made any improvements on the port side redundant. This reinforces the observation made by Arvis et al. (2007) where it was noted that in developing countries; inland logistics problem are more overwhelming than those faced in the port. Similarly the poor stakeholder co- ordination rated as ‘very poor’ by majority of respondents in our study ran contrary to the principles of Supply chain integration theory (Frohlich & Westbrook, 2001) where seamless stakeholder coordination facilitates transaction cost reduction thereby improving performance.

In qualitative theme, these findings are further validated. The commonplace breakdowns of equipment, fragmentation within bureaucracy and security concerns are not mere perceived problems but intrinsic systemic issue in the environment. Lack of formal communication forum for stakeholders implies problems (e.g. equipment breakdown or road closure), communicate via less official routes which in turn cause delays.

On the other hand, Warri Port fared poorly compared to other African Ports in countries such as Durban (South Africa) or Tema (Ghana) where digitalisation, multi stakeholders platform and multi modal transport were well embraced and integrated. UNCTAD (2022) has described investments in such infrastructure and processes as prerequisites for any port to become competitive in the global maritime sector.

Conclusion

This paper investigated the port efficiency and inland logistics at Warri Port, Nigeria using a mixed method research approach. The result unequivocally established a severe inefficiency in both port operations and inland logistics operations at the Warri Port, Nigeria. Vessel turnaround time(8.4days), cargo dwell time (9.7days) and customs clearance (5.2 days) remain substantially beyond national and international best practices.

Inefficient inland logistics marked by poor infrastructure conditions, pervasive checkpoints, long truck turnarounds (11.2hours) and poor stakeholder coordination is a major bottleneck in port operations in Warri.

Our DEA analysis demonstrated substantial technical inefficiencies with an average DEA efficiency score of 0.63. Our qualitative insights revealed that infrastructural deficiencies, fragmentation within bureaucracy, equipment malfunctions, and security challenges are root causes of these inefficiencies. If no prompt interventions are put in place, the competitiveness of Warri Port and by extension, Nigeria's maritime trade and economy will continue to decline.

Recommendations

Based on the findings of this study, the following recommendations are hereby made:

1. Infrastructure rehabilitation and modernization:

Urgent Rehabilitation of Access Roads from Warri Port to Major Hinterland corridors (Warri – Onitsha, Warri – Aba, Warri – Enugu); Procurement and Maintenance of modern equipment (Cranes, Forklifts, Reach Stackers) through Public–Private Partnerships; Creation of dedicated parking and truck holding areas to reduce gate congestion.

2. Digitalization and Automation of processes:

Adoption of fully Digitalised Port Community System (PCS) for Single Window clearance to hasten cargo clearance process. Deployment of tracking and logging technologies for transparent goods movement; Installation and Maintenance of working Container Scanners.

3. Stakeholder Coordination:

Establish a Monthly Port Logistics Stakeholder Forum (PLSF) involving NPA, Customs, Terminal Operators, Freight forwarders and Unions; Introduction of a Truck Appointment System for staggered operations.

4. Policy and Regulation Reform:

Lobby for withdrawal of Illegal checkpoints and reduce stops of police/ military on Warri - Onitsha corridor. Review of port levies and tariffs against services provided. Enforcement of port charges with clear penalties for infractions; Enforce NPA's 3 day cargo dwell time mandate and impose penalties for noncompliance.

5. Capacity Building and Security:

Provide relevant training to port personnel and logistics stakeholders on equipment operations and new technologies; strengthen Security collaboration between NPA, Nigeria Police and other private securities.

6. Long term Strategic Investments:

Reintroduce rail connectivity from Warri Port to the hinterland (Warri-Itakpe); Consideration for an inland dry port in the Onitsha-Enugu corridor.

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