The Role of Automotive in the Transport and Logistics of Seaport Operations: Engineering Perspective

Ekong. Godwin 1.

Centre for Automotive Training, Transport and Logistics (CATTL), Akwa Ibom State University (AKSU)

Email: goddy3e@yahoo.com, godwinekong@aksu.edu.ng

Abstract:

This paper presents the Role of Automotive in the Transport and Logistics of Seaport Operations: Engineering Perspective. Automotive can be described as any mechanical vehicle that can be used for transportation and logistics such as ships, cars, airplanes, trains, cranes, tricycles, and motorcycles, among others. Transportation modes are road, air, rail, sea, and cable while logistics is the process of scheduling and effecting the well-organised storage and transportation of goods from the point of origin to the delivery point for supply and distribution for the benefit of mankind. In all modes of transportation, automotive systems are used for transport and logistics. A seaport usually is a maritime facility that may include one or more wharves where ships may berth to load or unload and consists of cargo terminals, inner anchorages, outer anchorages, and a navigation channel. The engineering perspective in this study is the creative application of scientific and mathematical methods, for time, speed, distance, space, cost, mass, and weight-related concepts as applied in the effective operation and management of the automotive, transportation, and logistics issues in seaport operations. This will stimulate innovation, with improved automotive design capable of improving transportation systems and logistics hence improving the overall value chain associated with the seaport operations, leading to the creation of new job opportunities and services. The analyses of vessel speed with the time taken to reach the destination port for both bulk carrier and container ship from Aberdeen, United Kingdom to Apapa, Nigeria, Houston, United States of America to Apapa, Nigeria, Argentia, Canada to Apapa, Nigeria, Blexen, Germany to Apapa, Nigeria and Antwerp, Belgium to Apapa, Nigeria were examined. The result of the study confirms that the more the weight of the ship, the slower the speed of the vessel, hence, the more time taken to reach the destination port, leading to increased cost of transportation and logistics, hence an increased cost in the overall seaport operations. Therefore, this study aims to employ the principles of engineering in the effective operation of the seaport for global growth through sea transportation.

Keywords: Automotive, Transport, logistics, Seaport, Engineering Perspective.

1. INTRODUCTION

Automotive engineering involves the design, redesign, manufacturing, modification development, operation, preservation, and maintenance of an automobile such as buses, cars, trucks, and other vehicles. Automotive systems are applied to the seaport environment to enhance economic activities for the benefit of mankind. Strong, lightweight materials are being developed to improve fuel efficiency in automotive industries, hence an improvement in transportation and logistics activities with a reduction in the cost of the operation within the seaport. In seaport operations, cargo handling equipment (CHE) is vital to port operations and includes but is not limited to top handlers, side handlers, reach stackers, straddle carriers, gantry cranes, forklifts, terminal tractors, and yard trucks. This equipment is used to transport material or goods arriving at and departing from ports including bulk carrier and shipping containers known as container cargo.

In seaport operations, automotive such as maritime ships, trucks, cars, and cranes are used for the transportation of goods and services, hence enhancing the logistics operation within the seaport. Transport is a system or means of conveying people or goods from place to place using automotives such as ships, aircraft, vehicles, trains, and trucks, among others and Logistics is the detailed organization and implementation of complex operations. In a seaport, logistics involves how goods are acquired, stored, and transported to their final destination mostly with the help of automotive. Hence, automotive is a vital support for the growth, development, and operation of a seaport. An important connection exists between automotive, transport, and logistics to the overall operation of a seaport through the country's automotive capacity, government policies, and economic development. The Engineers' Perspective is all about innovation and finding solutions to complex problems of using automotives such as ships, cars, trucks, and flying boats to enhance the transport and logistics activities in seaport operations such as the shipment of persons and goods in and out of ports and the associated logistics. Engineers with great proficiencies are well prepared to stimulate the operations in and out of a seaport using automotive systems to enhance transport and logistics activities. In this paper, three elements are explored, the automotive, transport, and logistics relevance in seaport operation using Engineering perspectives. Engineering generally is a profession and may be classified into agricultural, chemical, civil, electrical and electronic, mechanical, marine, petroleum, industrial, production, and aerospace engineering, among others. Given the foregoing, most of the operations in seaport operations involve engineering skills and automotive equipment is key to transport and logistics activities.

1.1 Careers in the Seaport

Seaports function as important transportation hubs that facilitate goods movement to business in local communities and worldwide markets. It can connect goods to consumers through various routes such as our highway system, railroads, air transit, and domestic or international marine highways. Hence, seaport operations are crucial to the success of businesses involved in global trade. Well-organized seaport operations can help businesses optimise their supply chain management, reduce transportation costs, and improve customer satisfaction. The careers in seaport include but are not limited to automotive, transport, and logistics services such as stevedoring, marine, and passenger operations. The stevedoring operation involves the transferring of cargo between ship, shore, and storage areas, marine operations deals with marine craftsmanship and technology, and assisting with the movements of vessels, while passenger operations deals with assisting the movement of passengers to and from vessels such as ferries, cruise ships, land transports and maritime tourism (blue tourism).

2. REVIEW

Seaports are openings into national and international economies as they facilitate shipping trade flows across nations. This is enhanced by automotive, transport, and logistics activities. Goods and services, in one form or another depend on the seaports for shipment for example export-import of raw materials and finished and semi-finished products, are all dependent on transportation and shipping which form an integral part of the logistics activities in and out of the seaports, hence improving the whole supply chains responsible for shipping and delivery of orders to and from the warehouses across the supply chain networks.

According to [1], maritime transportation has long been recognized as the most efficient and cost-effective mode of transportation, but with its challenges such as port congestion. The issues and challenges affecting the efficient operation of seaport include seaport congestion such as ship berth congestion, ship work congestion, vehicle gate congestion, vehicle work congestion, cargo stack congestion, and ship entry and exit route congestion.

Port congestions can be attributed to inadequate docking facilities, accidents and navigational hazards, inadequate storage facilities, imports and exports imbalance, burdensome registration and documentation processes, truck congestion, congestion of cargo at storage yards, poor road infrastructure and network, strikes and industrial action by unions, manual data processing, inadequate infrastructure, lack of modern port equipment, and corruption and mismanagement, a sudden increase in international trade, port size and capacity, high clearance costs and demurrage from time to time, poor automotive, transport and logistics services in general. Some of the problems in ports can reduced by the use of Digital and Innovative Technologies, Continuous Training and retraining of staff, construction of Expansion and improvement of Infrastructure of the various modes of transport such as rail and roads, provision of modern and Smart Port Infrastructure including robot systems, Incentives to staff to avert strikes and promoted excellent, improvement on automotive systems. It should be noted that Infrastructure is critical to any transport system, logistics, and supply chain development objective in a seaport operation. The condition of available infrastructure such as automotive systems and level of integration directly impacts logistics access, cycle time, reliability, and cost of operation.

In their work by [2], seaports are seen as gateways into national economies as they facilitate shipping trade flows enhance the handling of logistical material and operations across all sectors of the national economy, and enumerate factors affecting the flow of shipping trade and logistics in Nigerian seaports. The study identifies the decisive port-related factors constraining the flow of shipping trade in Nigerian ports using a survey to obtain data on the influence of the identified factors on the flow of shipping trade in Nigerian ports with a concept of the Principal Component Analyses (PCA) to analyse of the data obtained.

In [3], congestion in ports is viewed as a phenomenon associated with delays, queuing, and extra time for the voyage and dwelled of ships and cargo at the port, which always occurs with unpleasant consequences on Logistics and supply chain, leading to into extra costs, loss of trade and disruption of trade, transport and logistics agreements. The findings conclude that African ports should enhance their regulatory mechanisms, and improve capacity and efficiency levels to cope with the increasing challenges of port congestion in years ahead. According to [4], haulage, and trucking are vital aspects of logistics in and around ports whether airports or seaports. After the shipping companies have delivered the goods at the ports, the port authorities will move the goods terminals for government agencies to examine the goods for compliance with regulations. Even within the terminals, they have to engage in logistics services to determine the type of truck or in-land transport route to use such as flat trailers, covered body or box trailers, vehicle carriers, low loaders, sided trailers, refrigerated trailers, dry bulk trailers, and bulk liquid trailers. The study concluded that delivery distance, nature of the goods, weight, dimension of the goods, and conditions of the road networks are the factors that affect logistics services in Nigerian ports.

Several authors have reviewed the seaport operations extensively but not much emphasis was given to the role of automotives in the transport and logistics of the seaport hence, the need for this study to show the importance of automotives for effective transportation and logistics activities within and outside of the seaport.

2.1 Seaport in Akwa Ibom State, Nigeria

The State has established a mega seaport known as Ibom Deep Seaport (IDSP) shown in Figure 1, which is in progress.

Figure 1: Ibom Deep Seaport, Akwa Ibom State, Nigeria [19]

Ibom Deep Seaport design according to the IDSP website indicates that it is for very large vessels that can load over 13 thousand containers in one voyage. The IDSP will be a transshipment port as smaller vessels will re-distribute cargo from the mega vessels to seaports, and river ports closer to the consignees within and outside Nigeria. This seaport is a greenfield deep sea port project located on the Atlantic coast about 65km to the southeast of Uyo in Akwa Ibom state, Nigeria. A State that is rich with natural mineral resources such as oil and gas both on and off-shore, clay, limestone, gold, palm fruit, salt, coal, silver nitrate, and glass sand, among others, and marine natural resources such as fish, crayfish, periwinkle, lobster, among others, then the activities of automotive, transport and logistics personnel and companies are vital to the successful operation of the seaport. The most important seaport in Nigeria is the Apapa Port Lagos shown in Figure 2.

Figure 2: Apapa Port Lagos, Nigeria [20]

2.2 Supporting Pillars of a Seaport Operation

- Academic institutions and Research Centre – such as the Centre for Automotive Training Transport and Logistics (CATTL), AKSU
- Aviation industry – such as Victor Attah International Ibom Airport, Uyo
- Power generation industry – Ibom Power Plant, Ikot Abasi
- The Private sector– Entrepreneurs, Transport owners, and all end users

The need for improvement in the automotive industries will lead to a better transport and logistics system in our seaport hence an improvement in our coastal recreation, maritime tourism, maritime transport, infrastructures, storage facilities, coastal security, and coastal educational management.

3. METHODOLOGY

The engineering perspective involves all innovative concepts and ways of finding solutions to complex problems relating to automotive, transport, and logistics in and out of a seaport. The methods applied in this study include but are not to limited time, speed, distance, space, mass, and weight-related concepts which are employed in the effective operation and management of the automotive, transportation, and logistics issues within a seaport.

3.1 Speed

Speed is a measure of the rate of change of the distance traveled by a moving object. Speed is a scalar quantity, which means that it is a unit of measurement that has magnitude but does not have direction.

$$Speed\ (S) = \frac{Distance}{Time} = \frac{D}{T} \qquad (m/s) \qquad (1)$$

$$SI\ unit: \frac{m}{s},\ ms^{-1} \qquad (2)$$

$$Dimension: LT^{1} \qquad (3)$$

Where S is the speed, expressed in miles per hour (mph),

D is the distance traveled, expressed in miles.

and T is the time, expressed in hours, h.

The vessel speed is expressed in Knot which one (1) knot is equivalent to 1.852 kilometers per hour.

3.2 Acceleration

Acceleration is the rate of change of speed and it is a measure of the rate at which the speed of an object is increasing or decreasing. Whenever the motion of a moving automotive is contemplated, it is unusual that the velocity will remain constant throughout its motion. This is so because the speed of the automotive typically increases and decreases over the course of their trajectories, hence acceleration is used in the design calculation involving braking systems of vehicles.

3.3 Mass

Mass, is a quantitative measure of inertia, a fundamental property of all matter. It is the resistance that a body of matter offers to a change in its speed or position upon the application of a force. The greater the mass of a body, the smaller the change produced by an applied force.

$$m = \frac{w}{g} \quad (kg) \qquad (4)$$

3.4 Weight

Weight is the force acting on an object due to gravity. The weight of an object depends on the gravitational field at the point in space where the object is. Therefore weight is a force, hence a vector quantity, meaning that it has magnitude and direction.

$$W = mg \quad (N) \qquad (5)$$

In waterways or sea transportation, the major types of vessels used based on their weight are the Bulk Carriers and the Container Ships. Bulk carriers are transportation vessels that are used to transport large amounts of bulk consignment such as large quantities of liquid or solid freight, such as oil, and raw materials in mining and agriculture, while Container ships are freight ships that carry their full load in truck-size containers. The largest bulk carrier is estimated to be 360,000 tons while the largest container ship is estimated to be 220,000 tons [5] and [6].

$$\text{Weight comparison : Bulk Carrier} > \text{Container Ship} \qquad (6)$$

For the role of automotive in the transport and logistics of a seaport to be stimulated, engineers need also to learn new techniques for solving problems, such as Teoriya Resheniya Izobretatelskikh Zadatch (TRIZ), structured and unstructured brainstorming, 40 inventive principles, Ideal Final Result and lateral thinking [7], [8], [9], [10], [11], [12, [13], [14], [15], and [16]. Lateral thinking involves problem-solving in an indirect and creative approach, typically through viewing the problem in a new and unusual light. According to [17], the application of creativity techniques by engineers, therefore, requires a lot of specific training, ingenuity, and critical thinking skills to apply in the design, and manufacturing of new automotive systems, maintenance of devices such as maritime ships in a Blue economy environment, cranes, and conveyors, and other devices such as compressors [18], leading to the tremendous improvement in the transport and logistics in seaport operations, hence, an increase in the internally generated revenue of a State and a Country.

4. RESULTS AND DISCUSSION

The results and discussion of this study are anchored on the engineering perspectives of time, speed, distance, space, cost, mass, and weight-related concepts in the improvement of transport and logistics situations from one port to another. In this study, nautical miles are used to measure the distance traveled through the water and it's equal to 1.15078 land miles or 1.852 kilometres. The nautical mile is based on the Earth's longitude and latitude coordinates, with one nautical mile being equal to one minute of latitude, while a knot is speed, where one nautical mile per hour is a knot. 1 knot is 15% faster than 1 MPH, hence, when an automotive is traveling at 1 knot, it follows that it is actual speed is 1.15 miles per hour, which would mean that the automotive is faster by 0.15 miles within that hour when compared to land. Though different ships have different speeds, It is usually accepted that a Container ship can have a top speed of 25–26 knots and an average speed of 17–18 knots while a Bulk carrier's top speed will be 16 knots and an average speed 12–13 knots. Bearing in mind the environmental conditions such as weather and the health of the automotive used, this study considers a Bulk Carrier speed between 10 – 14 knots and a Container ship of 15 -19 Knots for the analyses. It is important to note that the weight of the Bulk Carrier is more than that of the Container ship hence the Container ship travels faster than the Bulk Carrier ship confirming the concept in Equations 5 and 6.

4.1 Vessel Speed and Time Taken Result for both Bulk Carrier and Container Ship

This section presents the results and discussion of this work. The influence of parameters such as speed, distance, time, cost, and weight on the transport and logistics in seaport operation is presented. The vessel speed, time taken from take-off port to destination port in the study, Apapa, Nigeria, and the weight of each ship such as the bulk carrier and the container ship are determined to ascertain the functionality of the automotive concerning transportation and logistics cost, hence, the overall cost of the operation from the take-off port to the destination port with the application of relevant engineering concepts. The analyses of vessel speed with the time taken to reach the destination port for both bulk carrier and container ship from Aberdeen, United Kingdom to Apapa, Nigeria, Houston, United States of America to Apapa, Nigeria, Argentia, Canada to Apapa, Nigeria, Blexen, Germany to Apapa, Nigeria and Antwerp, Belgium to Apapa, Nigeria are presented in Tables 1 – 10 and shown graphically in Figures 1 – 10 respectively. The result of the study with bulk carriers and container ships indicates that the more the weight of the ship, the slower the speed of the vessel, hence, the more time taken to reach the destination port, hence, confirming the concept in Equation 6.

Table 1: Time Taken from Aberdeen, United Kingdom to Apapa, Nigeria by a Bulk Carrier

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	4454	10	18 days 13 hours
2	4454	11	16 days 21 hours
3	4454	12	15 days 11 hours
4	4454	13	14 days 07 hours
5	4454	14	13 days 06 hours

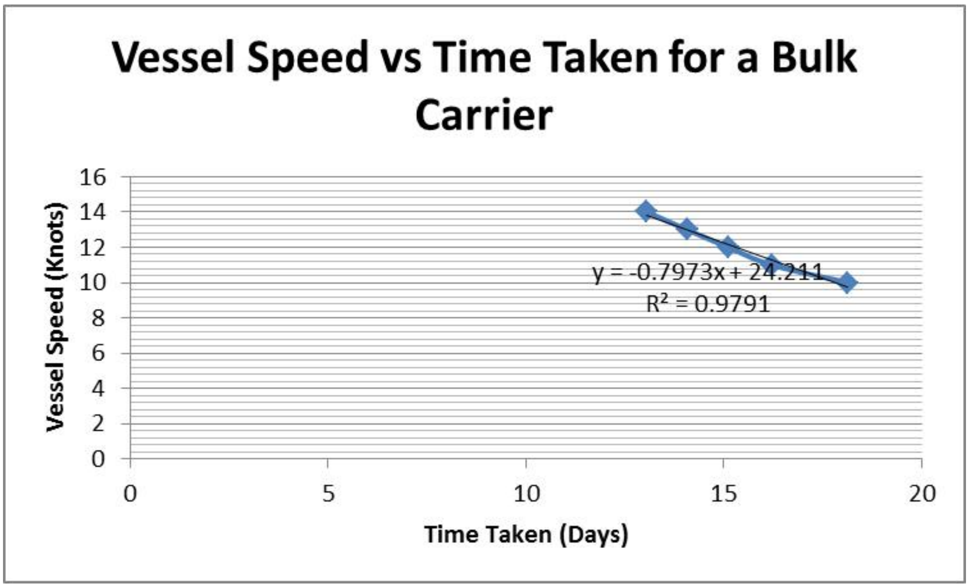

Figure 3: Vessel Speed against Time Taken for a Bulk Carrier from Aberdeen, United Kingdom to Apapa, Nigeria

Table 2: Time Taken from Aberdeen, United Kingdom to Apapa, Nigeria by a Container Ship

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	4454	15	12 days 09 hour
2	4454	16	11 days 14 hours

3	4454	17	10 days 22 hours
4	4454	18	10 days 07 hours
5	4454	19	9 days 18 hours

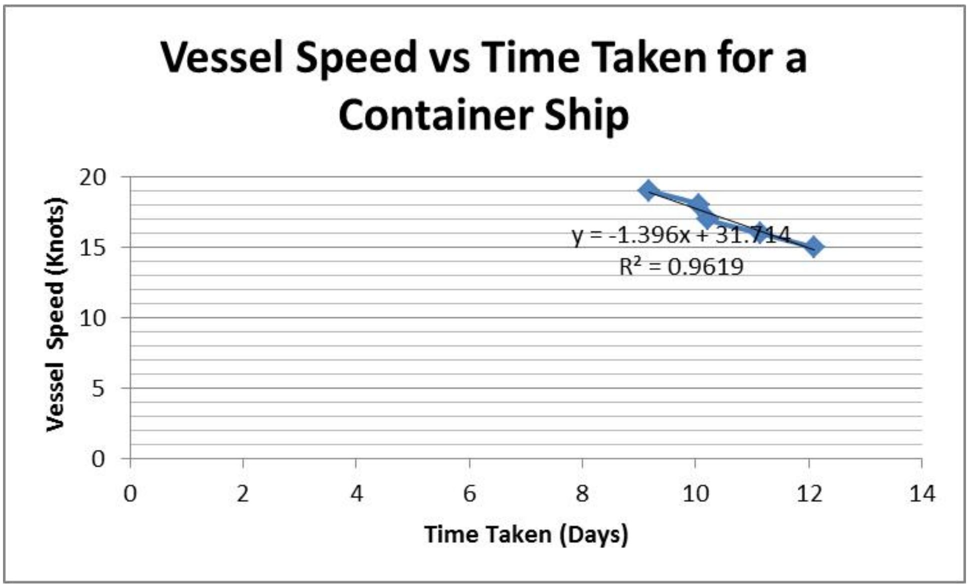

Figure 4: Vessel Speed against Time Taken for a Container ship from Aberdeen, United Kingdom to Apapa, Nigeria

Table 3: Time Taken from Houston, United State of America to Apapa, Nigeria by a Bulk Carrier

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	5952	10	24 days 19 hours
2	5952	11	22 days 13 hours
3	5952	12	20 days 16 hours
4	5952	13	19 days 02 hours
5	5952	14	17 days 17 hours

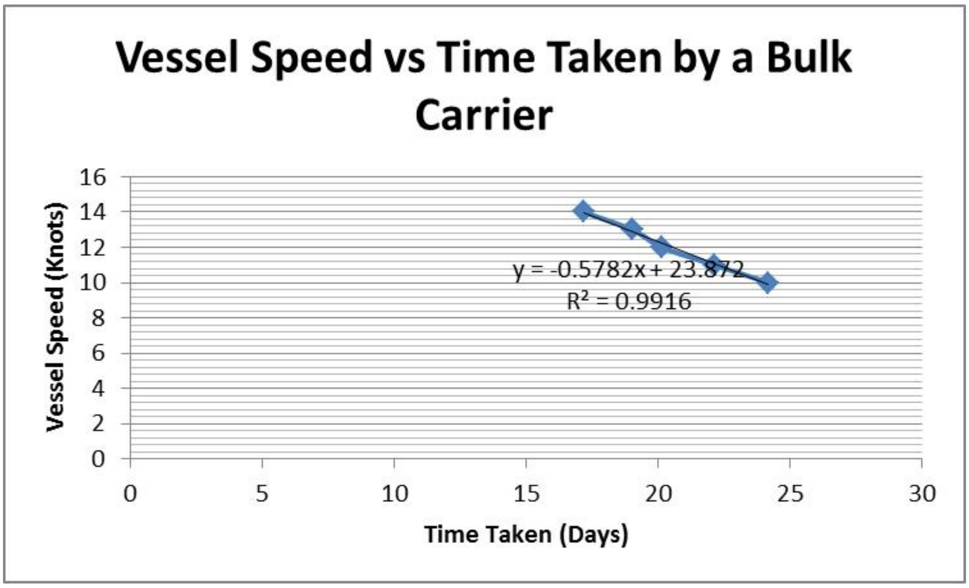

Figure 5: Vessel Speed against Time Taken for a Bulk Carrier Houston, United State of America to Apapa, Nigeria

Table 4: Time Taken from Houston, United State of America to Apapa, Nigeria by a Container Ship

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	5952	15	16 days 13 hours
2	5952	16	15 days 12 hours
3	5952	17	14 days 14 hours
4	5952	18	13 days 19 hours
5	5952	19	13 days 01 hours

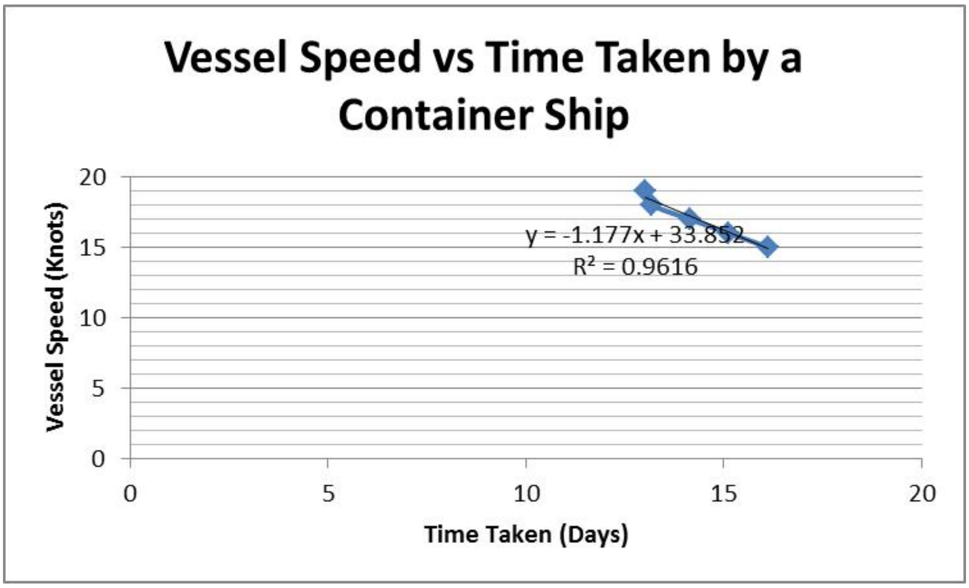

Figure 6: Vessel Speed against Time Taken for a Container ship Houston, United State of America to Apapa, Nigeria

Table 5: Time Taken from Argentia, Canada to Apapa, Nigeria by a Bulk Carrier

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	4288	10	17 days 21 hours
2	4288	11	16 days 06 hours
3	4288	12	14 days 21 hours
4	4288	13	13 days 18 hours
5	4288	14	12 days 18 hours

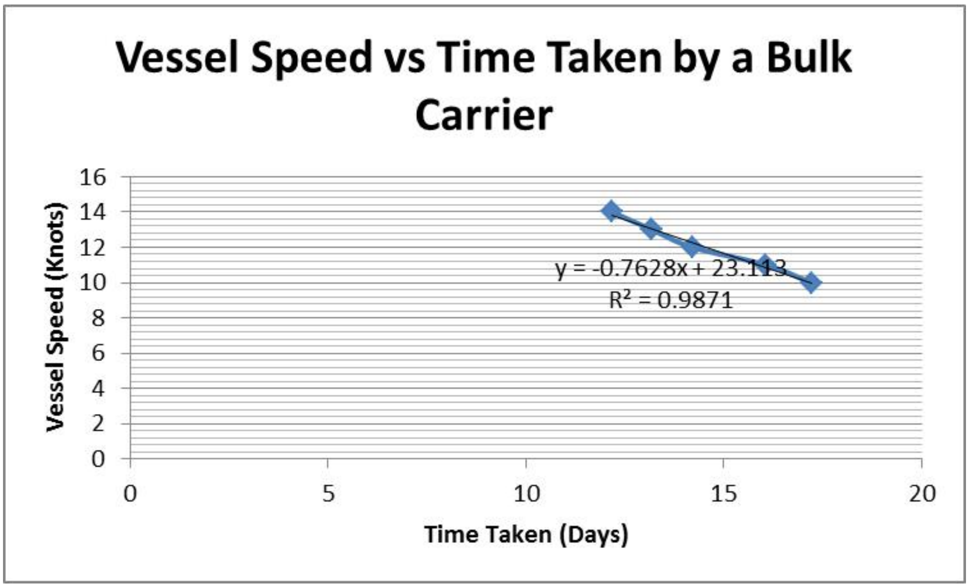

Figure 7: Vessel Speed against Time Taken for a Bulk Carrier from Argentia, Canada to Apapa, Nigeria

Table 6: Time Taken from Argentia, Canada to Apapa, Nigeria by a Container Ship

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	4288	15	11 days 22 hours
2	4288	16	11 days 04 hours
3	4288	17	10 days 12 hours
4	4288	18	9 days 22 hours
5	4288	19	9 days 10 hours

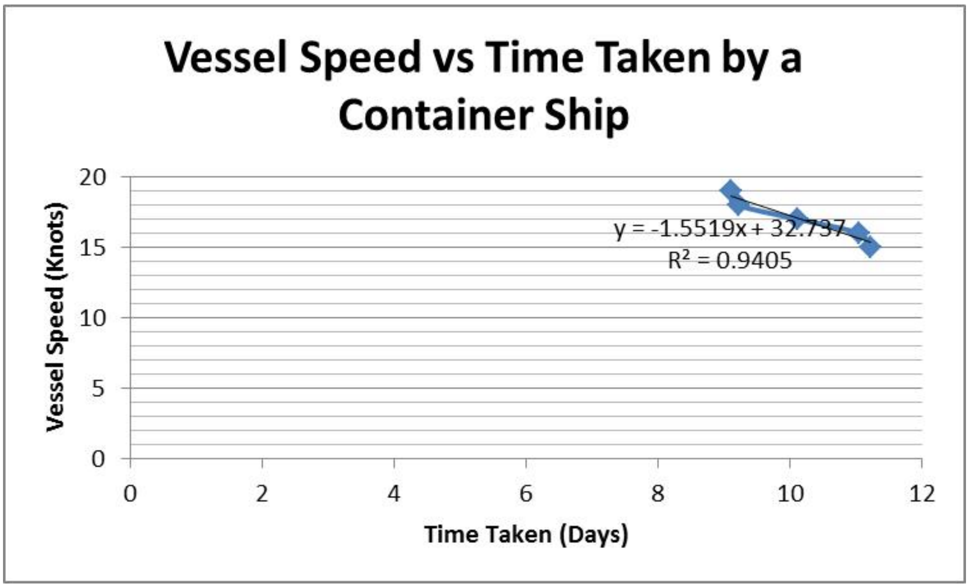

Figure 8: Vessel Speed against Time Taken for a Container ship from Argentia, Canada to Apapa, Nigeria

Table 7: Time Taken from Blexen, Germany to Apapa, Nigeria by a Bulk Carrier

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	4378	10	18 days 06 hours
2	4378	11	16 days 14 hours
3	4378	12	15 days 05 hours
4	4378	13	14 days 01 hours
5	4378	14	13 days 01 hours

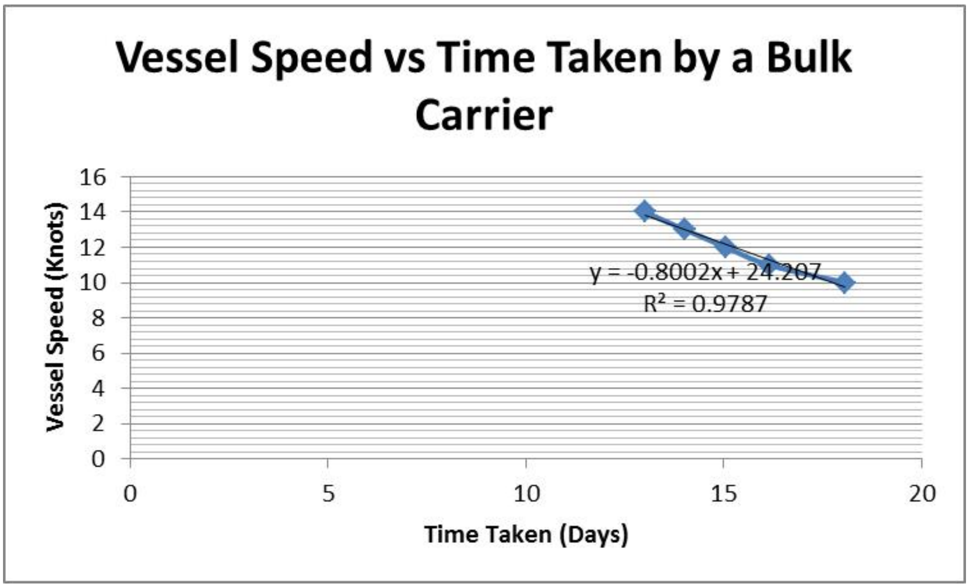

Figure 9: Vessel Speed against Time Taken for a Bulk Carrier from Blexen, Germany to Apapa, Nigeria

Table 8: Time Taken from Blexen, Germany to Apapa, Nigeria by a Container Ship

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	4378	15	12 days 04 hours
2	4378	16	11 days 10 hours
3	4378	17	10 days 18 hours
4	4378	18	10 days 03 hours
5	4378	19	9 days 14 hours

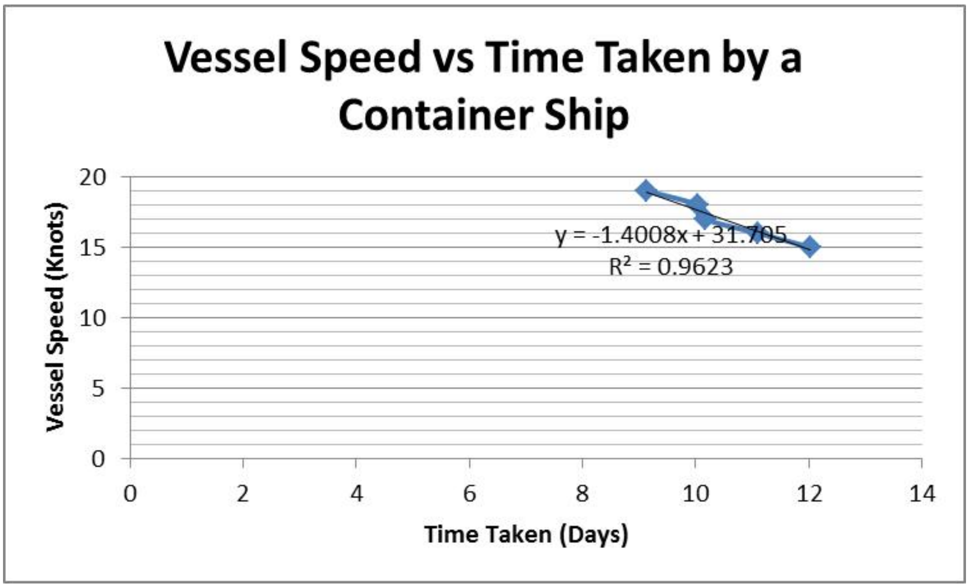

Figure 10: Vessel Speed against Time Taken for a Container ship from Blexen, Germany to Apapa, Nigeria

Table 9: Time Taken from Antwerp, Belgium to Apapa, Nigeria by a Bulk Carrier

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	4176	10	17 days 10 hours
2	4176	11	15 days 20 hours
3	4176	12	14 days 12 hours
4	4176	13	13 days 09 hours
5	4176	14	12 days 10 hours

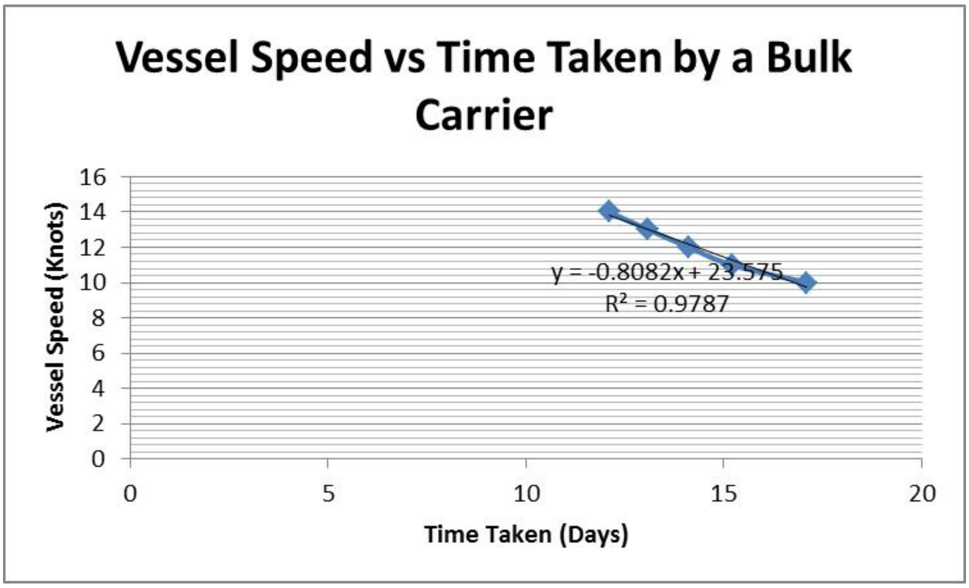

Figure 11: Vessel Speed against Time Taken for a Bulk Carrier from Antwerp, Belgium to Apapa, Nigeria

Table 10: Time Taken from Antwerp, Belgium to Apapa, Nigeria by a Container Ship

SN	DISTANCE (NAUTICAL MILES)	VESSEL SPEED (KNOTS)	TIME (DAYS)
1	4176	15	11 days 14 hours
2	4176	16	10 days 21 hours
3	4176	17	10 days 06 hours
4	4176	18	9 days 16 hours
5	4176	19	9 days 04 hours

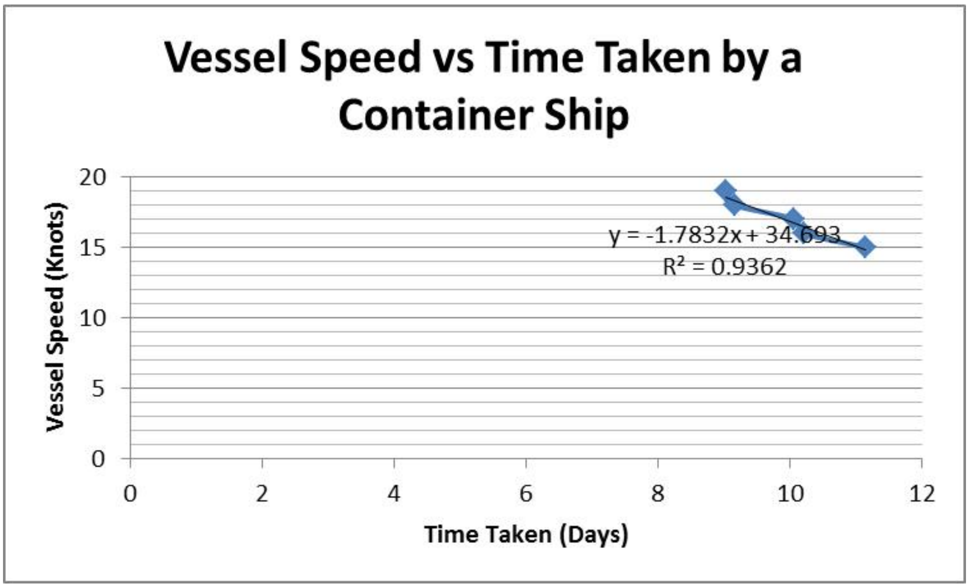

Figure 12: Vessel Speed against Time Taken for a Container Ship from Antwerp, Belgium to Apapa, Nigeria

4.2 Logistics Costs

In this study, the result shows that as the weight of the ship increases, there is a corresponding increase in the time taken to reach the destination port. This, in turn, will increase the logistic costs of automotive machinery maintenance, fuel consumption, and oil, used by the automotive, increase the cost of feeding onboard crew members and staff due to longer days on board, increase wages of staff, increase the cost of loading and unloading if there are stopover in other ports in the cause of the movement and cost due to environmental issues. In summary, there is an increased cost of transportation and logistics due to the type of shipment and vessel used.

5. CONCLUSIONS

In this study, the role of automotive in the transport and logistics of seaport operations: engineering perspective was investigated and the aim was achieved. The automotive used in this study are bulk carrier and container ship vessels used for transportation and logistics, and the transportation mode is the sea. Engineering perspectives are the creative application of scientific and mathematical methods, in speed, time, distance, cost, and weight-related concepts as applied in the automotive for the complex transport and logistics issues found in seaport operation. Engineering perspectives will stimulate innovation, with improved automotive design capable of improving transportation systems with innovation in logistics hence improving the overall value chain associated with the seaport operation, leading to the creation of new job opportunities and services. The analyses of vessel speed with the time taken to reach the destination port for both bulk carrier and container ship from Aberdeen, United Kingdom to Apapa, Nigeria, Houston, United States of America to Apapa, Nigeria, Argentia, Canada to Apapa, Nigeria, Blexen, Germany to Apapa, Nigeria and Antwerp, Belgium to Apapa, Nigeria were employed for this study. The result of the study shows that the more the weight of the ship, the slower the speed of the vessel, hence, the more time taken to reach the destination port, leading to increased cost of transportation and logistics, hence an increase in the overall operation of a seaport. The results of this study will stimulate improved innovation leading to the improvement of automotive, transport systems, and logistics services in seaport management and operation hence, the reduction in overall cost of operation in seaport operations for better services. This in turn will stimulate global economic growth and development through sea transportation.

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