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GREEN PORT INFRASTRUCTURE AND ENVIRONMENTAL PERFORMANCE AT SEAPORT, RIVERS STATE, NIGERIA.

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ABSTRACT

This article examines the relationship between green port infrastructure and environmental performance at Port Harcourt Port, Rivers State, Nigeria. The article is derived from the first objective of a broader study on sustainable port operations and environmental performance. A survey research design was adopted. Data were obtained from 267 respondents involved in port operations and environmental management, and all 267 questionnaires administered were retrieved and found valid. Descriptive statistics and Pearson Product Moment Correlation (PPMC) were used at the 5% level of significance. Descriptively, respondents agreed that green infrastructure investments enhanced environmental sustainability (mean = 3.3), that renewable-energy facilities reduced environmental degradation (mean = 3.1), and that eco-friendly port infrastructure improved overall environmental quality (mean = 3.0). However, respondents did not agree that the existing availability of environmentally friendly infrastructure had sufficiently reduced pollution (mean = 2.6) or that modern cargo-handling equipment had adequately improved environmental performance (mean = 2.6). The inferential result showed a positive and statistically significant relationship between green port infrastructure and environmental performance ($r = 0.153$, $p = 0.012$, $N = 267$). The null hypothesis was therefore rejected. The article concludes that green port infrastructure is associated with environmental performance at Port Harcourt Port, while the descriptive results also indicate areas where infrastructure adequacy and modern equipment require further attention. The article recommends sustained investment in environmentally friendly

facilities, cleaner cargo-handling equipment, renewable energy and environmental monitoring technologies.

KEYWORDS: green port infrastructure; environmental performance; sustainable port operations; seaport; Port Harcourt; Nigeria.

1. INTRODUCTION

Ports are critical interfaces between maritime and inland transportation and support the movement, handling, storage and distribution of goods. Their strategic economic role is accompanied by environmental pressures arising from vessel operations, cargo handling, energy consumption, equipment use, waste generation and related logistics activities. Sustainable port operations therefore increasingly require environmental considerations to be incorporated into infrastructure and operational decision-making.

Green port infrastructure refers to environmentally friendly physical facilities, technologies and systems intended to reduce the ecological footprint of port activities while maintaining operational effectiveness. Within the dissertation, green infrastructure includes environmentally friendly port facilities, modern cargo-handling equipment, renewable-energy facilities, environmental monitoring technologies and related sustainable infrastructure measures.

Environmental performance represents measurable outcomes associated with pollution prevention, emission control, waste minimization, resource efficiency, environmental protection and compliance with environmental standards. The first objective of the parent study was to determine the effect of green port infrastructure on environmental performance at Port Harcourt Port.

Port Harcourt Port provides a relevant setting because it is a major maritime facility in Rivers State within the Niger Delta environment. The dissertation describes the port as handling diverse categories of cargo and being exposed to environmental challenges associated with shipping, cargo handling, energy use, waste generation and industrial pollution.

The expansion of maritime and port activities increases the importance of environmentally responsible infrastructure. Where port facilities, cargo-handling systems and energy infrastructure are not sufficiently environmentally friendly, operational activities may contribute to pollution and resource inefficiency. The existence of sustainability policies does not automatically establish that infrastructure investments are producing measurable environmental outcomes.

The dissertation identifies a need for location-specific empirical evidence on the extent to which sustainable port operations translate into environmental performance at Port Harcourt Port. Within the green-infrastructure dimension, the issue is whether environmentally friendly infrastructure, modern equipment and renewable-energy facilities are associated with better environmental outcomes.

Objective 1: Determine the effect of green port infrastructure on environmental performance in Port Harcourt Port.

H₀₁: Green port infrastructure has no significant effect on environmental performance in Port Harcourt Port.

Conceptual and Theoretical Considerations

Green port infrastructure is conceptualized as the physical and technological resource base through which port operations can reduce environmental impacts. The dissertation discusses renewable-energy facilities, cleaner cargo-handling equipment, environmentally sustainable terminal designs and environmental monitoring technologies as components of green infrastructure.

The Resource-Based View provides a relevant explanation because environmentally responsible infrastructure can constitute a strategic resource or capability when effectively deployed. The Triple Bottom Line perspective also supports the integration of environmental sustainability with operational and economic objectives. Together, these perspectives provide a basis for examining infrastructure as a mechanism for improved environmental outcomes.

METHODOLOGY

The parent study adopted a survey research design. The accessible population was estimated at 800 respondents distributed between Port Harcourt Port and Onne Port, while the sample used for analysis comprised 267 respondents selected through stratified random sampling. The respondents included port management personnel, terminal operators, shipping agents, freight forwarders/logistics operators, environmental/regulatory officials and cargo-handling personnel.

Primary data were collected with a structured questionnaire. The data were analysed using descriptive statistics and Pearson Product Moment Correlation at the 5% significance level. The first objective was assessed using questionnaire items on environmentally friendly infrastructure, modern cargo-handling equipment, green infrastructure investment, renewable-energy facilities and eco-friendly port infrastructure.

RESULTS

The descriptive results showed differentiated perceptions across the five green-infrastructure items. Green infrastructure investments recorded a mean of 3.3 and were accepted. Adoption of renewable-energy facilities recorded a mean of 3.1 and was accepted. Eco-friendly port infrastructure recorded a mean of 3.0 and was accepted. In contrast, the availability of environmentally friendly port infrastructure as having reduced pollution recorded a mean of 2.6, while the use of modern cargo-handling equipment as contributing to improved environmental performance also recorded 2.6; both were below the criterion mean of 3.0.

The inferential analysis produced a Pearson correlation coefficient of $r = 0.153$, with $p = 0.012$ and $N = 267$. Since $p < 0.05$, the null hypothesis was rejected. The result indicates a positive and statistically significant relationship between green port infrastructure and environmental performance at Port Harcourt Port.

Indicator	Mean / r	p-value	Decision
Green infrastructure investment	3.3	—	Accepted
Renewable-energy facilities	3.1	—	Accepted
Eco-friendly port infrastructure	3.0	—	Accepted
Environmentally friendly infrastructure reduced pollution	2.6	—	Rejected
Modern cargo-handling equipment improved performance	2.6	—	Rejected
Overall PPMC relationship	$r = 0.153$	0.012	Significant; H_{01} rejected

DISCUSSION

The finding indicates that green port infrastructure has a positive and statistically significant relationship with environmental performance at Port Harcourt Port. The result suggests that infrastructure investments oriented toward environmental sustainability can be associated with improved environmental outcomes. At the same time, the descriptive findings show that respondents did not consider existing environmentally friendly infrastructure and modern cargo-handling equipment sufficiently effective in reducing pollution or improving performance, as both items recorded means of 2.6.

This combination of results is important. It suggests that the general direction of green infrastructure is positive, while the adequacy, availability or effectiveness of particular infrastructure components may still require improvement. The dissertation relates the finding to prior studies cited in its discussion, including work on green infrastructure, energy-

efficient lighting, environmentally friendly cargo-handling equipment, pollution-control technologies, shore power, renewable energy and smart terminal infrastructure.

The finding is also consistent with the Resource-Based View interpretation in the dissertation: infrastructure can function as a strategic resource when it is sufficiently developed and effectively deployed. From a Triple Bottom Line perspective, environmentally responsible infrastructure can support environmental objectives while contributing to efficient port operations.

Port management should incorporate green infrastructure into long-term modernization programmes rather than treating environmental facilities as isolated projects. Priority areas identified by the dissertation include environmentally friendly port facilities, cleaner cargo-handling equipment, renewable-energy installations and environmental monitoring systems.

The descriptive evidence also points to the importance of implementation quality. Investment should therefore be accompanied by performance indicators capable of tracking changes in emissions, pollution, energy use and other environmental outcomes. Regular assessment can help determine whether infrastructure investments are producing the intended environmental benefits.

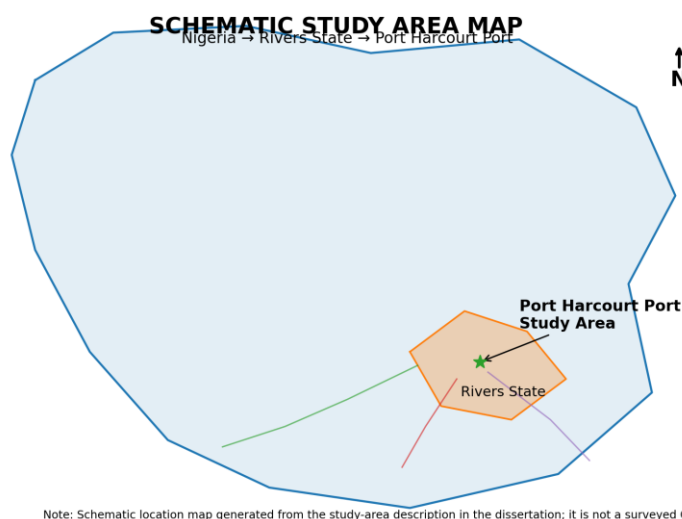


Figure: Schematic study-area map of Port Harcourt Port, Rivers State, generated from the study-area description in the dissertation.

CONCLUSION

The study provides empirical evidence of a positive and statistically significant relationship between green port infrastructure and environmental performance at Port Harcourt Port. The PPMC result of $r = 0.153$ with $p = 0.012$ indicates that the relationship was statistically

significant at the 5% level. The descriptive findings, however, show that respondents identified limitations in the adequacy or effectiveness of some environmentally friendly infrastructure and modern cargo-handling equipment.

The evidence therefore supports continued attention to green infrastructure while emphasizing the need for effective implementation, modern equipment, renewable-energy facilities and systematic environmental monitoring.

RECOMMENDATIONS

Increase investment in environmentally friendly port facilities and green technologies.

Progressively modernize cargo-handling equipment with cleaner and more energy-efficient alternatives.

Expand renewable-energy installations where operationally and economically feasible.

Strengthen environmental monitoring systems so that infrastructure investments can be linked to measurable environmental outcomes.

Integrate green infrastructure requirements into port modernization, procurement and performance-management processes.

Provide training and awareness programmes for port stakeholders on the use and maintenance of green technologies.

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