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Port Operations Mechanism and Container Ship Trade Effectiveness in Tincan Island Port

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Abstract- ***The study analyzed the impact of Port Operations Mechanism on container Vessel trade effectiveness in TinCan Island Sea Port. The study put forward three hypotheses based on the research questions and objectives. The study explored a time series data of TinCan Island Port from 2007 to 2023 covering the periods of Port concession on the key variables;, CONTAINERthrop, and VESSELGRT to determine the impact of Port operations mechanisms on container vessel trade effectiveness of the Tincan Island Port. The study employed logarithm base ten to transform data series and multiple regression analysis to evaluate the impact of the independent variables on the dependent variables as well as to determine the significant. The study found that there are positive correlations between the independent and dependent variables of the study. The study found that the TinCan Island Port has a constant trade of 2.416TEU of container traffic, a constant trade of 5.586tons of container throughput and a constant trade of 12.001tons of Vessel GRT with no improvements on the TinCan Island port. The study infers that among the Predictors variables only ACHR shows significant impact on Container traffic trade and container throughput trade. The study recommended improvement on ACHR which shows significant impact on container trade effectiveness in TinCan Island Port through implementing digitalization by leveraging technology to streamline operations and enhance communication between stakeholders, quick documentations and provision of necessary equipment needed for vessel operations and cargo handling and optimization of berth allocation to minimize waiting times and maximize berth productivity.***

Indexed Terms- ***Terminal operations, Container, Port & Vessel***

I. INTRODUCTION

1.1 Background to the study

In recent years Nigeria Sea Port industry has been transformed in phases through various policy reform strategies to achieve efficiency, productivity and competitiveness in Sea Port terminal operations to best practice in the global maritime commerce (Kareem, 2010). Today, the Port industry has been privatized to various private organizations who provide basic port functions such as ship and cargo handling services and pay loyalty to the Nigerian Ports Authority (NPA) under Landlord Port management model. According to Katsarova, (2013), Landlord Port model is a management approach whereby the Ports Authority owns the basic infrastructure, leasing them out to private operators, mostly on a long-term concession basis (25-30years), while retaining all regulatory functions in the Port. In a landlord model, the basic factors of Port terminal operations such as dock Labour, berths, cranes, warehouse, trucks services etc., are managed by private terminal operators in Nigeria seaports.

Sea Port operations refer to the range of activities involved in the management and handling of vessels, cargo, and passengers at a seaport. These operations are critical to the efficient functioning of seaports, which plays a crucial role in global trade and commerce. Port terminal Operations are array of duties or services legally provided by the local Port industry to seaport users in order to receive reward in terms of monetary gain from the users of those services (Nwoloziri, *et al,* 2024). Port operations are set of activities/services which the port industry provides through the experts (Concessionaires) to satisfy the port users (Nwoloziri, et al 2024). Effective and efficient seaport operations foster cargo throughput, vessel turnaround time, vessel traffic volume, berth occupancy, vessel tonnage etc., which are the basic factors used for operational rating of the port industry (Nwoloziri, et al 2024). Port container terminal operations include:

Port Operations: these are the services provided by the Port industry to a calling vessel. It involves various activities such as pilotage service, tug service, berthing and mooring services and onboard cargo handling

services. These are important services which the port industry either by the private operators or the Port Authority provides to the calling vessel as well as the vessels leaving the ports. A ship's fuel consumption curve is similar in shape to its horsepower and total resistance curves. A consistent voyage requires careful attention during transit and fuel consumption rates to ensure that the ship arrives at its destination with an adequate supply of fuel onboard at the required service speed of the vessel (Mac-Pepple *et al.,* 2021).

Cargo Operations: these are services rendered on import or export cargoes. Cargo operations are the array of legal services the port industry provides for safe and efficient delivery of cargo at the seaport. It involves custom examination, warehousing, crane services, stevedores, etc., provided by the port industry to the cargo owner or his agent at the port.

Passenger operations involve the handling of passengers, including embarkation and disembarkation, immigration and customs clearance, and passenger safety and security at the local ports. Chuku *et al,.*(2024), informed that When running at low speed inside or below 12 knots, it is evident that the EDDI for all of the vessels was improved due to their short length, breadth, draft, and prismatic coefficient. This is due to the observation that lowering these settings causes the EEDI achieved value to fall. This can be problematic for the ship's intact stability.

In Nigerian seaports today, Port Operations are shared between the Port Authority and the Concessionaire. The Port Authority has the responsibility of pilotage, berthing operations and other related services to the vessels entering and exiting the seaport terminals. On the other hand, terminal operations are carried out by private companies (concessionaires), who provide and maintain their own superstructure including cargo-handling equipment at the terminals. In other words, this implies that the concessionaires are charged with the responsibility of cargo handling, loading and unloading of containers. The concessionaires provide services to port users.

In Tincan Island Port, Nigeria, the effectiveness of seaport operations significantly impacts container vessel trade, efficient port operations, including cargo handling, vessel turnaround time, and berth occupancy, directly influence the speed and reliability of shipping, ultimately affecting trade flows and economic activity. Conversely, inefficiencies in seaport operations can lead to delays, increased costs, and reduced trade volumes. However, first the ranges of heel to be investigated need to be set, and for this analysis the range of heel angle is set from 0 - 1800 insteps of 10 degrees. Also, the desired vessel trim for each damage condition is set, at free to trim and the direction of trim is to be starboard assuming that all damages occurring on the passenger vessel hull takes place at the starboard (Chuku & Oludi, 2025).

Delay at the port occurs when a calling vessel cannot berth due to backlog of vessels awaiting berthing space or vessels at the berths are awaiting loading or discharging ((Nwoloziri, et al., 2024; Emeghara, et al., 2018)). Port delays are disruption in terminal operations that can give rise to long turnaround time, long awaiting time at anchorage, long stay at berth given rise to high berth occupancy which is not correspondent or correlational to vessel traffic volume at the ports. Delays in handling vessels and containers can lead to congestion, overcrowded container yards, and high demurrage and detention charges.

Nigeria seaport industry has pass through processes of development to ensure operational efficiency in shipping trade. Operations efficiency is the ratio of the input to run an operation and the output gained from the operation (Timothy, et al., 2015). This definition took note of both port users and the port operators. seaport is said to operate effectively when the operational efficiency of both the users and operators are optimally achieved at a given time frame and cost. When operational efficiency and effectiveness is achieved, the output to input ratio improves. Globally, seaports industries are faced with challenges of new technology, globalization and competition (Othman, et al., 2019). To meet customers' desire, seaport industry must ensure a satisfactory service delivery. A seaport could only continue to be relevant to customers if it operates with minimum delay, utmost efficiency and at a reasonable cost to users (Port Technology, 2017). Terminal operations are basically those activities that are involved in container handling and movement of containers through the port industry. Terminal operations are wide range of

activities which involves loading and discharging, transferring, stacking and movement of containers within and through the port industry (*Coşar, et al., 2018)*. This made container port terminal an intermodal terminal. It also includes warehousing, storage and other ancillary operations such as repairs and/or maintenance of containers within the terminal area. Port terminal operations can be categorized into three segments (*France, et al., 2010)*. The first segment of the container terminal operations concerns maritime operations which include tug operations (towage), pilotage, berthing and mooring operations at the port terminals. Second is, ship operations which involve the activities enabling discharging and loading/stowing of the vessel at terminals. Ship turnaround time is expected to be short and the terminal must accommodate the schedule integrity of shipping lines. Hence, ship operations enable and deploy quick attention to vessels on arrival at port terminal. Thirdly, cargo operations on the other hand refer to all activities involving cargo handling at terminal. The transferring of containers from quays to transit shed, stacking of containers, loading and unloading from truck chassis and railcars; also transferring to warehouses and storage areas within port terminal (*France, et al.,2010)*.

1.2 Statement of the Problem

There are so many factors militating against effective running of Nigerian seaports, before the concession in 2006, Nigerian Sea Port system was a public port run by Federal government budgetary allocation, which made the seaports suffer from inadequate infrastructural development which caused delays, high service cost and epileptic operations in the ports (Nwokedi, et al*,* 2021), this was as a result of insufficient budgetary allocation, late release of budget finance for development of port projects. Adebayo (2015) observes that the problem of delay was cumbersome in cargo clearing system in Nigerian ports resulting from Port Operations Mechanism and cargo trade volume in Nigerian Ports industry.

According to Adebayo (2015) the cargo clearing procedure which depends on manual transactions i.e., physical movements of documents to and from various processing centers across locations within and outside the ports premises was tedious and obsolete. Uzoanya (2020) concludes that the presence of so many government agencies in the Port cause a lot of bottleneck in cargo clearance process which results into delays and financial extortion and high cost of doing business at the various Ports. Gwandu (2020) refers that the inability of Nigerian seaports to deliver customer friendly services is as result of delays fostering corrupt practices vice versa, at the ports. According to Gwandu (2020), corruption is the greatest viral disease the sea-ports in Nigeria have to tackle in order to remain relevant in the global maritime industry. In his paper titled "Eradication of Corruption and Sharp Practices in the Seaports," he points that Nigeria aspiration of serving as a hub centre through her ports and playing a leading role in maritime industry in the West and Central African sub-region can only be achieved in an atmosphere devoid of corrupt practices and this situation can only be achieved under an atmosphere of transparency, accountability and commitment to universally accepted ethical standards which will lead to universally accepted operational standard in terms of port costs and operational delay in the Ports. Emeghara (2012), posits that the issues of delays in Nigeria seaports have shifted from berth scarcity-related to cargo-service problems. This informs that delays as witnessed in Nigerian seaports are related to service time of ships at berth rather than waiting to service time.

However, available empirical literature has seemingly failed to provide empirical evidence of the extent and significances of these identified impacts of these, specifically on container vessel trade in TinCan Island port container terminal. Available literature seems to suggest that increasing trend in shipping trade and ship calls to the container terminals are affected by Port Operations Mechanism causing delays, also noting that without similar increase in infrastructural provision in the port terminals is responsible for increasing ineffectiveness in shipping trade in the port terminals (Jana, et al, 2023). However, to this study, the extent to which Port Operations Mechanism affect container shipping trade in TinCan Island port terminal has not be determined in any empirical study. Hence, this has remained a problem because without the empirical information on the extent and significances of the impact in vessels operations in Nigerian container terminals, it is difficult for port operations policy be developed to reverse the adverse

effects of such in vessel operations in Nigerian ports. To overcome this problem, the need for the provision of empirical information to bridge the gap in literature on effect of port operations mechanism on container vessel trade effectiveness in TinCan Island Port Nigeria, be determined for purposes of developing port and container terminal operations policies that limits the impacts of such on the Nigerian port logistics sector.

1.3 Aim and Objectives of the Study

The aim of the study is to determine the impact of Port Operations Mechanism on Container Vessel Trade Effectiveness in TinCan Island Port Nigeria, whereas, the specific objectives include to:

i. Determine the impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container Traffic (TEU) Trade of TinCan Island Port
ii. Determine the impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container throughput Trade of TinCan Island Port
iii. Determine the impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Vessel GRT Trade of TinCan Island Port

1.4 Research Questions

i. Is the impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container Traffic (TEU) Trade of TinCan Island Port statistically significant?
ii. Is the impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container throughput Trade of TinCan Island Port statistically significant?
iii. Is the impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Vessel GRT Trade of TinCan Island Port statistically significant?

1.5 Hypotheses

i. $H0_1$: The impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container Traffic (TEU) Trade of TinCan Island Port is not statistically significant.
ii. $H0_2$: The impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container throughput Trade of TinCan Island Port is not statistically significant.
iii. $H0_3$: The impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Vessel GRT Trade of TinCan Island Port is not statistically significant.

1.6 Scope of the Study

Time scope: The secondary data collected for the study covered a period of 18 years from 2007 to 2024. The time scope of the data is thus between 2007 and 2024 covering the period over which data was collected which focused on the port concession era of the Nigerian ports.

Geographical Scope: The study is targeted at a particular port, TinCan Island Ports to provide empirical information on the effects of Port Operations Mechanism and Container Vessel Trade Effectiveness in TinCan Island Port Nigeria which no research has been done to bridge the gap in literature. Hence, data collected on this study is geographically concerned and collated from TinCan Island port.

Theoretical Scope: The theories considered for the study were Bureaucratic Management Theory, Traffic Congestion Theory, Frischmann Theories on Infrastructure Development and Resources Based Theory. These theories were the basis for the application of the estimation models to determine the effect of port operations mechanism and container vessel trade effectiveness in Tincan island port Nigeria.

1.7 Justification of the Study

This study is focused on determination of the effects Port Operations Mechanism and Container Vessel Trade Effectiveness in TinCan Island Port Nigeria. The study is very relevant and timely in this era of competitive shipping trade among African Nations. The study would be informative and significantly useful to policy makers in Nigeria maritime industry. The research results will be very useful for decision

making by the stakeholder in the industry. The review of literatures would provide good knowledge and instances on delay factors and effects in Nigeria port container terminal operations and trade effectiveness. The literatures reviews would also alongside the recommendations by the researcher would proffer suggestions as ways to mitigate the challenges and resolve port delays. The findings of this study will provide information on effect of Port Operations Mechanism and Container Vessel Trade Effectiveness in TinCan Island Port Nigeria specifically as it relates to Container Traffic Trade, Ship Traffic Trade and Vessel GRT Trade, which provide valuable information and empirical evidence of the state of the port industry. Notwithstanding, the study will serve a useful literature for further studies in the related area for academic scholars. This study will suggest further areas of study to bridge gaps in literatures.

II. MATERIALS AND METHODS

2.1 Research Design

The study employed a quantitative research design approach. The quantitative research design involved the use of secondary data from the Nigerian Ports Authority (NPA), a time series data that covers a period of 18 years. The approach is to use the time series data to determine the effect of Port Operations mechanism on Container Vessel Trade Effectiveness in TinCan Island Port.

2.2 Description of Nigeria seaports / the Study Areas

There are basically six major ports actively engaged in maritime activities in Nigeria and operated by the concessionaires. These are Lagos port complex (Apapa port and Tin-Can Island port); Onne port complex, Port Harcourt port complex. However, the study would focus on Tin Can Island Port (TCIP) as a major container port and fully operated by the concessionaires since 2006 which about 18years.

The port is located in North-West of Lagos Port Complex and has bearing of Latitude 62^0N and Longitude 30^023'E. The port was developed in 1975 when the country experienced increase in economic activities of the oil boom which led to high volume of import and export resulting to serious Port congestion at the time. The resultant effect created a situation where it became necessary for the government to initiate an actual means of decongesting the Port; by constructing a new Port on Tin Can Island. In 1976, the construction of the new Port started and was commissioned on 14th October, 1977. Tin Can Island Port Complex today comprise of RoRo and Tin Can Island Ports. This merger came with the concession of the terminals to five (5) Terminal Operators in May, 2006. The Port handles diversified cargoes with each terminal operator specializing in unique forms of cargo (Dry and Wet bulk cargoes, Box- Containerized cargoes, and RORO services). The Port handles vessels ranging from 100m – 260m.

2.3 Sources of Data

In carrying out this study, the researcher employed secondary sources of data collection. It is a data on time series of TinCan Island port extracted from NPA reports from 2007-2024.

2.4 Method of Data Analysis

For the purpose of this study, the researcher used tables and charts to represent the data collected and results of the study where necessary. For empirical analysis, the researcher employed Multiple Regression Analyses (MRA) for the hypothesis testing to determine the effect of port operational delays on container vessel trade of TinCan Island Port.

2.4.1 Multiple Regression Analysis (MRA)

Multiple regression analysis was used to evaluate the hypotheses and answer the research questions of the study. The data was transformed using the Logarithm base ten (Log_{10}) tool to be able to get all the variables in the same Log units. The Logarithm base ten transformations indicates the order of magnitude of a number, scale large numbers and small numbers, determine growth rates, increasing and decreasing order function of numbers also, for a nonlinear function. It is useful for a nonlinear statistical investigation of the effect of independent variable X (Port operations mechanism) on dependent variables Y (Vessel Container trade effectiveness); and it can be used to predict the relationship, control or optimize the value of the dependent variable Y (Ugwu, 2013). The relationship is formulated in an equation to express the value of Y in terms of the corresponding values of Xs and to enable future values of Y to be predicted in terms of the observed values of Xs to be controlled or

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optimized by manipulating the values of Xs. The independent variables X are called explanatory variables or controlled variables while the dependent variables Y is also called response variable.

The multiple regression can be expressed mathematically as follows:

$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \ldots\ldots\ldots + b_nX_n$

Where

Y is the dependent variables (vessel container trade effectiveness); i.e. Y = ($CONT_{trf;}$ $CONT_{throp;}$ $VESS_{GRT}$)

X is the independent variables (Port operations mechanism); X = (*AVTT+ACHR + ABOR)*

Hence, we model the Log_{10} transformation as follows:

$Log_{10}CONT_{trf} = \beta o + \beta_1 Log_{10} AVTT + \beta_2 Log_{10} ACHR + \beta_3 Log_{10} ABOR$ ……. *eq1*

$Log_{10}CONT_{throp} = \beta o + \beta_1 Log_{10} AVTT + \beta_2 Log_{10} ACHR + \beta_3 Log_{10} ABOR$ ……. *eq2*

$Log_{10}VESS_{GRT} = \beta o + \beta_1 Log_{10} AVTT + \beta_2 Log_{10} ACHR + \beta_3 Log_{10} ABOR$ ……. *eq3*

Where

$CONT_{trf}$= Container Traffic (TEU) Trade

$CONT_{throp}$ = Container Throughput Trade

$VESS_{GRT}$ = Vessel GRT Trade

AVTT = Average Vessel Turnaround Time

ACHR= Average Container Handling Rate

ABOR= Average Berth Occupancy Rate

βo= constant or the intercept of the graph

$\beta_{1;}$ $\beta_{2;}$ β_3 = slope of the graph

2.4.2 Test of Model Significance – ANOVA

To tested hypotheses, it is necessary to subject the data set to evaluation using the analysis of variance (ANOVA) and determine the coefficient through deterministic approach. These two forms the regression model. The analysis of variance approach seeks to split the variations of the dependent variable with its component parts. Variations in the dependent variables that are accounted for by the explanatory variables are called the explained variable. The R^2 is calculated from the regression table which gives the proportion of the total variation in the dependent variables. It explains the extent of variable in the data set or the population.

Decision Rule

For the purpose of this study the researcher chose 95% confidence interval or 5% level of significance (0.05). This implies that for a variable to be significant P-value must be less than 0.05 (P-value < 0.05), hence, a P-value < 0.05, we reject the null hypothesis and accept the alternative; whereas P-value > 0.05, we accept the null hypothesis and reject the alternative. If the null hypothesis is rejected, it means the effect is significant. Also, a value greater than 1 for F-ratio yield efficient model. That is, if f-ratio (calculated) is greater than f-ratio (tabulated) at Alpha ∞ - level of significance (k-1) (n-k). degrees of freedom, then we reject H_0 and accept H_1 and state there is some truth in the estimated model, hence, F-ratio (calculated) = $(R^2)/(K-1)$ $(1- R^2)/(N-K)$

Where:

R^2 = R square of the model

K = No of variables (independent and dependent)

N = No of observations

III. RESULTS AND DISCUSSION

3.1 Data Presentation

The data presented in the Table1 below shows the variables used for the study which include; Average Vessel Turnaround Time (AVTT), Average Container Handling Rate (ACHR), Average Berth Occupancy Rate (ABOR), Container Traffic (TEU) Trade, Container Throughput Trade, Vessel GRT Trade of the TinCan Island Container Terminal (TICT); a time series data covering a period of 17 years from 2007 to 2023 being the period of port concession which the study is aimed to evaluate the impact of Port Operations Mechanism on Container Vessel Trade Effectiveness in Tincan Island Port Nigeria. The data was sourced from the Nigerian Ports Authority annual report of the TinCan Island Port from 2007 to 2023.

The data presented in the Table1

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Year	Average Vessel Turnaround Time	Average Container Handling Rate	Average Berth Occupancy Rate	Container Traffic (TEU) Trade	Container Throughput Trade	Vessel GRT Trade
2007	3.77	985	86.00	256,963	3,660,616	30502604
2008	7.00	1596	61.00	416,479	4,524,101	34556886
2009	6.60	2083	72.00	543,819	4,425,833	39076852
2010	5.07	2198	73.00	573,615	4,853,529	3976893
2011	4.97	2720	69.00	709,880	5,745,702	32702604
2012	5.04	1733	69.91	452215	5,973743	32636886
2013	4.46	1949	65.90	508774	6609603	40096754
2014	3.95	1977	71.27	515898	6629753	47231548
2015	4.13	2916	54.10	761178	6171256	45864565
2016	3.51	1468	46.40	383212	5083760	45229402
2017	3.99	2968	43.92	774878	5746325	40694756
2018	4.12	3118	43.00	813700	6,240,828	4205685
2019	5.12	3238	51.00	845,157	5,904,054	4658031
2020	5.13	2767	50.00	722294	5,512,221	4380642
2021	2.00	2772	75.00	723371	6,699,277	4907524
2022	1.70	2733	43.73	713441	6,243,821	4958326

The Table2 below is the Logarithm Base ten (Log_{10}) transformations of the TinCan Island Container Terminal Key Indicators (TICT KPI).

Table 2: Log_{10} Transformation of TICT KPI 2007-2023

Average Vessel Turn around Time	Average Container Handling Rate	Average Berth Occupancy Rate	Container Traffic (TEU) Trade	Container Throughput Trade (Tons)	Vessel GRT Trade
0.57634135	2.99343623	1.934498	5.409871	6.563554	7.484337
0.84509804	3.203032887	1.78533	5.619593	6.655532	7.538535
0.819543936	3.31868927	1.857332	5.735454	6.645995	7.59192
0.705007959	3.342027688	1.863323	5.75862	6.686058	6.599544
0.696356389	3.434568904	1.838849	5.851185	6.759343	7.514582
0.702430536	3.238798563	1.844539	5.655345	6.776247	7.513709
0.649334859	3.289811839	1.818885	5.706525	6.820175	7.603109
0.596597096	3.296006669	1.852907	5.712564	6.821497	7.674232
0.615950052	3.46478752	1.733197	5.881486	6.790374	7.661477
0.545307116	3.166726056	1.666518	5.583439	6.706185	7.655421
0.600972896	3.472463897	1.642662	5.889233	6.75939	7.609538
0.614897216	3.493876111	1.633468	5.910464	6.795242	6.623837
0.709269961	3.510276844	1.70757	5.926937	6.77115	6.668202
0.710117365	3.442009159	1.69897	5.858714	6.741327	6.641538

0.301029996	3.442793226	1.875061	5.859361	6.826028	6.690862
0.230448921	3.436639632	1.640779	5.853358	6.79545	6.695335
0.361727836	3.433449794	1.579784	5.850024	6.794972	6.762454

3.2 Data Analysis

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	1.000[a]	1.000	1.000	.0000839

a. Predictors: (Constant), ABOR, AVTT, ACHR

Source: SPSS Output (2025)

The model summary Table3 entails that there is a perfect positive correlation or relationship existing between the data variables. The Table gave R value of 1.000, signifying that there is 100% correlation between dependent and independent variables. The R square value given in the table as 1.000, which infers that 100% of the variance in the dependent variable can be explain by the model and the model is extremely accurate in predicting the dependent variable.

Table 4: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	0.316	3	0.105	14954285.361	.000[b]
	Residual	0.000	13	0.000		
	Total	0.316	16			

a. Dependent Variable: CONT_trf_TEU

b. Predictors: (Constant), ABOR, AVTT, ACHR

Source: SPSS Output (2025)

The ANOVA output Table4 gave high value of F as 14954285.361 inferring that there is significant relationship between the data variables given the P value is less than 0.05 (0.000<0.05) meaning that the relationship between the data variables are significant at 95% significant level. Hence, this informs that the relationship between Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate and Container Traffic (TEU) Trade of TinCan Island Port is statistically significant. This informs that increase in Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate of the TinCan Island Port will increase the Container Traffic (TEU) Trade of the TinCan Island Port.

Table 5: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.416	0.001		2734.334	0.000	2.415	2.418
	AVTT	0.000	0.000	0.000	1.014	0.329	.000	.000
	ACHR	1.000	0.000	1.000	5650.854	0.000	1.000	1.001
	ABOR	0.000	0.000	0.000	-1.303	0.215	-.001	.000

a. Dependent Variable: CONT_trf_TEU

Source: SPSS Output (2025)

The Table5 shows the individual impact levels of the independent variables on the dependent variable of the study. It also shows which variable among the independent variables has significant impact on the dependent variable of the study. The unstandardized regression coefficient B (beta) known as the slope of the regression line represents the change in the outcome variable for one-unit change in the predictor variables. On the other hand, the constant known as the intercept represents the value outcome variable when all predictor variables are equal to zero. It is the

expected value of the outcome variable when all predictors variables are set to zero.

The model equation below shows the impacts of the independent variables on dependent variable.

$CONT_{trf\_TEU}$ =2.416 + 0.000_{AVTT} + 1.000_{ACHR} + 0.000_{ABOR} ……*Eq4*

From the model equation 4, it implies that container traffic trade of the TinCan Island port has a constant trade of 2.416TEU of container traffic trade when there is no additional increase or improvement on Average Vessel Turnaround Time (AVTT), Average Container Handling Rate (ACHR), and Average Berth Occupancy Rate (ABOR) of the TinCan Island port. However, only the Average Container Handling Rate (ACHR) that has a significant impact on container traffic trade of the port given that a unit improvement on the Average Container Handling Rate (ACHR) will improve container Traffic Trade by 1TEU, while Average Vessel Turnaround Time (AVTT), and Average Berth Occupancy Rate (ABOR) shows no insignificant at 95% significant level of the study.

Table 6: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.748[a]	0.560	0.458	0.0537563

a. Predictors: (Constant), ABOR, AVTT, ACHR

Source: SPSS Output (2025)

The model summary Table6 supports that there is a strong positive correlation or relationship existing between the Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Container throughput (Tons) Trade of TinCan Island Port. The Table gave R value of .748, signifying that there is 74.8% correlation between dependent and independent variables. The R square value given in the table as .560, which infers that 56% of the variance in the dependent variable can be explain by the model and the model is extremely accurate in predicting the dependent variable.

Table 7: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	0.048	3	0.016	5.515	0.011[b]
	Residual	0.038	13	0.003		
	Total	0.085	16			

a. Dependent Variable: CONT_thro_ton

b. Predictors: (Constant), ABOR, AVTT, ACHR

Source: SPSS Output (2025)

The ANOVA output Table7 gave high value of F as 5.515 indicating that there is significant relationship between the data variables given the P-value is less than 0.05 (0.011<0.05) meaning that the relationship between the data variables are significant at 95% significant level. Hence, this informs that the relationship between Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate and Container Traffic (TEU) Trade of TinCan Island Port is statistically significant. Therefore, increase in Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate will increase the Container throughput Trade Tonnage of the TinCan Island Port.

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Table 8: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	5.586	.566		9.864	.000	4.363	6.810
	AVTT	-.144	.085	-.331	-1.693	.114	-.327	.040
	ACHR	.342	.113	.657	3.011	.010	.097	.587
	ABOR	.059	.155	.085	.378	.711	-.276	.393

a. Dependent Variable: CONT_thro_ton

Source: SPSS Output (2025)

The Table8 shows the individual impact levels of the independent variables on the dependent variable of the study. It also shows which variable among the independent variables has significant impact on the dependent variable of the study. The unstandardized regression coefficient B (beta) known as the slope of the regression line represents the change in the outcome variable for one-unit change in the predictor variables. On the other hand, the constant known as the intercept represents the value outcome variable when all predictor variables are equal to zero. It is the expected value of the outcome variable when all predictors variables are set to zero.

From the model equation below represents the impacts of the independent variables on dependent variable.

$CONT_{throp}$ =5.586+ -0.144$_{AVTT}$ + 0.342$_{ACHR}$ +0.059$_{ABOR}$ ……*Eq5*

From the model equation 5, it implies that container throughput trade of the TinCan Island port has a constant trade of 5.586tons of container throughput trade when there is no additional increase or improvement on Average Vessel Turnaround Time (AVTT), Average Container Handling Rate (ACHR), and Average Berth Occupancy Rate (ABOR) of the TinCan Island port. However, only the Average Container Handling Rate (ACHR) that has a significant impact on container throughput trade of the port given that a unit improvement on the Average Container Handling Rate (ACHR) will improve container Traffic Trade by 0.342ton. While a unit increase in Average Vessel Turnaround Time (AVTT) will result to -0.144ton decrease or drop in container throughput trade, and a unit increase in Average Berth Occupancy Rate (ABOR) will result in 0.059ton increase container throughput trade of the TinCan Island port which their impacts show no significant at 95% significant level of the study.

Table 9: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.586[a]	0.344	0.192	0.4211960

a. Predictors: (Constant), ABOR, AVTT, ACHR

Source: SPSS Output (2025)

The model summary Table9 informs that there is a positive correlation or relationship existing between the Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Vessel GRT Trade of TinCan Island Port. The Table gave R value of .586, signifying that there is 58.6% correlation between dependent and independent variables. The R square value given in the table as .344, which infers that 34.4% of the variance in the dependent variable can be explain by the model showing that the model accounts for 34.4% in predicting the dependent variable.

Table 10: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.207	3	.402	2.268	.129[b]

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Residual	2.306	13	.177
Total	3.513	16	

a. Dependent Variable: VESS_grt

b. Predictors: (Constant), ABOR, AVTT, ACHR

Source: SPSS Output (2025)

The ANOVA output Table10 gave high value of F as 2.268 indicating that there is no significant relationship between the data variables also, given the P-value is greater than 0.05 (0.129>0.05) meaning that the relationship between the data variables is not significant at 95% significant level. Hence, this informs that the relationship between Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Vessel GRT Trade of TinCan Island Port is not statistically significant. Therefore, increase or improvement in Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate will not have a significant increase in Vessel GRT Trade of the TinCan Island Port.

Table 11: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	12.001	4.437		2.704	0.018	2.414	21.587
	AVTT	0.795	0.665	0.285	1.195	0.253	-.642	2.232
	ACHR	-1.546	0.889	-0.463	-1.740	0.105	-3.466	.374
	ABOR	-0.051	1.213	-0.012	-.042	0.967	-2.672	2.569

a. Dependent Variable: VESS_grt

Source: SPSS Output (2025)

The Table11 shows the individual impact levels of the independent variables on the dependent variable of the study. It also shows which variable among the independent variables has significant impact on the dependent variable of the study. The unstandardized regression coefficient B (beta) known as the slope of the regression line represents the change in the outcome variable for one-unit change in the predictor variables. On the other hand, the constant known as the intercept represents the value outcome variable when all predictor variables are equal to zero. It is the expected value of the outcome variable when all predictors variables are set to zero.

From the model equation below represents the impacts of the independent variables on dependent variable.

$VESS_{GRT}$ =12.001+ 0.795_{AVTT} + -1.546_{ACHR} +- 0.051_{ABOR} ……*Eq6*

From the model equation 6, it implies that container throughput trade of the TinCan Island port has a constant trade of 12.001 Vessel GRT Trade when there is no additional increase or improvement on Average Vessel Turnaround Time (AVTT), Average Container Handling Rate (ACHR), and Average Berth Occupancy Rate (ABOR) of the TinCan Island port. However, no variables showed any significant impact on the Vessel GRT Trade. Nevertheless, a unit increase in Average Vessel Turnaround Time (AVTT) will result to .795 increase in vessel GRT trade; a unit change in Average Container Handling Rate will result to a -1.546 decrease in vessel GRT trade and a unit change in Average Berth Occupancy Rate (ABOR) will result in -.051 change in vessel GRT trade of the TinCan Island port which their impacts show no significant at 95% significant level of the study.

3.3 Discussion of Findings

3.3.1 The impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container Traffic (TEU) Trade of TinCan Island Port

The finding of the study informs that there is a perfect positive correlation between Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Container Traffic (TEU) Trade of TinCan Island Port. the study informs

that the relationship between Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Container Traffic (TEU) Trade of TinCan Island Port is statistically significant at 95% significant level. The model equation 4, implies that container traffic trade of the TinCan Island port has a constant trade of 2.416TEU of container traffic trade when there is no additional increase or improvement on Average Vessel Turnaround Time (AVTT), Average Container Handling Rate (ACHR), and Average Berth Occupancy Rate (ABOR) of the TinCan Island port. The finding of the study infers that only the Average Container Handling Rate (ACHR) that has a significant impact on container traffic trade of the port given that a unit improvement on the Average Container Handling Rate (ACHR) will improve container Traffic Trade by 1TEU, while Average Vessel Turnaround Time (AVTT), and Average Berth Occupancy Rate (ABOR) show no insignificant at 95% significant level of the study.

The findings of this study can be justified by Okoro et al, (2022) on a Correlation Analysis of Ship Turnaround Time and Vessel Traffic in Nigerian Ports. The study investigated the correlation between ship turnaround time and vessel traffic in four Nigerian ports of Onne, Rivers, Delta and Calabar with a view of providing empirical justification for or against the assertion that long ship turnaround time in Nigeria ports is associated with the declining trend of vessel calls at the ports. Secondary data on the ship turnaround time (STRTt) and ship traffic (STt) of the ports were obtained from Nigerian ports Authority (NPA). The data obtained for each of the variables covered a period of 10 years between 2010 and 2019. The statistical tools of correlation analysis and trend analysis were used to analyze the data obtained. It was found that the effects of the of ship turnaround time on vessel calls to ports are port specific, suggesting that factors other than ship turnaround time, such proximity to shipper's location, port charges and ship dues, cargo safety, absence of bottlenecks in the customs and clearing process, etc., may interact to influence the choice of ports. The study also found that there is a weak association/relationship between ship turnaround time in ports and ship traffic/ship calls at ports which aligns with our finding that Average Vessel Turnaround Time (AVTT), and Average Berth Occupancy Rate (ABOR) show no significant at 95% significant level of the study and therefore has no significant impact on container traffic trade of TinCan Island Port Nigeria.

Similarly, Mogbojuri, (2020) examined the annual growth rate, turnaround time, berth occupancy rate and container throughput of Tincan Island Port. Secondary data was used to analyse the collected data. Ordinary Least Square regression was used to analyse the secondary data, which are the annual growth rate of container throughput, turnaround time and berth occupancy rate. The result showed an R2 value of 92.3% (R2 = 0.923) in the annual growth rate of container throughput. However, a unit increase in the turnaround time at the terminal has a negative effect of about 8.3% on the annual growth rate. All the other variables (number of vessels, container throughput and berth rate were significant at $p < 0.05$ with R2 = 0.748, 0.603 and 0.031, respectively. Based on the findings of the study, it was concluded that there was an annual growth rate of container throughput and gross registered tonnage of the vessel from 2005 to 2015. It was recommended that terminal operators should invest more in modern handling equipment to ease the movement of containers at the terminal. Training and retraining of indigenous personnel by terminal operators that will handle fast and modern equipment. This agree with our finding in that it informs that Average Vessel Turnaround Time (AVTT) has no significant impact on container traffic trade of TinCan Island Port Nigeria.

3.3.2 The impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container Throughput Trade of TinCan Island Port

The finding of the study shows a strong positive correlation between Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Container throughput (Tons) Trade of TinCan Island Port. The finding indicated that the positive correlation between Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Container throughput (Tons) Trade of TinCan Island Port is significant at 95% significant level. Therefore, improvement in Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth

Occupancy Rate will result to improvement in the Container throughput Trade Tonnage of the TinCan Island Port.

The study also infers that the container throughput trade of the TinCan Island port has a constant trade of 5.586tons of container throughput trade when there is no additional increase or improvement on Average Vessel Turnaround Time (AVTT), Average Container Handling Rate (ACHR), and Average Berth Occupancy Rate (ABOR) of the TinCan Island port. However, only the Average Container Handling Rate (ACHR) that has a significant impact on container throughput trade of the port given that a unit improvement on the Average Container Handling Rate (ACHR) will improve container Traffic Trade by 0.342ton while a unit increase in Average Vessel Turnaround Time (AVTT) will result to -0.144ton decrease or drop in container throughput trade, and a unit increase in Average Berth Occupancy Rate (ABOR) will result in 0.059ton increase container throughput trade of the TinCan Island port and their impacts show no significant at 95% significant level of the study.

The finding of this study aligns with that of Mogbojuri, (2020) on the examination of the annual Container growth rate, turnaround time, berth occupancy rate and container throughput of Tincan Island Port as well as that of Osondu-Okoro et al, (2022) on a Correlation Analysis of Ship Turnaround Time and Vessel Traffic in Nigerian Ports in that this study concluded that Average Vessel Turnaround Time (AVTT) and Average Berth Occupancy Rate (ABOR) have no significant impact at 95% significant level of the study in container throughput of Tincan Island Port.

3.3.3 The impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Vessel GRT Trade of TinCan Island Port

The result of this study informs that there is a positive correlation between Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Vessel GRT Trade of TinCan Island Port. It further shows that the relationship between the Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Vessel GRT Trade of TinCan Island Port is not significant at 95% significant level. Therefore, increase or improvement in Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate will not have a significant increase in Vessel GRT Trade of the TinCan Island Port.

The study concluds that container throughput trade of the TinCan Island port has a constant trade of 12.001 Vessel GRT Trade when there is no additional increase or improvement on Average Vessel Turnaround Time (AVTT), Average Container Handling Rate (ACHR), and Average Berth Occupancy Rate (ABOR) of the TinCan Island port; and no variables showed any significant impact on the Vessel GRT Trade. Nevertheless, a unit increase in Average Vessel Turnaround Time (AVTT) will result to .795 increase in vessel GRT trade; a unit change in Average Container Handling Rate will result to a -1.546 decrease in vessel GRT trade and a unit change in Average Berth Occupancy Rate (ABOR) will result in -.051 change in vessel GRT trade of the TinCan Island port which their impacts show no significant at 95% significant level of the study.

IV. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The study evaluated the impact of Port Operations Mechanism and Container Vessel Trade Effectiveness in TinCan Island Port Nigeria. The study highlighted some variables that measure the Port Operations Mechanism as Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate being the independent variables of the study; and Container Vessel Trade Effectiveness to including Container Traffic (TEU) Trade, Container throughput Trade (tons), and Vessel GRT Trade being the dependent variables. The study set three objectives and three hypotheses which were achieved in this study.

The findings of the study inform that there is relationship existing between the dependent and independent variables of the study, however, the study concludes that the relationship between Average Vessel Turnaround Time, Average Container

Handling Rate, Average Berth Occupancy Rate and Container Traffic (TEU) Trade is significant at 95%, however, the impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container Traffic (TEU) Trade of TinCan Island Port is not statistically significant. Hence, the Research $H0_1$ is accepted. Although, only Average Container Handling Rate that shows 1 unit significant among other variables.

Also, the findings of the study infer that there is relationship existing between the Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Container Throughput (tons) Trade which is significant at 95%. The study concludes that the relationship between Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Container Throughput (tons) Trade is significant at 95%, however, the impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Container Throughput (tons) Trade of TinCan Island Port is not statistically significant. Hence, the Research $H0_2$ is accepted. Although, only Average Container Handling Rate that shows significant among other variables.

Lastly, the findings of the study gathered that there is relationship existing between the Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Vessel GRT Trade which is significant at 95%. The study concludes that the relationship between Average Vessel Turnaround Time, Average Container Handling Rate, Average Berth Occupancy Rate and Container Throughput (tons) Trade is not significant at 95%, still, the impact of Average Vessel Turnaround Time, Average Container Handling Rate, and Average Berth Occupancy Rate on Vessel GRT Trade of TinCan Island Port is not statistically significant. Hence, the Research $H0_3$ is accepted.

4.2 Recommendations

From the findings, the study recommended improvement on Average Container Handling Rate which shows significant impact on container trade effectiveness in TinCan Island Port. This can be improved or achieved through implementing digitalization by leveraging technology to streamline operations and enhance communication between stakeholders, quick documentations and provision of necessary equipment needed for vessel operations and cargo handling. Optimization of berth allocation is also recommended to minimize waiting times and maximize berth productivity.

4.3 Contribution to knowledge

The study made contribution to literature in the area that the study introduced models to study the impact of Port Operations Mechanism and Container Vessel Trade Effectiveness in Tincan Island Port Nigeria. The study transformed the time series data collected using logarithm base ten transformation for a non-linear data. Multiple regression analysis was employed which is a contribution to knowledge in this regard. The developed model includes:

$CONT_{trf\_\text{TEU}} = 2.416 + 0.000_{AVTT} + 1.000_{ACHR} + 0.000_{ABOR}$

$CONT_{throp} = 5.586 + -0.144_{AVTT} + 0.342_{ACHR} + 0.059_{ABOR}$

$VESS_{GRT} = 12.001 + 0.795_{AVTT} + -1.546_{ACHR} + -0.051_{ABOR}$

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