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Smart & Resilient Logistics Corridors Future Gateway to the Green Trade

THE ROLE OF UPGRADING CONTAINER TERMINAL OPERATING SYSTEM (TOS) ON ENHANCING OPERATIONAL PROCESS OF ADEN CONTAINER TERMINAL

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ABSTRACT

Purpose: This research examines the role of upgrading the Terminal Operating System (TOS) at Aden Container Terminal, focusing on the transition from Zodiac version 5.2, in use since 2009, to the latest version 8 currently adopted in advanced DP World-operated ports, including Jebel Ali Terminal (C3). Zodiac is an integrated digital platform consisting of multiple subsystems and operational modules covering ship planning, yard management, gate operations, billing, and cargo traceability. The upgraded version introduces enhanced automation features, improved berth and yard planning capabilities, and optimized crane scheduling, all of which are expected to improve handling efficiency, operational transparency, and safety standards.

Research approach: The research adopts a descriptive-analytical approach to assess the potential impact of upgrading the Zodiac Terminal Operating System at Aden Container Terminal. The current operational environment, system capabilities, and expected performance enhancements are described based on available technical documentation and operational reports. A SWOT analytical framework is applied to evaluate strengths, weaknesses, opportunities, and threats associated with the system upgrade, providing a structured analysis of its anticipated operational implications.

Research Originality: The research is considered the first empirical study that identifies challenges encountered during the implementation of the new upgrade of the Zodiac system at the Aden container terminal and its effect on the operational process in the terminal for the year 2025.

Research Findings: The findings indicate that upgrading the TOS will significantly reduce vessel and container turnaround times, lower operational costs, optimize resource

utilization, and improve service reliability. Additionally, the upgrade supports environmental sustainability objectives, aligning with the United Nations Sustainable Development Goals (SDGs).

1. INTRODUCTION

A review conducted by UNCTAD [1] revealed that shipping is the dominant mode of freight transportation, whereas around 90% of world trade is transported via sea, with container transportation playing an increasingly significant role due to its technical and economic advantages over traditional methods. Furthermore, a study done by Ismail [2] indicated that container terminal ports in any country are the most integral link in the maritime transport process. In addition, it reduces the delay process and provides distinct services which increase the role of ports in distributing and importing and exporting goods. Likewise, the study of Elgazzar and Ismail [3] has demonstrated that strengthening the role of ports and increasing their competitiveness has become a necessity to keep pace with the rapid changes in the economic and technological aspects.

Through strategic improvements and modern technology, container terminals now offer superior, integrated logistical services, setting them apart from competitors.

Along the same lines, Hafez and Elbayoumi [4] have highlighted that container terminals accelerated their efforts to provide the best services to shipping lines, who consist of container ship owners from global companies, by reducing the time ships spend at the port and offering high-quality services. Another study conducted by Behar and Anthony [5] has indicated that this effort is not limited to shipping companies alone but also extends to local traders (importers and exporters), who are considered the core of commercial and service activities at many container terminals worldwide. Moreover, according to Gekara and Xuan [6], the acceleration or enhancement of supply chains, along with the speed of container handling and storage efficiency, have become some of the key factors for the success of container ports and the enhancement of their competitiveness.

Therefore, costs and time are the two main factors that determine the efficiency and competitiveness of a container terminal from the customer and port users' perspective, according to Hervás-Peralta et al., [7].

As a result, many container terminals have resorted to upgrading their operational, service, and financial systems to meet customer requirements. Ali et al., [9] demonstrated that Aden Container Terminal was one of the first container terminals in the Gulf of Aden and Red Sea region to begin operations in 1999, managed by the Singapore Port Authority. It was the first time a Terminal Operating System (TOS) was introduced to Yemeni seaports when PSA adopted the Computer Integrated Terminal Operating System (CITOS). This was followed by an operating system change when PSA's management of Aden Container Terminal was replaced by DP World, which then implemented the ZODIAC operating system. Currently, the management of Aden Container Terminal is working to upgrade the ZODIAC system from the current version 5.1 to the advanced version eight to keep up with global changes in container terminal services.

2. RESEARCH QUESTION

Is there an actual need to upgrade the ZODIAC system at the Aden Container Terminal at a time when the terminal is experiencing a decline in its activities and a decrease in the number of containers?

3. BACKGROUND

Quoc and Thanh [10] indicated that a Terminal Operating System (TOS) is the main application used by container terminals to plan, monitor, and execute container movements. Furthermore, a study by Inutsuka et al., [11] stated that TOS manages the transfer of containers between trucks, the yard, and vessels using heavy lifting equipment, streamlining operations like ship loading and unloading, container stowage, and yard management. In addition, Gaete et al., [12] clarified that a Container Terminal Operating System (CTOS) is a comprehensive software platform that optimizes operations within a container terminal. These terminals are key points in the supply chain, facilitating container transfers between ships, trucks, and trains. Likewise, Chhetri et al., [13] mentioned that the CTOS enhances efficiency by managing container handling, storage, and movement. Its key functions include planning systems for berth, yard, ship, and rail logistics within the terminal.

Additionally, according to a study by Zhang et al., [14], Terminal Operating System is the core application used by container terminals for planning, monitoring, and executing container movements. Weerasinghe et al., [15] pointed out that this includes managing the transfer of containers from truck to yard, truck to vessel, vessel to truck, and yard to truck using heavy lifting equipment. In this context, a TOS has been proposed to enhance the efficiency of port terminal operators and consists of six main modules: yard planning, vessel planning, berth planning, resource planning, interface module, and communications, according to a study conducted by Min et al., [16]. In fact, to improve port productivity, safety, and sustainability, the smart port initiative promotes the integration of information and communication technology. Therefore, Hervás-Peralta et al., [17] affirmed that implementing a TOS is essential for elevating port operations to a higher level of efficiency and sophistication.

Thus, Inutsuka et al., [18] asserted that the Integrated ITOS aims to improve the efficiency of container terminal operations. Finally, it is revealed in a study done by Inutsuka et al., [19] that TOS enhances security, productivity, and sustainability. In fact, they stated that TOS provides a suite of applications designed to collect, manage, store, analyze, and distribute information from various activities within container terminals [20].

3.1 The current system in Aden Container Terminal:

Aden Container Terminal (ACT) is the first and only container terminal in Yemen to implement a Terminal Operating System (TOS) to manage operational processes and financial transactions. Since its establishment, the terminal's infrastructure has been designed to support digital operational platforms. ACT began operations in 1999 under the management of the Singapore Port Authority, introducing CITOS as the first operating system to organize vessel planning, yard activities, gate control, and billing. In 2007, responsibility shifted to DP World, which deployed the Zodiac system developed internally to enhance automation, operational visibility, and integration between functions.

Over the last 15 years, the operations and IT teams have customized Zodiac version 5.1 to meet the terminal's evolving requirements. ACT was among the earliest terminals to adopt the system, and its operational feedback contributed to system refinement during implementation. With extended use of the current version and the advancements in container terminal digitalization, upgrading to Zodiac version 8 is now considered essential to maintain operational alignment with modern standards while supporting continuity, institutional knowledge, and compatibility with future developments.

3.2 Zodiac Version 5.2; strengths and weaknesses:

While Zodiac version 5.2 offers many benefits, it also has some limitations that have become evident as port operations evolve worldwide. Accordingly, upgrading to the latest

version of the Zodiac TOS will enable ACT to embrace modern service standards by incorporating automation and digitalization. This will significantly reduce the need for manual intervention in repetitive tasks, allowing the system to perform processes with greater speed and accuracy. Below is a comparison of its main strengths and drawbacks:

Table 1. Comparison of its main strengths and drawbacks.

Strengths	Weaknesses
The visual enhancements in Zodiac 5.2.	Ship planning is still largely manual.
Including color-coded containers, simplifying container selection and arrangement on vessels.	Requiring staff to conduct planning, weight calculations, and port assignments.
Features for managing customer information, such as assigning unique identification codes.	Does not fully support customer account management.
Semi-automated billing for container services, eliminating the need for manual invoicing.	It has limited functionality for automatically sorting containers by type, category, or operator.
Improved container yard management based on container type, size, and operator.	Lacks advanced automation and digitalization features.

Source: Researcher's own elaboration.

3.3 The new updates of the ZODIAC system:

Zodiac is considered one of the most rapidly growing and advanced systems, especially since DP World is working to replace existing systems in ports managed by the company with Zodiac. This involves around 65 container terminals worldwide [21]. Looking at the map of Red Sea ports, we find that the Zodiac system is applied in a significant number of ports in the Red Sea and Gulf of Aden regions. The map below shows the ports that operate with the Zodiac system:

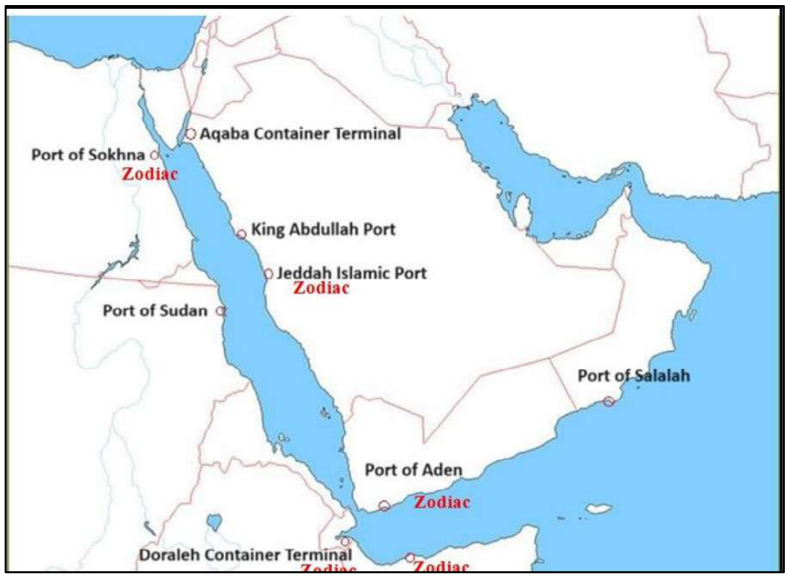

Figure 1. Sea Ports using Zodiac in Red Sea and Gulf of Aden region. Source: Google map.

The above Figure 1 illustrates the ports that use various versions of the Zodiac system. Consequently, Zodiac has become an increasingly widespread operational system, expanding not only within the Arab region but also globally. Currently, it presents strong competition to several renowned international systems, such as Navis, particularly in ports currently or formerly managed by DP World. [22]

Except for global terminal operators with their own proprietary TOS, one realistic option for terminal operators seeking to introduce a TOS is a customized system based on a suite of TOS packages offered by various companies around the world.

According to Webinar Care, an online business site, nine products listed in Table 2 are the best TOS packages in 2024.

Table 2. Digital operations and transactions leader companies.

Product Name	Company	Country	Introduced Area	Note
Navis N4	Navis	U.S.	All over the world, especially in the U.S. and Europe	
OPUS Terminal	Cyber logitec	Korea	Korea, Thailand, Malaysia, Indonesia, the UAE, the United States, Spain, and Brazil, etc.	
GullsEye	GullsEye	Turkey		
Master Terminal	JADE Logistics	U.S.	U.S., UAE, New Zealand, etc.	Group company of Navis
Hogia Terminal	Hogia	Sweden	Sweden, New Zealand, etc.	
CommTrac	TBA	U.K.		For bulk and Ro-Ro terminals
CATOS	Total softbank	Korea	Asia, Europe	
Mainsail	Mainsail	U.S.	U.S., U.K., etc.	
Autostore TOS	TBA	U.K.		

Source: https://webinarcare.com/best-terminal-operating-systems/ (2024).

However, global port management companies like the Port of Singapore Authority (PSA) and Dubai World (DP World) have developed their proprietary systems. These in-house solutions have been adopted as competitive alternatives, offering advanced technical and operational capabilities for managing the companies' extensive port operations.

3.4 Importance of upgrading to Zodiac Eight:

The urgency for Aden Container Terminal to upgrade its operational and billing systems has increased for several reasons:

3.4.1 Streamlined Workflows: To simplify processes and ensure fast, secure transactions.

3.4.2 Improved Customer Service: Moving from traditional methods to real-time processes will enhance the quality of services offered to customers.

3.4.3 System Integration: Linking operational and financial systems will create a seamless interaction, allowing customers to automatically and continuously access billing details and account statements.

3.4.4 Dynamic Container Planning: Optimizing container planning on vessels and in storage yards by managing Bills of Lading more effectively, which will boost terminal efficiency and minimize resource waste during loading and unloading.

3.4.5 Support for Zodiac System: As DP World has upgraded all its terminal systems, maintaining outdated or unsupported versions has become costly and inefficient for the technology provider [23].

3.5 Zodiac Eight Features:

Zodiac version eight is an advanced version of DP World's in-house Terminal Operating System (TOS), designed to enhance operational efficiency across its global network. These versions feature improved automation capabilities, enabling optimized container

handling, yard management, and equipment scheduling. Actually, the systems offer real-time visibility, integrating data from multiple operational areas to support dynamic decision-making. Enhanced multi-modal support allows seamless coordination between sea, rail, and road transport, while scalability ensures the TOS can be tailored for terminals of varying sizes. Additionally, integrated billing features automate charge calculations for terminal services, and the system's cloud-based deployment options facilitate remote access and updates. The upgraded user interface and analytics tools empower users with actionable insights and comprehensive reporting, ensuring optimal performance and data-driven management across DP World's terminals. [24]

Attached below is Table 3. highlights the main features of the Zodiac program in its updated version eight.

Table 3. Key Features of Zodiac Eight.

End-to-End Integration	Real-Time Data and Visibility	Automated Workflows
Zodiac is designed to integrate seamlessly with various port and terminal operations, including cargo handling, gate operations, and vessel planning. This integration enables efficient coordination of different processes within a terminal.	The system provides real-time monitoring and tracking of container movements, equipment status, and terminal operations. This visibility helps in optimizing yard planning, vessel stowage, and resource allocation.	Zodiac supports automated decision-making processes, such as yard crane and equipment scheduling. The system optimizes equipment usage to reduce operational delays and increase productivity.
Advanced Planning and Scheduling	Integrated Billing and Invoicing	Analytics and Reporting
It includes modules for vessel planning, yard management, and gate operations. The system facilitates dynamic planning and scheduling, allowing terminals to adapt to changes in vessel arrival times or cargo volumes.	Zodiac includes a billing module that automates the calculation of charges for various terminal services, such as container handling, storage, demurrage, and ancillary services. This module ensures accurate and timely invoicing by integrating with the operational data in real-time.	Zodiac provides comprehensive analytics and reporting tools that enable terminal managers to track key performance indicators (KPIs), identify operational bottlenecks, and make data-driven decisions to improve efficiency.

Source: Aden Container Terminal IT Section (2025).

4. RESEARCH PROBLEM

The current container management system at Aden Container Terminal faces significant challenges in coping with the increasing demands of modern container ships. As global shipping trends shift towards larger vessels with higher capacities, the terminal's existing infrastructure and technology have proven insufficient to handle these advanced ships efficiently. The outdated system results in delays, operational inefficiencies, and limited throughput, which hinder the terminal's competitiveness in the global shipping industry.

Moreover, the inability to integrate seamlessly with newer shipping technologies exacerbates these issues, leading to higher operational costs and reduced customer satisfaction. This problem underscores the urgent need for a system upgrade to align with the evolving demands of modern maritime logistics.

Therefore, the research problem revolves around whether there is indeed a need to upgrade the operational system at the Aden Container Terminal and whether the current environment is suitable and supportive for such an upgrade.

5. RESEARCH METHODOLOGY

This research adopted a descriptive-analytical approach to achieve its aims and objectives. The analysis was initially conducted using the SWOT framework to evaluate the strengths, weaknesses, opportunities, and threats associated with upgrading the Zodiac system. To validate and extend the SWOT findings, semi-structured interviews were conducted with key decision-makers at Aden Container Terminal. These interviews provided practical insights into the operational, managerial, and strategic implications of implementing the new system version. Combining documentary analysis with expert input enabled a comprehensive evaluation of both internal and external factors affecting the planned system upgrade, thereby ensuring a more holistic understanding of the overall operational environment.

6. RESEARCH VARIABLES

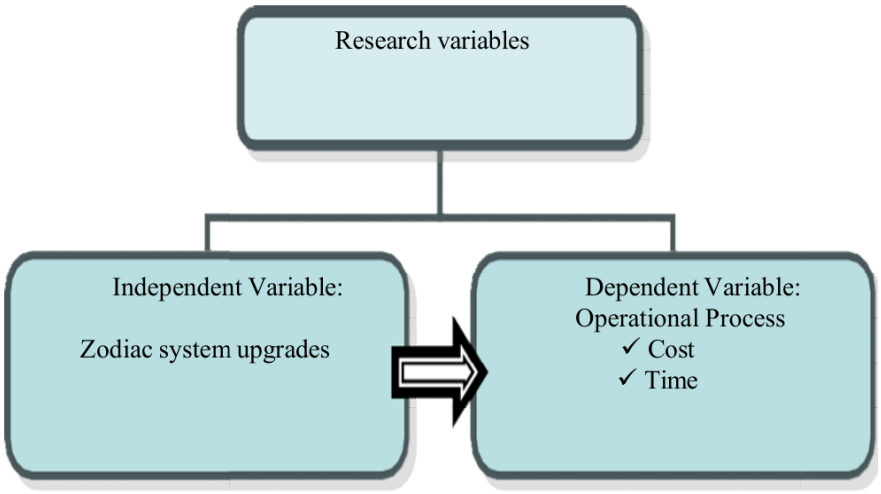

Figure 2. Research variables.

7. EMPIRICAL ANALYSIS

7.1 Quantitative Financial Analysis Model for Upgrading the Container Terminal Operating System (Zodiac 5.2 to Zodiac 8):

This section presents a quantitative financial analysis of the costs and benefits associated with upgrading the Container Terminal Operating System (TOS) at the Port of Aden from the current version, Zodiac 5.2, to the latest release, Zodiac 8. This upgrade represents a strategic investment aimed at improving port operational efficiency and increasing productivity through the adoption of advanced digital technologies in terminal management. The Port of Aden has already gained positive experience with Zodiac, as the system was first implemented in 2010, replacing the previous CITOS system to enhance digital capabilities and data analysis in support of operational efficiency. Current preparations are underway to upgrade the terminal's operational system from Zodiac 5.2 to Zodiac 8, which is expected to streamline procedures, automate transactions, and simplify processes.

According to the Chairman of the Aden Ports Development Company, the advanced generation of the Zodiac system ushers in a new era for Yemeni ports, contributing to higher productivity rates and more efficient terminal management compared to earlier systems. Consequently, the forthcoming upgrade to Zodiac 8 is expected to deliver

greater operational benefits related to defined investment costs. The following section outlines the cost-benefit analysis of this upgrade, supported by data and examples from other ports that have implemented similar systems.

Expected Investment Costs of the Upgrade [25]:

- o System License Acquisition: The core cost relates to procuring the Zodiac 8 software package and associated usage rights. Based on the terminal's capacity (approximately one million TEUs annually), the licensing cost is estimated at around USD 1.0 million, covering both the core modules and required add-ons.
- o Staff Training: Employees in operations, vessel and yard planning, gate management, and cargo handling, alongside crane operators and yard controllers, must be trained on the system's new features. This includes workshops and intensive training courses to ensure smooth transition, estimated at USD 300,000, covering expert trainers, training materials, and staff time.
- o Infrastructure Upgrades: Implementing Zodiac 8 requires upgrading servers, storage capacity, and network devices to guarantee optimal performance. Estimated at USD 0.5 million, this includes enhancements to the data center, wireless networks across the yard, tablets, and backup power systems.
- o Technical Support and Implementation: External consultants from the system vendor will be engaged to install and integrate the new system with other platforms (e.g., customs or the port community system - PCS). This also covers initial technical support during launch. Estimated at USD 200,000 for consulting fees, testing, and quality assurance.

Table 4. Expected Investment Costs of the Upgrade.

ITEM	ESTIMATED COST (USD)
Zodiac 8 annual license	2,000,000
Annual Technical Support	500,000
Training & Capacity Building	300,000
IT Infrastructure Upgrades	500,000
Support during Implementation	400,000
Total Capital Investment	3,700,000

Source: Aden Container Terminal Budget Report (2024).

Economic Benefits after the Upgrade

In return for the above investment, the Zodiac 8 upgrade is expected to generate a range of economic and operational benefits, positively impacting the performance and profitability of the container terminal. Key benefits include:

- o Reduced Ship Turnaround Time: Expected reduction by up to 10%, improving vessel service efficiency, enabling the port to accommodate more vessels annually and reducing delays, thereby boosting shipping line satisfaction.
- o Increased Crane and Yard Productivity: Automated task allocation for cranes and yard equipment optimizes utilization, potentially improving berth productivity by approximately 30% post-implementation, according to prior studies of modern TOS systems.
- o Improved Yard Operations Efficiency: Real-time tracking of container and equipment locations reduces unproductive moves and manual effort, minimizing resource wastage.

- o Enhanced Accuracy and Reduced Human Error: A unified platform integrates operations (berth, yard, gate, and CFS), providing real-time, reliable data across all users.
- o Faster Gate Operations & Reduced Truck Waiting Times: Streamlined truck flows reduce congestion within and around the terminal and simplify customs clearance through integration with unified service platforms.
- o Environmental & Cost Savings: Reduced equipment idle time lowers fuel consumption by 20-30%, decreasing emissions and aligning with international environmental standards, potentially attracting green incentives.
- o Optimized Empty Container Handling: By shifting from FIFO-based loading to system-managed free pool operations, Zodiac 8 minimizes wasted resources and fuel, streamlining empty container repositioning.

Table 5. Estimated Annual Benefits from Upgrading to Zodiac 8.

ITEM	ANNUAL VALUE (USD)	NOTES
Handling (Additional Revenues)	8,900,000	~30% productivity increase, less shifting expenses
Labor Cost Savings	300,000	Due to partial automation
Fuel & Equipment Savings	700,000	Reduced idle moves
Improved Revenue Collection	500,000	Full, timely fee collection
Total Net Annual Benefits	10,400,000	Before annual maintenance

Source: ACT Feasibility Study - ZODIAC upgrades (2024) [26].

Tables 4 and 5 are intended to provide an approximate assessment. For instance, cumulative improvements are assumed to generate around USD 7 million annually in net benefits, via revenue gains or cost reductions. Actual outcomes will vary depending on post-upgrade operational volumes and utilization of the system's full capabilities. For example, should Aden Terminal experience a 20-30% increase in annual throughput, driven by enhanced efficiency and customer satisfaction, actual returns could exceed the above estimates.

7.2 SWOT analysis:

The research utilized SWOT analysis as a tool to assess the internal and external factors influencing the implementation of the new proposed Zodiac system on the operational process at Aden Container Terminal. Next, internal (strengths and weaknesses) and external (threats and opportunities) factors will be reviewed as shown in Figure 3.

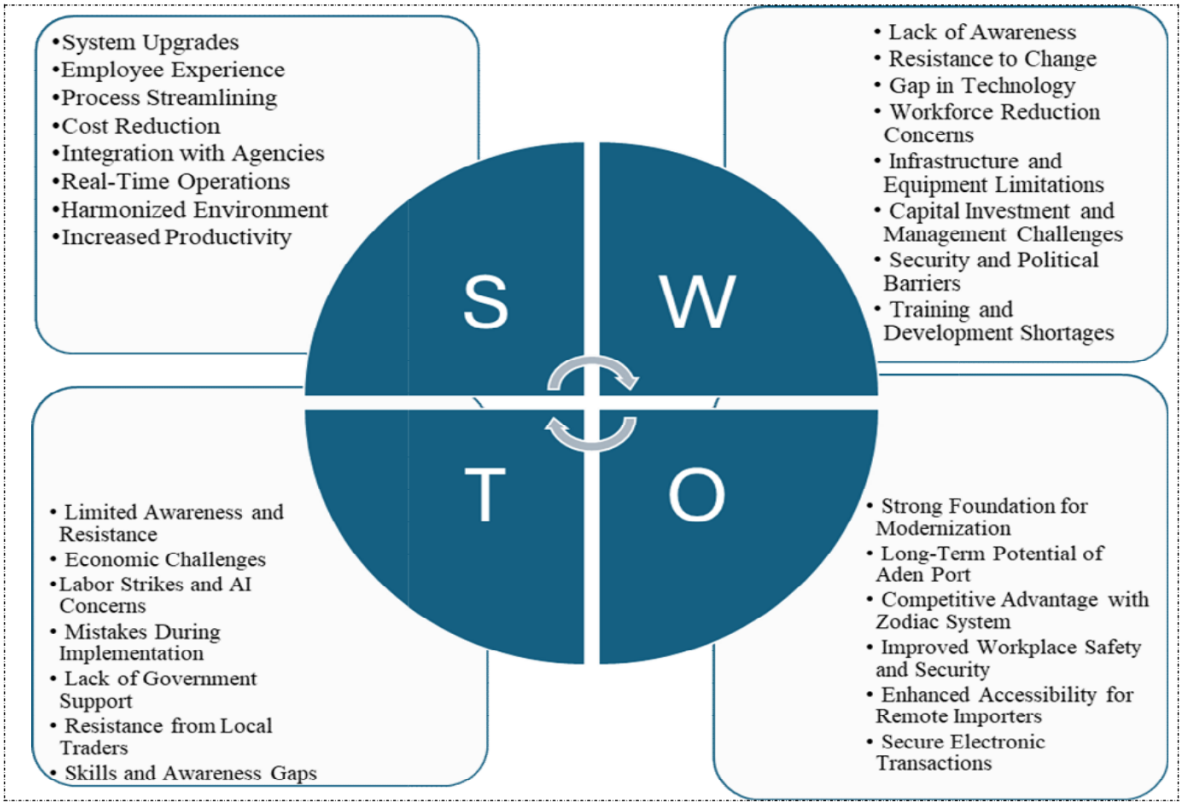

Figure 3. SWOT Analysis of the new Zodiac updated system.

7.2.1 Strength

1. The terminal workforce already has substantial experience with different TOS platforms, which facilitates a smooth transition and higher acceptance of the new system.
2. The new Zodiac system will automate major operational processes and significantly reduce manual handling.
3. The upgrade will improve operational speed and reduce costs for both the terminal and its customers.
4. The system will enhance data integration and information exchange with key stakeholders such as customs, inland transport, and security agencies.
5. Real-time operations will improve data accuracy and enable automatic billing based on actual service delivery.
6. The upgrade will strengthen coordination between operational departments, leading to higher productivity.

7.2.2 Weaknesses:

1. A considerable portion of staff lack sufficient knowledge of advanced terminal operating systems, automation tools, and AI applications used in modern container terminals.
2. Resistance to change presents a key challenge during system transition and may slow implementation of new upgrades.
3. There is a substantial technological gap between the current system and modern automated, AI-driven platforms, resulting in limited understanding of the capabilities and added value of advanced solutions.

4. Concerns among employees regarding potential job reduction due to automation negatively impact acceptance of the new system.
5. Limited infrastructure and insufficient technical resources required to support the full deployment of the upgraded Zodiac system present practical implementation barriers.

7.2.3 Threats:

1. Limited understanding among the commercial and logistics sector regarding the benefits of modernized terminal systems may generate resistance and negatively influence stakeholder acceptance of the upgrade.
2. Insufficient readiness or cooperation from key operational partners including customs, security agencies, and transport service providers may hinder system integration and delay implementation.
3. Persistent economic instability and reduced commercial activity may restrict available funding required for infrastructure upgrades, capacity building, and change-management programs.
4. Workforce fears related to job security and automation may trigger operational disruptions, including labor resistance or strikes during the transition phase.
5. Early operational errors or system adoption challenges may create negative perceptions about the new technology, resulting in reduced confidence and potential pressure to revert to previous manual processes.

7.2.4 Opportunities:

1. The Aden Container Terminal's status as Yemen's only dedicated container terminal positions it strategically to lead digital modernization and strengthen its national and regional role.
2. The current lower activity level offers a suitable window to implement upgrades with minimal operational disruption, enabling smoother transition and system stabilization before future trade growth.
3. With improved stability and modernization, Aden Port can enhance its competitiveness, positioning itself as a cost-effective gateway for Yemen and a potential logistics hub for regional maritime trade.
4. System upgrades that improve operational transparency, speed, security, and reliability will enhance customer service levels and attract new global shipping lines seeking efficient turnaround times.
5. Increased automation and digital services will reduce manual errors, enable remote commercial processing, support environmental sustainability goals, and strengthen financial and operational governance across terminal operations.

8. CONCLUSION

1) The research confirms a clear need to upgrade the current Zodiac 5.2 system, given advancements in digital technologies and evolving operational requirements in modern container terminals.
2) The existing system remains functional but no longer meets contemporary standards for automation, vessel planning, yard efficiency, data integration, and billing accuracy.
3) Upgrading to Zodiac 8 is expected to enhance operational performance by reducing manual processes, improving turnaround time, and enabling real-time data visibility and stakeholder connectivity.

4) The upgraded system is expected to improve revenue generation, enhance billing accuracy, reduce resource waste, and ensure better cost control leading to higher net financial returns.
5) The SWOT analysis indicates that while significant benefits are anticipated, successful implementation will require addressing workforce readiness, infrastructure gaps, and resistance to change.
6) Despite external challenges such as economic constraints and stakeholder preparedness, strong opportunities exist to position Aden Container Terminal as a competitive regional gateway.
7) The upgraded system is timely and strategically aligned with future growth, environmental sustainability, and the digital transformation of port operations.

9. RECOMMENDATION

The research relied on the use of the descriptive method to analyze the work environment surrounding Aden Container Terminal. It discussed the updating and upgrading of terminal operating and service systems at the terminal amidst a continuous decline in terminal activity and increasing challenges and risks in the Red Sea and Gulf of Aden region. Using the SWOT analysis tool, it was found that Aden Container Terminal has an infrastructure capability for accommodating updates to its service and operational systems, as well as financial transactions. The terminal's workers have gained extensive experience through collaboration with previous companies that established advanced operating systems at that time and trained Aden Container Terminal's operations team, who have since become key players in adapting operating programs to suit the terminal's specific environment.

The study concluded that there is a need to upgrade the operational programs at the Aden Container Terminal to keep pace with developments in port services and reduce waste in equipment and resource utilization, in line with the United Nations' goals for sustainable port operations and environmental preservation. The current period is considered the most suitable for organizing internal affairs and upgrading the terminal's operational systems in preparation for the post-war phase, when a political settlement is expected to restore normalcy and security in Yemen.

Accordingly, the researcher recommends upgrading operational programs and systems to align with global standards, as doing so will ensure technical support from the software provider due to the systems' modernity. This upgrade aims to reduce effort, manage resources efficiently, and accelerate services, thereby enhancing customer satisfaction. Additionally, the Terminal Operating System (TOS) upgrade should comprehensively cover all service aspects within the container terminal, ensuring seamless interaction among all departments to support the upgrade plans. Before implementing the TOS upgrade, it is crucial to educate and reassure employees that the company will not reduce the workforce in favor of automation; rather, automation will focus on handling routine tasks, removing monotony, and fostering an environment that encourages employees to innovate and continuously improve services.

In conclusion, further work could focus on examining the impact of system upgrades on productivity, employee adaptation and training, customer satisfaction metrics, comparative studies of automation and workforce dynamics, cost-benefit analysis of technological upgrades, global standards benchmarking, and the sustainability and environmental impact of new operational systems.

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