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Maritime Sector Automation Poised to Enhance Global Trade Competitiveness and Resilience

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Abstract

Information technology has recently emerged as a significant concern in the dissemination of scientific and technical knowledge. This research uses existing data to provide a comprehensive framework for digitalization technologies and its maritime economic effects. We addressed both technical and administrative concerns within a cohesive framework to better understand the nuances of marine digitization initiatives. The findings confirm the theory behind the suggested procedures for implementation. Top-down leadership, change agents and sponsors, open communication channels, buy-in from people being changed, and upkeep activities facilitated by those helping to bring about the change are all examples of good practices. The challenges of adapting to change include a lack of digital capabilities, a lack of leadership characteristics, a costly sector, the prolonged life cycle of vessels, a competitive economy, an industry in the early stages of digitization, and the need to modernize the company while keeping it functioning. This study contributes to our understanding of how organizations adapt to change. This study introduces the four phases of automation as "Management, assets, and functionality," IT and system integration, cutting-edge technology and practical solutions, energy savings and enhanced performance. The existing state of affairs will be taken into account before any automated methods are implemented. After a structure has been created, the future state will be examined. The resources will be used to establish data. At this point, the process will be fully automated. Digitalization's analytical procedures cut down on pollutants and fuel costs.

I. INTRODUCTION

Shipping goods across oceans is an age-old practice. It's cheaper than flying, but it takes twice as long. This method is often employed in the mass production of metal ores, wheat, and coal, as well as the manufacture of fuel, gas, and chemicals for ships. However, between 1980 and 2018, intermodal transportation volumes increased at a compound annual growth rate of 8%. The world's cargo ports are estimated to process 793.26 million TEUs in 2018. As of 2019 (UNCTAD) According to the International Maritime Organization (IMO), marine transport accounts for an ever-increasing proportion of global trade. The increased volume has presented challenges and opportunities for those working in maritime transportation, port management, and rural distribution. They want to get a larger portion of the worldwide market while cutting costs and improving efficiency and advantages. The role of ICT as a critical enabler of these objectives is now well recognized and appreciated. The use of ICT has greatly improved communication between stakeholders and led to more efficient and effective operations. As of the year 2020 (Zerbino). Electronic Data Interchange (EDI) has been created, for instance, to allow for the digital transmission of documents. The plan is to switch to digital files from paper ones. The Port Community System (PCS) was developed by port authorities to manage administrative tasks and port activities. It's a great tool for managing large amounts of data, and it's especially useful for the logistics of shipping containers. Due to the complexity of the maritime transportation industry, this data system promotes and accelerates cross-actor collaboration. It has been shown that

Used, for instance, in the time-consuming customs procedures associated with shipping and receiving containers at a port. By eliminating the need to repeatedly submit the same paperwork, PCS integration with the customs system speeds up the clearance process and reduces costs. The Automatic Identification System (AIS) has been used to keep tabs on ships and prevent head-on accidents. The safety and security of marine traffic is bolstered as a result. Information and communication technologies (ICTs) have been extensively employed in maritime commerce, regulation, logistics, and finance since their inception in the 1960s. They make it easier for

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people to move information around and share it with one another. Nonetheless, most participants in the shipping industry still manually process legal documents like the Bill of Lading (BoL), Border control Declarations, and the Certificate of Origin. Outdated inter-organizational information exchange platforms mean that many parts of the supply chain still rely on manual processes (Loklindt et al., 2018). Containers often stop for almost half their journey due to operational actors not always having all the information they require (Jensen et al., 2014). Limited transparency and overall lack of trust among the parties concerned are the results of a lack of coordination and information sharing. It's a security risk and it adds to the strain. Delays and errors in the flow of information have consequences for business processes. Global trade is hampered by problems in the supply chain caused by factors such as the variety of people involved, the complexity of their relationships, the regulations that apply, and the price of information. There is an urgent need for cost-cutting initiatives in the transportation sector, such as the digitization of document exchanges throughout the industry (Loklindt et al., 2018).

As much as 20% of an organization's operational budget might be wasted due to improperly organized information (Den Norske Veritas, 2017). Goals of reducing costs, strict regulation in the marine industry such as environmentally friendly goals, and the massive amounts of data that maritime firms must manage to improve performance are the primary forces propelling technological advancement (Gausdal et al., 2018). Therefore, there is a great chance for the industry to advance ICTs and usher in a new era of digitalization. The maritime industry is seeing an explosion of new ideas. Industrial 4.0, eMaritime, e-Navigation, Intelligent Port, and Block chain Bill of Lading are all examples of areas where automation has been discussed recently, both in the corporate and academic worlds. New technologies based on IoT, Data Management, Cloud Services, Cyber-Physical Systems (CPS), and Smartphone technology, among others, have contributed to this phenomenon. (Saravanan,2019)

Businesses, government procedures, and supply chain management will all be altered by the introduction of cutting-edge technology. Many players in the maritime industry are betting on the promise of cutting-edge innovation to boost their operations and competitiveness and win the industry over the long haul. Forty percent of the 75 port-related innovation initiatives studied in one research were found to increase transparency in the maritime supply chain via better dissemination of data.

II. MARITIME TRANSPORT SERVICES IN THE WORLD ECONOMY

The second half of the twentieth century saw a significant expansion in international commerce as a consequence of globalization and improvements in transportation infrastructure. More than 75% of worldwide commerce is moved by water, hence the growth of global services has led to the expansion of maritime services. For the sixteenth year in a row, 1999 saw a rise in worldwide seaborne commerce, which resulted in a total volume of over 5200 million tones. It is predicted that by 2005, 5350 MMT of cargo would have been transported through sea. The total dwt of all ships in the world's oceans increased by 1.3% in 1999, reaching 799 million. Large open registration countries and developing economies both boosted their fleets by 0.3%, while the developed world's fleet shrank by 0.3%. Although developed countries account for the vast majority of ship registrations in major open-registry countries, developing economies have progressively increased their share of tonnage, which in 1999 accounted for about a third of the world's total.

In 1997, 45% of underwater trade volume was attributable to refining capacity (the vehicles and public of crude oil goods), 23% was attributable to thirsty bulk traffic (the vehicle of coltan and phosphorous), and 32% was attributable to lining circulation (the transit of reasonably high traffic carried by cargo vessels, wrap vessels, and other vessels). To keep up with the exponential growth in cargo volume in this international marketplace, all nations must continually improve and modernize their maritime transportation infrastructure. This calls for cutting-edge innovations in marine transportation and safe harbor infrastructure, as well as on land. Markets that can't provide their clients with an environment like this will likely lose them. Many poor countries cannot afford the massive capital expenditures needed to keep up with the increasing size and complexity of ships and maritime ports. Therefore, there is a rising movement toward privatization, international cooperation, and interconnected systems. Those who choose to ignore climate change run the danger of falling behind the pack. Financial and deliberate factors have frequently stymied the development of liberalization, despite the fact that government agencies in both developed and developing economies agree that a liberalization seafaring conveyance region would allow stockholders to voluntarily function shipments, port facilities, and ancillary activities, thereby facilitating

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employment. This means that discriminatory and nondiscriminatory laws continue to interact significantly in this field.

Eighty to ninety percent of international commerce occurs by maritime transport, which annually transfers around 10 billion tons of cargo, liquid and solid bulk freight over the earth's crust (Walker et al., 2019). Throughout time, people and goods have needed to traverse oceans and continents via ship. Marine transportation has shown to be an effective and efficient means of transporting almost any commodity, whereas air transport has proven to be preferable for perishable and high-value goods. Ship transportation was further bolstered by the industrial revolution's use of internal combustion, and it was further transformed in the name of efficiency by the widespread adoption of container shipping. Another innovation in maritime transport was the practice of "containerization," which made it unnecessary for ships to be dedicated to a single commodity (as all commodities are housed in a fundamental product) and enabled completely equalized inter-modal connections. The TEU, or 20-foot equivalent unit, is a measurement of the amount of goods that can be transported in a single 20-foot container. 40 foot equivalence units (FEU) are the standard length of containers carried by railroad cars and large cargo ships.

At the beginning of 2018, there were 94,171 industrial vessels in the global fleet, as reported by the United Nations (UN) (UNCTAD, 2018) (see Fig. 1 for a comprehensive overview by ship type and Table 1 for a more detailed breakdown by area). Most of them use diesel fuel, which is bad for the environment. Because each boat has its own rocket engine, they are both energy consumers and producers.

The contribution of international shipping operations to global warming is estimated using these methods (which necessitate the development of new resources and the generation of new waste). Given the increasing social and economic importance of water transportation and the urgent need to reduce greenhouse gas emissions, watercraft are an essential piece of the climate change mitigation puzzle. Sea transport is responsible for around 2.2% of anthropogenic pollutants in 2012, down from 2.8% in 2007 before the global financial collapse, as reported by the International Maritime Organization (IMO).

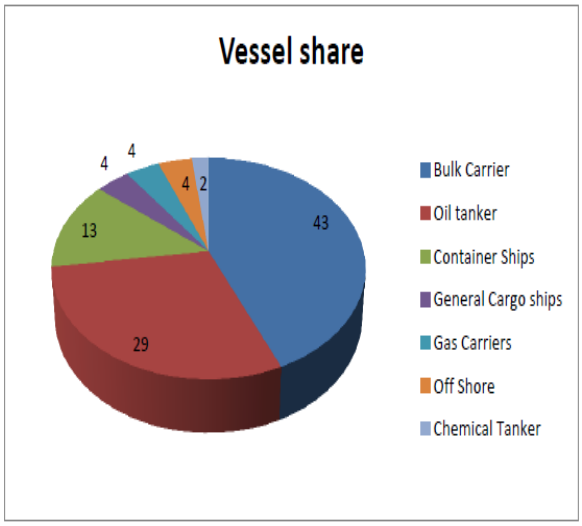

Fig 1. World vessel share (UNCTAD,2018)
Table 1. Total breakdown by region

Country	Indonesia	Panama	Japan	China	US
Number of vessels	8782	8052	5289	4287	3611
Best 3 experts	Coal, palm oil, gasoline gas	petrol, coal, bananas	vehicle quantities, ICs,	Communications paraphernalia, processors, office machine parts	gasoline, coaches, airplanes

Maritime boats may be used for a wide variety of purposes, including transporting people, protecting territory, catching fish or collecting other aquatic resources, and providing navigational or maintenance services to other ships. Not only does commerce add to the environmental impact of maritime transportation, but so do all of these other applications.

III. STEPS OF AUTOMATION

The importance of automation and recent developments in AI, block chain, IoT, and mechanization cannot be overstated in the realm of maritime transportation. They aid in streamlining present processes, creating new commercial opportunities, and altering distribution channels and commercial exchanges worldwide. However, there are risks and significant expenses associated with using these technology for marine operators in developing countries. Therefore, it is necessary to provide a fair playing field.

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The impact of technology on maritime transport may be broken down into five phases:
a Take stock of where you are right now.
c. Look into your potential future state
d. Establish a Plan of Action
It's okay to use data as a tool.
Techniques for Automated Tasks e

a. Take stock of where you are right now.
Carefully inspect the data sets. How does your company go about collecting data? Who will be receiving this data, and what will it be used for? How is data processed throughout its life cycle (from collection to verification to cleaning to delivery to consumption)? How is it stored, protected, and verified? You may begin to plan the data architecture that will serve as the backbone of your digitalization with a thorough analysis of the data on which your decisions are based and how they are made.

b. Look into your potential future state
In a perfect world, how would you use this data? Where do you think such information would be most useful to your organization? How may this affect the future of your business? In the face of increasing supply chain volatility, maybe the numbers might help you show more openness. It's possible that you wish to rapidly grow your business by investing in new technology, staff members, and/or customers. In an increasingly competitive industry, these numbers might be useful in guiding you toward enhanced service and more customer retention. When deciding what information to prioritize, start with the goals of your business.

c. Establish a Plan of Action
It is important to prioritize data integration (as outlined above) before beginning a digital transformation program. Make sure your data is valid, verified, consistent, and ready to allow automation and analytics across different user groups by developing a framework to manage all of your data. Many of the first industries to adopt digitalization failed to take this crucial step, and as a result, their data-driven initiatives failed to provide the expected advantage because they lacked the proper data governance framework.
It's okay to use data as a tool.
When making the switch from manual to digital procedures, many businesses encounter difficulties with data management. This approach wastes time, is inefficient, and puts people in harm's way. With well-organized data, your company may take proactive measures to use information for risk mitigation, service expansion, and energy development via increased efficiency, productivity, and creativity. However, the obligation chief in your organization sees data as an asset. Customers with sway over the company's direction must understand the value of statistics and spread that understanding from the top down.

IV. AUTOMATION METHODOLOGY

The transition to digitalization and automation in the maritime sector is gaining momentum. In order to boost productivity and stay competitive, businesses are adopting digital technologies. Moreover, they are being implemented to hasten the decarburization of the sector and reduce the negative effects of marine commerce on the environment by the middle of this century. For better monitoring, control, performance assessment, and verification, digital data from sensing and certain other accessible data may be used. To guarantee effective, ecologically friendly policies and to increase short- and long-term profitability, maritime players must reevaluate and change their current approach. The following matters must be discussed in the political shows. Fig. 2 outlines the stages of automation implementation.

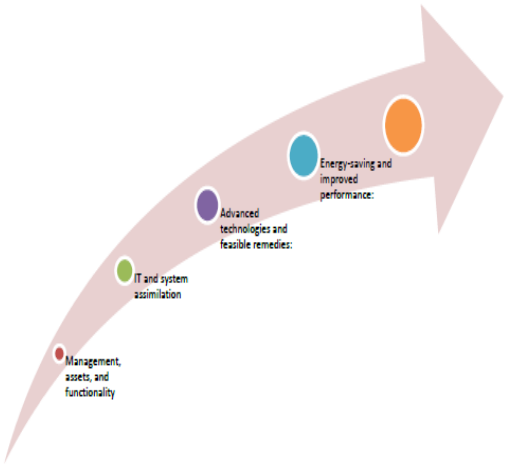

Fig 2. Automation Methodology

a. Management, assets, and functionality
Intangible assets like managerial abilities are examples of management resources. Managers with strong administrative skills may steer their organizations and put their strategic and tactical plans into action by coordinating the efforts of a variety of external stakeholders. The method used to improve administrative performance is shown in Fig. 3.

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Figure 3: Methods for better management, asset, and functionality enhancement.

Integration of Technology and Systems b.

A network of interconnected computer systems that facilitates electronic computing systems, management and vessel control systems, and centralized access to data and/or training. Processes for implementing a quote can be part of an integrated system, as can processes for managing industrial equipment (such as reducing power consumption, keeping track of machinery, and transferring heating oil), cargo (such as tracking cargo, creating inert gas, loading, and emptying), and so on. Integration of IT and related systems is shown in Fig. 4.

Figure 4: Integrating New Technology and Systems

Learning to Use the IBS (Integrated Bridge System)

A reliance network is "a network of interrelated and tightly grouped displays that modules that offer rely principally to navigation, propulsive, management, and measure data." IBS's mission is "to encourage competent personnel to manage ships in a safe and efficient manner." It's a decentralized network that makes it possible for many pieces of navigational gear to function simultaneously and accurately. Several functions, including transit implementation, connection, equipment management, and security, may benefit from the data collected and managed by IBS's inertial sensors.

Together with other technologies, the IBS functions as a type of navigator management platform that supplies all navigational information for a ship in a centralized location. Keep in mind that not all vessels suffer from the same IBS. The specifics of the boat's roof, the ship's unique equipment, and the overall architecture of the bridge's gear would all affect the best approach.

At least two of the following capabilities are available on the IBS platform:

Implementing a New Passage; Media; Machine Control; Transporting Goods

Guaranteeing safety and security

c. Modern tools and doable solutions:

To improve the efficiency of maritime transportation, the following measures must be taken. Detailed procedures are shown in Fig. 5.

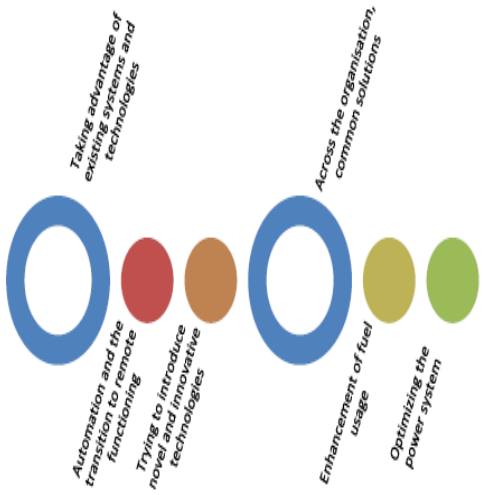

Figure 5: Modern methods and doable solutions

The increasing tendencies are being driven by need. Innovations in shipbuilding, energy, smart transportation, improved materials, robotics, and communications, as well as a more educated and

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skilled workforce, are having a profound effect on how the maritime industry handles emerging challenges and opportunities. According to the Global Marine Technological Report 2030, the future of commercial traffic will be heavily impacted by big tech ecosystems, which will have far-reaching ramifications for ship building and optimization. As fierce competition drives technological capability as well as manufacturing performance to achieve a competitive edge, the first arena for innovation emerges from within the industry itself. The second arena, from other sectors, presents developing technology that can be transferred to ship systems to improve safety and economic as well as monetary effectiveness.

Table 2 details the many available technologies.

Table 2: How the marine sector has evolved to become more efficient

Shipbuilding	Design flexibility, efficient customization, waste reduction, and virtual inventory management will drive future construction technologies. Aside from product breakthroughs in organizational effectiveness, ecological impact is a primary motivator for implementing new shipbuilding technology.
Propulsion and Powering	Ship impulsion and power production will be major areas of technical advancement. It is not just the spectrum of relevant technology, which encompasses forthcoming technologies, substitute fuels, propulsive power strategies, hybrid power production, and pollution reduction technologies.
Smart Shipping	Today's concept of unpiloted equipment, as healthy as data-ambitious assistance such as vessel performance analysis and climate direction-finding, may be measured manifestations of the smart ship – the innovative smart ship will incorporate a variety of associated techniques to increase operational efficiency, ship managerial staff, compliance, judgement, environmental obligations, and also increase safety and servicing of vessel and crew through communications infrastructure.
Big Data and Analytics	Thanks to the help of communication technology, archived data may be stored aboard a ship or ashore. Moreover, AI abilities will serve as human data interpreters. These systems will mix machine learning technologies language understanding to provide a user-friendly interface between humans and machines.
Robotics	By 2030, there will still be 3 original types of robots being used. The first kind will be a teaching robot, the second one is a functional robot (manage an asset), and the third a micro, which will be helpful for inspections in difficult, dangerous conditions. Cognitive, versatile, imitation, sensing, and adaptability will be leveraged by these robotics.
Communications	Ships nowadays create, gather, and transmit the ever quantity of statistics. Wireless telecommunications have been widely adopted for numerous centuries to provide real data transmission. Merely a few instances are marine very high frequency (VHF) facilities, satellites, and WiFi. Using a larger frequency range enables the sending of many messages at a quicker data transfer rate.

d. Energy-saving and improved performance:
at addition to reducing turnaround time at ports, additional methods for increasing ship efficiency include slowing down operational planning, increasing capacity and resource usage, and accurately communicating across shipping firms for optimum route planning. Figure 6 depicts the process of implementing the energy-saving system.

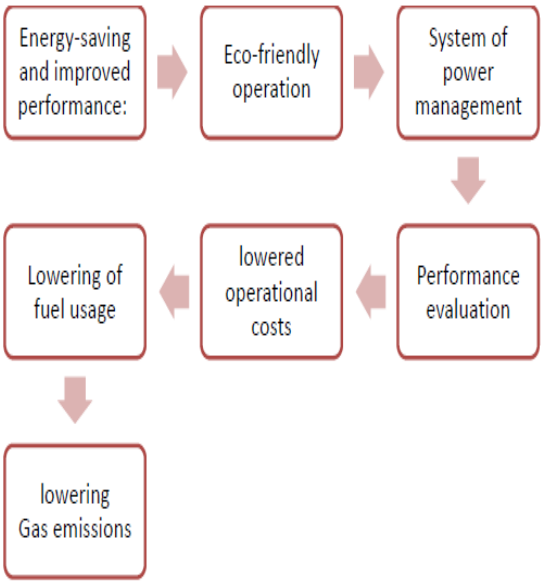

Figure 6: Energy-Saving Plan

Taking these measures can help you save energy and money. As a result, there is less waste in the system and it functions more efficiently.

V. CONCLUSION

This research provided a summary of the role played by Port Activity Applications in international commerce. This section provides an overview of the Maritime Activity Application process and its results. The role of ports in fostering development and the impact of shipping on international trade are then discussed. Next, we'll go through the five steps that make up the Automation Methodology: assess the present, probe the future, build a structure, recognize

data as a useful tool, and automate. After that, they start using the automated system. Management, assets, and functionality; integration of IT and systems; advanced technology and practical solutions; reduced energy consumption; enhanced performance. When these concerns are addressed, a significant improvement in losses is shown. As a result, both fuel expenses and environmental damage may be effectively mitigated. Overall system functionality may be strengthened.

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