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THE EFFECTS OF CONTAINER SHIP CONGESTION ON PORT PERFORMANCE IN TANZANIA: THE CASE OF DAR ES SALAAM PORT

BY

Henry J Njau[1] , Lucas Mwisila.[2] Diana Kiwia[3]

[*1]MA Student, Dar-es-salaam Maritime Institute (DMI)
[2]Senior Lecturer, Dar-es-salaam Maritime Institute (DMI)
[3]Assistant Lecturer, Dar-es-salaam Maritime Institute (DMI)

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Corresponding author:

Henry J Njau

Abstract

Congestion caused by container ships appears to be a significant issue in several ports worldwide, including the port of Dar es Salaam. However, as a result of increased global trade, ships are becoming larger and more numerous, which presents a greater challenge for many ports worldwide, especially in Asia and Africa. In addition, a lot of ports are underequipped with cranes, ship-to-shore gantry cranes, and other necessary equipment for loading and unloading container cargo ships. The study used a survey design, with the main methods of gathering data being interviews, observations, and questionnaires. Questionnaires and interviews with one hundred (100) respondents were conducted. Based on the study's findings, a number of variables were assessed as potential contributors to the port's performance-damaging container ship congestion in Dar es Salaam. These included insufficient technology and information systems, insufficient handling equipment, a restricted capacity for container yards, and inefficient operations. Based on the study's findings, a number of variables were assessed as potential contributors to the port's performance-damaging container ship congestion in Dar es Salaam. These included insufficient technology and information systems, insufficient handling equipment, a restricted capacity for container yards, and inefficient operations. Various proposals and potential solutions were put up to address these problems. Purchasing equipment to boost capacity and enhancing operational effectiveness through the use of tangible tools like cranes, forklifts, rich strikers, etc. were two of these. The use of cutting-edge technology and information systems for improved operations is required to cut down on delays.

Keywords: Container Ship Congestion, Port performance, ship delays, shipping

1.0 Introduction

A significant portion of the shipping sector is the port; ships need ports to load and unload goods as a result, port efficiency impacts the whole shipping sector. In order to accommodate the increasing container cargo volume of ships as a result of the growth of global commerce and technical advancements in ship design, contemporary ports should concentrate on growing and expanding the port space and investing in cutting-edge machinery and other infrastructures (Aisha et al., 2020). Furthermore, for port performance to increase ship delays congestion problem has to be solved when transporting products to customers and businesses (Panahi et al., 2022).

Container ship congestion has been a major issue on a global scale recently, which has raised freight charges and reduced port efficiency (Mlambo, 2021). Container ship congestion occurs when there are more ships arriving at a port than it can accommodate as a result, ships must wait a long time to dock and unload. Due to rising freight costs and declining port efficiency, this situation negatively impacts the port's and the economy's performance (Mira et al., 2019). Moreover, Congestion from container ships is one of the major problems that many ports across the world are facing. This problem impedes the efficient facilitation of trade and economic expansion. But as the world's trade expands, ships are getting bigger and heavier, which makes it more difficult for many ports to handle them (Fahim et al., 2022). Furthermore, many ports were not designed to handle and store large volumes of cargo, and the transportation infrastructure of roads and trains needs to keep up with the demand for quick cargo processing (Xu et al., 2021).

The United Republic of Tanzania, Dar es Salaam Port is the principal gateway for Tanzania's international trade, offering access to landlocked countries in the region, including Zambia, Malawi, Burundi, Rwanda, and Uganda (Mwendapole & Zhihong, 2020). According to the CAG report 2022 commented that TPA faces problems with the operation capacity of the TPA where there are number of a berths that are not well operated because of a lack of equipment and capital. These trigger the long turnaround time of the ships due to the long time for loading and unloading from ships, and documentation procedures. Currently at Dar es Salaam Port, container handling or ship dwell time takes an average of seven to fourteen days Maneno (2019). From the current situation, there is a need for assessing the impact of container ship congestion at the Port of Dar es Salaam which is the main objective of this study.

Ports need to expand their buildings, hire additional personnel with the necessary skills, and buy the newest equipment for handling cargo. The number of berths, the time it takes to load and unload ships, the cargo handling equipment, and the documentation processes are all problematic at Dar es Salaam Port right now. Now, ship stays or cargo processing at the port of Dar es Salaam takes an average of seven days (Mwendapole & Zhihong, 2020). Analyzing the problems and factors contributing to container congestion at the Port of Dar es Salaam is the aim of this research project.

A theory provides a broad justification for how and why variables interact, particularly how they affect one another (Galvan 2017). In the same way that a theory aids in making sense of how actual findings that at first glance seem unconnected. To simulate container vessels congestion, the research will apply the theory of queuing.

1.1 Queuing Theory

The behavior of waiting lines and the method of providing services are both explained by the theory of queuing, a well-known mathematical model (Aziziankohan et al., 2017). Originally created by Agner Krarup Erlang in 1909 to study telephone traffic, the idea has subsequently been used in many industries, including logistics and transportation. The notion of queuing is based on the idea that clients show up at a service location at random times and take a particular amount of time to be serviced. A queue or waiting line develops when client demand for a service exceeds the facility's ability to handle it. According to Zhu et al. (2017), the number of available service channels, the facility's service rate, and the pace at which customers arrive all affect the length of the line and the waiting time.

The idea of queuing may be used to predict the behavior of vessels waiting outside the anchorage for berth allocation and cargo handling in the context of container ship congestion and port performance at the Port of Dar es Salaam. Port operations are delayed and inefficient when ships must wait in line outside the port because the demand for port services exceeds the port's ability to manage them. According to Muhizi et al. (2017), shippers would pay more demurrage and detention fees the longer they must wait, which might raise prices and make Tanzania's exports less competitive. To apply the theory of queuing to this research, data on the number of service channels (such as berths, cranes, and labor), as well as the arrival rate of ships at the port and the port's efficiency in processing cargo and ships, must be collected.

The information would be utilized to create a queuing model that would calculate the waiting time and length of the line for ships waiting outside of ports as well as the effects of congestion on port performance indicators like vessel turnaround times, berth productivity, and cargo handling productivity (Muhizi et al., 2017). The study can shed light on the causes and effects of container ship congestion on port performance at the Port of Dar es Salaam and identify potential remedies to lessen the negative effects of congestion by comprehending the behavior of waiting lines and the procedure of service delivery using the theory of queuing.

2.0 Methodology

The research was conducted at the primary port in Tanzania, namely Dar es Salaam, which experiences a high influx of container ships, leading to port congestion. The study employed a mixed-method approach that incorporated both qualitative and quantitative techniques, with a quantitative emphasis due to the requirement for statistical analysis (Sun et al., 2018). The utilization of mixed research methodologies was chosen for their systematic and scientific capacity to assess the interplay of various factors, which is particularly relevant to the subject matter.

The study initially aimed to involve 100 participants, chosen through a combination of simple random and purposive sampling methods. These participants were selected as follows: eight by port management, forty from TPA Staff, six from TASAA, eight from the Truck Owner Association, fifteen from TRA, six from Tanzania Shipping Agencies, and seven from the Tanzania Freight Forwarders Association. However, due to the statistical margin of error set at 0.05 using Slovin's algorithm, a total of 95 participants were included in the study to collect data. Obtaining data from certain organizations, including TPA, proved challenging due to confidentiality concerns, despite the importance of such data.

Data collection involved the use of questionnaires, interviews, and observations, and incorporated closed-ended questions pertaining to respondent demographics, as well as both closed- and open-ended questions concerning productivity, congestion, and potential congestion reduction strategies related to cargo ships (Kumar, 2011). To ensure research tool reliability, the study employed the Cronbach Alpha test using SPSS software to assess the internal consistency of the questionnaire items.

The quantitative data demonstrated good reliability, with all variables scoring between 0.70 and the highest possible score of 0.95, as indicated by (Mohsen and Reg, 2011). For qualitative data reliability, a smaller sample of ten respondents was tested, and transcripts were carefully reviewed to ensure accurate transcription. Additionally, ten pilot survey participants reviewed the study's findings and conclusions to validate the qualitative data. Data analysis involved various tasks such as coding, transcription of interviews, data entry into Microsoft Word, data familiarization, and multiple readings. Quantitative data was subjected to examination using SPSS software, generating descriptive and inferential statistics, including correlations, linear regression models, and frequency distributions.

3.0 Analysis

The three main goals of the analysis are to: assess the correlation between port performance at the Port of Dar es Salaam and container vessel congestion; explore the relationship between port productivity at the Port of Dar es Salaam and container cargo productivity; and suggest potential solutions for reducing container ship congestion at the Port of Dar es Salaam. Mean and standard deviation are two examples of inferential and descriptive statistics that were used in the study's analysis. Furthermore, according to Conner & Johnson (2017), a higher mean score denotes a higher degree of agreement with a statement, whereas a lower mean score suggests a lesser level of agreement.

The relationship and connection between the independent and dependent variables were ascertained using the fitness model. The table below shows the model's level of fitness.

Table 3.0.1: Model Fitness

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.701	0.591	0.364	0.49850	2.285

Source: Research Findings (2023)

Predictors: (Continuous), the productivity level of cargo, congestion on container ships, and possible solutions to reduce container ship congestion. The subordinate variable Port Efficiency with a value of 0.701, the correlation coefficient "R" in the table above indicates a strong positive correlation between the dependent variables (port performance) and the independent variables (congestion on container ships, cargo productivity, and possible solutions for reducing congestion on container ships). Furthermore, an R Square, or "coefficient of determination" of 0.591 indicates that the model can account for 59.1% of the variance in the dependent variable.

Table 3.0.2: ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	20.203	4	5.051	20.325	0.000a
Residual	32.554	131	0.249		
Total	52.757	135			

Source: Study Results (2023).

Container ship congestion, cargo productivity, and possible solutions to the problem are the following predictors (constant). As the significance level of "000" indicates a substantial relationship, the information above shows a high correlation between the variables. This shows that port performance, a dependent variable, is significantly impacted by the independent variables of container ship congestion, cargo productivity, and possible solutions for reducing container ship congestion. After the analysis, the prediction regarding independent variables on the dependent variable was evaluated using multiple regression analysis. The present study was structured to investigate the effects of container ship congestion, cargo delivery, and productivity levels, and possible mitigation techniques on port performance. Table 4.3 presents a multiple regression diagram.

Table 3.0.3: Multiple Regression Analysis

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	3.155	.211		14.959	.000
Container ship congestion	.127	.042	.152	2.989	.004
Container ship cargo delivery level	.115	.084	.122	1.101	.001
Ship congestion alleviation strategies	.107	.035	.156	3.087	.002

Source: Research Findings 2023

The findings show that the congestion caused by container ships has a t-value of 2.989 and a positive standardized coefficient (Beta = 0.152). Nonetheless, the corresponding p-value is less than 0.05, indicating significance. It shows that all variables have a positive association that is statistically significant. Therefore, the statistical evidence supports this relationship as significant even though there appears to be a positive association between the predictors' variables (container ship congestion, level of container cargo productivity, potential strategies for alleviating port container ship congestion) and port performance.

4.0 Discussion and Findings

Evaluating the connection between port performance at the Port of Dar es Salaam and container ship congestion is the study's primary goal. Inferential statistics are used to present the results. The relationship between container ship congestion and port performance was investigated using the fitness model, ANOVA, correlation, and multiple linear regressions.

The findings show that the congestion caused by container ships has a t-value of 2.989 and a positive standardized coefficient (Beta = 0.152). The corresponding p-value of 0.004, however, is less than the conventional significance criterion of 0.05, suggesting that the link is statistically significant and positive. Thus, even if there seems to be a positive correlation between port performance and container ship congestion, this relationship is supported as significant by the statistical data.

According to a respondent who was interviewed, the Dar es Salaam port's performance is significantly impacted by ship congestion. This is because the port is not equipped to handle large container ships, there is a shortage of yard space, and the equipment facilities are outdated. All of these add to the backlog of container ships and impede the port of Dar es Salaam from operating as it should. The same data showed that there is a lengthy wait period of up to seven days for container ships, whether they are berthing or charging and discharging.

The level of container cargo productivity on the performance of the Port of Dar es Salaam

On the other side, there is a statistically significant and positive correlation between Port Performance and the amount of container freight delivery. With a t-value of 3.087, a p-value of 0.002, and a standardized coefficient (Beta) of 0.156, all of which are below the conventional statistically important threshold of 0.05. This implies that improved port performance is linked to a rise in the effectiveness of container cargo-level delivery. By examining the container terminal's berthing infrastructure, the study also looked at how the Port of Dar es Salaam was affected by the performance and volume of cargo delivered in containers. First of all, berth count is an important consideration. When there are more ships arriving than there are berths available, congestion arises.

We can assess each terminal's impact on port performance and congestion by counting the number of berths it has. Second, the length of the berth is important. Larger vessels can be accommodated on longer berths, which can increase productivity because of the increased ability to handle cargo. Through an examination of the average and total length of each berth, we can determine how well-suited each berth is for different vessel sizes and how this can affect productivity. Finally, throughput capacity—a measure of the volume of container cargo a port can handle—is essential to efficiency. Processing goods more efficiently can result from higher throughput capacity. To evaluate the throughput capacities of each port, the average and total berth lengths are calculated.

Table 4.0.1: Berth per terminals

Terminals	**Number of Berths**	**Load Capacity**
General cargo terminal	4	5.2 million tons
Container terminal	7	6.8 million tones
Grain Terminal	1	30,000 tons
Oil terminal	2	150000 (Metric Tonnes)

Source: Port Dar es Salaam (2023)

Based on the berthing infrastructure calculations for Tanzania's Dar es Salaam Ports, it is clear that the number of births and the servicing capacity berth are important factors in guaranteeing effective port operations when evaluating the appropriateness of berthing infrastructure. Therefore, to determine if the berthing infrastructure is acceptable, calculations were made using the berthing infrastructure, taking into account both the average berth capacity per terminal and the container terminal's overall capacity.

Comparably, it was noted that the container ships were waiting for berthing because the other berth was unproductive because the TPA was unable to manage it. Additionally, according to a TPA respondent who was interviewed, there are four berths that are non-operational as a result of the previous investor's contract expiring. As a result, the Authority is finding it difficult to get in touch with new investors, and a tender for berths 8 through 11 has been announced since August 2023. Low productivity is caused by the berth's increased idleness and container ship delays. Congestion also raises the cost of transportation and additional port fees for ships, which results in TPA underperformance.

Potential Strategies for Alleviating Container Ships Congestion at the Port of Dar Es Salaam

The study's third goal was to provide possible solutions for reducing the backlog of container ships at the Port of Dar Es Salaam. The next step was asking the respondents to mark the options on a Likert scale that appropriately represented the ways in which port operations strategies impacted port performance. Table 4.3.1 presents a summary of the results pertaining to the stated objective.

Table 4.0.1 Mean and Standard deviation of variables indicators

Statement	**Mean**	**Std. Deviation**
Customs clearance	4.00	0.528
Technology and automation	4.00	0.00
Port expansion	4.00	0.418
Public Private Partnership	4.00	0.05

Source: Field data, (2023)

Table 4.0.1 results indicate that several parameters, to varying degrees, affect port performance. Among these, the mean score for technology and automation, port growth, public-private partnerships, and customs clearance levels was 4.00, suggesting that respondents were mostly in agreement that these factors improved port performance. This consensus is further supported by the modest standard deviations. The elements of human capital, customs clearance, automation and technology, port development, and PPP all have a significant impact on improving operational efficiency.

According to qualitative research, TPA's equipment is outdated, its information systems aren't advanced enough to serve customers without upsetting them, its handling capabilities pale in comparison to developed nations, and certain berths aren't operational because there isn't enough money, equipment, or trained staff to operate and maintain them. Lin, Zeng, Luo, and Nan (2022) found that three possible approaches—a hybrid strategy, an investment in human technology, and automation—were examined to reduce ship congestion during such periods. The hybrid approach proved to be the most successful in lowering traffic, improving integrated service quality, and keeping container costs stable. The hybrid strategy's multifaceted approach, which combines the most effective components of the other two strategies, is responsible for its success. It tackles congestion more extensively by optimizing fixed assets and human technologies simultaneously. Efficiency and scalability are given top priority in this approach since they are essential for port operations, particularly in times of disruption.

5.0 Conclusion and Recommendations

5.1 Conclusion

First, a key component of port performance is the availability of sufficient people for port operations. According to the report, having enough employees is essential for timely cargo processing, vessel berthing, and effective documentation procedures. Employees who work in port operations are crucial to maintaining the efficiency of port operations and improving port performance.

Second, in order to accommodate vessels of different sizes, the infrastructure for berthing must be suitable. The port's capacity to accommodate various vessel types and cargoes is directly impacted by the quantity and length of available berths. The results show that berthing infrastructure forms the basis for effective port operations and is customized to meet the particular needs of each terminal. Last but not least, cutting down on ship turnaround time requires adequate container freight handling equipment. According to the report, effective container freight handling machinery is essential for accelerating the loading and unloading of cargo. To meet the demands of port operations, the Port of Dar es Salaam must guarantee that its cargo handling equipment is sufficient, well-maintained, and up-to-date.

5.2 Recommendations

The following suggestions are made to improve the Port of Dar es Salaam's performance: Optimize Staffing Levels: To ascertain the ideal staffing numbers necessary for effective port operations, the port authorities should carry out assessments on a regular basis. This entails appointing, educating, and keeping skilled workers to manage the rising cargo volumes and guarantee the prompt completion of port operations. Invest in Berthing Infrastructure: The port should give priority to developing and modernizing its berthing facilities because proper berthing infrastructure is essential for accommodating boats of different sizes. This means extending and increasing the number of berths in addition to maintaining them in order to meet the needs of different terminals. Upgrade Equipment for Handling Container Cargo: The port ought to invest in state-of-the-art cargo handling equipment to expedite the loading and unloading processes. This means making regular maintenance plans and purchasing new cranes, forklifts, and container-handling equipment to ensure optimal performance. Implement Advanced Technologies: The port should explore the adoption of advanced technologies such as digital port management systems, automated cargo handling systems, and real-time vessel tracking.

These technologies can enhance operational efficiency, reduce turnaround times, and improve overall port performance. Enhance Communication and Collaboration: Clear communication and collaboration among various port stakeholders, including port authorities, terminal operators, shipping lines, and customs officials, are essential for smooth port operations. Regular meetings, information-sharing platforms, and joint initiatives can foster better coordination and mutual understanding.

Improve Workplace Safety and Security: The port must prioritize the safety and security of its employees and its infrastructure. This means implementing comprehensive safety protocols, training staff on safety, and installing state-of-the-art security systems to fend off potential threats. Conduct Frequent Performance Evaluations: The metrics pertaining to port performance, such as waiting times, berth occupancy rates, cargo handling times, and vessel queue lengths, should be evaluated by the port authorities on a frequent basis. These evaluations may identify areas that require development and guide future investment decisions.

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