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Artificial Intelligence Implementations Towards Shaping the Future of Digital World

THE DIGITAL TRANSFORMATION AND ITS IMPACT ON MARITIME TRANSPORT GEOECONOMY, CASE STUDY: DCHC AS A HUB TERMINAL IN DAMIETTA PORT/EGYPT/EAST MEDITERRANEAN

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ABSTRACT

As the global economy undergoes rapid changes with the rise of Asian and African economies, Egypt is set to play a crucial role in the future of international trading. By the year 2075, the GDP of China, India and United States shall be nearly equal, while Indonesia is predicted to become the 4th largest economy of the world by 2050. In this regard, Egyptian positioning along Suez Canal to Africa, Asia and Europe is crucial to improve its participation in the global digital economy. Egypt is set to enhance its standing in international economic arrangements such as BRICS, the Belt and Road Initiative (BRI), and the African Continental Free Trade Area (AfCFTA). Thus, the country's maritime transport sector is increasingly instrumental to realizing its economic ambitions. A key element of this transformation is Damietta Port, which is becoming increasingly important in Egypt's maritime development. On the other hand, technology upgrades at the port including an advanced Vessel Traffic Management System (VTMS) are an issue. Especially since the start of operation of the second new container terminal will make such systems indispensable. By means of a case study methodology, this paper analyzes the current operational strategies and technological infrastructure of DCHC, while highlighting the advancements involved in making them more efficient. In particular, it conversations about the VTMS represent the next step after the complete implementation of TOS Navis N4 to handle DCHC operations. It is also proposed to use the Portchain portal for vessel berth management. According to the paper, the efforts concerning the implementation of VTMS and the establishment of strategic alliances with globe partners, DCHC will be considerably more competitive in the global digital economy. With DCHC with better quality and advance Services. Damietta Port will be one of the main players in the advancement of Egypt's economy globally.

Keywords: Economic transformation, digital economy, global alliances, Damietta Container and Cargo Handling Company (DCHC), Vessel Traffic Management Systems (VTMS), smart logistics, automation.

1. INTRODUCTION

The global economy is undergoing rapid transformations, with emerging Asian and African economies playing an increasingly pivotal role in reshaping international trade patterns. As we approach the middle of the 21st century, the economic landscapes of major powers such as China, India, and the United States are predicted to converge, and nations like Indonesia are poised to become global economic leaders [1]. In this context, Egypt's strategic position along the Suez Canal the vital maritime corridor connecting Africa, Asia, and Europe offers a unique opportunity for the country to strengthen its role in the global digital economy. The application of new technologies and innovations is important for the successful operation of seaports; their use reduces costs, facilitates business, increases transparency, and attracts new business entities. [2]

Belt and Road Initiative (BRI)', Egypt's geostrategic location and policy preferences unite China and Egypt on various subjects, including trade, investment, and finance. Egypt is just one of many actors that have joined the BRI, but due to its possession of the Suez Canal, it is of special interest to China. [3]. In addition to BRICS and BRI, Egypt's involvement in the African Continental Free Trade Area (AfCFTA) marks a strategic move to enhance its integration into Africa's economic landscape. Egypt, through its membership, seeks to contribute to and benefit from the growing African market by improving its logistics infrastructure, streamlining trade processes, and enhancing connectivity across the continent. [4]

The safety of navigation, including in port waters and along coasts, has been a concern since the advent of maritime trade dating back at least 2000 years. One of the first well-documented examples of a lighthouse, the Pharos of Alexandria in Egypt, was built in 300–280 BC.

The evolution of regulatory and organizational frameworks for navigational safety and efficiency is charted. Relevant work of (IMO), International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), European Commission (EC), and European Maritime Safety Agency (EMSA) is elaborately discussed. The transformative role of the European Maritime Single Window environment (EMSWe) is examined. VTMS of the future in the emerging context of the fourth industrial revolution driven by artificial intelligence, machine learning, and maritime autonomous surface ships [5].

A Vessel Traffic Management System (VTMS) is a sophisticated maritime traffic monitoring and management solution designed to enhance the safety and efficiency of vessel navigation within specific geographic areas, such as ports, harbors, and coastal regions. VTMS integrates various technologies, including radar, Automatic Identification Systems (AIS), closed-circuit television (CCTV), and VHF communication, to monitor and manage vessel movements.

The International Maritime Organization (IMO) defines Vessel Traffic Services (VTS), which form the basis of VTMS, as services implemented by competent authorities to improve the safety and efficiency of vessel traffic and protect the environment. [6]

Numerous major container ports worldwide have adopted VTMS to streamline operations and enhance safety. Notable examples include:

1. Port of Singapore, Singapore
2. Port of Rotterdam, Netherlands
3. Port of Shanghai, China
4. Port of Los Angeles, USA
5. Port of Antwerp, Belgium

These ports have integrated VTMS into their operations to enhance safety, efficiency, and environmental protection. VTMS enhance maritime operations by improving safety through collision prevention and navigational support. They increase efficiency by reducing waiting times and optimizing berth usage. VTMS also protect the environment by minimizing accident risks and lowering emissions. Additionally, they bolster security with continuous monitoring for suspicious activities and ensure compliance with regulations.

For example, the Port of Rotterdam plays a decisive part in the process of Digital Transformation (DT) through the cooperation with clients, business partners and digital platforms in order to make Rotterdam a hotspot for the development of the most promising digital innovations; they are also investing in new digital infrastructure that can help create the right conditions for extensive digitalization [7] . The Maritime and Port Authority of Singapore launched the Smart Port Challenge 2017 to encourage start-up and organizations collaboration, pushing DT into the industry, harnessing technologies to add value to the maritime logistics chain, also collaborating with the Port of Rotterdam in the same kind of endeavor" [8]. However, according to [9] , collaborations need formal governance to address members' concerns about who owns the data, how the data is protected, and who can access the data.

Egypt's maritime sector is at a pivotal juncture, with significant Foreign Direct Investment (FDI) in new and existing container terminals aimed at enhancing the country's capacity and competitiveness. Recent initiatives include the development of major terminals in Damietta, Alexandria, and Abu Qir, which, together with ongoing projects, position Egypt as a potential hub for regional and global trade. These expansions are complemented by efforts to adopt advanced digital technologies, such as Terminal Operating Systems (TOS) navis N4, PORTCHAIN portal and (VTMS), to improve operational efficiency and support the anticipated growth in container traffic.

2. LITERATURE REVIEW

Table1-Previous studies

year	Author's name	Study's name	variables	results
2021	Edvard Tijan a, Marija Jović b, Saša Aksentijević c, Andreja Pucihar d	Digital transformation in the maritime transport sector [10]	factors and barriers to digital transformation in the maritime transport sector.	**Cost reduction Streamlining operations Shorter time delays New and emerging technologies Processing large amounts of data Changing customer behaviors and expectations Competitive environment Regulatory requirements Improving stakeholder collaboration Data transparency cultural readiness for changes**
2021	Esslam Hassan Dimitrios Dalaklis	Maritime surveillance in the Gulf of Suez: identifying opportunities for future improvements opportunities for future improvements [11]	Vessel Traffic Management Systems (VTMS)	**Maritime surveillance and monitoring data within and around Egyptian waters is gathered by a number of agencies for a range of different purposes including promoting safe navigation, environment protection, managing fisheries, and monitoring borders and migration control. Each of these maritime stakeholders are working independently and each entity follows a sectoral approach to MS and the absence of a multidisciplinary approach.**
2022	Kevin Daly Tadas Gedminas	The Path to 2075 — Slower Global Growth, But Convergence Remains Intact [1]	Egypt's strategic role in global trade	**By 2075, with the appropriate policies and institutions, Egypt could be among the world's largest economies.**
2021	Bo Feng Qiwen Ye	Operations management of smart logistics [12]	Smart logistics	**Smart logistics is a promising solution for meeting the increasing complexity and volume of logistics operations due to the global collaboration and integration of online and offline channels. The lack of general smart logistics management framework is caused by the undiscovered effect mechanism of related technologies on current logistics operations.**
2020	W.K. Kon a, Noorul Shaiful Fitri Abdul Rahman b, Rudiah Md Hanafiah c, Saharuddin Abdul Hamid d	The global trends of automated container terminal [13]	Automation	**The adoption of ACT technology by container terminal operators could increase the terminal efficiency in productivity, cost reduction and environmental sustainability. Owing to global environmental awareness, the research trend of container terminal field and container terminal operator in the terminal**

				design is much more environmentally friendly oriented
2018	Cosimo Magazzino Marco Mele	On the relationship between transportation infrastructure and economic development in China [14]	Port infrastructure development	**Transport investments significantly boost economic growth at the national level by enhancing market access and reducing logistics costs. Regional Disparities: The impact varies across regions, with rural and underdeveloped areas benefiting more through poverty alleviation and economic integration. Maintenance Challenges: Lack of infrastructure maintenance diminishes long-term benefits, particularly in the medium term.**
2022	**Dalibor Pelevic,Mimo Drašković, Ranka Krivokapić**	**IMPLEMENTATION OF MODERN INFORMATION SOLUTION FOR GREATER EFFICIENCY OF INTERMODAL TRANSPORT THROUGH PORT OF BAR CASE STUDY – NAVIS [15]**	**NAVIS – Terminal Operating System**	**The importance of Digitalization of logistical processes that an unstoppable process. All the ports of the world must adapt to the needs of shipping companies. The requirements for digitizing the process are one of them. The efficiency of shipping goods is one of the basic prerequisites for the competitiveness of a port.**

As in Table1 The reviewed literature highlights the growing importance of digital transformation in ports, the role of VTMS, and the need for modern logistics systems to stay competitive in the global market. As DCHC continues to develop its capabilities, embracing digital and automated systems will be crucial in realizing Egypt's ambitions to become a key player in the global digital economy.
Since 2017, DCHC has positioned itself as a key player in the East Mediterranean region, attracting THE Alliance to make Damietta Port as a primary hub while executing transformative development projects. Major upgrades include extending quay lengths to 1,650 meters, increasing depths for larger vessels, and expanding storage areas to 1 million square meters, alongside specialized facilities for refrigerated and LCL cargo. These enhancements have enabled DCHC [16] to consistently handle over one million TEUs annually since 2017. placed as the 90th largest container terminal globally in Lloyd's List [17]and achieving a world-leading 60.2% growth rate in container throughput.

3. METHODOLOGY

3.1. Research Approach

This paper employs a case study approach, focusing on Damietta Port and its container terminal operations. The case study method is particularly suitable for investigating complex phenomena within their real-life contexts, enabling an in-depth understanding of the port's current operations, challenges, and opportunities for improvement. The paper examines Damietta Port's strategic initiatives, emphasizing its adoption of digital transformation technologies, such as Vessel Traffic Management Systems (VTMS), and its role within Egypt's economic framework.

3.2. Data Collection

The paper adopts a mixed-methods approach to gather comprehensive data, utilizing the following sources:

3.2.1. Primary Data:

- **Interviews**: Structured interviews with key stakeholders, including port authorities, terminal operators, and shipping line representatives, to understand operational challenges and technological needs.
- **Site Observations**: Direct observations of port operations to assess existing processes and identify potential areas for improvement.

3.2.2. Secondary Data:

- **Port Data Analysis**: Analysis of operational and financial records from Damietta Port, including throughput data, berth productivity, and logistical performance metrics.
- **Public Records**: Review of government reports, international trade statistics, and global best practices in port operations and VTMS deployment.
- **Literature Review**: Insights from academic research and industry publications to contextualize findings within global trends and frameworks.

This methodology ensures a holistic evaluation of DCHC's role in the global digital economy, highlighting actionable insights to enhance its global competitiveness.

4. RESULTS AND DISCUSSION

4.1. Current Infrastructure

DCHC has positioned itself as a leader in the region by integrating cutting-edge technologies into its operations. Central to its infrastructure is the NAVIS N4 Terminal Operating System (TOS), a robust platform used for optimizing vessel operations, yard storage, and gate management. This system has significantly enhanced the terminal's efficiency by automating workflows, reducing manual interventions, and enabling seamless coordination across different operational stages.
In addition to TOS, DCHC became the first container terminal in the Eastern Mediterranean to adopt the global PORTCHAIN platform as a berth alignment network to Increase the speed of alignment with cloud-based solutions for predictable berth and schedule operations.
. This advanced solution revolutionizes berth scheduling by leveraging artificial intelligence and machine learning to streamline vessel berthing plans, minimize waiting times, and optimize quay utilization. These innovations highlight DCHC's commitment to smart logistics and operational excellence.
Moreover, DCHC's infrastructure is continuously evolving to meet the demands of global trade. Recent upgrades include an expanded quay length, deeper draft capabilities, and increased terminal capacity. These developments position DCHC as a pivotal hub for regional and international shipping lines, aligning with Egypt's vision for a digitally integrated and economically competitive maritime sector. This version combines technical details with strategic insights, emphasizing DCHC's innovation and leadership in adopting modern technologies.

4.2. Operational Performance

The following tables highlight DCHC's operational performance metrics, showing the impact of infrastructure enhancements and technological upgrades.

Table 2-DCHC's Key Performance Metrics for Terminal Operations

No.	Metrics	No.	Metrics
1	Vessel Name	12	**Operation Time**
2	Shipping Line	13	**Stay Duration After Operation**
3	Shipping Agency	14	**Time At Quay**
4	Waiting Time at Berth	15	**Total Operating Time**
5	Arrival at Berth	16	**Net Operating Time**
6	Berthing Date	17	**Movements**

7	Start of Operations	18	**Vessel Productivity Per Hour**
8	End of Operations	19	**Crane Productivity Per hour**
9	Departure Date	20	**Number of Cranes Operating**
10	Berthing Time	21	**Heavy Crane Movements**
11	**Waiting Time Before Operation**	**22**	**Is the vessel within or out Window**

Source: Author's own compilation based on primary data collection

Table 2 contains data that has been collected and analyzed to reflect the operational performance of DCHC. The paper analyzed the performance of these parameters over different time periods in 2023 to clearly show the changes in performance. The method used ensures a ship-specific analysis. This means that the situation of each ship's operations cycle was examined against the predetermined criteria such as berth availability, crane allocation, and unforeseen logistic issues.
This method follows good practices of maritime transport research, as well as global standards recommended by major international organizations of the field like the International Maritime Organization (IMO) and the International Association of Ports and Harbours (IAPH). This paper assesses the ability and efficiency of terminal management processes in responding to planned operations and unpredictable events.
We not only examined key performance indicators (KPIs) such as waiting times, crane productivity and conformance to berthing windows for individual vessels but also in light of infrastructure improvements. The analysis helps to understand whether DCHC will be able to meet the increasing maritime trade demands without compromising on the operational excellence of global standards.

Table 3-*Comparison between Before and after main development projects in DCHC*

Item	*Before*	*After*	*Development Ratio*	*Time periods*
Ship to shore cranes	*10*	*13*	*30%*	***January 2023***
Quay length	*1050 m*	*1650 m*	*57%*	***November 2019 :2024***
Storage Yards	*620,000 m2*	*1,000,000 m2*	*61.3%*	***2016 : 2024***
Water depth	*13.25 m*	*17 m*	*28.3%*	***2016 : 2024***
Annual capacity	***1.4 million TEU***	***2.0 million TEU***	***43%***	***2017 : 2024***

Source: Author's own compilation based on primary data collection

Table 3 illustrates a significant transformation in DCHC's operational and infrastructural capabilities following major development projects. The 30% increase in ship-to-shore cranes and the 57% extension in quay length demonstrate strategic enhancements to accommodate larger vessels and higher throughput. Similarly, the 28.3% improvement in water depth enables the terminal to serve next-generation ships with deeper drafts, while the 61.3% expansion in storage yards supports greater operational flexibility.

The 43% increase in annual capacity from 1.4 to 2 million TEUs underscores the terminal's enhanced readiness to handle growing trade volumes. These developments reflect a balanced and comprehensive approach to infrastructure upgrades, aligning with global standards and reinforcing DCHC's competitiveness in the maritime logistics sector.

4.3. Contribution to the Egyptian Market

Table 4- DCHC's Total Container Throughput (2016: 2023)

Year	Throughput	Change ratio
2016	879,991	
2017	1,226,522	**39.4 %**
2018	1,228,302	**0.15 %**
2019	1,154,223	**(- 6.0 %)**
2020	1,130,611	**(- 2.0 %)**
2021	1,082,991	**(- 4.2 %)**
2022	1,229,500	**13.5%**
2023	**1,969,463**	**60.2%**

Source: Author's own compilation based on primary data collection

Table 4 presents DCHC's total container throughput from 2016 to 2023, highlighting the terminal's strategic importance in the Egyptian market. Despite experiencing a temporary decline between 2019 and 2021 due to global and regional challenges, the terminal exhibited exceptional resilience and recovery. This is evidenced by the notable 60.2% increase in throughput in 2023, reflecting the culmination of strategic initiatives, infrastructure upgrades, and operational optimization.

DCHC's long-term strategic planning played a critical role in these achievements. In 2017, the company successfully deepened berth depths from 13.25 meters to 14.5 meters, enabling it to join the prestigious "One Million TEU Club." Building on this foundation, DCHC embarked on a 56-month project starting in August 2018 to rehabilitate and reinforce container berths while further increasing depths. Despite the operational challenges of reallocating one-third of the main berth, DCHC mitigated impacts by incorporating two additional berths of 400 meters each and implementing a balanced operational strategy.

DCHC's forward-thinking investment in three Malaccamax quay cranes, expansion of yard space, and acquisition of additional RTG yard cranes further supported these efforts. These enhancements not only restored operational balance but also propelled the terminal to achieve record-breaking container throughput, earning DCHC the distinction of ranking first globally in container throughput growth, as recognized by Lloyd's List.

This trajectory underscores DCHC's vital contribution to Egypt's maritime trade and its alignment with national economic objectives. By continuously adapting to market dynamics and achieving operational excellence, DCHC has solidified its position as a cornerstone of the global supply chain and a benchmark for container terminal development.

Table 5-Egyptian Containers Throughput (Without additional moves) from 01/01/2023 – 31/12/2023

Rank	Port	Terminal	Export	Import	Transit	Throughput	Total of Terminals
1	Port Said East	SCCT	219,998	73,256	3,247,011	3,540,265	**3,540,265**
2	Damietta	DCHC	352,356	113,529	1,306,127	1,772,012	**1,772,012**
3	Alexandria	ACCHCO	318,625	435,761	5,055	759,441	**1,627,828**
		AICT	363,336	342,369	0	705,705	
		TMT	60,176	62,500	40,006	162,682	
4	Sokhna	DP World	455,239	434,888	2,514	892,641	**892,641**
5	Port Said	PSCCHC	108,402	127,404	200,960	436,766	**436,766**
6	Other		45,266	57,392	2	102,660	**102,660**
			Total				**8,372,172**

Source: Author's own compilation based on primary data collection

The data presented in Table 5 provides a comprehensive overview of container throughput across various Egyptian ports during the year 2023. This analysis highlights the operational performance of (DCHC) and its pivotal role in the national maritime logistics landscape.

In total, Egyptian ports handled 8,372,172 TEUs of container throughput, with DCHC representing approximately 21.17% of the national total. This significant contribution underscores DCHC's strategic position in facilitating maritime trade and its ongoing commitment to enhancing operational efficiency. Notably, DCHC's impressive throughput is complemented by its ability to handle 1,306,127 TEUs in transit, which accounts for 27.20% of the total transit volume across Egyptian terminals. This positions DCHC as a critical player in the transshipment sector, reinforcing its importance in regional logistics.

Comparatively, the Port Said East (SCCT) terminal emerges as the leader in total throughput, handling 42.29% of the national total. It also dominates transit operations, with a staggering 67.62% of the total transit throughput. Despite the competitive landscape, DCHC's performance showcases its resilience and adaptability amidst ongoing infrastructure projects, such as the deepening of berths and the enhancement of terminal facilities. The competitive positioning of (DCHC) With a capacity of 2 million TEU, DCHC holds a strong market position, although it still trails behind SCCT (5 million TEU) and the under construction terminal Damietta Alliance (3.3 million TEU).

Accordingly, in the very near future, the overall capacity of Damietta Port will reach about (5.5 million TEU). In conclusion, the analysis of container throughput in 2023 illustrates DCHC's vital role in Egypt's maritime logistics framework. The terminal's ability to maintain substantial throughput levels amidst challenges not only underscores its operational excellence but also highlights its potential for future growth in a rapidly evolving global trade environment.

5. CONCLUSIONS

The findings from the results and discussion highlight the critical need for digital transformation at Damietta Port to address current operational inefficiencies and to leverage its strategic advantages in global trade. The existing infrastructure reveals significant technological gaps, particularly in the implementation of an advanced (VTMS), which is essential for enhancing operational efficiency, reducing congestion, and accommodating increasing volumes of international trade. The integration of VTMS, along with strategic partnerships, especially with BRICS and initiatives like the Belt and Road Initiative (BRI), can catalyze the port's digital evolution and position it as a competitive player in the global logistics and maritime sectors.

DCHC possesses robust operational capabilities that rival many major ports. However, it must continue to invest in technology (navis N4 and Portchain) and infrastructure to enhance its competitive position in the future. By focusing on strategic improvements and leveraging advanced technologies, DCHC can further solidify its role as a key player in Egypt's maritime trade landscape.

Overall, the implementation of VTMS can significantly enhance the competitiveness of Damietta Container and Cargo Handling Company in the market by improving the efficiency and quality of its logistics services. Efficient management of vessel traffic is crucial for reducing operational delays. Currently, the absence of a unified VTMS at Damietta leads to frequent berthing conflicts and inefficient resource utilization. VTMS introduces real-time vessel tracking and predictive analytics to manage incoming and outgoing traffic, significantly reducing delays. The strategic implementation of VTMS at DCHC is crucial for improving operational efficiency, enhancing safety, and aligning with Egypt's digital transformation goals. This initiative positions the company as a leader in the maritime logistics sector.

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