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WATER TEMPERATURE AND SHIP PERFORMANCE IN ONNE AND RIVERS PORT IN NIGERIA

Wariboko, V.A.*1, Enyioko, N.C.*2, Mathias, U.I.*3, Ebere, N.*4, Eleyi, E.*5, Nwoloziri, C.N.*6, Bereiweriso, L.*7

*1,2,3,4,5,6,7Department Of Maritime Science, Faculty Of Science, Rivers State University, Nkpolu Oroworukwo, Port Harcourt, Nigeria.

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ABSTRACT

The study examined the relationship between water temperature and ship performance along Onne and Rivers ports in Nigeria. Cross sectional research design was adopted for the study. The population of the study consisted of 125 ship crew members from 25 ships (taken from the study areas). Eighty-five (85) crew members and seventeen (17) ships were from Onne Port and forty (40) crew members, and eight (8) ships were from Rivers Port. A sample of 83 respondents were studied. Descriptive and inferential statistics were used to analyze data in this study. Person's Product Moment Correlation Co-efficient (r) was used to test the hypotheses in this study. The study revealed that an increase in the temperature of sea water leads to a decrease in hull resistance, thus a decrease in rate of ship's fuel consumption which will lead to an increase in daily distance covered and reduce delay along Onne and Rivers port waterways. Conclusively, it is evident from the study that there is significant relationship between water temperature and the rate of ship fuel consumption along Onne and Rivers port waterways. The study therefore recommends that: Constant dredging of the channels in the waterways along Onne and Rivers port by the appropriate authorities. The wrecks along Onne and Rivers port waterways should be removed by the appropriate authorities as this will enhance ship speed, reduce delay in ship turnaround time and thus increase ship performance. The hull form of a ship should be considered when building in such a way as to maximally optimize its effects. All obstructions and impediments that limits ship performance along Onne and Rivers port waterways should be removed by the appropriate authorities.

Keywords: Water Temperature, Ship Fuel Consumption, Daily Distance Covered, Ship Performance.

I. INTRODUCTION

The Onne Port and the Rivers Port, Port Harcourt in Rivers state Nigeria, are both part of the Eastern ports of the Nigeria Ports Authority, located in the Gulf of Guinea and strategically positioned to aid the business of ports operations. Also, they are among the busiest ports in the country. The Nigeria Ports Authority carries out its operations in affiliation with the presidency of (Nigeria) and the Nigeria Shippers council (Ibikunle, 2019). Port operation involves overseeing the movement of ships in the water ways, in the course of these movements' ships experience some resistance which try to inhibit movement or velocity and distance covered per unit time thereby causing delay and other logistics consequences. These forces of resistance are known as the hull resistance forces (Odiegwu & Enyioko, 2022).

The United State Naval Academy defined hull resistance as the force required to tow the ship in calm water at a constant velocity. As a ship moves through calm water, the ship experiences a force acting opposite to its direction of motion. This force is the water's resistance to the motion of the ship, which is referred to as "total hull resistance" (RT) (Gebruiksvoorwaarden, 2022). It is this resistance force that is used to calculate a ship's effective horsepower. A ship's calm water resistance is a function of many factors, including ship speed, hull form (draft, beam, length, wetted surface area), and water temperature. Total hull resistance increases as speed increases (USNA, 2021). The power required to propel a ship through the water is the product of total hull resistance and ship speed.

Ship performance is defined as the combined change in the performance of the hull, propeller and engine over time, assuming no alterations have been made to its design. One simple definition of performance is the rate of fuel consumption required to move the vessel through the water for the given conditions, which may be operational (speed or draught) or environmental (wave height, wind speed, etc.) (Aldous, 2015). In 2019, the

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Marine Insight News Network reports that another way of measuring ship performance is by measuring the daily fuel consumption and the daily distance covered. In this way, the daily mean power and mean speed may be calculated, and the result plotted in the speed/power diagram for comparison with the trial results (Gebruiksvoorwaarden, 2022).

Ship performance can also be monitored using the Kyma Ship Performance software, it is a sophisticated solution for overall vessel performance monitoring. This system integrates the Kyma Power Meter system with advanced Windows based PC software that continuously monitors performance data (Gebruiksvoorwaarden, 2022).

The body of a boat is called its hull, the hull of a ship is the most notable structural entity of the

Objective of the Study

The main objective of the study is to examine the relationship between water temperature and ship performance along Onne and Rivers Port water ways, Nigeria.

Research Question

The following research question has been examined and tested in this study:

To what extent does the water temperature relate with ship performance?

Research Hypotheses

The following hypotheses have been formulated in this study:

H_{01}: There is no significant relationship between the water temperature and ship's fuel consumption.

H_{02}: There is no significant relationship between the water temperature and daily distance covered.

II. LITERATURE REVIEW

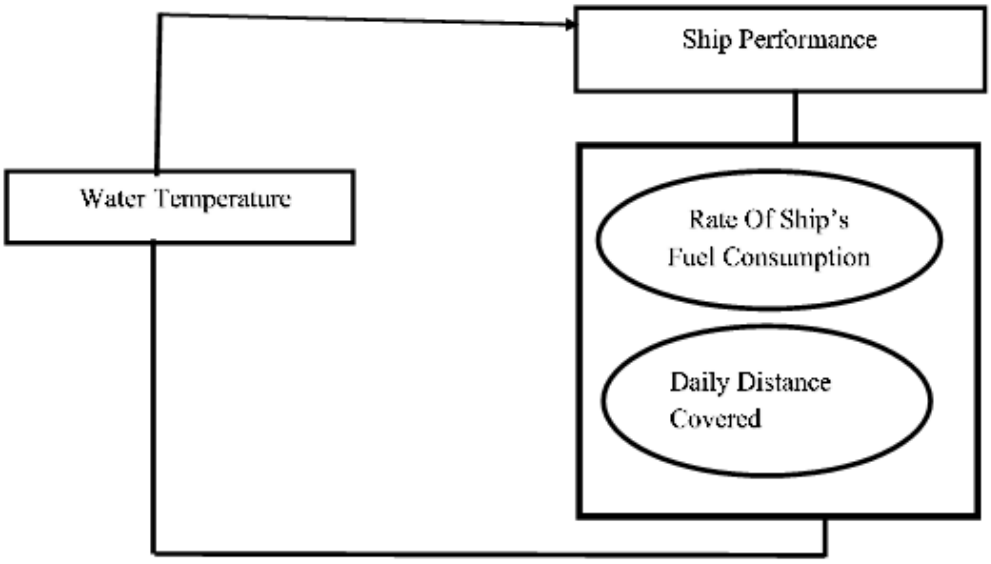

Figure 1: Conceptual Framework of the Relationship Between Water Temperature and Ship Performance in Onne and Rivers port, Nigeria

Sources: Buckles, S., (2022). How Far Can You Sail in One Day? written by in beginner in

Chakraborty, S. (2021). Marine insight naval architecture Hull of a Ship – Understanding Design and Characteristics. Journal of Engineering Science and Technology 17(1):106-0126.

The relevant literature in this study were reviewed under the following subheadings: Nature of the area of the study, water temperature, ship performance, ship fuel consumption, daily distance covered, planed behaviour theory and general system theory, relationship between water temperature and ship performance and empirical studies.

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Nature of the Study Area (Onne Port)

Onne Port Complex is situated on the Bonny River Estuary along Ogu Creek and it is the first port of its kind in Nigeria that operated the Landlord Port Model devised to encourage private sector participation in the Port Industry. ONNE is located at West Africa, Gulf of Guinea in Nigeria at coordinates N 04° 41' 04.19" - E 007° 09' 27.00". The official UN/Locode of this port is NGONN (Marinetraffic, 2022). Strategically located, the Port is one of the largest Oil and Gas Free Zone in the world supporting exploration and production for Nigerian activities. The Free Zone provides a logistics Oil Service centre for the Oil and Gas Industry in Nigeria both Onshore and Offshore. It also provides easy access to the entire West African and Sub-Sahara Oil fields (Nigerian Port Authority, 2022).

The Port accounts for over 65% of the export cargo through the Nigerian Sea Port. There are multiple operations that are carried out in the Port in addition to the Oil and Gas operations. Some of such multiple operations are General Cargoes, Bulk Cargoes (Dry & Wet), Oil Well Equipment, Containerized Cargoes and other Logistics Services provided to companies that are customers and tenants. Hence the Port is a multi-purpose Cargo Port. The Port covers an area of 2,538.115 hectares. Onne port operates with 12hour pilotage service (06:00h – 18:00h). The last inward pilotage is 4 PM (1600hrs) and the last outward pilotage is at 2 PM (1400hrs).

ONNE is a Medium-sized Port. The types of vessels regularly calling at ONNE are Offshore Supply Ship (23%), Container Ship (12%), Crew Boat (11%), Patrol Vessel (10%), Bulk Carrier (5%). The maximum length of the vessels recorded to having entered this port is 295 meters. The maximum draught is 11.4 meters. The maximum Deadweight is 69193t (Marinetraffic, 2022).

As per Latest NTM attached – Permissible Draft: INTELS FLT- 9.7m; BRAWAL- 7.7m, INTELS FOT-10.6m; INDORAMA- 10.6; WACT-10.6m, NOTORE- 7.7m (Marinetraffic, 2022).

Rivers Port

The Rivers Port, Port Harcourt is at coordinates N 04° 46' 02.99" - E 007° 01' 57.00". The official UN/Locode of this port NGPHC. The types of vessels regularly calling at Port Harcourt port are Offshore Supply Ship (19%), Crew Boat (14%), Bulk Carrier (10%), passenger (8%), Other (6%). The maximum length of the vessels recorded to having entered this port is 200 meters. The maximum Deadweight is 63878t. Water density: 1.009-1.016 · Port is Situated 35 NM from FWB up Bonny Estuary · Pilot is compulsory for vessels exceeding 500GRT. (Marinetraffic, 2022).

Table 1: Terminal berths and draft at NPA Port Harcourt

S/NO	Terminal Births	Draught
1)	Berth 1	7m
2)	Berth 2	7.8m
3)	Berth 3	10.5m
4)	Berth 4	10.5m
5)	Berth 5	6m
6)	Berth 6	7.5m
7)	Berth 7	9m
8)	Berth 8a	7.5m
9)	Berth 8b	8m

Source: Marinetraffic, 2022

Water Temperature

Temperature is the measure of heat. Water temperature is a physical property expressing how hot or cold water is. As hot and cold are both arbitrary terms, temperature can further be defined as a measurement of the average thermal energy of a substance. Thermal energy is the kinetic energy of atoms and molecules, so temperature in turn measures the average kinetic energy of the atoms and molecules. This energy can be

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transferred between substances as the flow of heat. Heat transfer, whether from the air, sunlight, another water source or thermal pollution can change the temperature of water (Gebruiksvoorwaarden, 2022). Density is the measure of how closely any given entity is packed or it is the ratio of the mass of the entity to its volume. The relation between density and temperature is inversely proportional. Change in density will be reflected in a change in temperature and vise-versa. When density increases, the temperature decrease, and when density decreases, temperature increases.

Since the waterways of Onne and Rivers port are sea water let us look at saltwater temperature point: It is important to note that salinity not only affects water density, but it can shift the maximum density and freezing points of water. As the salt concentration increases, both maximum density and the freezing point will decrease. Average seawater has a salinity level of 35 PPT (parts per thousand) and has a shifted maximum density of -3.5°C. This is more than a 7° difference from freshwater and is below seawater's freezing point of 1.9°C. However, this maximum density is never reached. Instead, the process on convection simply circulates the cooling water until the entire surface water column reaches the freezing point

The coldest recorded natural seawater temperature was -2.6°C, recorded beneath an Antarctic glacier. Likewise, the coldest ocean currents recorded were -2.2°C at a depth of 500 m. In both cases, hydrostatic pressures allowed water to remain liquid at such cold temperatures.

A study carried out by Nitonye and Dick (2015) on the effect of fluid density on ship hull resistance and powering from the department of marine engineering rivers state university shows a positive correlation between water density and ship hull resistance. Therefore, from the foregoing as water temperature decreases, the resistance of a ship increases and vice versa.

Also, Terese Richmond et all in 2014 carried out a study on how Ships are sensitive to many factors, including the depth of a channel and the extent of sea ice. Increasing temperatures could reduce the amount of sea ice in many important shipping lanes, extending the shipping season. Warmer winters will likely lead to less snow and ice accumulation on vessels, decks, and rigging in marine transportation. In the Arctic, warmer temperatures could also open up the possibility of a Northwest Passage during portions of the year, which could reduce delay in shipping times and increase the daily distance covered. However, these new passages may also provide a pathway for invasive species transport and survival.

Shipping lanes experiencing sea level rise will be able to accommodate larger ships, thereby increasing the daily distance covered by a ship, reducing the delay and reducing shipping costs. However, higher sea levels will mean lower clearance under waterway bridges. In inland waterways where water levels are expected to decline, as in parts of the Great Lakes, ships could face weight restrictions, as channels become too shallow (Terese Richmond et all, 2014).

Ship Performance

Ship performance is defined as the combined change in the performance of the hull, propeller and engine over time, assuming no alterations have been made to its design. One simple definition of performance is the rate of fuel consumption required to move the vessel through the water for the given conditions, which may be operational (speed or draught) or environmental (wave height, wind speed, etc.) (Aldous, 2015). In 2019, the Marine Insight News Network reports that another way of measuring ship performance is by measuring the daily fuel consumption and the daily distance covered. In this way, the daily mean power and mean speed may be calculated, and the result plotted in the speed/power diagram for comparison with the trial results.

Ship performance can also be monitored using the Kyma Ship Performance software, it is a sophisticated solution for overall vessel performance monitoring. This system integrates the Kyma Power Meter system with advanced Windows based PC software that continuously monitors performance data. The software includes sea-trial or model tank propulsion baselines, which can be displayed graphically, Allowing the comparison of the actual condition vs the design ship condition, in real-time mode (Gebruiksvoorwaarden, 2022).

Another way of monitoring ship performance is using machine-learning method. The hydrodynamic performance of a sea-going ship varies over its lifespan due to factors like marine fouling and the condition of the anti-fouling paint system. In order to accurately estimate the power demand and fuel consumption for a planned voyage, it is important to assess the hydrodynamic performance of the ship. The current work uses machine-learning (ML) methods to estimate the hydrodynamic performance of a ship using the onboard

recorded in-service data. Three ML methods, NL-PCR, NL-PLSR and probabilistic ANN, are calibrated using the data from two sister ships. The calibrated models are used to extract the varying trend in ship's hydrodynamic performance over time and predict the change in performance through several propeller and hull cleaning events. The predicted change in performance is compared with the corresponding values estimated using the fouling friction coefficient (ΔCF). The ML methods are found to be performing well while modeling the hydrodynamic state of the ships with probabilistic ANN model performing the best, but the results from NL-PCR and NL-PLSR are not far behind, indicating that it may be possible to use simple methods to solve such problems with the help of domain knowledge.

For most ships delivered from a shipyard there is a diagram showing the relation between speed and required power for one or more loading conditions, under standard conditions of trim and weather. But the ship owner knows that this speed cannot be maintained for the daily commercial operation and defines a "service speed" for the ship, which takes into account the power reductions due to weather, marine growth and hull surface fouling. Hence this relation between speed and power for a ship in service will give its performance.

Other factors influencing the ship's performance are draft, temperature and salinity, weather conditions and sea current (MI News Network, 2019)

Ship Fuel Consumption

Vessel fuel consumption has emerged as one of the key contributors to environmental deterioration and rising operational cost to the maritime industry. In practice, fuel efficiency can be achieved by design or operational approaches in newly designed or in-service vessels (Keh-Kim Kee et al, 2018).

The amount of fuel carried on a container ship varies based on the engine capacity and size of the ship, which themselves are a function of the particular trading route the ship operates in and the optimal speed of the ship's engine. The amount of fuel actually be used on a sailing depends primarily on the ship's speed. Most ship engines have been designed for top speeds ranging between 20 and 25 knots per hour, which is between 23 and 28 miles per hour. A Panamax container ship can consume 63,000 gallons of marine fuel per day at that speed (Benzinga,2020; Odiegwu & Enyioko, 2022).

The ship speed is a key in maritime transport. The non-linear relationship between speed and fuel consumption shows that lower-speed vessels will consume less fuel than high speed vessels. By lowering the speed of the vessel, it is expected that fuel consumption is also reduced (Psaraftis, et al. 2013). Presence of fouling on the hull increases the ship resistance therefore results an increase in ship fuel consumption

Daily Distance Covered (Delay)

Ship's delay is the difference between actual time of arrival (ATA) and expected time of arrival (ETA) (Erwin, 2020). According to cargoport report (2020) Bad weather, port congestion, strikes, container shortages and changes in service schedule can delay a ship's departure, arrival, loading and unloading. Additionally, ships can get held up at sea due to navigational hazards (floating ice) and technical malfunctions. Delays also occur when the ship takes a detour, makes additional stops or skips a port. According to a Schedule Reliability report covering the east-west trade lanes, less than 50% of ships were on time while 10% were late by three days in 2019. Relationship were developed to expressed the overall travel speed and delays as function of elements that were descriptive of the port congestion and change in service schedule (Harold Micheal, 2019). Buckles in his research on How far you can sail on one day? Discovered that on average, sailboats can sail up to 100 NM (115 miles or 185 km) in one day when they run downwind. If the engine is used at all, this distance can increase to 130 NM on longer passages. With shorter passages, 60 NM is more typical. Large boats are faster than small boats.

The actual distance (nautical mile) covered by the ship from noon to noon is measured using the ship's log (Chakraborty S., 2021). Speed and Distance are highly correlated but not identical because speed is measured instantaneously and distance travelled is cumulative over time (Pazouki, et al 2017).

Theoretical Framework

Two theories have been reviewed as the ones underpinning the study. They are planed behaviour theory and general system theory:

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Planed Behaviour Theory

Theory of planed behavior poses that the adoption or the performance of sustainable shipping practices is correlated with the company's attitude, where attitude is the reflection of the firm'sbeliefs on the outcome of the selection (Yuan et al., 2017). The notion firms have towards ship performance is aligned to what academia poses and is reflected around the triple bottom line of people-planet-profit (Zhou & Vinh, 2016). In this context the hull resistance aspect is reflected with the provision of safety, while the planet aspect relates to the environmental integrity and resource preservation. Lastly the performance aspect is an operational derivative under the two previous lenses through a dynamic relationship among them, along with the reciprocal relationships coming from the outer environment of the firm.

The proactive approach that was showed by the hull resistance, along with the perception thatthere will be no field for conducting business unless it is secured, preserved and sustainable is aligned with Zhou and Vinh (2016). Authors posed managerial philosophy towards performance and the viewpoint of incorporating ship performance to the values, goals, and objectives of the firm as suitable solutions, rather than a must-do trade-off. Examined hull resistance supported such a statement since they positioned themselves in the center of the responsibility and perceive the conduction of business and operations as an outcome with respect to the first two aspects of the triple bottom line (peopleand planet).

Hong, Chu and Wang (2011) posed that the norms an entity is encountering are influenced by the approval or disapproval of specific behaviors by the outer environment. Yuan et al. (2017) extended it to the shipping context by posing stakeholders as the outer environment that approved or reject a certain behavior. The position as a central actor showed by hull resistance, combined with the proactive strategy towards regulation compliance and the development of normative behavior when referring to the outer environment contradicts the notion of approval or disapproval (Odiegwu & Enyioko, 2022). Though the solutions offered and suggested from various stakeholders in the shipping industry are operational, technical and market-based, the approval or disapproval derives from the central actor, in this instance the shipowner. The evaluation of each proposed choice is filtered and as posed in the results, the already developed normative and proactive approach endorses straight forward and real-life applicable solutions (Yang, 2019). Such a resistance characterization of hull is also supported by the fact that the expansion and further development of the implemented measures is correlated with ensuring actual results in terms of emission reduction and resource preservation. Hence, the market-based mechanisms were not supported and were instead disregarded.

General System Theory

The purpose of a theory is to explain, analyze, and possibly predict future trend of events and outcomes. A theory is a generalized explanation of the relationship that exists in a phenomenon with the primary purpose of explaining and predicting the phenomena (To understand port operations and marine terminals in Nigeria, we employed general system theory as our theoretical framework of analysis for this work.

The General System Theory was developed by biologist Ludwig von Bertalanffy in 1936 (von Bertalanffy, 1938). He felt the need for a theory to guide research in several disciplines because he saw striking parallels among them. His hunch was that if multiple disciplines focused their research & theory development efforts, they would be able to identify laws & principles which would apply to many systems. This would allow scholars & scientists to make sense of system characteristics such as wholeness, differentiation, order, equifinality, progression & others. With a common framework, scientists could better communicate their findings with each other & build upon each other's work. He believed that over time, what was discovered would come to be applicable to life in general.

General systems theory stresses the importance of groups and their influences over individual people. We all exist within a set of nested social systems. These nested social systems can include families, organizations, neighborhoods, societies, cultures, etc. According to this theory, we can only understand individual behavior by considering these group influences (Hsu, 2012).

According to general systems theory, addiction is caused by larger social systems that surround an individual. To illustrate this somewhat confusing concept, consider a single cell within an organism. In order to understand the behavior of a single cell, we need to understand the tissue, the organ, the organ system, and the body, in which the cell is functioning (Von Bertalanffy,1968).

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Systems theory proposes that all systems should maintain balance and harmony. The common expression, "Don't rock the boat" aptly describes a system's need to maintain balance. Therefore, every individual within any given system participates in the maintenance of that balance no matter how resisting the components are (Abramowicz & Hejmlich, 2015).

Accordingly, systems theory sees an organization as a unified purposeful entity composed of interrelated parts, rather than dealing separately with various parts of the organization. The theory gives managers a way of looking at an organization as a whole and part of the external environment. The theory makes the manager to understand the activity of any part as it affects the activity of all other parts or segments. Going by the general system theory, the job of a manager in an organization is to ensure that all parts of the organization are coordinated internally so that the organization's goal can be achieved (Anyanwu, 2014). Above all, general system theory stresses the central point that the management of an organization cannot respond only to what administrative laws demand but must place what administrative laws dictate into perspective with other resistances and environmental pressures (Odiegwu & Enyioko, 2022).

Relationship between Water Temperature and Ship Performance

Water temperature plays a very important role in various environmental factors as well as economic factors for the operator of the vessel. Speed of the ship has an impact at both design level and operational level, hence its performance. At the design level, bigger container ships with less speed are being constructed to obtain less CO2 emissions per container. At the operational level, the practice of reducing speed as a response to depressed market conditions and high fuel prices known as slow steaming is being used in almost all commercial shipping sector (Agarwal, 2019). The amount of fuel consumed is very important as it is the most expensive element of transportation by sea for ships. Water temperature is measured in knots; 1 knot = 1.852 km/hr or 1 nautical mile = 1.852 km (Buckles, 2022).

It is well known that the shape of the water temperature plays an important role in the overall performance, efficiency and stability of ships. It is therefore crucial to obtain optimal design of the ship water temperature right from the conceptual design stage (Buckles, 2022). A paper presented by Hock (2015) demonstrated through a case study the optimization process of the water temperature design of offshore vessel for reduced resistance and improved seakeeping. Their results demonstrated an improvement in the performance as well as efficiency of the design process.

Empirical Studies

Vessels move through waters by overcoming the resisting force from the water and air. This force, known as the total resistance, is overcome by the provision of effective power from the propulsion system so that the ship can sail at a given speed. Resistance estimation holds immerse importance in the design stage of a vessel. Based on the results of the resistance estimation of a ship, the selection of the right propulsion system is done. According to team Naval arch (2020) the most accurate and reliable method for calculating a ship's resistance is by performing a model test. It involves building a scaled down model of the actual vessel, performing tests on it in a model basin, and extrapolating the results to the actual vessel. However, model tests are usually performed at the end of the design cycle, and they are quite cost prohibitive. In the early design stages, with limited data available, empirical methods can be used to give a fair estimate of a ship's resistance (Odiegwu & Enyioko, 2022). Emil (2020) in his work study of semi empirical method for ship resistance calculation has demonstrated the feasibility and accuracy of interpolating between measurement data from model resistance series when estimating unknown hulls were conducted. The results showed that it is possible to estimate the total resistance with semi-empirical methods to an unknown hull by linear interpolation with an accuracy of below 5% in the designed speed interval both for FDS-5 and JBC. The CFD simulations achieved a lower accuracy compared to the semi-empirical approach, however by further calibrating the models, the accuracy could potentially be improved. Based on the above writeups the study hypothesized that: H_{01}: There is no significant relationship between the water temperature and ship's fuel consumption. H_{02}: There is no significant relationship between the water temperature and daily distance covered.

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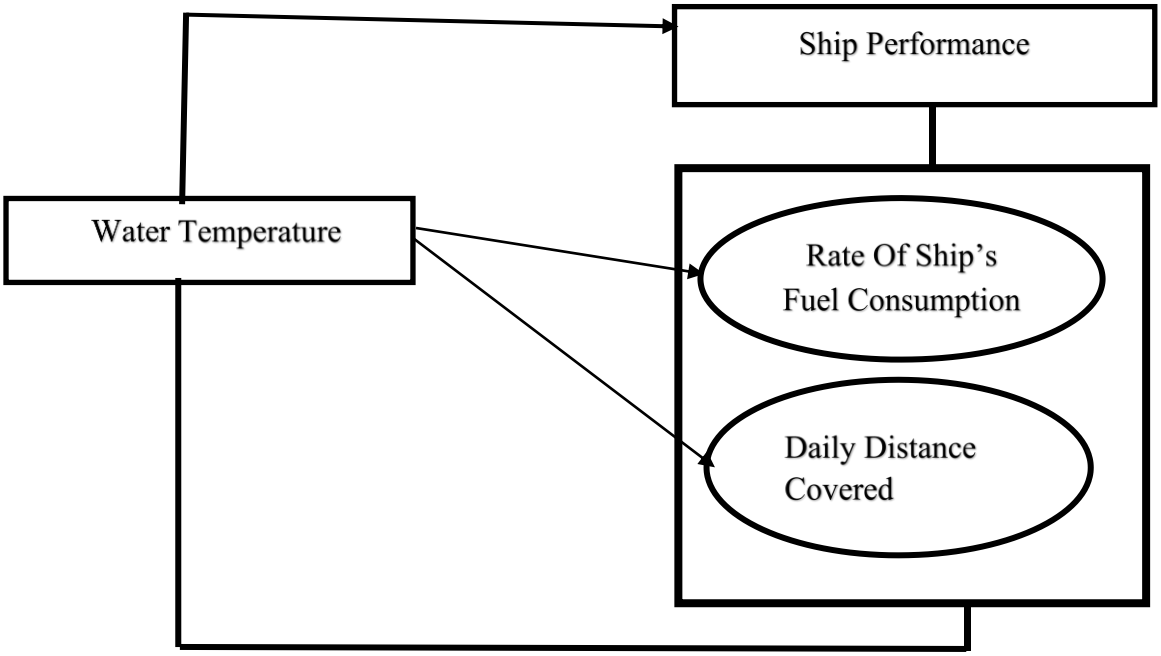

Figure 2: Operationalized Framework of the Relationship Between Water Temperature and Ship Performance in Onne and Rivers port, Nigeria

Sources: Buckles, S., (2022). How Far Can You Sail in One Day? written by in beginner in

Chakraborty, S. (2021). Marine insight naval architecture Hull of a Ship – Understanding Design and Characteristics. Journal of Engineering Science and Technology 17(1):106-0126.

III. METHODOLOGY

The research design applied in this study is the cross-sectional research design. The survey method emphasizes quantitative analysis where data are collected through questionnaire, interview or from existing documents (Odiegwu & Enyioko, 2022).

Population of the Study

The population of the study consisted of 125 ship crew members from 25 ships (taken from the study areas). 85 crew members and 17 ships were from Onne Port and 40 crew members were from Rivers Port.

Sample Technique and Sample Size

The sample technique used in this study was the simple random technique. The choice of this method was predicted on the fact that every element in the study shall have equal chance of being studied. The study used prof. Taro Yamane's sample size formula to determine the sample size as follows

$$n = \frac{N}{1 + N(e)^2}$$

Where;

n = sample size

N = population of the study

e = level of significance selected at 5%

accordingly, the sample size (n) for the study was calculated thus;

$$n = \frac{125}{1 + 125\ (0.05)^2} = \frac{125}{1.3125} = 96$$

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Sample size (n) = 96

Methods of Data Collection

Data collection is the process of gathering data from either the primary or secondary sources for the purpose of the study analysis. Copies of questionnaire were used to elicit data from respondents on whom they will be administered to. The secondary source data was sourced through annual reports, and gazette etc. in all triangulation approach will be used in the data collection.

Method of Data analysis

In this study, percentages, ratio, frequency distribution, scaling, ranking and other statistical tools were used to analyze and achieve research objectives. Pearson's Product moment correlation coefficient was used to test the extent of relationship between individuals and collective variable(s). also, Pearson's product moment correlation coefficient was used to test the hypotheses formulated in the study. All these analyses were computed through the use of statistical package for social sciences (SPSS) IBM SPSS statistics 25 version.

In this study the reliability was verified by conducting a confirmatory test of internal consistency on the instrument with the study sample, using the Cronbach alpha that was computed with SPSS software. Hence, the result was more than 0.7 threshold.

Table 2: Test of Reliability

S/N	Instruments	No. of Items	Cronbach Alpha
1.	Water Temperature	5	0.820
2.	Ship's Fuel Consumption	5	0.921
3.	Ship's Daily Distance Covered	5	0.895
	Mean Reliability	**2.636 ÷ 3 = 0.8786**	

Source: Survey data 2022 and SPSS 25.0 output.

From the Cronbach Alpha result shown in Table 2 above, the instrument is seen to be reliable one and generally related to the subject matter examined in the study. The data collection instrument was tested for reliability using Cronbach's Alpha and the study is within the acceptable range of 0.70 and above, the overall reliability (mean reliability) test of the instrument is 0.8786. this has been achieved in line with Akujuru and Enyioko's (2018) stipulation that the use of the SPSS software package would practically help in testing the reliability of the instrument. Validity test was also done, using expects knowledgeable on the subject matter under investigation, pears review and supervisor's approval to ascertain that the instruments are relevant and measure what they are expected/ design to measure. The dimension and measures of the constructs have Alpha value above the Nunnally threshold 0.7; therefore, it is considered reliable.

IV. RESULTS AND ANALYSIS

The field and survey exercise were carried out by the researcher which involved the administration of the copies of questionnaire to the ship crew members. After administering the instruments, the respondents were given a time space of one month to respond to the instrument. Thereafter copies of the questionnaire were retrieved physically from the respondents by the researcher through well-established enumerators. A total number of 96 copies of questionnaire were distributed to the respondent from 125 crew members from 25 ships. A total of 88 copies of questionnaire were retrieved from them. After editing the retrieved copies of questionnaire, the copies found useful were 83. The 83 copies of questionnaire were considered as valid and suitable for data analysis in this study. The administration and retrieval of copies of the questionnaire are shown in Table 3:

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Table 3: Administration and Collation of Questionnaires

s/n	Crew Position	Number of Questionnaires Administered	Number of Questionnaires Collected	Number of Questionnaires Found Useful	Response Rate (%)
1.	Captain	23	21	20	87
2.	Chief Engineer	24	23	22	83
3.	Chief Mate	17	15	14	82
4.	Oiler	10	9	8	80
5.	Deckhand	22	20	19	86
	Total	**96**	**88**	**83**	**86**

Source: Survey data 2022 and SPSS 25.0 output.

Table 3 shows how the copies of questionnaire were administered to the respondents.

With respect to the captains, 23 copies of the questionnaire were administered to them, 21 copies were collected, after editing them, 20 representing 87% response rate were found useful in this segment. With respect to the Chief engineers, 24 copies of the questionnaire were administered to them, 23 copies were collected, after editing them, 22 representing 83% response rate were found useful in this segment. With respect to the chief mates, 17 copies of the questionnaire were administered to them, 15 copies were collected, after editing them, 14 representing 82% response rate were found useful in this segment. With respect to the oilers, 10 copies of the questionnaire were administered to them, 9 copies were collected, after editing them, 19 representing 86% response rate were found useful in this segment. With respect to the deckhands, 27 copies of the questionnaires were administered to them, 20 copies were collected, after editing them, 19 representing 86% response rate were found useful in this segment. In all 96 copies of the questionnaires were administered to the crew members, 88 copies of questionnaire were collected, after editing them, 83 copies of questionnaire representing 86% response rate were found useful in this segment. All the analyses were done using the SPSS 22.5 guidelines.

Water Temperature

Table 4 give detailed analysis on how water temperature as a dimension to hull resistance has been examined to determine its relationship to ship performance along Onne and Rivers Ports waterways.

Table 4: Descriptive Statistics of Water Temperature

S/N	Descriptive statistics	N	Mean (x)	Standard Deviation (±SD)
1.	The resistance reduction becomes increasingly limited with the improvement of water temperature.	83	3.7562	0.83460
2.	The low-temperature circuit is used for low-temperature zone machinery and this circuit is directly connected to the main seawater central cooler thar enhances ship performance.	83	3.2483	0.99411
3.	Water temperature is maintained by low-temperature fresh water and the system normally comprises of the jacket water system of the main engine encouraging ship performance.	83	3.0777	0.89974
4.	Higher speed is possible in the freshwater system which results in reduced piping and low installation cost	83	3.1831	0.95746

5.	Since the temperature-controlled is irrespective of seawater temperature, the stable temperature is maintained which helps in reducing machinery wear down and sustenance of ship performance.	83	2.5088	1.12156
	Valid N (listwise)	83		

Source: Survey data 2022 and SPSS 25.0 output.

Table 4 reveals the responses of the respondents. The first statement item was to find out if the resistance reduction becomes increasingly limited with the improvement of water temperature. From the mean and standard deviation scores of 3.7562±0.83460, the respondents strongly agreed that the resistance reduction becomes increasingly limited with the improvement of water temperature. The second statement item was to find out if the low-temperature circuit is used for low-temperature zone machinery and this circuit is directly connected to the main seawater central cooler thar enhances ship performance. From the mean and standard deviation scores of 3.2483±0.99411, the respondents agreed that the low-temperature circuit is used for low-temperature zone machinery and this circuit is directly connected to the main seawater central cooler thar enhances ship performance. The third statement item was to find out if water temperature is maintained by low-temperature fresh water and the system normally comprises of the jacket water system of the main engine encouraging ship performance. From the mean and standard deviation scores of 3.0777±0.89974, the respondents strongly agreed that water temperature is maintained by low-temperature fresh water and the system normally comprises of the jacket water system of the main engine encouraging ship performance. The fourth statement item was to find out if higher speed is possible in the freshwater system which results in reduced piping and low installation cost. From the mean and standard deviation scores of 3.1831±0.95746, the respondents strongly agreed that higher speed is possible in the freshwater system which results in reduced piping and low installation cost. The fifth statement item was to find out if since the temperature-controlled is irrespective of seawater temperature, the stable temperature is maintained which helps in reducing machinery wear down and sustenance of ship performance. From the mean and standard deviation scores of 2.5088±1.12156, the respondents agreed that since the temperature-controlled is irrespective of seawater temperature, the stable temperature is maintained which helps in reducing machinery wear down and sustenance of ship performance.

All analyses are gotten using the SPSS 22.5 guidelines.

Fuel Consumption

Table 5 gives detailed analysis on how fuel consumption as a dimension to ship performance has been examined to determine its relationship to ship performance along Onne and Rivers Ports waterways.

Table 5: Descriptive Statistics of Fuel Consumption

S/N	Descriptive Statistics	N	Mean (x)	Standard Deviation(±SD)
1.	Decreasing ship speed is a good effort to reduce emissions from ships and fuel consumption	83	2.2580	1.22354
2.	Presence of fouling on the hull increases the ship resistance therefore results an increase in ship fuel consumption, which directly increases operational costs of ship	83	3.3039	0.99621
3.	The non-linear relationship between speed and fuel consumption shows that lower-speed vessels will consume less fuel than high speed vessels.	83	3.0318	0.95039
4.	By lowering the speed of the vessel, it is expected that fuel consumption and ship emissions are also reduced	83	3.2544	0.98883
5.	Speed of a ship depends on various factors like	83	3.3216	1.06481

	displacement of the vessel, draft, wind force and direction, sea weather condition, condition of the hull and the propeller and fuel consumption rate.	
	Valid N (listwise)	83

Source: Survey data 2022 and SPSS 25.0 output.

The first statement item was to find out if decreasing ship speed is a good effort to reduce emissions from ships and fuel consumption. From the mean and standard deviation scores of 2.2580±1.22354, the respondents disagreed that Decreasing ship speed is a good effort to reduce emissions from ships and fuel consumption. The second statement item was to find out if the presence of fouling on the hull increases the ship resistance therefore results an increase in ship fuel consumption, which directly increases operational costs of ship. From the mean and standard deviation scores of 3.3039±0.99621, the respondents agreed that the presence of fouling on the hull increases the ship resistance therefore results an increase in ship fuel consumption, which directly increases operational costs of ship. The third statement item was to find out if the non-linear relationship between speed and fuel consumption shows that lower-speed vessels will consume less fuel than high speed vessels. From the mean and standard deviation scores of 3.0318±0.95039, the respondents agreed that the non-linear relationship between speed and fuel consumption shows that lower-speed vessels will consume less fuel than high speed vessels. The fourth statement item was to find out if by lowering the speed of the vessel, it is expected that fuel consumption and ship emissions are also reduced. From the mean and standard deviation scores of 3.2544±0.98883, the respondents agreed that by lowering the speed of the vessel, it is expected that fuel consumption and ship emissions are also reduced. The fifth statement item was to find out if the speed of a ship depends on various factors like displacement of the vessel, draft, wind force and direction, sea weather condition, condition of the hull and the propeller and fuel consumption rate. From the mean and standard deviation scores of 3.3216±1.06481, the respondents agreed that the speed of a ship depends on various factors like displacement of the vessel, draft, wind force and direction, sea weather condition, condition of the hull and the propeller and fuel consumption rate.

Daily Distance Covered (Delay)

Table 6 gives detailed analysis on how daily distance covered (delay) as a dimension to ship performance has been examined to determine its relationship to ship performance along Onne and Rivers Ports waterways.

Table 6: Descriptive Statistics of Daily Distance Covered (Delay)

S/N	Descriptive statistics	N	Mean (x)	Standard Deviation(±SD)
1.	Trimming out the sterndrive or outboard lifts the bow, reduces the wetted surface of the hull and thus drag, and increases speed	83	3.3110	0.87648
2.	Stability is determined by the force of buoyancy provided by the underwater parts of a vessel, coupled with the combined weight of its hull, equipment, fuel, stores, load and daily distance covered	83	3.2332	0.97597
3.	Speed and power for a ship in service will give the daily fuel consumption and the daily distance covered	83	3.2438	1.09184
4.	The daily mean power and mean speed may be calculated, and the result may be plotted in the speed/power diagram for comparison with the daily distance covered	83	3.2085	1.11518
5.	Diminishing power output and increasing fouling in the hull, resulting in increasing fuel consumptions affects the daily distance covered.	83	2.8314	0.97775
	Valid N (listwise)	83		

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Source: Survey data 2022 and SPSS 25.0 output.

The first statement item was to find out if trimming out the sterndrive or outboard lifts the bow, reduces the wetted surface of the hull and thus drag, and increases speed. From the mean and standard deviation scores of 3.3110 ±0.87648, the respondents agreed that trimming out the sterndrive or outboard lifts the bow, reduces the wetted surface of the hull and thus drag, and increases speed. The second statement item was to find out if stability is determined by the force of buoyancy provided by the underwater parts of a vessel, coupled with the combined weight of its hull, equipment, fuel, stores, load and daily distance covered. From the mean and standard deviation scores of 3.2332±0.97597, the respondents agreed that stability is determined by the force of buoyancy provided by the underwater parts of a vessel, coupled with the combined weight of its hull, equipment, fuel, stores, load and daily distance covered. The third statement item was to find out if the speed and power for a ship in service will give the daily fuel consumption and the daily distance covered. From the mean and standard deviation scores of 3.2438±1.09184, the respondents agreed that speed and power for a ship in service will give the daily fuel consumption and the daily distance covered. The fourth statement item was to find out if the daily mean power and mean speed may be calculated, and the result may be plotted in the speed/power diagram for comparison with the daily distance covered. From the mean and standard deviation scores of 3.2085±1.11518, the respondents agreed that the daily mean power and mean speed may be calculated, and the result may be plotted in the speed/power diagram for comparison with the daily distance covered. The fifth statement item was to find out if diminishing power output and increasing fouling in the hull, resulting in increasing fuel consumptions affects the daily distance covered. From the mean and standard deviation scores of 2.8314±0.97775, the respondents disagreed that the diminishing power output and increasing fouling in the hull, resulting in increasing fuel consumptions affects the daily distance covered.

Statistical Test of Hypotheses and Their Interpretations

Water Temperature (x) and Rate of Ship's Fuel Consumption (y) in Onne and Rivers Ports

To test the relationship between water temperature and rate of ship's fuel consumption along Onne and Rivers Port waterways. The study formulated the following hypothesis: H_{01}: There is no significant correlation between Water temperature and rate of ship's fuel consumption (y) in Onne and Rivers ports.

Table 7: Result of Water Temperature (x) and Rate of Ship's Fuel Consumption (y) in Onne and Rivers Ports

S/N	Correlations	Water Temperature	Rate of Ship's Fuel Consumption
1.	Pearson Correlation Ship Speed		0.728**
2.	Sig (2-tailed)		0.000
3.	N		83
4.	Pearson correlation Rate of Ship's Fuel Consumption	0.728**	
5.	Sig (2-tailed)	0.000	
6.	N	83	

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Survey Data 2022, SPSS Version 25 Output window

Table 7 shows the inferential test results of the relationship between water temperature and rate of ship's fuel consumption along Onne and Rivers Ports Water ways. This positive large value of r (= 0.728) says that there is a strong positive correlation between Water temperature (x) and Rate of ship's fuel consumption (y) in Onne and Rivers ports. Because of the positive value of r direction is said to be the same: That is, as one increases, so also does the other. Since the p-value (= 0.000) is less than the level of significance, α (= 0.05), we therefore, reject the null hypothesis and conclude that: There is a significant correlation between Water temperature and rate of ship's fuel consumption (y) in Onne and Rivers ports. This simply means that water temperature has a strong relationship with rate of ship's fuel consumption which is one of the key performance indicators to measure ship's performance along Onne and Rivers ports.

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Water Temperature (x) and Delay (Daily Distance Covered) (y) Along Onne and Rivers Ports Waterways

To test the relationship between water temperature and delay (daily distance covered) along Onne and Rivers Port waterways. The study formulated the following hypothesis: H_{02}: There is no significant correlation between water temperature and delay (daily distance covered) (y) in Onne and Rivers ports.

Table 8: Result of Water Temperature (x) and Delay (Daily Distance Covered) (y) in Onne and Rivers Ports

S/N	Correlations	Water Temperature	Delay (Daily Distance Covered)
1.	Pearson Correlation Ship Speed		0.686**
2.	Sig (2-tailed)		0.000
3.	N		83
4.	Pearson correlation Rate of Ship's Fuel Consumption	0.686**	
5.	Sig (2-tailed)	0.000	
6.	N	83	

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Survey Data 2022, SPSS Version 25 Output window

Table 8 shows the positive large value of r (= 0.724) says that there is a strong positive correlation between water temperature (x) and Delay (daily distance covered) (y) in Onne and Rivers ports.

Because of the positive value of r direction is said to be the same: That is, as one increases, so also does the other. Since the p-value (= 0.000) is less than the level of significance, α (= 0.05), we therefore, reject the null hypothesis and conclude that: H_{i2}: There is a significant correlation between Water temperature and delay (daily distance covered) (y) in Onne and Rivers ports. This simply means that water temperature has a strong relationship with delay (daily distance covered) which is one of the key performance indicators to measure ship's performance along Onne and Rivers ports.

Table 9: Summary on the Results on Test of the Research Hypotheses

S/N	Research Hypothesis	r value	Result	Decision
1.	H_{01}: There is no significant relationship between the water temperature and ship's fuel consumption.	0.728	Positive and Significant	Reject
2.	H_{02}: There is no significant relationship between the water temperature and daily distance covered.	0.686	Positive and Significant	Reject

Source: Survey Data 2022, SPSS Version 25 Output window

Table 9 has revealed in summary that the study rejected all the null hypotheses and accepted the alternate hypotheses: H_{i1}; there is a significant relationship between water temperature and ship's fuel consumption along Onne and Rivers Ports waterways. H_{i2}; there is a significant relationship between water temperature and daily distance covered (delay) along Onne and Rivers Port waterways.

V. DISCUSSION OF FINDINGS

The findings of this study were drawn from the analyses of the results in the previous section. In this chapter, the study discussed the findings from the results and analyses.

Relationship Between hull form and Daily Distance Covered (Delay) Along Onne and Rivers Port Waterways

This positive large value of r (0.667) says that there is a strong positive correlation between hull form and Delay (daily distance covered) along Onne and Rivers ports waterways. Because of the positive value of r, direction is said to be the same: That is, as one increases, so also does the other. This finding agrees with the view of Hock (2015) in his paper of international conference on computer applications in shipbuilding

incorporated concepts from free form deformation and computational intelligence, he demonstrated through a case study the optimization process of the hull form design of offshore vessel for reduced resistance and improved seakeeping. Their results demonstrated an improvement in the performance as well as efficiency of the design process, and hence increase the daily distance covered and decrease the delay of ships (Dion Fabiani, 2015).

Relationship Between Water Temperature and Ship's Fuel Consumption Along Onne and Rivers Port Waterways.

The results with regards to the relationship between water temperature and ship's fuel consumption shows that there is a significant correlation between Water temperature and rate of ship's fuel consumption in Onne and Rivers ports; the positive large value of r (= 0.728) also points to the strong positive correlation between Water temperature and Rate of ship's fuel consumption in Onne and Rivers ports. Because of the positive value of r, direction is said to be the same: That is, as one increases, so also does the other. This study supports Nitonye and Dick (2015) position on the effect of fluid density on ship hull resistance and powering from the department of marine engineering rivers state university which shows a positive correlation between water temperature and ship hull resistance. Therefore, from the foregoing as water temperature decreases, the resistance of a ship increases and thus the rate of the ship's fuel consumption increases too and as water temperature increases, the resistance of a ship decreases and thus the rate of the ship's fuel consumption decreases.

Relationship Between the Water Temperature and Daily Distance Covered.

The study found that there is a large positive value of r (= 0.724) which shows a strong positive correlation between water temperature and daily distance covered (delay) in Onne and Rivers ports waterways. The study also found that water temperature as one of the dimensions of hull resistance affects daily distance covered (delay) of ships along Onne and Rivers ports waterways which is one of the measures in measuring ship performance. Because of the positive value of r direction is said to be the same: That is, as water temperature increases, so also does daily distance covered increases (Gebruiksvoorwaarden, 2022).

This study supports Terese Richmond et all (2014) point on how Ships are sensitive to many factors, including the depth of a channel and the extent of sea ice. Increasing temperatures could reduce the amount of sea ice in many important shipping lanes, extending the shipping season. Warmer winters will likely lead to less snow and ice accumulation on vessels, decks, and rigging in marine transportation. In the Arctic, warmer temperatures could also open up the possibility of a Northwest Passage during portions of the year, which could reduce delay in shipping times and increase the daily distance covered. However, these new passages may also provide a pathway for invasive species transport and survival (Gebruiksvoorwaarden, 2022). Shipping lanes experiencing sea level rise will be able to accommodate larger ships, thereby increasing the daily distance covered by a ship, reducing the delay and reducing shipping costs. However, higher sea levels will mean lower clearance under waterway bridges. In inland waterways where water levels are expected to decline, as in parts of the Great Lakes, ships could face weight restrictions, as channels become too shallow (Terese Richmond et all, 2014).

VI. CONCLUSION

From the test and hypotheses in this study, it is evident and conclusive that:

1. Water temperature has been a strong factor in measuring the rate of ship fuel consumption along Onne and Rivers port waterways.
2. The level of distance covered (delay) with time is determined by the water temperature at a particular time.

VII. RECOMMENDATIONS

The study has been embarked upon to empirically examine the relationship between water temperature and ship performance along Onne and Rivers port waterways. Based on the findings and conclusion on the study, the following recommendations have been made:

1. Constant dredging of the channels in the waterways along Onne and Rivers port by the appropriate authorities is advice as this will enhance ship speed and thus ship performance.

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2. The wrecks along Onne and Rivers port waterways should be removed by the appropriate authorities as this will enhance ship speed, reduce delay in ship turnaround time and thus increase ship performance.
3. The hull form of a ship should be considered when building in such a way as to maximally optimize its effects.
4. All obstructions and impediments that limits ship performance along Onne and Rivers port waterways should be removed by the appropriate authorities.

APPENDIX

SUMMARY OF WATER TEMPERATURE

Descriptive Statistics

	N	Mean	Std. Deviation
The resistance reduction becomes increasingly limited with the improvement of water temperature.	83	3.7562	0.83460
The low-temperature circuit is used for low-temperature zone machinery and this circuit is directly connected to the main seawater central cooler that enhances ship performance.	83	3.2483	0.99411
Water temperature is maintained by low-temperature fresh water and the system normally comprises of the jacket water system of the main engine encouraging ship performance.	83	3.0777	0.89974
Higher speed is possible in the freshwater system which results in reduced piping and low installation cost	83	3.1831	0.95746
Since the temperature-controlled is irrespective of seawater temperature, the stable temperature is maintained which helps in reducing machinery wear down and sustenance of ship performance.	83	2.5088	1.12156
Valid N (listwise)	83		

Source: SPSS ver. 25 Output window

SUMMARY OF RATE OF SHIP'S FUEL CONSUMPTION

Descriptive Statistics

	N	Mean	Std. Deviation
Decreasing ship speed is a good effort to reduce emissions from ships and fuel consumption	83	2.2580	1.22354
Presence of fouling on the hull increases the ship resistance therefore results an increase in ship fuel consumption, which directly increases operational costs of ship	83	3.3039	.99621
The non-linear relationship between speed and fuel consumption shows that lower-speed vessels will consume less fuel than high speed vessels.	83	3.0318	.95039
By lowering the speed of the vessel, it is expected that fuel consumption and ship emissions are also reduced	83	3.2544	.98883
Speed of a ship depends on various factors like displacement of the vessel, draft, wind force and direction, sea weather condition, condition of the hull and the propeller and fuel consumption rate.	83	3.3216	1.06481
Valid N (listwise)	83		

Source: SPSS ver. 25 Output window

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SUMMARY OF DELAY (DAILY DISTANCE COVERED)

Descriptive Statistics

	N	Mean	Std. Deviation
Trimming out the sterndrive or outboard lifts the bow, reduces the wetted surface of the hull and thus drag, and increases speed	83	3.3110	0.87648
Stability is determined by the force of buoyancy provided by the underwater parts of a vessel, coupled with the combined weight of its hull, equipment, fuel, stores, load and daily distance covered	83	3.2332	0.97597
Speed and power for a ship in service will give the daily fuel consumption and the daily distance covered	83	3.2438	1.09184
The daily mean power and mean speed may be calculated, and the result may be plotted in the speed/power diagram for comparison with the daily distance covered.	83	3.2085	1.11518
Diminishing power output and increasing fouling in the hull, resulting in increasing fuel consumptions affects the daily distance covered.	83	2.8314	0.97775
Valid N (listwise)	83		

Source: SPSS ver. 25 Output window

COMPUTING PEARSON PRODUCT MOMENT CORRELATION COEFFICIENT BETWEEN WATER TEMPERATURE (x) AND RATE OF SHIP'S FUEL CONSUMPTION (y) IN ONNE AND RIVERS PORTS

The stated hypotheses are as follows:

H_0: $\rho_s = 0$: There is no significant correlation between Water temperature and rate of ship's fuel consumption (y) in Onne and Rivers ports;

H_1: $\rho_s \neq 0$: There is a significant correlation between Water temperature and rate of ship's fuel consumption (y) in Onne and Rivers ports;

Correlations

			Water temperature	Rate of ship's fuel consumption
Spearman's rho	Water temperature	Correlation Coefficient	1.000	.728**
		Sig. (2-tailed)	.	.000
		N	83	83
	Rate of ship's fuel consumption	Correlation Coefficient	.728**	1.000
		Sig. (2-tailed)	.000	.
		N	83	83

**. Correlation is significant at the 0.01 level (2-tailed).

Source: SPSS ver. 25 Output window

From the SPSS output window, the correlation coefficient of the variables x and y is 0.728

INTERPRETATION

This positive large value of r (= 0.728) says that there is a strong positive correlation between Water temperature (x) and Rate of ship's fuel consumption (y) in Onne and Rivers ports.

Because of the positive value of r direction is said to be the same: That is, as one increases, so also does the other.

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Since the p-value (= 0.000) is less than the level of significance, α (= 0.05), we therefore, reject the null hypothesis and conclude that:

H_1: $\rho_s \neq 0$: There is a significant correlation between Water temperature and rate of ship's fuel consumption (y) in Onne and Rivers ports;

COMPUTING PEARSON PRODUCT MOMENT CORRELATION COEFFICIENT BETWEEN WATER TEMPERATURE (x) AND DELAY (DAILY DISTANCE COVERED) (y) IN ONNE AND RIVERS PORTS

The stated hypotheses are as follows:

H_0: $\rho_s = 0$: There is no significant correlation between water temperature and delay (daily distance covered) (y) in Onne and Rivers ports;

H_1: $\rho_s \neq 0$: There is a significant correlation between water temperature and delay (daily distance covered) (y) in Onne and Rivers ports;

Correlations

			Water temperature	Delay (daily distance covered)
Spearman's rho	Water temperature	Correlation Coefficient	1.000	.686**
		Sig. (2-tailed)	.	.000
		N	83	83
	Delay (daily distance covered)	Correlation Coefficient	.686**	1.000
		Sig. (2-tailed)	.000	.
		N	83	83

**. Correlation is significant at the 0.01 level (2-tailed).

Source: SPSS ver. 25 Output window

From the SPSS output window, the correlation coefficient of the variables x and y is 0.724

INTERPRETATION

This positive large value of r (= 0.724) says that there is a strong positive correlation between water temperature (x) and Delay (daily distance covered) (y) in Onne and Rivers ports.

Because of the positive value of r direction is said to be the same: That is, as one increases, so also does the other.

Since the p-value (= 0.000) is less than the level of significance, α (= 0.05), we therefore, reject the null hypothesis and conclude that:

H_1: $\rho_s \neq 0$: There is a significant correlation between Water temperature and delay (daily distance covered) (y) in Onne and Rivers ports.

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