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Vessel Design and Operational Efficiency for Nigerian Cabotage

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ABSTRACT

This research involved an in-depth analysis of the maritime vessel design intricacies and operational efficiency of Cabotage vessels in Nigeria, which included general cargo vessels, tugboats, tanker vessels, and service vessels. It examined specifically the vessel design speed, vessel transit speed, vessel transit time, and vessel-specific fuel oil consumption. The research utilised data sources such as the vessels' design and operational manuals, class reports, and survey certificates to enable a comprehensive investigation into the intricate relationship between Cabotage vessel design technicality and their operational efficiency. The methodology employed in this study encompassed bivariate correlation analysis, with a particular emphasis on the Spearman correlation analysis. This analytical approach was utilized to scrutinize the data, and the significance level was set at 0.05 for the two-tailed tests. The outcomes of this extensive research endeavour offer valuable insights into the connections between vessel design intricacies and operational efficiency within the class of Cabotage vessels in Nigeria. The results showed that the observed correlation did not reach statistical significance at the 0.05 level. As a result, the findings of this research indicate that while relationships exist, they may not be substantial enough to draw conclusive significance.

1. Introduction.

The maritime industry in the 21st century is experiencing rapid growth, driven by continuous technological advancements on a global scale (Gavalas, et al., 2022; Hlali and Wanis, 2020; Anatoli, 2019). Those involved in vessel design, construction, operation, and port management worldwide share a common focus on ensuring optimal performance and safety (Jinfen, and Ângelo, 2023).

The design of maritime vessels involved for careful consideration of technical aspects such as hull design, propulsion systems, and stability (Chen-Hsiu, 2024). This reflection to detail gives intentions to improve vessel performance, fuel efficiency, and environmental responsibility. Moreover, vessel efficiency is likewise influenced by many factors such as crew training, maintenance practices, and route planning (Huan, et al., 2024). The connection with the advanced technologies and the implementation of effective operational strategies, maritime companies can improve vessel efficiency and minimize the operational costs (Lindstad et al., 2013).

Sea transportation plays an important role in facilitating international business transactions on a large scale (Vladimir & Stanislav, 2018). The need for sea transportation is closely related to growth in the economy and technology. According to Wuisan et al. (2012), more than 90% of international commerce depends on sea transport. Sea transport is connected to developments in the economy and technology. Maritime transportation, facilitated through sea crafts, meets the requirement for energy, raw material, food, and consumer goods worldwide. Careful designs of ships help increase efficiency by reducing fuel cost, increasing freight capacity, improving safety, and lowering costs for the purpose of generating higher profits (Veenstra et al., 2006; Sinay, 2023).

Globalization has caused maritime shipping to increase much more, and it made number of ships go up too. From 1970

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to 2005, there was a 70 percent growth in world's merchant ships. Using more ships meant that more fuel got burned and this produced higher pollution in world (Veenstra et al., 2006; UNCTAD, 2022). Ships make emissions when they are using fuel, these include gases like carbon dioxide, sometimes a carbon monoxide, nitrogen oxides, methane, black carbon, sulfur oxides and other small particulates (Taih-Cherng et al., 2014; Roy et al., 2001). The ways that people design ships is why it is so important for keeping environment good. Ship pollution creates problems with air quality and water. But if shipbuilders and managers try to improve the design and how ships are driven, they could help a lot to less pollution and make shipping connect to a sustainability idea (Felício et al., 2021).

Nevertheless, making vessel operations restored can bring batter results, such as improve productivity and making things work more efficient. It also brings down time ships are not working, the costs of maintenance will be less, safety is stronger and there is improvement in how the environment is treated (Maloni et al., 2013). These kinds of upgrades can make shipping companies more competitive, as well as making profits higher. It also can help people who are working on the ships to have a better lives.

The Cabotage Act that came in 2003 as a government rule wants to protect the shipping market of the country. To do this, coastal ship trading is given only to Nigerian ship owners, if their vessels are built, registered, and managed by Nigerians within Nigeria. Cabotage vessels are ships that move goods or people from one Nigerian place to another in the country. This encompasses various activities such as transporting goods and passengers related to mineral and non-natural resource exploration, offshore and inland water transportation, as well as other commercial marine operations in Nigerian waters, including towage, pilotage, dredging, salvage, and bunkering (Ferdinand and Henry, 2018). The application of a "Waiver Clause" permits the use of foreign vessels and personnel in cases where there is a lack of such resources within the country, subject to the guidelines outlined in the Cabotage Act of 2003 (Ferdinand and Henry, 2018).

The Act categorizes certain vessel types as Cabotage Vessels, including passenger vessels, crew boats, fishing trawlers, barges, tugs, offshore service vessels, anchor handling tugs and supply vessels, floating petroleum storage, dredgers, and tankers, as well as any other crafts or vessels involved in the transportation of persons, property, or substances, whether on, though, or underwater (Edmund, 2018).

Seaport and container port efficiency acts like a key factor for judging performance in maritime transport and maritime sector (Hlali, 2018; Hlali et al., 2023). Recently, one of the highest directions in maritime transport is about trying to optimize how technical vessels are designed so that they can work more efficient in operations. Main goals mainly include obtaining economic scale for bigger container ships movement, to help make transport that is greener as well as helping develop blue economy things (Ana and Viorela, 2019). In addition, the ship design characteristics such as size, handling necessities, and compatibility with terminal infrastructure which impact on operational efficiency and minimize vessel delays which is a grave aspect for port efficiency (Nwoloziri et al., 2026). These aims make industry look for newer ship design solutions for dealing with various technical issues, such as hull construction, propeller systems, keeping stability, safety measures or effect on the environment (Jelena and Maja, 2021). Ultimately, it is about maximizing ship working ability and while also lower running costs and smaller environmental impact. To accomplish this imposes a inclusive considerate of both the vessel's technical basics and the operational demands of crew and stakeholders. Ultimately, the objective is to create vessels that prioritize safety, reliability, and efficiency while effectively serving the maritime industry and the environment.

Habitually, ships are considered with an importance on serene waters and a reliable design speed. Nevertheless, ships encounter the variations of speeds and sea conditions through their operative lifecycles. Recognizing the profound connection between the environment and a ship's conduct at sea, there is an insistent need to design ships that conduct to energy-efficient, to safety, and capable of transporting robust performance under the sea conditions. Therefore, this study focuses on the examination of the technical intricacies of maritime vessel design and operational efficiency, with a precise concentration on Cabotage vessels in Nigeria. The purpose is to evaluate the impact of vessel design technology on operational efficiency of Cabotage vessels operating in Nigeria coastal waters to cut operating costs while mitigating environmental hazards following the next Hypotheses,

H_1= Vessel engine capacity and vessel design speed do not exhibit a significant relationship.

H_2= Vessel engine capacity and vessel transit speed do not display a significant relationship.

H_3=Vessel engine capacity and specific fuel oil consumption do not demonstrate a significant relationship.

H_4=Vessel engine capacity and vessel time of transit do not indicate a significant relationship.

H_5=Vessel load factor and vessel design speed do not reveal a significant relationship.

H_6=Vessel load factor and vessel transit speed do not manifest a significant relationship.

H_7=Vessel load factor and specific fuel oil consumption do not establish a significant relationship.

H_8=Vessel load factor and vessel transit time do not establish a significant relationship.

Lately, ship demand has shot up and pushed global shipping into overdrive. More ships on the water means more fuel burned and higher emissions, which isn't great for the environment. To tackle this, ship designers and builders have turned to new technology, building bigger vessels that help companies save money on bulk shipments. These ships aren't just larger, it crafted to run efficiently, crowd more speed out of less fuel, and make maritime operations smoother overall (Harilaos and Christos, 2013; Yupeng and Li, 2017). Diesel engines are still the go-to for most coastal vessels, especially for containers, tankers, and service ships. It plays a central role in ships design and operation (Tien, 2020).

Vessel engine design and speed share a close relationship, with ship speed having a substantial impact on both environmental and economic factors for vessel operators (Karl et al., 2020). Ship speed effects a variety of environmental aspects and economic attentions for operators, as defined by Karl (2020). At the design level, larger container ships with reduced speed are being constructed to minimize CO2 emissions per container. In the shipping world, “slow steaming” — cutting down a vessel’s speed to match fuel prices and market demands — has become pretty standard (Meyer et al., 2012). So, knowing how fast a ship moves, and what affects that speed, really matters.

Charting and navigation of ship prove that nautical miles are essential, it based on the Earth’s circumference, serve as a fundamental unit. The Modern ships employ GPS (Global Positioning System) for specific speed amount, including a transmitter, receiver, and satellite system. GPS technology is accurate method for measuring a vessel’s speed. Alternatively, Doppler shift and correlation velocity log (CVL) are used to measure speed (Dinesh, et al., 2015).

To design a vessel’s speed, various operational and design factors must be considered. Among all consumables on a ship, fuel is the costliest element. Owners seek to construct economical ships with reduced fuel consumption to navigate the challenges of today’s world marked by ongoing oil crises and rising fuel prices. Thus, merchant ships are designed to be as economically efficient as possible, depending on the cargo they transport, the chosen route, and their draft (Liviu, (2015).

Fuel consumption is closely tied to the displacement of the ship and its power, mainly determined by the vessel’s speed in knots and the displacement, which represents the weight of water displaced by the submerged portion of the vessel (Nicolas and Dimitris, 2016). Increasing displacement (engine load factor) directly requires more power and consequently, more fuel. Contrariwise, the repetition of the ship’s speed leads to rise in fuel consumption. Ioannis and Nikitas (2015) recapitulated that the outcome of increase speed on fuel consumption is significantly higher than the effect of the increase of the displacement or the payload.

The critical role of speed in a ship’s operation. However, constraints are placed on increasing displacement due to technological limitations, draft restrictions in different areas and routes like coastal waters. The increase in fuel consumption per ton is relatively reasonable compared to the increase in fuel consumption per knot of speed. For each ship, there exists an economically favorable range of speed and displacement that prudent ship owners should adhere to in order to achieve profitability in the maritime industry, where freight and charter prices depend on the supply and demand for ship tonnage, among other factors.

The speed of a ship is influenced by several factors, including vessel displacement, draft, wind force and direction, sea weather conditions, hull and propeller condition, and more (Nicolas and Dimitris, 2016). When a ship’s empty it rides higher in the water. Less of the hull is underwater, so there’s less drag holding it back. That lets the ship move faster and use less engine power (Cheol-Min et al.). But once you start loading it, everything shifts. The ship settles lower, more of the hull gets submerged, and resistance increases. With the same amount of engine power, a loaded ship just can’t go as fast (Ulio et al., 2022).

Other factors, such as wind force magnitude and direction, impact the load on the main engine, either increasing or decreasing the vessel’s speed for a given main engine RPM (Revolution per minute); also, Hull and propeller fouling, on the other hand, contribute to increased drag resistance on the hull, reducing the ship’s speed for the same main engine load (Maloni et al., 2013; MAN, 2012).

Containership fuel consumption is defined by the ship engine size and its cruising speed, which displays an exponential relationship overhead fourteen knots (Alenxanderos et al., 2017). For instance, a containership with a capacity of approximately 8,000 TEU would consume approximately 225 tons of bunker fuel per day when cruising at 24 knots. Reducing the speed to 21 knots results in a 33% decrease in fuel consumption, down to about 150 tons per day. While shipping lines seek to minimize fuel consumption by adopting lower speeds, this advantage must be balanced with longer transit times and potentially deploying additional ships on pendulum services to maintain the same port call frequency.

Alenxanderos et al., (2017) classified the main ship speed into four categories. First category is the optimal cruising speed for containerships with normal speed (20-25 knots), it considered for effective fuel consumption, typically around 24 knots. The second category is the slow steaming (18-20 knots) is a fuel-saving policy that outcomes in longer transit times, with over 50% of global container shipping. The third category is the extra slow steaming (15-18 knots) more diminishes speed for minimal fuel consumption on explicit roads, and the lowest cost speed (12-15 knots) is the lowest officially practicable speed, but is not implemented due to undesirable service stages.

The practice of slow steaming appeared through the financial crisis during the period 2008-2009 once global trade declined instantaneously with the entrance of novel capacity ordered during prior years (Theo and Athanasios, 2021). In response, maritime shipping companies introduced slow steaming and even extra slow steaming services on several of their pendulum routes. This allowed them to incorporate additional ships while maintaining a similar frequency of port calls. It was initially expected that, with the resumption of growth and increased traffic, maritime shipping companies would return to their regular cruising speeds. However, shipping companies sustained to implement slow steaming as a cost-cutting measure, frequently using environmental attentions to validate this training. The slow steaming become now the innovative typical that the industry participants must adapt.

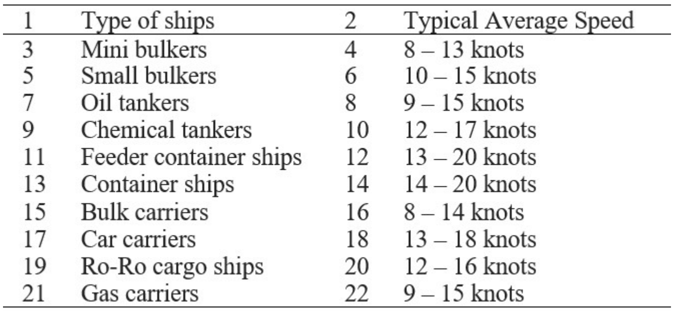
Slow steaming necessitates adjustments to engines originally designed for a specific optimal speed of approximately 22-25 knots, causing them to operate at around 80% of their full power capacity for that speed (Maloni et al., 2013). To implement slow steaming, the main engine must undergo a ”derating” process, which involves adapting it to the new speed and power level (around 70%). This entails modifying the timing of fuel injection, adjusting exhaust valves, and replacing other mechanical components in the engine. The continued practice of slow steaming has implications for maritime routes, supply chain management, and the use of trans-shipment hubs.

The influence of slow steaming differs dependent on the type of trade involved, with low-value containerized goods, for example waste products being less exaggerated compared to time-sensitive retail trade.

As the ships move from the calm waters to the harsh ocean environment, there is a significant variation in their efficiency, especially because of the wind and waves. These factors result in increased resistance and reduced forward speeds in real sea states, necessitating a revaluation of hydrodynamic performance beyond traditional assessments of calm water resistance (Maysam, et al., 2016). Studies by (Bolbot and Papanikolaou (2016); Percy et al. (2020); Kim et al. (2021) have examined the optimization of hull shapes and sectional area curves to minimize both wave-making resistance and added resistance in waves. These efforts have positively directed to distinguished reductions in resistance and enhancing ship performance.

Container and cruise ships, as well as roll-on/roll-off vessels, yield more substantial benefits in terms of fuel and emissions reduction compared to smaller, slower-moving vessels such as bulkers, general cargo, and tanker ships (Sui, et al., 2020). While these measures can increase transit times, they generally fall within acceptable vessel arrival windows. To encourage ship operators to comply with reduced speed requirements, incentives can be established to offset any additional transit time-related costs. Over time, the shipping industry has established standards for ship sizes, capacity, fuel consumption, and, of course, ship speed. Various types of ships adhere to industry-average speeds, which may vary based on specific owner requirements and operational needs.

Table 1: Ship Speed regulation.



1	Type of ships	2	Typical Average Speed
3	Mini bulkers	4	8 – 13 knots
5	Small bulkers	6	10 – 15 knots
7	Oil tankers	8	9 – 15 knots
9	Chemical tankers	10	12 – 17 knots
11	Feeder container ships	12	13 – 20 knots
13	Container ships	14	14 – 20 knots
15	Bulk carriers	16	8 – 14 knots
17	Car carriers	18	13 – 18 knots
19	Ro-Ro cargo ships	20	12 – 16 knots
21	Gas carriers	22	9 – 15 knots

Source: Authors.

2. Methodology.

The study employed a method of data collection based on secondary sources. These secondary data were extracted from ship documents, including vessel class records, operational manuals, daily logbooks, and monthly reports. As part of a pilot study, the researcher visited ports, jetties, dockyards, and anchorages where many Cabotage vessels were stationed. Information was obtained directly from ship operators, specifically ship masters, chief mates, and chief engineers on board Cabotage vessels operating in Nigerian waters.

For this study, Spearman Rank correlation analysis was chosen. Spearman Rank correlation necessitates sorting the data and assigning specific ranks to each value, with 1 being the lowest rank. In the case of repeated data values, equal ranks are assigned based on their average. Spearman's rank correlation assesses the strength and direction of the association between two ranked variables. It measures the monotonicity of the connection between two variables, which shows how efficiently a monotonic function can capture their relationship. The formula for Spearman's rank coefficient as bellow:

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{\left(n\sum x^2 - (\sum x)^2\right)\left(n\sum y^2 - (\sum y)^2\right)}} \tag{1}$$

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \tag{2}$$

In the formula provided:

ρ represents the Spearman's rank correlation coefficient.

" d_i " denotes the difference between the two ranks of each observation.

"n" stands for the number of observations.

The Spearman Rank Correlation (ρ) is akin to the correlation coefficient and can assume values between +1 and -1. Here's the interpretation:

A value of +1 signifies a perfect association of ranks.

A value of 0 indicates no association between ranks.

A value of -1 suggests a perfect negative association of ranks.

For this analysis, a two-tailed significance level of 0.005 was utilized.

The inspection of maritime vessel design intricacies and operational efficiency holds great significance for numerous compelling reasons. To initiate, maritime vessels stand as critical properties for international trade and transport. An effective vessel design holds the latent to restrain fuel consumption, increase cargo capacity, and reinforce safety measures and reduce cost for shipping companies. Also, the vessel operations optimization led to efficiency and productivity.

3. Results and Discussion.

The study encompassed four categories of vessels involved in Cabotage operations in Nigeria: general cargo vessels, tanker vessels, tugboats, and supply/service vessels. Information was gathered on various aspects, including main engine power (KW), specific fuel oil consumption, vessel designed speed, vessel transit time, vessel load factor, and vessel transit time. These data were tabulated in a tabular form (Table 4.1, 4.2, 4.3, and 4.4) in the appendix pages.

Where:

ME.kW represents Main Engine Power in Kilowatts (kW); SFOC is the Specific Fuel Oil Consumption (g/kW.h); VDS represents Vessel Design Speed (Knots)/Service speed; VTS is the Vessel Transit Speed (Knots); while LF represents the Load Factor (%).

The analysis in Table 2 shows:

Main Engine Power (KW) vs. Vessel Design Speed:

Weak positive correlation (22.6%)

Not statistically significant (p-value > 0.005)

Suggests no significant relationship between main engine power and vessel design speed.

Main Engine Power (KW) vs. Vessel Transit Speed:

Weak positive correlation (27.3%)

Not statistically significant (p-value > 0.005)

Indicates no significant relationship between main engine power and vessel transit speed.

Main Engine Power (KW) vs. Vessel Transit Time:

Weak positive correlation (22.9%)

Not statistically significant (p-value > 0.005)

Implies no significant relationship between main engine power and vessel transit time.

Main Engine Power (KW) vs. Specific Fuel Oil Consumption:

Strong negative correlation (52.7%)

Statistically significant (p-value < 0.05)

Suggests a significant relationship between main engine power and specific fuel oil consumption.

Load Factor vs. Vessel Design Speed:

Strong negative correlation (64.7%)

Statistically significant (p-value < 0.05)

Indicates a significant relationship between load factor and vessel design speed.

Load Factor vs. Vessel Transit Speed:

Strong positive correlation (56.0%)

Statistically significant (p-value < 0.05)

Implies a significant relationship between load factor and vessel transit speed.

Load Factor vs. Vessel Transit Time:

Weak positive correlation (30.3%)

Not statistically significant (p-value > 0.05)

Suggests no significant relationship between load factor and vessel transit time.

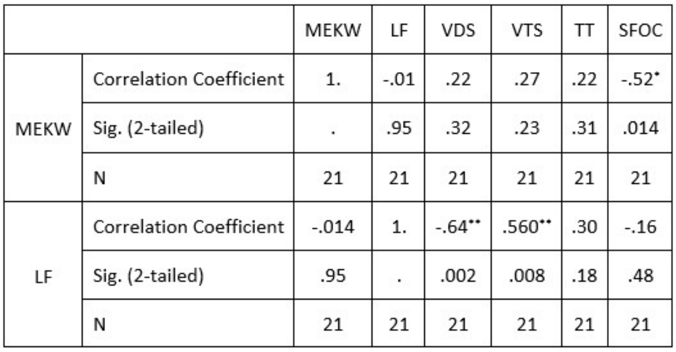
Load Factor vs. Specific Fuel Oil Consumption:

Weak negative correlation (16.2%)

Not statistically significant (p-value > 0.05)

Indicates no significant relationship between load factor and specific fuel oil consumption.

Table 2: Spearman's Correlations of Characteristics of Surveyed General Cargo Vessels.



		MEKW	LF	VDS	VTS	TT	SFOC
MEKW	Correlation Coefficient	1.	-.01	.22	.27	.22	$-.52^{*}$
	Sig. (2-tailed)	.	.95	.32	.23	.31	.014
	N	21	21	21	21	21	21
LF	Correlation Coefficient	-.014	1.	$-.64^{**}$	$.560^{**}$	.30	-.16
	Sig. (2-tailed)	.95	.	.002	.008	.18	.48
	N	21	21	21	21	21	21

*. Correlation is significant at the 0.05 level (2-tailed).

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

Source: Authors.

The analysis in Table 3 shows:

Main Engine Power (KW) vs. Vessel Design Speed:

Weak negative correlation (4.7%)

Not statistically significant (p-value > 0.05)

Suggests no significant relationship between main engine power and vessel design speed.

Main Engine Power (KW) vs. Vessel Transit Speed:

Weak positive correlation (28.0%)

Not statistically significant (p-value > 0.05)

Indicates no significant relationship between main engine power and vessel transit speed.

Main Engine Power (KW) vs. Vessel Transit Time:

Weak negative correlation (0.8%)

Not statistically significant (p-value > 0.05)

Implies no significant relationship between main engine power and vessel transit time.

Main Engine Power (KW) vs. Specific Fuel Oil Consumption:

Weak positive correlation (16.8%)

Not statistically significant (p-value > 0.05)

Suggests no significant relationship between main engine power and specific fuel oil consumption.

Load Factor vs. Vessel Design Speed:

Weak negative correlation (30.8%)

Not statistically significant (p-value > 0.05)

Indicates no significant relationship between load factor and vessel design speed.

Load Factor vs. Vessel Transit Speed:

Weak negative correlation (29.4%)

Not statistically significant (p-value > 0.05)

Implies no significant relationship between load factor and vessel transit speed.

Load Factor vs. Vessel Transit Time:

Weak negative correlation (10.8%)

Not statistically significant (p-value > 0.05)

Suggests no significant relationship between load factor and vessel transit time.

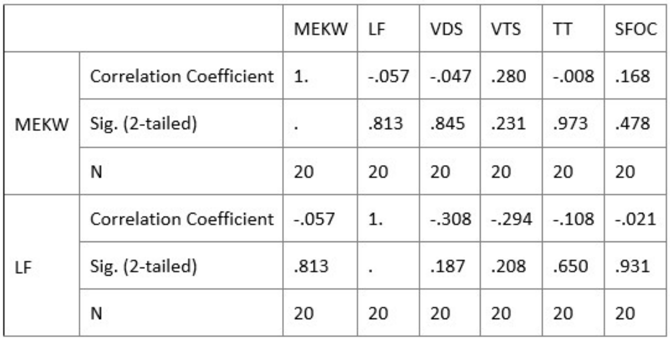
Load Factor vs. Specific Fuel Oil Consumption:

Weak negative correlation (-2.1%)

Not statistically significant (p-value > 0.05)

Indicates no significant relationship between load factor and specific fuel oil consumption.

Table 3: Spearman's Correlations of Characteristics of Surveyed Tanker Vessel.



		MEKW	LF	VDS	VTS	TT	SFOC
MEKW	Correlation Coefficient	1.	-.057	-.047	.280	-.008	.168
	Sig. (2-tailed)	.	.813	.845	.231	.973	.478
	N	20	20	20	20	20	20
LF	Correlation Coefficient	-.057	1.	-.308	-.294	-.108	-.021
	Sig. (2-tailed)	.813	.	.187	.208	.650	.931
	N	20	20	20	20	20	20

Source: Authors.

The analysis in Table 4 shows:

Main Engine Power (KW) vs. Vessel Design Speed:

Weak positive correlation (18.6%)

Not statistically significant (p-value > 0.05)

Suggests no significant relationship between main engine power and vessel design speed.

Main Engine Power (KW) vs. Vessel Transit Speed:

Weak positive correlation (13.8%)

Not statistically significant (p-value > 0.05)

Indicates no significant relationship between main engine power and vessel transit speed.

Main Engine Power (KW) vs. Vessel Transit Time:

Weak positive correlation (9.8%)

Not statistically significant (p-value > 0.05)

Implies no significant relationship between main engine power and vessel transit time.

Main Engine Power (KW) vs. Specific Fuel Oil Consumption:

Weak positive correlation (13.1%)

Not statistically significant (p-value > 0.05)

Suggests no significant relationship between main engine power and specific fuel oil consumption.

Load Factor vs. Vessel Design Speed:

Negative correlation (41.9%)

Not statistically significant (p-value > 0.05)

Indicates no significant relationship between load factor and vessel design speed.

Load Factor vs. Vessel Transit Speed (RPM):

Strong positive correlation (62.2%)

Statistically significant (p-value < 0.05)

Implies a significant relationship between load factor and vessel transit speed (RPM).

Load Factor vs. Vessel Transit Time:

Weak positive correlation (7.5%)

Not statistically significant (p-value > 0.05)

Suggests no significant relationship between load factor and vessel transit time.

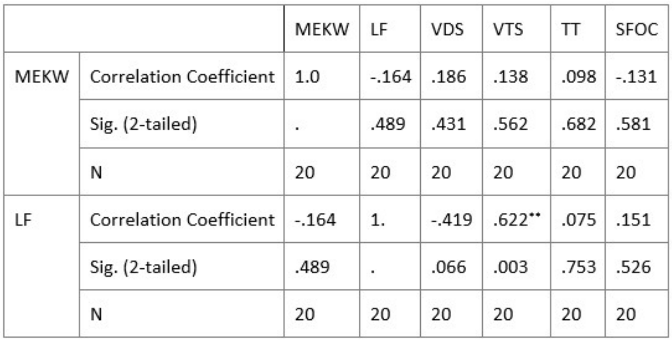
Load Factor vs. Specific Fuel Oil Consumption:

Weak positive correlation (15.1%)

Not statistically significant (p-value > 0.05)

Indicates no significant relationship between load factor and specific fuel oil consumption.

Table 4: Spearman's Correlations of Characteristics of Surveyed Tugboat.



		MEKW	LF	VDS	VTS	TT	SFOC
MEKW	Correlation Coefficient	1.0	-.164	.186	.138	.098	-.131
	Sig. (2-tailed)	.	.489	.431	.562	.682	.581
	N	20	20	20	20	20	20
LF	Correlation Coefficient	-.164	1.	-.419	.622**	.075	.151
	Sig. (2-tailed)	.489	.	.066	.003	.753	.526
	N	20	20	20	20	20	20

Source: Authors.

The analysis in Table 5 shows:

Main Engine Power (KW) vs. Vessel Design Speed:

Weak positive correlation (32.4%)

Not statistically significant (p-value > 0.05)

Suggests no significant relationship between main engine power and vessel design speed.

Main Engine Power (KW) vs. Vessel Transit Speed:

Strong negative correlation (41.9%)

Not statistically significant (p-value > 0.05)

Indicates no significant relationship between main engine power and vessel transit speed.

Main Engine Power (KW) vs. Vessel Transit Time:

Very weak positive correlation (24.9%)

Not statistically significant (p-value > 0.05)

Implies no significant relationship between main engine power and vessel transit time.

Main Engine Power (KW) vs. Specific Fuel Oil Consumption:

Strong positive correlation (52.6%)

Statistically significant (p-value < 0.05)

Suggests a significant relationship between main engine power and specific fuel oil consumption.

Load Factor vs. Vessel Design Speed:

Strong negative correlation (87.4%)

Statistically significant (p-value < 0.05)

Indicates a significant relationship between load factor and vessel design speed.

Load Factor vs. Vessel Transit Speed:

Weak positive correlation (38.0%)

Not statistically significant (p-value > 0.05)

Implies no significant relationship between load factor and vessel transit speed.

Load Factor vs. Vessel Transit Time:

Very weak negative correlation (11.6%)

Not statistically significant (p-value > 0.05)

Suggests no significant relationship between load factor and vessel transit time.

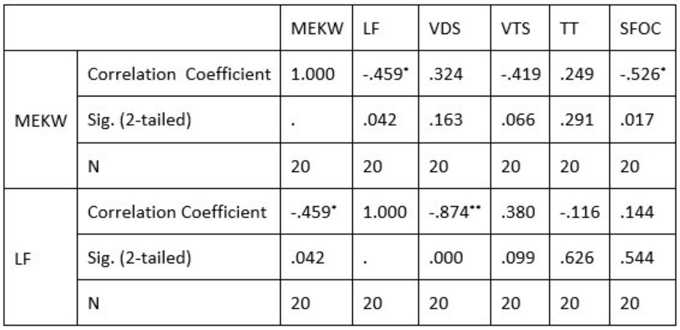
Load Factor vs. Specific Fuel Oil Consumption:

Weak positive correlation (14.4%)

Not statistically significant (p-value > 0.05)

Indicates no significant relationship between load factor and specific fuel oil consumption.

Table 5: Spearman's Correlations of Characteristics of Surveyed Supply Vessel.



		MEKW	LF	VDS	VTS	TT	SFOC
MEKW	Correlation Coefficient	1.000	-.459*	.324	-.419	.249	-.526*
	Sig. (2-tailed)	.	.042	.163	.066	.291	.017
	N	20	20	20	20	20	20
LF	Correlation Coefficient	-.459*	1.000	-.874**	.380	-.116	.144
	Sig. (2-tailed)	.042	.	.000	.099	.626	.544
	N	20	20	20	20	20	20

*. Correlation is significant at the 0.05 level (2-tailed).

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

Source: Authors.

Conclusions.

Maritime industry in Nigeria is experiencing rapid growth, marked by the increasing registration of vessels for Cabotage operations. This growth has caused in a considerable volume of coastal shipping trade, mainly profiting indigenous ship owners flying the Nigerian flag. Nigeria privileges a large sea for maritime activities, accompanied by ports equipped and jetties that enable vessel operations and cargo handling. The operation of the cabotage continue within the ports and inland channels, where they transport locally generated cargoes along the coastal areas of the country, in agreement with the recognized policy. There are approximately six major ports and numerous jetties where these vessels operate, transporting cargo from its point of origin to the intended destination.

This study investigated of the maritime vessel design technicality and operational efficiency of Cabotage vessels in Nigeria. The study detected numerous types of vessels operating under the Cabotage Act, such as general cargo vessels, tugboats, tanker vessels, and service vessels. The study evaluated the relationships connecting the design technical aspects of these vessels, such as the engine capacity and the load factor with the design speed, vessel transit speed, vessel transit time, and vessel-specific fuel oil consumption. The findings of the study conclude that correlation exit between the variables but not statistically significant at 0.05 level. As a result, the findings of this research indicate that while relationships exist, they may not be substantial enough to draw conclusive significance.

References.

Anatoli, A. (2019). The Challenges of the Digital Technology Era for Maritime Education and Training. Conference: 2019 *European Navigation Conference (ENC)*. 1(2). https://doi.org/10.1109/EURONAV.2019.8714176.

Ana, C. O., Viorela, S. (2019). The Economic Impact of the Blue Economy. International Scientific Conference Communicative Action & Transdisciplinary in the Ethical Society. 2(7), 23-24.

Bolbot, V. & Papanikolaou, A. (2016). Optimization of ship's bow form for the added resistance in waves. International Conference on Maritime Technology and Engineering (MARTECH). Lisbon, Portugal https://www.researchgate.net/publication/305072600_Optimization_of_ship's_bow_form_for_the_added_resistance_in_waves.

Cheol-Min L, Jin-Won Y, Jung-Eun C., Inwon, L. (2019). Effect of bow hull forms on the resistance performance in calm water and waves for 66k DWT bulk carrier. *International Journal of Naval Architecture and Ocean Engineering*, 11(2), 723-735. https://doi.org/10.1016/j.ijnaoe.2019.02.007.

Chen-Hsiu L. (2024). Maximizing Efficiency in the Suez Canal: A New Approach to Evaluate the Impact of Optimal Time-Varying Tolls on Ship Arrival Times. *Journal of Marine Science Engineering, 12*(1), 76-92. https://doi.org/10.3390/jmse12010076.

Dinesh, S., Zainal, F. M. A. and Asmariah, J. (2015). Evaluation of the accuracy of global positioning system (GPS) speed measurement via GPS simulation. *Technical Bulletin* 8(2):121-128.

Edmund Mbama Chilaka. (2018). Nigerian Cabotage Law and the Development of Indigenous Maritime Capacity. *Journal of Nigeria Transport History*. 23(5). 1-22.

Felício, J. A., Ricardo R., and Vitor C. (2021). Green Shipping Effect on Sustainable Economy and Environmental Performance, *Sustainability* 13(8): 42-56. https://doi.org/10.3390/su13084256.

Ferdinand O. A., & Henry, C. A. (2018): Cabotage Regimes and their Effects on States' Economy. NAUJILJ. 9 (1). 71-82.

Gavalas, D., Syriopoulos, T. & Roumpis, E. (2022). Digital adoption and efficiency in the maritime industry. *Journal of shipping trade* 7(11). https://doi.org/10.1186/s41072-022-00111-y.

Harilaos, N. P. and Christos, A. K., (2013). Speed models for energy-efficient maritime transportation: A taxonomy and survey. *Transportation Research Part C Emerging Technologies* 26(26):331-35.1. https://doi.org/10.1016/j.trc.2012.09.012.

Huan, T., Zheyu, L. and Yufeng, Z. (2024). Study on Cost-Effective Performance of Alternative Fuels and Energy Efficiency Measures for Shipping Decarbonization. *Journal of Marine Science Engineering 12*(5), 743 -167; https://doi.org/10.3390/jmse12050743.

Hlali, A. (2018). Efficiency of the 26 major container ports in 2015: Comparative analysis with different models. In: The 5th International Conference on Business Economics. Marketing & Management Research.

Hlali, A., and A. Wanis. (2020). Theoretical Highlights in Container Port Logistics Systems. *Journal of Marine and Island Cultures*, 9 (2): 181–191. https://doi.org/10.21463/jmic.2020.09.2.13.

Hlali, A., Ablanedo-Rosas, J. H., & Ruiz-Torres, A. J. (2023). Operational efficiency of major cargo seaports in some developing regions: Results from a bootstrap DEA. *International Journal of Shipping and Transport Logistics*, 16(3/4), 1. 290-319. https://doi.org/10.1504/IJSTL.2023.129874.

Ioannis, D., Nikitas, N. (2015). Slow Steaming Options Investigation Using Multi-Criteria Decision AnalysisMethod. https://www.researchgate.net/publication/281495086_slow_steaming_options_investigation_using_multi_criteria_decision_analysis_method.

Jinfen, Z. & Ângelo, P. T. (2023). Safety and Efficiency of Maritime Transportation and Ship Operations. Journal of Marine Science and Engineering. 4(8), 34-57.

Jelena, N. and Maja, Š. (2021). A Contribution to the Sustainable Development of Maritime Transport in the Context of Blue Economy: The Case of Montenegro. *Sustainability* 13(6): 3079. https://doi.org/10.3390/su13063079.

Karl, J., Catrin, L., Johan, W., & Erik F. (2020). Consequences of speed reductions for ships - An impact study for shipping companies and Swedish business. https://www.researchgate.net/publication/345330637_Consequences_of_speed_reductions_for_ships_-_An_impact_study_for_shipping_companies_and_Swedish_business.

Kim, Y., Beom-Soo K., Min-jae, O., Jae-Hoon, L., & Myung-Il, R. (2021). Study on Hull Optimization Process Considering Operational Efficiency in Waves. *Theoretical and Numerical Marine Hydrodynamics*. 9(5):898. https://doi.org/10.3390/pr9050898.

Lindstad, H. Egil J & Inge S. (2013) Reductions in cost and greenhouse gas emissions with new bulk ship designs enabled by the Panama Canal expansion. *Energy Policy*, 2013 59(i C), 341-349. https://doi.org/10.1016/j.enpol.2013.03.046.

Liviu L. R. (2015). Economic efficiency of sea transport. Case study: Constan Gala i Economic efficiency of sea transport. *procedia Economics and Finance* 32 (2015) 1598 – 1607.

Maloni, M., Paul, J. A. & Gligor, M. G. (2013). Slow steaming impacts on ocean carriers and shippers. *Maritime Economy and Logistics*, 15, 151–171.

Meyer, I., Stalbock, R. & Voss, S. (2012). Slow Steaming in Container Shipping, *In Proceedings. 2012 IEEE System Science*, 1 3 06-1 3 1 4.

Maloni, M., Paul, J. & Gligor, D. (2013). Slow steaming impacts on ocean carriers and shippers. *Maritime Economics and Logistics,* 15, 151–171 (2013). https://doi.org/10.1057/mel.2013.2.

Maysam M. S., Sadat-Hosseini, S. H., Carrica, P. M., Frederick S., (2016). Ship–Ship interactions in calm water and waves. Part 2: URANS validation in replenishment and overtaking conditions, *Ocean Engineering*. 111(2016), 627-638. https://doi.org/10.1016/j.oceaneng.2015.10.039.

Nicolas, B., and Dimitris, K. (2016). On the Estimation of Ship's Fuel Consumption and Speed Curve: A Statistical Approach. *Journal of Ocean Engineering and Science* 1(2). https://doi.org/10.1016/j.joes.2016.02.001.

Nwoloziri, C. N., Nze, I. C., & Hlali, A. (2026). Delays in container vessels operations and trade in container terminals: Empirical insights on Nigerian container terminals. Case Studies on Transport Policy, 23, 101655. https://doi.org/10.1016/j.cstp.2025.101655.

Percy, A. H., Kanzumba, K. & Bubele, P. N. (2020). Improving Energy Efficiency of Thermal Processes in Healthcare Institutions: A Review on the Latest Sustainable Energy Management Strategies. *Energies* 2020 *13*(3), 569; https://doi.org/10.3390/en13030569.

Roy, M. J., Boiral, O. & Lagace, D. (2001). Environmental Commitment and Manufacturing Excellence: A Comparative Study within Canadian Industry. *Business Strategy and the Environment*, 10 (5): 257–268.

Sui, C, de Vos P, Stapersma D, Visser K, Ding Y. (2020). Fuel Consumption and Emissions of Ocean-Going Cargo Ship with Hybrid Propulsion and Different Fuels over Voyage. *Journal of Marine Science and Engineering*. 8(8):588. https://doi.org/10.3390/jmse8080588.

Sinay (2023). What are the main technological innovation in the maritime industry for 2023? Available@ https://sinay.ai/en/what-are-the-main-technological-innovation-in-the-maritime-industry-for-2023.

Theo, N. and Athanasios A. P. (2021). Disruptions and resilience in global container shipping and ports: the COVID-19 pandemic versus the 2008–2009 financial crisis. *Maritime Economics & Logistics*, 23(22). https://doi.org/10.1057/s41278-020-00180-5.

Tien, A. T. (2020). Effect of ship loading on marine diesel engine fuel consumption for bulk carriers based on the fuzzy clustering method. *Ocean Engineering* 2(7), 107-383. https://doi.org/10.1016/j.oceaneng.2020.107383.

Ulio, B., Sonia Z., Diaz-Casas, V. (2022). Review of ship energy efficiency, *Ocean Engineering.* 257 (111594). https://doi.org/10.1016/j.oceaneng.2022.111594.

Veenstra, A. W. & Ludema, M. W. (2006). The relationship between design and economic performance of ships. 33(2):159–171.

Vladimir, J. & Stanislav, P. (2018) Global Economy Crisis and its Impact on Operational Container Carrier's Strategy. *Traffic& Transportation* 30(2):187. https://doi.org/10.7307/ptt.v30i2.2440.

Wuisan, L., J. Van Leeuwen, & C. S. A. Van Koppen. (2012). Green International Shipping through Private Governance: A Case Study of the Shipping Project. *Marine Policy*, 36 (1): 165–173.

Yupeng, Y. and Li, Z., (2017). Analysis of the operational ship energy efficiency considering navigation environmental impacts. *Journal of Marine Engineering & Technology* 16(3):1-10. https://doi.org/10.1080/20464177.2017.1307716.