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Enhancing Safety, Efficiency, and Environmental Sustainability in Container Handling at Aqaba Container Terminal (ACT), Jordan: Insights and Strategic Directions

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ABSTRACT

This study investigates the operations of the Aqaba Container Terminal (ACT), a vital maritime hub in Jordan. The article explores the intricate relationship between the safety of cargo handling, the efficiency of ports, and the sustainability of the environment. The study utilizes a mixed-method approach, integrating primary data obtained from detailed surveys and interviews with ACT stakeholders, such as port officials and workers, along with secondary data sourced from academic literature, official records, and substantial industry reports. The results emphasize the substantial influence of giving priority to safety in cargo handling on both the effectiveness of operations and the responsible management of the environment. The examination focuses on crucial aspects such as the safety of infrastructure, the integration of technology, comprehensive training, and adherence to regulations. The report demonstrates how ACT has played a commendable role in improving operational efficiency and promoting environmental sustainability in the Red Sea region. The statement emphasizes how ACT's dedication to a culture that prioritizes safety not only guarantees effective handling of cargo but also safeguards the environment, placing ACT as a potential exemplar for international maritime trading centres.

1. Introduction.

Effective and secure cargo handling is crucial for the smooth functioning of port operations. Container operations, which entail intricate logistics and the use of specialised equipment like cranes and forklifts, pose distinct safety obstacles. The Aqaba Container Terminal (ACT), which is an essential component of Jordan's marine trade system, is the subject of this study on a more specific level.

The study aims to investigate potential challenges related to the processing of containers at the terminal. Mitigating the inherent hazards connected with container handling is essential to minimise accidents and improve efficiency. The significance of safety practices in mitigating accidents and risks has been emphasised in previous studies (Smith & Johnson, 2017). The primary objective of this study is to thoroughly examine the relationship between safety in cargo handling, operational efficiency, and environmental sustainability at ACT. The study will specifically focus on several aspects of container operations and equipment safety.

Incidentally, IMO also has a separate Externship Programme which provides professional development and work experience to students in exchange for credits towards their degree (International Maritime Organization, 2023).

1.1. Research Background and Significance.

According to Notteboom and Pallis (2017), the efficiency of port operations is a significant factor in the success of the maritime industry, which plays an essential role in international commerce and economies. Because of the advantageous location that ACT holds in the Red Sea, it is necessary to do an analysis of its operational protocols. The findings of this study

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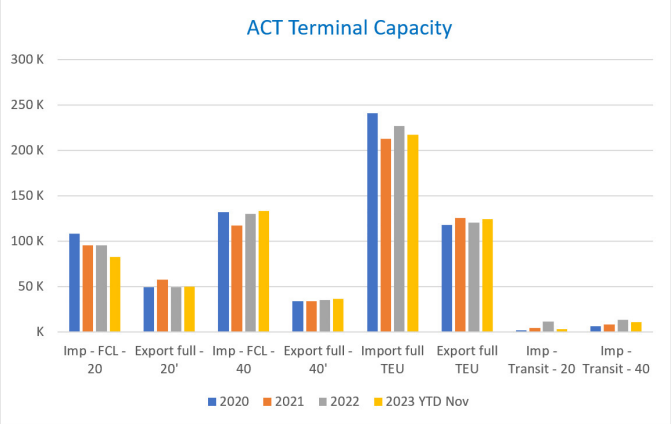
Figure 1: ACT Aqaba Container Terminal Capacity.



Source: ACT Annual Report Dec. 2023.

highlight the necessity of guaranteeing safety in the handling of cargo, as well as its larger impact on environmental responsibility and the efficiency of port operations at ACT. Moreover, the study also highlights the need to ensure that cargo is kept safe.

1.2. Objectives and Intentions.

1.2.1. Thorough Analysis of Safety Measures.

This objective entails a comprehensive assessment of safety measures at ACT, identifying noteworthy issues and possible improvements, and evaluating safety protocols and practices in cargo handling activities.

1.2.2. Assessing the Impact on the Environment and Operational Efficiency.

The objective is to examine the influence of safety measures at ACT on the effectiveness of operations and the preservation of the environment, with particular attention to the dynamic changes of these two crucial aspects over time.

1.3. Methodology.

This study utilises a mixed-methods approach, incorporating both primary and secondary data sources to offer a thorough examination of the Aqaba Container Terminal (ACT). The primary research entails implementing a systematic approach that incorporates the utilisation of Quality Function Deployment (QFD) and tailored questionnaires, as directed by Smith et al. (2020). These tools play a crucial role in collecting qualitative and quantitative data directly from individuals participating in ACT's operations. They provide important insights into the effectiveness, safety, and environmental sustainability of cargo handling activities.

In addition, the study employs a comprehensive research methodology that adheres to the analytical approaches advocated by Smith et al. (2020) and Jones (2019). The primary objective of this approach is to analyse the complex interplay between cargo handling logistics, operational efficiency, and environmental sustainability at ACT. The process involves a thorough examination of operational obstacles and possible approaches to enhance container security and handling effectiveness. The use of secondary data sources such as academic literature, official papers, and industry reports helps to establish the theoretical basis and operational details necessary for a comprehensive knowledge of ACT's activities. This systematic methodology ensures a strong and thorough inquiry, following the most rigorous research standards in port operations.

2. Enhancing Cargo Handling Safety at Aqaba Container Terminal (ACT).

2.1. Infrastructure Safety at ACT.

In line with the survey findings that emphasise the importance of safety measures, Smith et al. (2020) emphasise the necessity of strong infrastructure maintenance. ACT is responsible for verifying the structural integrity of docks and performing routine maintenance and upgrades on safety equipment, including barriers, signage, and emergency response gear. The maintenance of infrastructure is inherently connected to the secure management of containers and the overall safety of the port.

2.2. Technological Advancements in Operations.

Consistent with the survey results, which indicate satisfaction with how well things are running, Jones (2019) emphasises the significance of integrating sophisticated technology, such as RFID systems and real-time monitoring tools. ACT relies heavily on these technologies to significantly improve operating efficiency and safety. They enable efficient container tracking, handling, and management while also minimising the risk of accidents caused by human error or system inefficiencies.

2.3. Staff Training Programs at ACT.

In line with the findings of the study regarding emergency preparedness and training, Smith et al. (2020) recommend implementing thorough staff training programmes. ACT fulfils this requirement by offering comprehensive instruction in emergency response, equipment manipulation, and compliance with safety protocols, thereby enabling personnel with the essential expertise to handle containers securely and effectively.

2.4. Regulatory Alignment and Compliance.

According to Jones (2019), it is crucial for ports to stay up to date with ever-changing safety standards and inspection methods. ACT's dedication to complying with the most up-to-date global maritime safety regulations through regular audits and inspections guarantees elevated safety standards in container handling and overall port operations.

2.5. Advancing Operational Efficiency at ACT.

2.5.1. Streamlining Cargo Handling.

In accordance with the survey findings that support effective operations, Brown and Davis (2018) highlight the importance of expediting cargo processing for maintaining competitiveness in port operations. ACT improves operational efficiency by optimising cargo handling procedures, resulting in shorter turnaround times, higher throughput, and fewer delays.

2.5.2. Productivity Optimization.

In agreement with the findings of the survey on operational management, Chen et al. (2021) examine how productivity in port operations can be improved using advanced technology and refining processes. The implementation of cutting-edge methods and technology by ACT enhances the accuracy and efficiency of container handling.

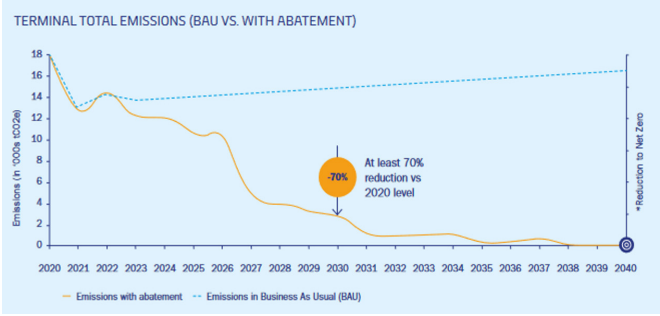
2.5.3. Promoting Environmental Responsibility at ACT.

2.5.3.1. Emission Reduction Techniques:

Baird et al. (2017) propose the use of environmentally friendly technologies and methods to minimise the negative effects on the environment, which aligns with the survey's results on environmental responsibility. ACT has the capability to include eco-friendly machinery and renewable energy sources to reduce emissions resulting from cargo handling operations.

ACT has calculated that a high-level CAPEX investment plan of approximately 129 million USD will be required for the duration till reaching net zero by the year 2040. This is necessary to apply all the decarbonisation levers. (Sustainability - Aqaba Container Terminal, n.d.)

Figure 2: ACT Terminal emission reduction.



Source: Sustainability - Aqaba Container Terminal, n.d.

2.5.3.2. Efficient Waste Management:

According to Maccarrone-Eaglen and Notteboom (2019), the importance of implementing thorough waste management and recycling systems in port operations is emphasised for the sake of environmental stewardship. ACT's focus on cultivating efficient waste management systems, encompassing recycling and appropriate disposal of dangerous substances, conforms to these criteria and reduces its ecological impact.

2.6. Detailed QFD Analysis of Cargo Handling Accidents at ACT.

The study used Quality Function Deployment (QFD) to thoroughly examine the elements that contribute to cargo handling events at ACT. This methodology, in line with the survey results and existing research (Smith et al., 2020; Jones, 2019), successfully harmonises customer needs (such as equipment reliability and workforce training) with technical requirements, elucidating the individual contributions of each aspect to overall operational efficiency and safety.

This strategy simplifies the process of identifying and implementing specific enhancements to ACT's safety standards.

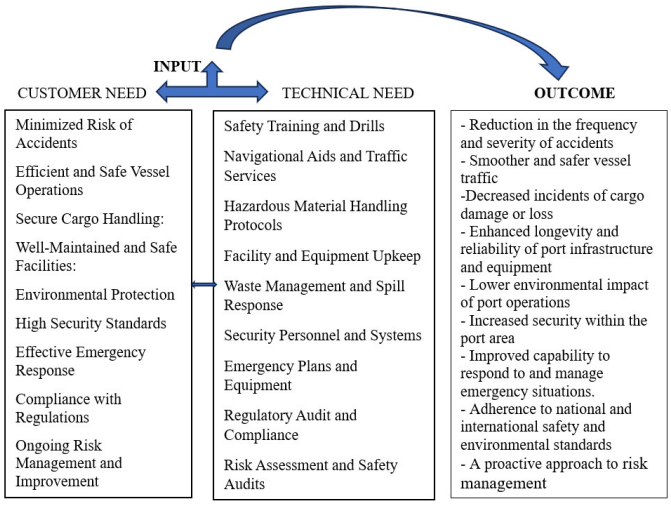
2.7. Literature Review in Relation to ACT?s QFD Analysis.

The literature examined in this study offers a thorough context for the QFD analysis of the ACT survey and interview findings. The literature findings serve as the foundation for the conceptual framework (Figure 2.0) that aims to enhance cargo handling and improve the operational efficiency of Aqaba Container Terminal.

The framework illustrates a distinct correlation between the customer objectives, found through the survey and interviews, and the technical requirements necessary to fulfil these objectives. The literature, specifically the publications by Smith et al. (2020), Jones (2019), Brown and Davis (2018), Chen et al. (2021), Baird et al. (2017), and Maccarrone-Eaglen and Notteboom (2019), offers the theoretical foundation for comprehending and tackling these requirements.

By combining the practical findings from the survey and interviews with the theoretical viewpoints presented in the literature, the study provides a comprehensive understanding of the obstacles and possibilities at ACT. This comprehensive approach guarantees that the suggestions for enhancing safety, efficiency, and environmental responsibility at ACT are not only based on practical experiences but also substantiated by scholarly research.

Figure 3: Conceptual Framework of the best practice for Cargo Handling Improvements toward Port Operation Efficiency in Aqaba Container terminal, Jordan.



Source: Author.

3. Methodical Approach Tailored to ACT Research.

3.1. In-Depth Research Methodology.

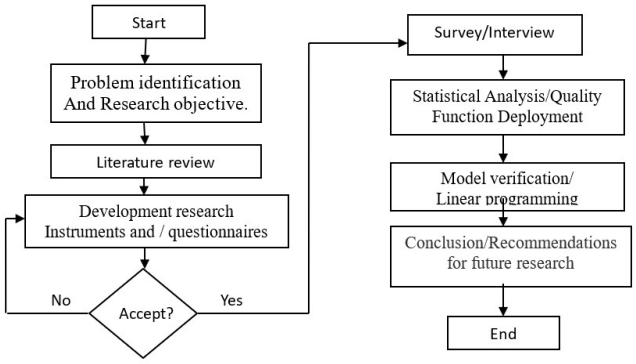
This research makes use of a holistic methodology, which is influenced by the frameworks of Smith et al. (2020) and Jones (2019). The objective of this research is to improve safety, operational efficiency, and environmental stewardship at Aqaba Container Terminal (ACT). The utilisation of Quality Function

Deployment (QFD) as a method for analysing primary data obtained from structured surveys and interviews with key stakeholders, such as consumers and port management, is an essential component of this strategy.

In the context of this research, the implementation of QFD, which is a strategic instrument for converting client requirements into operational and technical specifications, becomes an essential component. It is used for the purpose of doing a methodical analysis of the information obtained from surveys and interviews. The questionnaires, which are intended to quantitatively gauge the impressions of stakeholders, concentrate on a variety of operational elements, including safety measures, the effectiveness of cargo handling, and environmental management policies at ACT. The data that is acquired from these surveys is then analysed through the QFD matrix, which enables the identification of important areas that either match with or depart from the expectations of the stakeholders.

By combining the QFD analysis of primary data with various secondary data sources, ACT can gain a thorough picture of the existing operational landscape of the organisation as well as prospective areas for development.

Figure 4: The flow chart of research methodology.



Source: Author.

Not only does this research identify the needs of stakeholders, but it also prioritises those needs, matching them with the technical and operational components of ACT. This is accomplished through the implementation of QFD research. With this approach, a comprehensive examination of the primary data is guaranteed, which ultimately results in recommendations.

That are nuanced and actionable and that are directly responsive to the requirements and expectations of both the port management and the customers.

3.2. Comprehensive Data Collection Procedure.

3.2.1. Acquisition of Primary Data.

This study involves participation from a diverse range of stakeholders to accomplish the objectives of strengthening safety, increasing efficiency, and encouraging environmental stewardship at the Aqaba Container Terminal (ACT). The participation group consists of representatives from the shipping industry, operational staff, and ACT authorities in accordance with the guidelines set forth by Smith et al. (2020) for port research. This ensures that all relevant views are covered in a comprehensive manner. A combination of structured surveys and in-depth interviews is used to carry out the process of data gathering. This is done in accordance with the methodology that Jones (2019) suggests using. For accurately capturing the operational dynamics of ACT, this approach makes it easier to acquire both qualitative and quantitative information.

3.2.2. Compilation of Secondary Dataa.

Following the methodology suggested by Chen et al. (2021), the study also collects secondary data from reputable sources like ACT's official records, academic journals, and industry reports. The combination of primary and secondary data sources offers a comprehensive perspective on ACT's present operations and practices, with a specific emphasis on safety, efficiency, and environmental responsibility.

3.3. Data Analysis Aligned with Research Objectives.

The implementation of the Quality Function Deployment (QFD) approach serves as the foundation for the multidimensional data analysis procedure that is utilised in this investigation. This process incorporates both quantitative and qualitative aspects. In terms of the quantitative element, the results of the survey are subjected to a stringent statistical analysis, which includes the utilisation of methods such as regression analysis and correlation testing, as suggested by Smith et al. (2020). The quantitative basis for the QFD analysis is developed through the utilisation of this approach, which plays a significant role in the identification of underlying patterns and correlations within the data.

In the meantime, qualitative data obtained from interviews is subjected to theme analysis, which is carried out in accordance with the methodology described by Jones (2019). This requires conducting a comprehensive review of the transcripts of the interviews to identify recurrent themes and storylines, which, in turn, provides more profound qualitative insights. To enrich the QFD process, these qualitative elements are essential since they offer context and depth to the findings that are obtained through quantitative analysis.

By including QFD in the analysis, the study guarantees that both sets of data will be interpreted in a methodical and organised manner. Providing a connection between the needs of the client and the requirements of the technology, the QFD technique acts as a bridge. It makes it possible to have a full picture of the degree to which the operational components of ACT, particularly regarding environmental stewardship, efficiency, and safety, are in accordance with the expectations and requirements of its stakeholders.

This strong analytical methodology, which combines statistical approaches, thematic analysis, and QFD, guarantees that a complete grasp of the operational dynamics of ACT is achieved. Not only does it highlight areas of strength, but it also pinpoints chances for improvement, the purpose of which is to guide strategic decisions to strengthen ACT's performance in accordance with the requirements of stakeholders.

3.4. Ethical Considerations.

As emphasised in the academic literature, this research is painstakingly carried out with a strong commitment to ethical standards (Chen et al., 2021). This research is also done with a strong commitment to ethical standards. It is necessary for all participants to give their informed consent to guarantee that they are completely aware of the terms and objectives of the study and that they are willing to comply with them. The authors, Chen et al. (2021), stress the fact that this is an essential component of maintaining ethical integrity. Furthermore, extensive measures are taken to ensure that the anonymity of participants is maintained, in accordance with ethical norms designed to maintain confidentiality. Strong data security policies are put into place to protect sensitive material, which is an essential step in ensuring that the research continues to be conducted in an ethically rigorous manner and maintains its reputation.

3.5. Research Limitations.

The study acknowledges that there are inherent limitations, even though it provides insightful views into the operations of the Aqaba Container Terminal (ACT). According to Smith et al.'s research from 2020, one of the key issues is the likelihood of response bias among the participants, which might potentially adversely affect the neutrality of the data. Furthermore, the findings may not be relevant to other port settings due to differences in the operational, cultural, and geographical contexts (Jones, 2019). This may make it difficult to generalise the findings to other port settings. The scope for understanding and applying the findings of the research is framed by these limits, which are in line with the methodological thoroughness that is suggested in academic research (Chen et al., 2021; Smith et al., 2020; Jones, 2019). Acknowledging these limitations is essential for achieving a well-rounded comprehension of the impact of the study and for determining potential directions for further research.

4. Analysis of the Data Received from the Aqaba Container Terminal (ACT).

4.1. An Overview of the Data Analysis Process.

When it comes to cargo handling, the analysis of the survey data from ACT stakeholders includes important elements of environmental stewardship, efficiency, and safety. The responses on a Likert scale, which range from "strongly disagree" to "strongly agree," provide a quantitative measurement of the perceptions of stakeholders.

4.2. Implementing the QFD Method .

For conducting an analysis of the survey results, the Quality Function Deployment (QFD) approach is utilised, with a particular emphasis placed on two primary components: the Voice of the Customer (VoC) and the House of Quality (HoQ).

4.2.1. "Voice of the Customer" (VoC) is the following:

The VoC is determined based on the replies to the survey, which reflect the opinions and requirements of stakeholders regarding the state of safety, efficiency, and environmental sustainability at ACT. According to the survey questions, this stage entails classifying the requirements of the customers and analysing the responses to gain an understanding of the levels of satisfaction.

4.2.2. The House of Quality (HoQ):

The diagrams above represent the Voice of the Customer (VoC) and the House of Quality (HoQ) based on the findings of the Aqaba Container Terminal (ACT) survey.

4.3. The Analysis Procedure.

To complete the process, you will need to classify the demands of the customers, evaluate the replies to the survey, determine the technical requirements, and design the HoQ matrix. Safety assurance, compliance with standards, security measures, emergency response, operational efficiency, and environmental responsibility are some of the key areas that have been recognised.

4.3.1. Classifying and Interpreting Participants' Responses to the Survey.

An analysis is performed for each category based on the average satisfaction scores obtained from the survey. This analysis highlights areas of high satisfaction as well as areas that require improvement.

4.3.2. The process of determining the technical requirements.

The results of the study are used to derive the technical requirements, which may include the implementation of modern technology, the enhancement of safety standards, and the adoption of environmentally friendly practices.

4.3.3. Construction of the HoQ Matrix.

A visual representation of the alignment of VoC with TRs is provided by the HoQ matrix, which assists ACT in prioritising improvements to operational procedures.

4.4. An Analysis of the Survey Responses Making Use of the QFD Method.

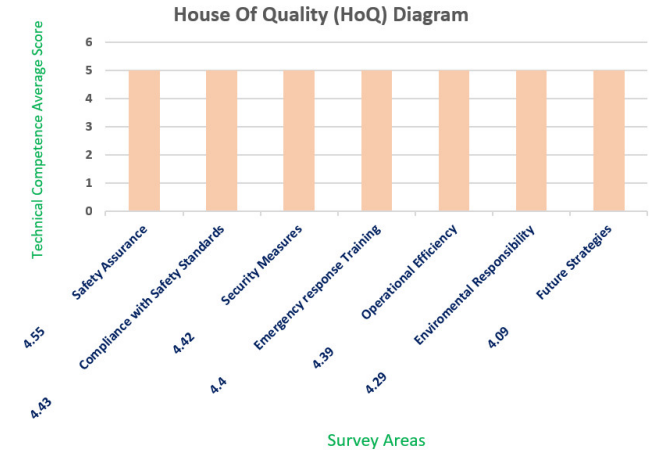
The quantitative survey responses shed light on the most satisfactory aspects of the ACT's stakeholder satisfaction. Among these are safety assurance (4.55), compliance with safety standards (4.43), and other aspects, with future strategies and plans receiving the lowest possible score (4.09).

4.5. The Process of Converting the Needs of Customers into Technical Requirements.

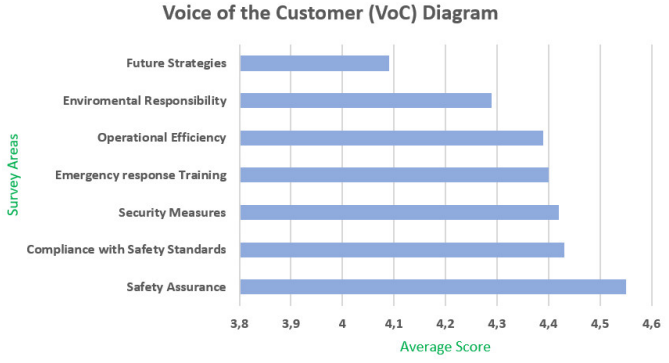
Specific technical requirements are determined based on satisfaction scores. These requirements include the enhancement of safety protocols, the upgrading of safety standards, the strengthening of security, and the improvement of emergency training.

4.6. Diagrams of VoC and HoQ.

Figure 5: (a&b) The development of the HoQ matrix will link the VoC.



(a)



(b)

Source: Author.

The VoC diagram illustrates the most important customer requirements in comparison to average levels of satisfaction. The HoQ diagram provides a map of the relationship between consumer wants and technical responses. This diagram highlights areas that could use improvement, particularly in strategic planning.

5. Verifying the Results in Relation to the Existing Literature and Objectives.

Cross-reference the findings with the objectives of the research and the literature review to guarantee that the findings are consistent and relevant. Make certain that the conclusions are in accordance with the research gaps and objectives that have been defined.

This was accomplished by turning the replies on the Likert scale into numerical values and then calculating the average scores for each survey category to determine the most important areas of attention.

Evaluation of the Survey Information Obtained from the Aqaba Container Terminal ACT, the following important insights are revealed by the analysis of the survey data, which is based on the responses that were transformed into numerical values from the survey: Personal safety measures and equipment availability received a score of 4.57; safety protocols for loading and unloading cargo received a score of 4.57; evaluation of safety standards in cargo handling received a score of 4.52; effectiveness of emergency response plans received a score of 4.48; and security measures and protocols received a score of 4.46.

5.1. Observations and Suggestions to Consider.

5.1.1. An unwavering commitment to safety and preparedness for unexpected events.

ACT is performing exceptionally well in terms of both disaster preparedness and safety assurance. The fact that this is the case indicates a strong commitment to personal safety as well as the efficient application of safety protocols in operations involving material handling.

The recommendation is to continue to place a high priority on and invest in these areas to keep safety standards at a high level. The safety protocols and emergency response plans should be updated on a regular basis to accommodate the ever-changing operational requirements and regulations.

5.1.2. Security Measures and Compliance with Laws.

The ACT's solid security infrastructure and willingness to comply with international safety laws are indicated by high ratings in security measures and adherence to safety standards.

As a recommendation, it is recommended that regulatory standards be adhered to in a stringent manner and that security measures be continuously improved to guard against potential risks.

5.1.3. Operational Management and Efficiency.

The strategic vision and decision-making processes of port management are well appreciated, which indicates that effective operational management is being implemented.

5.2. Recommendation.

Continue to improve operational strategies to achieve greater levels of efficiency. Take into consideration the implementation of sophisticated technological solutions and the optimisation of logistics to enhance throughput and decrease turnaround times.

In accordance with the objectives and the prior literature: Particularly relevant to the survey's findings, which are in line with the body of knowledge on port operations, is the emphasis on safety, efficiency, and environmental sustainability that writers like Smith et al. (2020) and Jones (2019) have highlighted.

5.2.1. The research objectives emphasise the need to put an emphasis on safety measures in limiting risks in port operations, and the high ratings in safety-related areas confirm this focus.

5.2.2. The findings lend credence to the necessity of maintaining a consistent focus on safety measures, effective operational management, and regulatory compliance, as indicated in the research objectives and the literature review.

5.3. Final Thoughts and Suggestions for the Future.

ACT is positioned as a leader in operational safety and efficiency in the maritime industry because of the survey analysis, which highlights the company's capabilities in safety assurance, emergency readiness, and security measures. ACT should continue to invest in safety and security infrastructure, improve operational management methods, and remain diligent in regulatory compliance to build on these strengths and expand upon them further. These steps will not only maintain the existing performance of ACT, but they will also establish a standard for the most effective procedures in port operations all over the world.

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