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Author Affiliation:
Logistics and Transport Technology Department, Federal University of Technology, Akure, Nigeria

✉**Corresponding Author:**
Logistics and Transport Technology Department, Federal University of Technology, Akure, Nigeria;
Email: injoku@futa.edu.ng, Tel.: +2348036645117

Dr. I. Njoku bagged Bachelor of Technology, Master of Science and Doctor of Philosophy degrees in Maritime Transport Management from the Federal University of Technology, Owerri Nigeria (FUTO) in 2000, 2009 and 2015 respectively. He also obtained another Master's degree in Financial Management from FUTO in 2007. He is a Lecturer at the Department of Logistics and Transport Technology, Federal University of Technology, Akure Nigeria. His area of specialization includes maritime transport and shipping finance. He has published widely in both national and international journals. He is a member of CILT, Nigeria.

Mr. S. O. Aggrey pursed Bachelor of Technology degrees in Transport Management Technology from the Federal University of Technology, Akure Nigeria (FUTA) in 2021. He is now working in the industry.

Dr. C. U. Akpudo had Bachelor of Technology and Master of Science in Maritime Transport Management from the Federal University of Technology, Owerri Nigeria (FUTO) in 2009 and 2015 respectively. He obtained Doctor of Philosophy degrees in Transport Management Technology; option Maritime Transport from Federal University of Technology, Akure, Nigeria, in 2021. He is a Lecturer at the Department of Logistics and Transport Technology, Federal University of Technology, Akure Nigeria. His area of specialization is maritime transport. He has published a number of research papers in reputed international and local journals. He is a member of NIM, Nigeria.

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DISCOVERY
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Appraisal of channel management and port performance: A case study of Apapa port complex, Lagos state, Nigeria

Njoku I✉, Aggrey SO, Akpudo CU

ABSTRACT

This paper evaluates the channel management in relation to port performance with a focus on Apapa Port Complex Lagos, Nigeria. The objective of the research is to examine the effect of the draught of the Apapa port-channel on the vessel gross registered tonnage (GRT) and cargo throughput as well as vessel turnaround time. Secondary data employed for the research were obtained from statistical abstracts of the Nigeria Ports Authority and were analysed using the regression model. The scope of research covered a total of nine (9) years beginning from 2012 to 2020. The study revealed that the channel's depth leading to Apapa port has substantial impact on the cargo throughput and ship' GRT with p values of 0.000183926 and 6.17E-06 respectively. It also showed that the draught of the channel along the Apapa port undermines vessel turnaround time with a p-value of 0.453 due to the maintenance of the channel within the period under examination. The paper suggests that government should provide a conducive environment by constantly dredging the channels and encouraging concessionaires to install functional port handling equipment to help port operations for quick vessel turnaround time.

Keywords: Channel, Throughput, Dredging, Cargo, Turnaround Time, Maintenance

1. INTRODUCTION

In recent times, World globalization and containerization have led to a significant increase in ship traffic in most of the commercial ports around the world. The importance of ports and their accessibility to economic development and nation-building cannot be over-emphasized, as it played a vital role to import and export trade in most countries especially Nigeria [1]. According to [2], a port is referred to as a harbour or an area which provides shelter to vessels (transferring cargo or passengers) and as well allows

periodic or constant transactions of shipment. The port can be a natural formation or artificial creation that provides a place for the loading and discharging of cargo. Ports can serve large seagoing ships and small watercrafts plying inland waterways such as rivers and lakes. Therefore, the draught of the ports channel plays a vital role in allowing various types of ships to enter and berth at the port. With specific regards to maritime boundaries, a channel serves as a passage or route that connects the sea and port starting from the internal water to the outside bar has a great impact on economic growth [3].

Traffic capacity is a key indicator for finding waiting times or delays, which points to the port's performance. Since the approach channels usually constitutes bottlenecks to accessing the ports; hence capacity analysis of the port's approach channels becomes essential when designing a port, or mapping out strategies for traffic management, especially for those ships moving dangerous goods [4].

Reference [5] noticed that some bigger vessels are not able to use the port because of the shallowness of the channel, so this has awakened some governmental agencies such as Nigeria Port Authority (NPA) through the Lagos Channel Management Company (LCM) to see into these issues on how to manage the channel by increasing the depth of navigable areas and markings of navigational aids. The LCM plays an important role in coordinating, controlling, monitoring, and maintaining the channel using dredging, ensuring the safety of the navigable waters, positioning of navigational aids and the maintenance of ship traffic.

The clamour for rescue by foreign ships has prompted this research to get interested in investigating the problems encountered by vessels passing along the Lagos port channel that may result in low port efficiency and reducing the economic fortunes of the Nation by reason of inconsistent removal of wrecks, inconsistent dredging, non-replacement of damaged navigational aids. The operation of the channel is reduced to a status of an unbalanced busy-idle pattern that has some degree of impact on the normal utilization of the navigable channel.

Then again, the constraints of channel settings and natural conditions will also prolong the unproductive ships' waiting time (at anchorage or berth), creating a 'bottleneck' phenomenon, which at serious status, will affect the throughput of the wharves and cause a colossus waste of the transportation capacity of the ships. The effectiveness of the port depends on the channel's depth being capable of accommodating bigger vessels and consequently increase the cargo throughput. Without the ability to dredge, probably, all the major ports in the world would not have developed to their present level and big draft vessels will not be able to enter the port and trade could not have grown to its present level. The Lagos channel is the principal navigable route of Nigeria being situated on the Gulf of Guinea.

In light of the above, the appraisal of the port-channel management and port performance becomes necessary to provide empirical findings on whether the depth of channel impact positively on cargo throughput, vessels' GRT and turnaround time of the vessel. These are the objectives of the study.

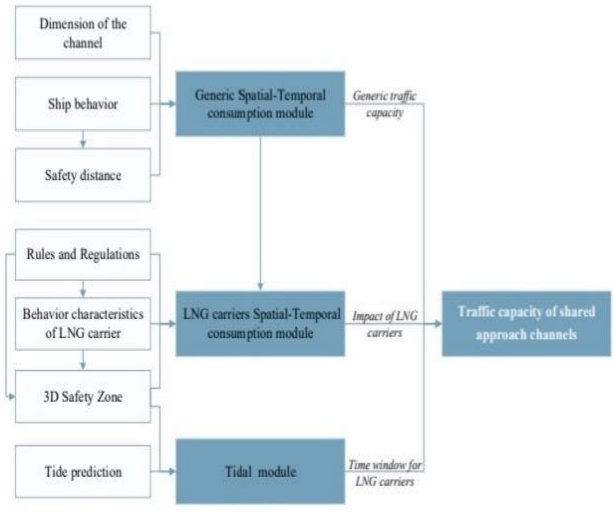

Figure 1: The capacity analysis framework for shared approach channels

Source: adopted from Xiang, *et. al* (2020)

2. RELATED WORK

This paper defines the approach channel's capacity as the number of ships passing through the channel segment per unit time. Therefore, some literature on capacity analysis were reviewed, since capacity is a significant indicator of traffic management in the port system. The framework of capacity analysis as in Figure 1 was adopted [6]. Reference [7] presented the conflict technique to estimate the traffic volume of the interaction on the waterways, which originated from the analogy of roads and channels.

Reference [8] studied the traffic capacity of the split estuary by making use of the vast Ship Domain Theory and Automatic Identification System (AIS) data. The spatial-temporal consumption analysis was employed to compute the marine traffic capacity of the watercourse network. This theory originated from road traffic. Reference [9] used the inland waterways network as the research object, the spatial-temporal consumption technique was adopted in constructing the traffic capacity model, which considered the occupation of different waterway nodes.

The empirical review on port performance using different indicators have been conducted by many scholars both at the national and international levels. Some of them include Reference [10] and [11]. The later analyzed the impact of port operational performance on the Nigerian economy, with emphasis on Apapa port. It was discovered that the GRT of the vessels is significantly contributing to the Nigerian Gross Domestic Product (GDP) at 0.05 significant level and that cargo throughput and vessel traffic have a positive impact on the economy and nonetheless have no significant influence on the Nigerian GDP at 0.05 significant level. Reference [12] and [13] analyzed the influence of infrastructure on trade and economic growth in designated economies in Asia using the gravity model. Among the variables used in their analysis was the port infrastructural quality. Their findings suggest that the country's export capacity depends on the quality of port infrastructure as a proxy for transport infrastructure. Their findings were buttressed with the findings of [14] which discovered that bilateral trade flows in South East Asia were affected by transport infrastructure, mainly ports and ICT.

3. METHODOLOGY

The study area is Nigeria as the economic growth of Nigeria is what the study is concerned with. Nigeria is geographically located on the West Africa coast of the continent of Africa, north of the Bights of Benin and Biafra (Gulf of Guinea) and south of the Sahara Desert that stretches into the Republic of Niger. The seaport under review is the Apapa Port Complex that is located in Lagos State, Nigeria. The study employed the survey and quantitative approach and so can be said to be descriptive as it tends to find out the impact of the quality of the Lagos port-channel management on port performance.

The specific data types required for the realisation of the stated objectives for the study are data on GDP of Nigeria, data on cargo throughput and data on the depth of the port channel. The secondary data used for the study were extracted from the statistical abstract of the NPA. The study covered nine years period starting from 2012-2020. Both inferential and descriptive statistical analyses were utilized in the study based on the objectives that guided the research. The regression statistic was used to test the hypotheses which are stated as follows:

Hypothesis One (H_{01})*:*
There is no significant relationship between the draught of Apapa port channel and the cargo throughput
Hypothesis Two (H_{02})*:*
The relationship between Apapa port channel's depth and the GRT is not statistically significant.
Hypothesis Three (H_{03})*:*
There is no existing significant relationship between the depth of Apapa port-channel and turnaround time of vessels.

4. RESULTS AND DISCUSSION

Depth of Apapa Port Channel and Cargo Throughput

Table 1 shows the cargo throughput, percentage of cargo throughput and depth of port-channel from 2012 to 2020. Cargo throughput is the totality of inward and outward cargo handled in a port within a given period. The result shows that the throughput was appreciating from 2012 to 2015 as the channel's depth increases (See Figure 2). From 2016 to 2018, cargo throughput slight decreased even when the deepness of the channel was still increasing. This might be because of an economic recession within the period which directly affected the importation of cargo into the country. The result implies that as the water depth increases, the cargo throughput in Apapa port increases as well.

Table 1: The Cargo Throughput and Depth of Port Channel

Year	Cargo Throughput (Metric Tons)	Percentage of Cargo Throughput	Depth of Channel (m)
2012	19,957,705	6.3	7.0
2013	20,344,118	6.9	8.0
2014	20,622,804	7.8	9.4
2015	20,750,771	9.6	10.5
2016	19,055,385	10.7	11.8
2017	18,909,238	11.1	11.8
2018	19,657,098	12.1	12.5
2019	22,098,435	13.0	13.0
2020	17,986,998	10.2	13.0
	178,882,552		

Source: Nigeria Port Authority, Abstract of Apapa Port Statistics

In figure 2, the greatest depth of the channel is 13m as at 2019 and 2020 as cargo throughput declines in 2020. This might be due to the covid'19 pandemic that ravaged the country. The analysis shows that the ports witnessed an increase in cargo throughput mainly as a consequence of the constant maintenance and capital dredging of the approach channels to the nation's ports by the LCM.

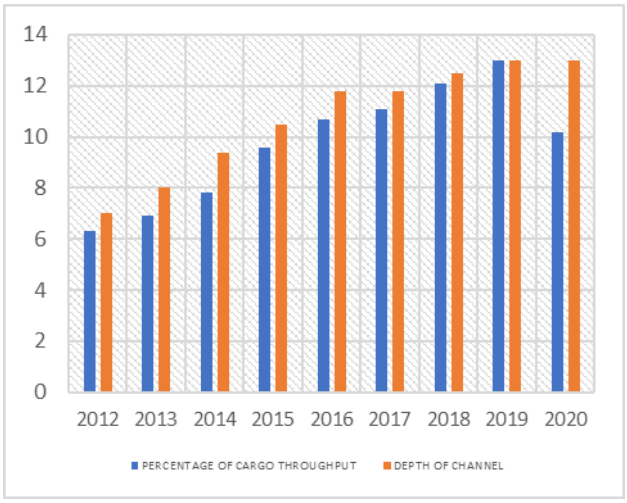

Figure 2: Percentage Cargo Throughput and Depth of Apapa Port Channel.

Source: Authors field work, 2021

The coefficient value of the regression result presented in Table 2 reveals that the significant impact the variable has on the cargo throughput. According to the result, it was ascertained that the improvement in the depth of the port-channel positively increases the cargo throughput of the port. The coefficient value thus is 0.879; which means that the port-channel's depth has an 87% influence on cargo throughput. The result thus reveals a p-value of 0.000183926, which is below 0≤.05. It is however pertinent to reject the earlier stated null hypothesis and go for the alternative hypothesis which states that there is a significant relationship between the depth of the water in the Apapa port channel and the cargo throughput in Apapa port. As the water's depth increases, so the cargo throughput also increases. The increasing rate of cargo throughput every year shows that Apapa port is reliable and efficient.

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Table 2: Regression of Depth of Port Channel on Cargo Throughput.

Regression Statistics					
Model	Multiple R	R Square	Adjusted R Square	Standard Error	P- value
Value	0.93799137	0.87982781	0.86266036	0.85780842	0.000183926

Source: Authors SPSS result output, 2021

The Depth of Apapa Port Channel and the Vessel GRT

Table 3 shows the relationship between vessel gross tonnage that passes through the Lagos channel to Apapa port between 2012 and 2020. The result shows that the GRT of the vessels coming into the port increases from 2012 to 2020 as the depth of the channel increases (See Figure 3). The deeper the channel's draught, the bigger the size of the vessel that pass through it. The analysis shows that Apapa port recorded an increase in the GRT primarily due to the constant dredging of the channel by LCM limited which indicates that there is a significant relationship between the deepness of the channel and the GRT.

Table 3: Vessel Gross Tonnage and the Channel Depth

Year	GRT	Percentage of Vessel GRT	Depth of Channel
2012	13,003,225	5.2	7.0
2013	13,459,458	5.4	8.0
2014	16,469,320	6.6	9.4
2015	23,139,112	9.2	10.5
2016	25,784,118	10.3	11.8
2017	28,111,564	11.2	11.8
2018	29,258,335	11.7	12.5
2019	32,869,251	13.1	13.0
2020	33,510,981	13.4	13.0
	215,605,364	100	

Source: Nigeria Port Authority, Abstract of Apapa Port Statistics

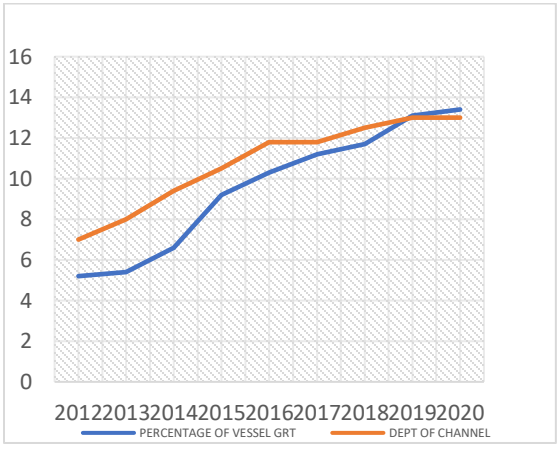

Figure 3: The Percentage of vessel GRT that passes through Apapa port-channel

Source: Authors field work, 2021

Table 4 shows the coefficient value of the regression result, which reveals the significant impact the depth of port-channel has on the GRT of the vessel coming into the port. The coefficient value thus is 0.97; the depth of the port-channel will have a 97% influence on GRT. The result thus reveals a p-value of 6.17E-06, which is below 0≤.05. It is however pertinent to reject the earlier stated null hypothesis and go for the alternative hypothesis which states that there is a significant relationship between the water's depth in Apapa port channel and the GRT.

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Table 4: Regression of Depth of Apapa Port-Channel against GRT

Regression Statistics					
model	Multiple R	R Square	Adjusted R Square	Standard Error	P-value
Value	0.986443	0.973069	0.96858	0.513949	6.17E-06

Source: Authors SPSS result output, 2021

The Apapa Port Channel's Depth and Turnaround Time

The vessel turnaround time is the total time a vessel spends in the entry of the port and coming outside the port. Table 5 shows the relationship between turnaround time of the vessels that pass through the Apapa port channel and the depth of water. The result indicates that as the depth increases, the turnaround time of the vessel decline from 13.69 days in 2012 to 6 days in 2014. It later increased to 8.6 days in 2015 despite the fact the increase in depth of the port channel. As at 2018 and 2020, the vessel turnaround time decrease due to good channel maintenance and the port efficiency i.e., there is a positive relationship between the depth and the ship turnaround time. But, unlike 2015 to 2016, the vessel turnaround time increases and this shows that the port was not well managed within this period. The depth of port-channel is dredged down to 13-13.5 meters as at 2018-2020. So, starting from 2018, vessel turnaround time began to decrease. The above result is as plotted in Figure 4.

Table 5: Turnaround Time and the Depth of Apapa Port-Channel

Year	Turnaround Time (In Days)	Depth of Channel (m)
2012	13.69	7.0
2013	9.64	8.0
2014	6.00	9.4
2015	8.60	10.5
2016	9.37	11.8
2017	8.94	11.8
2018	6.70	12.5
2019	7.59	13.0
2020	6.70	13.0

Source: Nigeria Port Authority, Abstract of Apapa Port Statistics

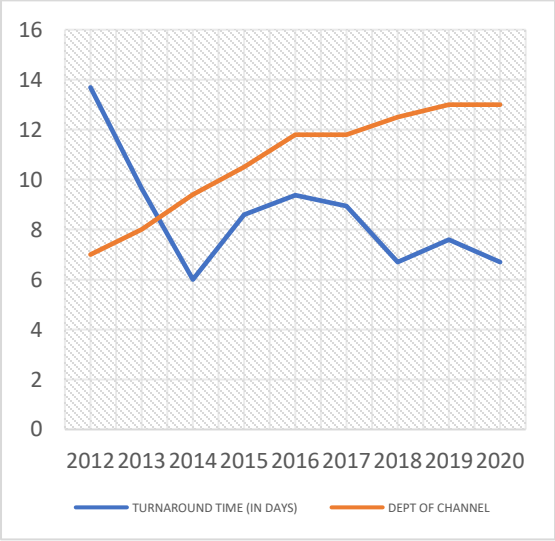

Figure 4: Vessel turnaround Time and Depth of Lagos Channel

Source: Authors field work, 2021

Table 6 shows the coefficient value of the regression result, which reveals the significant impact the depth of port-channel has on the vessel's turnaround time at Apapa port. The result thus reveals a p-value of 0.453376, which is higher than the significant value of 0.05. It is however appropriate to accept the earlier stated null hypothesis which states that no significant relationship exists between the channel's depth and the vessel turnaround time.

Table 6: Regression of Depth of Port-Channel against Turnaround Time

Regression Statistics					
Model	Multiple R	R Square	Adjusted R Square	Standard Error	P- value
Value	0.311006	0.096724	0.096724	1.416701	0.453376

Source: Authors SPSS result output, 2021

5. CONCLUSION

This research was able to investigate the relationship existing between channel management and port efficiency in Apapa port. It was clearly shown that the water's depth along the Lagos Channel has had significant effects on the throughput and vessel GRT; negatively affects the vessel's turnaround time of Apapa port owing to poor maintenance of the channel. But as from 2018, vessel turnaround time began to decrease. It was shown that dredged channels also have a positive effect on the draft of vessels navigating through the channel. In conclusion, the port channel's depth is well managed and it can occupy a vessel of 34,640.330 gross tonnages. Also, the channel's draught has an effect on the vessel turnaround time but the way the port is run makes the turnaround time to be high.

The following suggestions were made to improve the port situation. The government should review relevant Merchant Shipping Acts and harmonize them with the Nigeria Maritime and Safety Agency (NIMASA) performing a regulating function and coordinating the implementation of all shipping policy issues. The federal government should also provide a conducive environment for shipping industries in Nigeria and provide adequate facilities like navigational aids to enhance safety and efficiency in the channel. Finally, the government should encourage the terminal concessionaires with necessary incentives to be able to acquire functional port handling equipment to help port operations for quick vessel turnaround time and to improve their level of operations as to make our seaports globally competitive.

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Conflict of Interest

The author declares that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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