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# Assessment of the Impact of Port Investments on Port Operational Performance: A Case Study of Major Seaports in Tanzania, with a Focus on the Moderating Role of Improved Port Facilities

## By

**Mr. Kelvin Raphael[1], Miss. Saufa Mfanga[2], Mr. Franco Mwakatage[3], Miss. Christer Kiwanuka[4], Miss Okuly Muro[5] , Miss Vulfrida Teye[6], Dr. Lufunyo Hussein[7]**

[1,2,3,4,5,6,7]Tanzania Port Authority (TPA) - Bandari College, P.O. Box 9184, Dar es Salaam - Tanzania

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***Abstract***

*This study assesses the effect of port investments on the port operational performance of Tanzania's three main seaports, Dar es Salaam, Tanga, and Mtwara. The research aimed to identify the connection between investments in superstructure, infrastructure, and logistics services and port performance, while also evaluating the moderating role of ongoing facility improvements. Specifically, the study assesses the relationship between investment in superstructure and seaport performance, evaluates the link between investment in infrastructure and seaport performance, analyzes the relationship between investment in logistics services and seaport performance, and investigates how continuous facility improvements influence these relationships. The study adopted a positivist philosophy and an explanatory cross-sectional design, using a quantitative approach. A sample of 385 respondents, including Tanzania Ports Authority (TPA) employees, shipping agents, and clearing and forwarding agents, was drawn through stratified random sampling. Data were collected via structured questionnaires and secondary sources, then analyzed using descriptive statistics and Partial Least Squares Structural Equation Modelling (PLS-SEM). Reliability was confirmed with Cronbach's alpha coefficients above 0.7. Results showed statistically significant positive relationships between improved superstructure, infrastructure, and logistics services, and port performance ($p < 0.05$). Continuous improvement of port facilities significantly strengthened these relationships. The study concludes that infrastructure upgrades, enhanced superstructures such as cranes and ICT systems, and streamlined logistics operations contribute substantially to port efficiency, throughput, and service quality. It is recommended that TPA intensifies investments in automation, digitization, and integrated communication systems, and prioritizes continuous upgrades to meet international competitiveness standards.*

***Keywords:*** *Port investments, Superstructure, Infrastructure, Logistics services, Port performance, Continuous improvement*

## INTRODUCTION

Ports are essential gateways for global trade, enabling the movement of about 80% of worldwide trade volumes by sea (UNCTAD, 2023). In Tanzania, seaports significantly contribute to economic development, linking the nation to international markets and neighboring regions. As trade volumes increase, the need for efficient, high-capacity, and technologically advanced port operations has grown (Mlimbila & Mbamba, 2018; Wang, Chu & Kim, 2020). Port performance includes operational efficiency, cost-effectiveness, turnaround time for vessels, and throughput capacity (Tossa, 2016; Notteboom, Pallis & Rodrigue, 2022).

Investments in port infrastructure, superstructure, and logistics services are crucial for enhancing operational performance (Vaggelas, 2019). Infrastructure encompasses quay walls, dredging, and transport connections, while superstructure pertains to cranes, warehouses, ICT systems, and security facilities (Li, Lee & Hong, 2021). Logistics services involve processes for cargo clearance, intermodal connections, and the efficiency of freight networks. Over the past five years, the Tanzania Ports Authority (TPA) has made substantial upgrades, including the installation of ship-to-shore gantry

*Corresponding Author: **Mr. Kelvin Raphael**

cranes, deepening of berths, expansion of storage facilities, and improvements to ICT systems.

Despite these enhancements, performance issues remain. Reports suggest that the ports of Dar es Salaam, Tanga, and Mtwara continue to encounter challenges in cargo handling, vessel turnaround, and logistics integration (Mapunda, 2016; Mwendapole & Jin, 2020; Malanga, 2023). Prior research has either concentrated on specific aspects (like infrastructure or logistics services) or overlooked the moderating effect of continuous facility upgrades (Sun & Kauzen, 2023; Tengecha & Zhang, 2020). This creates a significant gap in comprehending the comprehensive and moderated relationships between investments and performance.

The current study aims to fill this gap by combining infrastructure, superstructure, and logistics services into a single analytical framework while assessing the moderating impact of ongoing improvements. Rooted in Neoclassical Economic Theory and Systems Theory, it asserts that coordinated investments across subsystems, enhanced by continuous upgrades, are vital for maintaining sustainable port competitiveness.

By providing empirical evidence from Tanzania's three primary ports, the research will contribute to theoretical and practical advancements. The results will guide TPA in formulating investment strategies, aid policymakers in infrastructure development, and enhance academic discussions on improving port performance in developing economies.

## LITERATURE REVIEW

### Port Performance and Port Investments

Port performance encompasses the effectiveness, productivity, and quality of services provided in maritime operations, including metrics such as vessel turnaround time, cargo throughput, operational efficiency, and return on investment (Konrad, 2017; Ivan, 2022). Key performance indicators (KPIs) for ports cover operational, financial, environmental, and safety aspects, such as equipment utilization, berthing duration, and energy consumption per handled unit (ICS, 2013). Conversely, port investments refer to the allocation of financial and physical resources to infrastructure, superstructure, and operational systems, intended for capacity expansion, modernization, and technological upgrades to boost competitiveness and service quality.

### Theoretical Framework

The **Neoclassical Economic Theory** establishes the relationship between port investment and performance by suggesting that enhanced infrastructure and technology lead to increased total factor productivity, thus improving service quality and market accessibility (Lakshmanan, 2011). Additionally, **Systems Theory** views ports as interconnected subsystems, including infrastructure, superstructure, and logistics that must operate cohesively to optimize performance (Bertalanffy, 1950; Cornell & Jude, 2015). This dual theory implies that investments aimed at all subsystems, supported by ongoing improvements, can provide synergistic advantages for port operations.

### Superstructure and Port Performance

Superstructures, including ship-to-shore gantry cranes, mobile cranes, warehouses, and information and communication technology systems, have a direct impact on cargo handling efficiency, clearance speed, and safety (Mlimbila & Mbamba, 2018). For example, advanced ICT enables real-time tracking and quicker documentation processes, while modern cargo-handling machinery reduces the idle time of vessels. Research by Erkyehun (2021) and Mlimbila & Mbamba (2018) corroborates that these advancements positively affect throughput and operational effectiveness. However, many past studies in Tanzania have primarily concentrated on correlation analyses, overlooking moderated relationships and the interaction with ongoing facility improvements.

### Infrastructure and Port Performance

Port infrastructure, such as quay walls, dredging depth, road and rail connections, and mooring facilities, constitutes the foundation of maritime operations (Kasypi et al., 2013; Peng, 2022). Well-established infrastructure allows for the accommodation of larger vessels, expedites loading and unloading, and ensures reliable hinterland connections. Liu (2019) pointed out that insufficient infrastructure limits port capacity, whereas Liang & Liu (2020) illustrated that enhancements in infrastructure improve logistics performance, which subsequently promotes trade and economic development. In Tanzania, significant investments in quay deepening and berth expansion have been undertaken to address these limitations, yet their overall impact on performance has not been adequately studied.

### Logistics Services and Port Performance

Effective logistics services such as optimized clearance procedures, reduced cargo dwell times, and efficient intermodal connections are vital for a port's competitiveness (Eliakunda et al., 2018). Collaboration among port community stakeholders, including shipping lines, freight forwarders, and customs authorities, alleviates procedural bottlenecks and enhances the flow of cargo (Li et al., 2021). Munim & Schramm (2018) highlighted that logistics performance serves as a mediator in the connection between infrastructure quality and trade growth, particularly in developing nations. Nonetheless, a comprehensive assessment of logistics services in conjunction with infrastructure and superstructure investments remains sparse in the Tanzanian context.

### Continuous Improvement of Facilities

Continuous improvement involves ongoing maintenance, technological advancements, and procedural innovations to sustain and elevate performance gains (Wagner et al., 2022). In port settings, this can encompass activities like fairway deepening, the automation of cargo-handling operations, and the digitization of clearance processes. These enhancements not only prevent deterioration but also adapt facilities to meet changing market demands and environmental regulations. Although qualitative case studies have examined these dimensions in Europe and Asia, quantitative data, especially

  

regarding their moderating effects in the investment-performance relationships, are still limited in Sub-Saharan Africa.

**Conceptual framework**

Conceptual framework exhibits how independent variables such as superstructure, infrastructure and logistics services influence dependent variable which was port performance when moderated by continuous port facility improvements. The empirical studies of port management show that port infrastructures such as berth depth, road and rail on terminal area, presence of mooring and fenders equipments as well as strong quay-wall can influence port performance by increasing port operational efficiency as well reduces ship turn-around time and increase port throughput (Peng, 2019; Liu, 2019; Liang & Liu, 2020) Also, superstructures such as cranes, size of port area, buildings at the terminal for storage and offices, port security among others has a significant impact on port performance (Mlimbila & Mbamba, 2018; Erkyehun, 2021). Besides, logistic and shipping services when implemented properly can enhance port performance (Munim & Schramm, 2018; Eliakunda et al., 2018; Li et al., 2021). Maintenance and improvement of port facilities ensured the continuous provision of quality services. Therefore, continuous maintenance and improvement of port facilities can increase the effect of investment in superstructure, infrastructure and logistic services on port performance (Wagner et al., 2022).

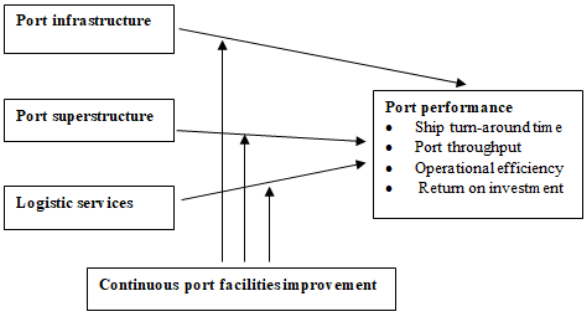


**Figure 1: Conceptual Framework of Port Performance**

## METHODOLOGY

The research was grounded in a positivist philosophy, concentrating on objective and measurable relationships. It utilized an explanatory cross-sectional design, which is appropriate for examining causal-effect hypotheses within a single period (Saunders et al., 2016). A quantitative methodology was implemented, with data sourced from a stratified random sample comprising 385 participants (TPA staff, shipping agents, and clearing and forwarding agents) from the ports of Dar es Salaam, Tanga, and Mtwara. Stratification was used to ensure representation from various functional roles. The sample size was calculated using Yamane's formula, and proportional allocation to strata was conducted through Skinner's method.

Primary data were collected using structured questionnaires, with additional information obtained from secondary sources (port annual reports and operational logs). Reliability was evaluated through Cronbach's alpha (≥0.7), while construct validity was confirmed via pilot testing. Data analysis involved descriptive statistics and Partial Least Squares Structural Equation Modelling (PLS-SEM), which facilitated the simultaneous estimation of intricate, moderated relationships.

## RESULTS AND DISCUSSION

**Profile of Respondents**

The objective of the respondent profile was to gather general information about the participants. The data presented includes age, work experience, the seaport where the respondent was located, the category of respondent from the two groups under study (TPA employees and Port users), and the type of business conducted by port users.

**Age**

Respondents were required to provide their age. Table 4.1 displays the age distribution of the respondents.

**Table 4.1 Respondents' Age**

| Age | Frequency | Percent |
|---|---|---|
| 18-35 | 212 | 49.0 |
| 36-49 | 178 | 41.0 |
| 50 ABOVE | 44 | 10.0 |
| **Total** | **434** | **100** |

Source: Field data (2025)

Table 4.1 indicates that 49.0% of all respondents fell within the age range of 18-35, while 41.0% were between the ages of 36-40, and only 10.0% were aged 50 and older. This information suggests that all respondents were adults with a sound mind.

**Respondents' Work Experience.**

The respondents were obliged to indicate their Work experience in terms of years they have spent with their employment. Table 4.2 Shows the distribution of work experience of respondents who were selected.

**Table 4.2 Respondents' Work Experience**

| Time | Frequency | Percent |
|---|---|---|
| 0-5 | 189 | 46.0 |
| 6-10 | 170 | 39.1 |
| 11-20 | 65 | 15.0 |
| 21 ABOVE | 10 | 2.3 |
| **Total** | **434** | **100** |

Source: Field data (2025)

  

Table 4.2 reveals that 46.0% of all participants have been employed for 0-5 years, while 39.1% have worked in their occupation for 6-10 years. Additionally, 15.0% of respondents have over 10 years of work experience, and 2.3% have more than 20 years of experience. This information suggests that the majority of respondents, specifically 56.4%, possess more than 5 years of experience in the maritime industry.

**Respondents' Sea port**

The respondents were obliged to indicate Seaport where they work Table 4.3 Shows the distribution of sea ports of respondents who were selected.

**Table 4.3 Respondents Sea ports**

| Port | Frequency | Percent |
|---|---|---|
| DSM | 332 | 76.4 |
| MTWARA | 51 | 11.8 |
| TANGA | 51 | 11.8 |
| **Total** | **434** | **100** |

Source: Field data (2025)

Table 4.3 indicates that 76.4% of all participants were from the Dar es Salaam port, while 11.8% of respondents came from both the Mtwara and Tanga ports. This information suggests that the predominant number of respondents is from Dar es Salaam port, which is Tanzania's primary port with a larger workforce and a greater number of national port users. Additionally, this port is currently undergoing significant projects aimed at enhancing its facilities.

**Measurement of reliability**

Reliability pertains to the consistency of the study's results. This study employed Cronbach's Alpha as the reliability metric, which is the most widely utilized indicator of internal consistency (reliability); the nearer the Cronbach Alpha value is to 1, the more consistent the items in the measurement are. The results for the utilized variables are shown in Table 4.4 below.

**Table 4.4 variables' Reliability Level**

| Variables | Cronbach's Alpha | N of items |
|---|---|---|
| Improved superstructure | 0.836 | 7 |
| Improved infrastructure | 0.813 | 5 |
| Improved facilities | 0.845 | 7 |
| improved performance | 0.726 | 6 |

Source: Field data (2025)

According to Table 4.4 above, the first objective was to assess the impact of the enhanced superstructure (investment) on seaport performance, which achieved a Cronbach's alpha of 0.836; this indicates a ≥0.8, signifying good and acceptable higher internal consistency for this objective.

The second objective aimed to evaluate the influence of improved infrastructure (investment) on seaport performance, which received a Cronbach's alpha score of 0.813; this also shows a ≥ 0.8, representing good and acceptable higher internal consistency for the objective. The third objective sought to analyze the effect of enhanced facilities (investment) on the performance of port users' logistics services, resulting in a Cronbach's alpha of 0.845, indicating a ≥ 0.8, which reflects good and acceptable higher internal consistency for this objective.The fourth objective involved examining the effect of improvements in port facilities, superstructure, infrastructure, and logistics services (investment) on seaport performance, scoring a Cronbach's alpha of 0.726, which translates to a ≥ 0.7, indicating acceptable internal consistency for this objective.

**Respondents' Category**

The respondents were obliged to indicate their category among the two under study, which was port users and TPA employees. Table 4.5 shows the distribution of the Respondents' Category.

**Table 4.5 Respondents Category**

| Port | Frequency | Percent |
|---|---|---|
| **Port Users** | 125 | 29.0 |
| **TPA STAFF** | 309 | 71.9 |
| **Total** | 434 | 100 |

Source: Field data (2025)

**Descriptive Statistics**

**Mean and Standard Deviation, and Frequency**

The table below shows the mean and standard deviation of the respondents about the role of improved superstructure on logistics operations

**Table 4.6: The effects of improved superstructures on port logistics operations**

| Statements | N | Mini | Maxi | Mean | Std. D |
|---|---|---|---|---|---|
| Availability of adequate equipment has enhanced effective cargo handling | 309 | 1.00 | 5.00 | 4.2686 | .74882 |
| Improved ICT systems facilitate fast cargo clearance | 309 | 1.00 | 5.00 | 4.2427 | .65166 |

  

| | | | | | |
|---|---|---|---|---|---|
| The port has ensured the safety of cargo and other properties | 309 | 1.00 | 5.00 | 4.4563 | .74437 |
| Electrical installation at the port distributes electricity effectively | 309 | 1.00 | 45.00 | 4.2557 | 2.40724 |
| Installed ship-to-shore cranes to fasten loading and unloading operations | 309 | 1.00 | 5.00 | 4.1586 | .65274 |
| Port quay including warehouse, yard facilitates business operation | 309 | 2.00 | 5.00 | 4.2006 | .61781 |
| Availability of office buildings provides onsite business continuity | 309 | 2.00 | 5.00 | 4.1036 | .60487 |

Source: Field data (2025)

In the table 4.6 above the mean and standard deviation of the respondents about about the effects of improved superstructures on port logistics operations, Whereby ensured safety of cargo and other properties and availability of adequate equipment which has enhanced effective cargo handling scored the highest mean of 4.2686 and 4.4563 respectively however all statements had the higher rank to the maximum such Improvement in ICT systems which facilitate fast cargo clearance, at the installation and distributes electricity effectively, Installed ship to shore cranes in some ports that fasten loading and unloading operations expansion of Port quay including warehouse, yard facilitates business operation and availability of office buildings provides onsite business continuity which scored 4.2427,4.2557,4.1586,4.2006, 4.1036 respectively.

**Table 4.7: The effects of improved superstructures on port logistics operations**

| Statements | Strongly disagree% | Disagree% | Neutral% | Agree % | Strongly agree % |
|---|---|---|---|---|---|
| **S1** | 0.6 | 1.0 | 11.3 | 45.0 | 42.1 |
| **S2** | 0.6 | 0.3 | 7.1 | 57.9 | 34.0 |
| **S3** | 1.3 | 0.0 | 7.4 | 34.3 | 57.0 |
| **S4** | 0.6 | 00. | 10 | 64.7 | 24.3 |
| **S5** | 0.3 | 1.0 | 9.7 | 60.5 | 28.5 |
| **S6** | 0.0 | 0.3 | 10.0 | 58.9 | 30.7 |
| **S7** | 00 | 0.6 | 1.7 | 64.4 | 23.3 |

Source: Field data (2025)

Table 4.7 above illustrates the recommendations from respondents regarding the impact of improved superstructures on port logistics operations, with 57.0% of participants strongly agreeing and 45.0% agreeing that the presence of adequate equipment has improved cargo handling efficiency. Furthermore, 64.7% of respondents agreed, and 24.3% strongly agreed, that the electrical installations at the port effectively distribute electricity. Additionally, 64.4% agreed while 23.3% strongly affirmed that the availability of office buildings ensures business continuity on site at their ports. Lastly, 60.5% of participants agreed, and 28.5% strongly agreed that ship-to-shore cranes have been installed at their ports to expedite loading and unloading operations.

**Table 4.8: The effects of improved infrastructure on port logistics operations**

| Statements | N | Mini | Maxi | Mean | Std. D |
|---|---|---|---|---|---|
| Apron mooring equipment ensures the dock can moor and secure ships | 309 | 2.00 | 5.00 | 3.9061 | .58186 |
| Quay walls can handle tidal seismic tresses and small collisions | 309 | 3.00 | 5.00 | 4.1812 | .57505 |
| Land reclamation increased the port area the terminal | 309 | 1.00 | 5.00 | 4.0421 | .59884 |

  

| | | | | | |
|---|---|---|---|---|---|
| facility is stable | | | | | |
| Availability of marine facilities improved the navigation system | 309 | 1.00 | 5.00 | 4.1715 | .66428 |
| Quay way construction enhanced the quay to handle tidal | 309 | 2.00 | 5.00 | 4.2492 | .64921 |

Source: Field data (2025)

In Table 4.8 above, the average and standard deviation of the respondents regarding each statement about the impact of enhanced infrastructure on port logistics operations are presented. The construction of quayways, which ensured the safety of the quay for handling tidal influences, received the highest average score of 4.2492. This data suggests that there has been an improvement in the quay at Tanga and Dar es Salaam ports. Similarly, land reclamation that enhanced the stability of port terminals received a high average score of 4.0421, indicating significant enhancements in the port terminals at Dar es Salaam and Tanga. Other statements also received reasonable average scores, such as the ability of quay walls to withstand tidal, seismic stress, and minor collisions, which were rated at 4.1812, and the availability of marine facilities that improved navigation systems, rated at 4.1715. However, apron mooring equipment designed to secure ships at the dock received a score of 3.9061, indicating that there has been only minimal improvement in this aspect of the infrastructure in the ports under study.

**Table 4.9: The effects of improved infrastructure on port logistics operations**

| Statements | Strongly disagree% | Disagree% | Neutral% | Agree% | Strongly agree% |
|---|---|---|---|---|---|
| S1 | 0.0 | 1.0 | 19.1 | 68.3 | 11.7 |
| S2 | 0.0 | 0.0 | 9.1 | 63.8 | 27.2 |
| S3 | 0.6 | 0.0 | 12 | 69.3 | 18.1 |
| S4 | 0.3 | 0.3 | 12 | 56.6 | 30.7 |
| S5 | 0.6 | 0.3 | 28.5 | 33.7 | 36.9 |

Source: Field data (2025)

The table above shows respondents recommendation on the statements about the effects of improved infrastructure on port logistics operations that 69.3% of respondents agreed while 18.1% of respondents Strongly agreed that Land reclamation increased port area the terminal facility is stable, 68.3% of respondents agreed while 11.7% of respondents strongly agreed that Apron mooring equipment ensure the dock can moor and secure ships. 63.8% of respondents agreed, while 27.2% of respondents strongly agreed. 56.6% of respondents agreed, and 30.7% of respondents strongly agreed that the availability of marine facilities improved the navigation system.

**Table 4.10: The effects of improved facilities on port users' logistics operations**

| Statements | N | Mini | Maxi | Mean | Std. D |
|---|---|---|---|---|---|
| A high number of ships for export and import increases the needs for your service | 125 | 1.00 | 5.00 | 3.5920 | .81415 |
| Exporters increase access to overseas markets due to regular shipping | 125 | 2.00 | 5.00 | 3.6800 | .79919 |
| The frequency of ship calls increases the utilization of your services | 125 | 2.00 | 5.00 | 3.8720 | .82282 |
| The port has increased cargo handling capacity and value-added services | 125 | 2.00 | 5.00 | 3.8960 | .79132 |
| Decreased truck turnaround time | 125 | 1.00 | 6.00 | 3.9200 | .83859 |
| Less container dwell time | 125 | 2.00 | 2.00 | 5.00 | 3.9920 |
| Improved seaside and land-side connectivity that lowers transit costs | 125 | 2.00 | 5.00 | 4.0320 | .80258 |

Source: Field data (2025)

In table 4.9, we see the mean and standard deviation of the respondents regarding each statement related to the impact of improved facilities on port users' logistics operations. The statement regarding reduced container dwell time received the highest mean of 5.00, indicating an enhancement in cargo clearance times at seaports, particularly in container handling, since the improvements were made. Furthermore, the

  

statement about enhanced seaside and land-side connectivity that reduces transit costs achieved a mean score of 4.0320, highlighting significant progress in port logistics connectivity. On the other hand, the other statements received relatively moderate scores, such as the observed increase in the number of ships for export and import which heightened demand for port user services, as well as exporters gaining better access to overseas markets due to a regular shipping schedule and a rise in the frequency of ship calls, scoring 3.5920, 3.6800, and 3.8720, respectively.

**Table 4.11: The effects of improved facilities on port users' logistics operations**

| Statement | Fair% | Good% | Very good% | Excellent% |
|---|---|---|---|---|
| S1 | 9.6 | 30.4 | 50.4 | 9.6 |
| S2 | 8.0 | 28.8 | 50.4 | 12.8 |
| S3 | 6.4 | 21.6 | 50.4 | 21.6 |
| S4 | 4.8 | 22.4 | 51.2 | 21.6 |
| S5 | 4.8 | 24 | 48 | 23.2 |
| S6 | 2.4 | 21.6 | 50.4 | 25.6 |
| S7 | 2.4 | 23.2 | 43.2 | 31.2 |

Source: Field data (2025)

Table 4.11 presents the recommendations from respondents regarding how improved facilities impact port users' logistics operations, with 50.4% of respondents giving a Very Good recommendation to statements indicating that an increased number of ships for export and import has led to a greater demand for their services, that exporters have gained better access to international markets due to regular shipping, that the frequency of ship calls has enhanced the use of their services, and that a reduction in container dwell time has been noted. Furthermore, 51.2% of respondents also provided a Very Good recommendation regarding the assertion that the port's cargo handling capacity and value-added services have been enhanced. To assess the impact of port investment on seaport performance, respondents were asked to evaluate the effects of improved infrastructure on port logistics operations using a 5-point Likert scale, and the following results were obtained.

**Table 4.12: To determine the role of investment port performance**

| Statements | N | Mini | Maxi | Mean | Std. D |
|---|---|---|---|---|---|
| A high number of scheduled ship calls allows for high service frequency | 309 | 2.00 | 5.00 | 3.8479 | .69285 |
| High number of linear shipping companies indicates competition in market | 309 | 3.00 | 43.00 | 3.7994 | 2.35733 |
| Large ship associated with economies of scale on sea leg | 309 | 3.00 | 5.00 | 3.9935 | .53448 |
| Observe decrease in ship waiting time to berth | 309 | 3.00 | 5.00 | 4.1036 | .59403 |
| Decrease in ship cargo turnaround time | 309 | 2.00 | 43.00 | 3.8479 | 2.95959 |
| Reduced equipment downtime | 309 | 3.00 | 5.00 | 3.7994 | .52796 |

Source: Field data (2025)

Table 4.12 displays the average and standard deviation of respondents regarding each statement on how enhanced facilities impact port users' logistics operations. The lowest container dwell time achieved the highest average of 5.00, suggesting that there has been an improvement in cargo clearance times at seaports, particularly concerning container handling. Additionally, the statement regarding enhanced seaside and landside connectivity that reduces transit costs attained a mean of 4.0320, indicating a significant advancement in port logistics connectivity. In contrast, the other statements received moderately favorable scores, such as the observation of a high number of ships for both export and import, which amplifies the demand for port users' services, exporter's increased access to international markets due to regular shipping, and the frequency of ship calls that enhances the utilization of port users' services, which scored 3.5920, 3.6800, and 3.8720, respectively.

**Table 4.13: In order to determine the role of investment port performance**

| Statements | Strong disagree% | Disagree% | Neutral% | Agree% | Strongly agree% |
|---|---|---|---|---|---|
| S1 | 0.0 | 1.00 | 29.8 | 52.8 | 16.5 |

  

| | | | | | |
|---|---|---|---|---|---|
| S2 | 0.0 | 0.0 | 49.2 | 34.0 | 16.8 |
| S3 | 0.0 | 0.0 | 14.5 | 71.5 | 13.9 |
| S4 | 00 | 0.0 | 12.9 | 63.8 | 23.3 |
| S5 | 0.0 | 0.3 | 48.5 | 30.1 | 20.4 |
| S6 | 0.0 | 0.0 | 6.5 | 68.9 | 24.6 |

Source: Field data (2025)

The table above shows that 50.4% of respondents provided a very good recommendation to the statements that a high number of ships for export and import increased the need for their services, exporters increased access to overseas markets due to regular shipping, and the frequency of ship call increased utilization of their services, and less container dwell time was observed. Also, 51.2% of respondents provided a very good recommendation to the statement that the port has increased cargo handling capacity and value-added services.

**Hypothesis Testing**

This part presents the mode of fitness correlation and regression analysis of the study and tolerance of independent variables. The model of fitness was performed to find how the independent variables identified by the researcher, as presented in the literature review, can be used to predict the causality of port investment in Sea Ports.

**Mode Fitness**

The R-squared and F test were used to measure the overall significance of the regression line as presented in the table below.

**Table 4.14 Coefficients of Determination**

| Dependent variable: | R | R Square | Adjusted R Square |
|---|---|---|---|
| Effects of port investments | .501a | .451 | .234 |

Source: Field data (2025)

Table 4.14 above provides the *R* and *R*2 values. The *R* value represents the simple correlation, which is 0.501 (the "R" Column), which indicates a high degree of correlation. The *R*2 value (the "R Square" column) indicates how much of the total variation in the dependent variable, Port Investments, can be explained by the independent variables: Improved facilities, improved infrastructure, improved superstructures and improved port performance. In this case, the independent variable can explain the Effects of Port Investments by 45.1% in Seaports, and other factors contribute 54.9 %.

**Analysis of Variance (ANOVA)**

ANOVA Analysis of Variance is a statistical method used to test differences between two or more means

**Table 4.15 Analysis of variance results**

| | Sum of Squares | Df | Mean Square | F | P-value |
|---|---|---|---|---|---|
| Regression | 9.405 | 3 | 3.135 | 14.110 | .000b |
| Residual | 27.996 | 126 | .222 | | |
| Total | 37.401 | 129 | | | |

Source: Field data (2025)

Table 4.15 above demonstrates that the regression model predicts the dependent variable with considerable accuracy. This shows the statistical significance of the regression model conducted here, with a p-value of 0.000, which is less than 0.05. A p-value lower than 0.05 (typically $\leq 0.05$) indicates statistical significance. This suggests strong evidence against the null hypothesis, indicating that there is less than a 5% chance that the null hypothesis is true (implying that the results are random). Thus, the null hypothesis, which stated that "There was no statistically significant and positive effect of continuous improvement and investment in port facilities on the relationship between superstructure, infrastructure, logistics activities, and port performance," has been rejected in favor of the alternative hypothesis. The findings align with those of Munim, Z. H., & Schramm, H. J. (2018), who found significant economic impacts arising from the quality of port infrastructure and logistics performance. This study aimed to analyze how enhanced port infrastructure quality contributes to the logistics performance of a country. Furthermore, the findings are consistent with the work of Okeudo, G. N. (2013), who reported that port reforms led to a substantial increase in cargo throughput compared to the pre-reform period. Additionally, Ernst & Young (2016) noted that a port's capacity largely relies on its infrastructure's ability to handle cargo, the size and quantity of berthing vessels, and productivity evaluated by the rate of vessel turnover. Regarding enhanced port superstructure, the results of this study coincide with the findings of Kang, Z., & Guo, X. (2018), who stated that ongoing advancements and improvements in remote monitoring technology, along with real-time oversight of port machinery parameters via software systems, enable timely problem detection, thereby boosting enterprise efficiency and minimizing disruptions to production activities while enhancing economic efficiency.

Alongside improved port superstructure, the study's findings also align with Yang, Y. C., & Chang, W. M. (2013), who demonstrated that electric rubber-tired gantries (E-RTGs) provide a notable performance boost compared to traditional RTGs. Their research compared the operational efficiency of rubber-tired gantries (RTGs) and electric rubber-tired gantries (E-RTGs), focusing on energy savings and CO2 emissions reduction, while also examining the implications of E-RTG adoption on green port policies among international hub ports. Moreover, Mlimbila and Mbamba (2018) concluded that ICT plays a significant role in assessing the impact of superstructure on port performance.

In terms of enhanced logistics services at the port, Jouad, S., & Hamri, M. H. (2020) concluded that the integration of information systems leads to reduced vessel docking times and increased productivity at berths. The purpose of their research was to explore how information systems could

  

enhance port performance. The port needs to harmonize the clearance process, boost inter-process communication, and align various operations to augment logistics efficiency and competitiveness. Issues such as high tariffs, logistics costs, the absence of a single clearance window, and multiple agencies managing cargo clearance must be addressed as they affect the port's efficiency and effectiveness (Eliakunda et al., 2018).

## CONCLUSION AND RECOMMENDATIONS

The focus of this study on port investment included activities such as enhancing terminals, expanding capacity, and implementing new technological upgrades like automated handling systems. Conversely, enhancing logistics operations performance involves various metrics, including reducing transit times, which is the duration required for goods to pass through the port, and throughput, which refers to the quantity of cargo processed by the port. Efficiency describes how smoothly operations function within the port, while reliability indicates the consistency of meeting scheduled arrivals and departures. Cost encompasses the financial implications associated with logistics operations, and port capacity refers to the maximum volume of cargo that a port can manage over a specific timeframe, which may be influenced by investment. Infrastructure development includes the physical assets of the port, such as those used for cargo handling, storage spaces, transportation links (like rail and road), and access to essential utilities such as electricity and water.

The findings indicated positive results from the improvements made by TPA to the seaports, specifically DSM, MTWARA, and TANGA. There was an enhancement in the availability of equipment to expedite cargo and ship handling operations; however, at Mtwara port, the available equipment does not meet the demand due to increased activity. Nonetheless, there has been progress in the ICT systems related to cargo management, such as the POAS, which aids in cargo clearance and provides real-time updates on cargo status.

The study also identified significant upgrades to berths that ensure safe mooring and ship securing. The presence of berthing facilities like fenders and bollards, along with other mooring structures, has allowed for the accommodation of larger vessels. However, the results highlighted that the quality of port infrastructure greatly influences the logistics performance of both a port and a country. In line with findings from Hausman et al. (2013), it was determined that logistics performance impacts seaborne trade through the port community (port users), leading to increased competition among shipping agents. Hence, it can be concluded that if port infrastructure is not continuously enhanced, it could have a considerable negative effect on the country's economy.

Nevertheless, there was noted improvement in the cargo handling capacity of seaports, which has led to an uptick in ship calls of various sizes, as well as a reduction in truck turnaround times, indicating increased speed in discharge and delivery operations. Overall, the study's findings align with existing transportation economics literature, which emphasizes the essential role of quality port facilities and infrastructure, as well as logistics performance, in contributing to a country's economic growth. For example, Portugal-Perez and Wilson (2012) discovered that the quality of port infrastructure significantly affects port logistics performance and has implications for seaborne trade. Consistent with the findings of Hausman et al. (2013), it was asserted that logistics performance influences seaborne trade within the port community (port users), fostering greater competition among shipping agents. Therefore, it can be reiterated that if port infrastructure does not undergo continuous improvement, it may result in significant adverse consequences for the country's economy.

### 5.3 Recommendation

Based on the research objectives and results, the following recommendations emerge from this study.

(i) The port superstructure, which includes all terminal handling equipment (Mobile Crane, Gantry Crane, SSG, Reachstacker, Forklift, etc.), along with electrical and telecommunication installations and wiring, as well as warehouses and container yards, is crucial for forecasting container throughput and, by extension, port performance. It is advised that TPA implement automated processes and robotics. Automation and robotics are transforming port operations, resulting in greater efficiency and a decreased dependency on manual labor. Automated container handling, unmanned vehicles, and robotic cranes optimize cargo movements, ensuring faster turnaround times for ships. Furthermore, these technologies enhance safety protocols and reduce human error, creating a more secure and efficient port setting.

(ii) The port's infrastructure, including berths, gates, aprons, mooring equipment, fenders, paving, terminal roads, and on-dock rail facilities, is essential for the functioning of the seaport. Therefore, it is recommended that TPA adopt smart infrastructure and digitalization, which are vital for contemporary port optimization. Integrated systems that leverage the Internet of Things (IoT), real-time data analytics, and artificial intelligence allow port authorities to gather crucial insights into their operations. This improved visibility enables them to spot bottlenecks, refine vessel berthing schedules, and enhance cargo handling processes, thereby reducing wait times and boosting overall productivity.

(iii) The study indicates that the port should synchronize the clearance process, enhance inter-process communication, and harmonize procedures to bolster logistics efficiency and competitiveness. This is crucial for TPA to continually enhance the quality of port logistics services, such as those provided by yards, warehouses, and terminal roads, as these factors lead to improved logistics performance, resulting in increased seaborne trade and greater economic growth.

*Corresponding Author: **Mr. Kelvin Raphael**

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*Corresponding Author: **Mr. Kelvin Raphael**